Nutrient Management in Chrysanthemum (*Chrysanthemum morifolium* Ramat) cv. Bidhan Madhuri

A
THESIS SUBMITTED TO
THE ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN AGRICULTURE
(FLORICULTURE AND LANDSCAPING)

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COLLEGE OF AGRICULTURE
ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
BHUBANESWAR-751003, ODISHA
2018

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CERTIFICATE-I

This is to certify that the thesis entitled **"Nutrient Management in Chrysanthemum (*Chrysanthemum morifolium* Ramat) cv. Bidhan Madhuri"** submitted in partial fulfilment of the requirements for the award of the degree of **MASTER OF SCIENCE IN AGRICULTURE (FLORICULTURE AND LANDSCAPING)** to the Orissa University of Agriculture and Technology is a faithful record of bonafide and original research work carried out by **SUBRAT KUMAR SENAPATI**, **Adm. No. 07FLS/16** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma.

It is further certified that the assistance and help received by him from various sources during the course of investigation has been duly acknowledged.

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(Dr. Tushar Kanti Das)
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CERTIFICATE – II

This is to certify that the thesis entitled **"Nutrient Management in Chrysanthemum (*Chrysanthemum morifolium* Ramat) cv. Bidhan Madhuri"** submitted by **SUBRAT KUMAR SENAPATI, Adm. No. 07FLS/16** to the Orissa University of Agriculture and Technology, Bhubaneswar in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURE (FLORICULTURE AND LANDSCAPING)** has been approved by the Student's Advisory Committee and the External Examiner.

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ACKNOWLEDGEMENT

Though only my name appears on the cover of this disquisition, a great many people have contributed to its production. I availed this unique privilege to express my prolong and profound sense of reverence and infinitum gratitude to Dr Tushar Kanti Das, Former Professor, Department of Floriculture and Landscaping, College of Agriculture ,O.U.A.T, Bhubaneswar for his inspiring guidance, constructive criticism, keen supervision, continuous cordial encouragement and timely advisement during the entire course of investigation and preparation of manuscript .His sustained interest to impart knowledge, valuable help and above all noble advice, affectionate attitude at each and every step during the entire period of study and experiment cannot be measured by any unit.

With a sense of high resolve and reverence my sincere and deep sense of gratitude to the members of my advisory committee, Dr. Sashikala Beura, HOD, Department of Floriculture and Landscaping, Dr. S.K.Palai ,Associate Professor, Department of Floriculture and Landscaping and Dr. A.Mishra , Associate Professor, Department of Soil science and Agricultural Chemistry ,College of Agriculture ,OUAT, Bhubaneswar. I would like to express my sincere gratitude to Ms.S.Bhuyan, Senior Technical Assistant, AICRP on Floriculture for her constant supervision in leading my path to achieve the destination during the entire move despite her heavy schedule of work.

I am heartily thankful to Dr.(Mrs.) Geeta Pandey, Assistant Professor,Department of Floriculture and Landscaping, Dr Kaberi Maharana, Assistant Professor,Department of Floriculture and Landscaping whose encouragement, guidance and constant support from the initial to the final level enabled me to walk through the tough periods with ease.

I express my sincere thanks to Mr. Ramesh , Mr. Kanhu and other technical and non-technical staff members of BTCC for their selfless help and cooperation during the field work.

Without the esteemed blessings of my beloved parents nothing can be possible. It is an honour for me to avail this rare opportunity to evince my deep sense of gratitude

to my parents for their dedicated efforts, moral support and supreme sacrifice which act as strong pillar on my path towards achieving the goal. I have indeed no words to express my respect to my elder brother for his consistent inspiration, unconditional love and support during the period of investigation.

I cannot forget friends who went through hard times together, cheered me on and celebrated each accomplishment: Rudra ,Pradyot, Suchi, Nicky, Banani, Debasish, Sitakant, Henny, Pavni ,Abhipsa di,Deepali di and Lucy di. This thesis would not have been possible without their unforgettable support.

Lastly, I bowed down my head before the omnipresent all-might-spiritual Divine Juga Purushottam “Sri Sri Thakur Anukulachandra” and Goddess “Maa Jhadeswari” whose esteemed blessings showed me a spark of spiritual light in darkness.

Bhubaneswar — Subrat Kumar Senapati

Date- — 07 FLS/16

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

%	Per cent
/	Per
@	At the rate
C.D.	Critical difference
CV	Cultivar
cm	Centimetre
m^2	Meter square
DAP	Days after planting
DAT	Days after transplanting
e.g.	(exempli gratia) For example
et al.	(et alia) And others
etc.	(et cetera) And other similar things
E-W	East-West
g	Gram
ha	Hectare
i.e.	(id est.) That is
K	Kalium(Potassium)
m	Metre
mm	Millimetre
N	Nitrogen
No.	Number
N-S	North-south
O.U.A.T.	Orissa University of Agriculture and Technology
P	Phosphorus
ppm	parts per million
RH	Relative Humidity
S.E(m.)	Standard Error of Mean
Viz.	videlicet (Namely)

ABSTRACT

The present investigation entitled Nutrient management in chrysanthemum (Chrysanthemum morifolium Ramat) cv. Bidhan Madhuri was carried out at BTCC, OUAT, Bhubaneswar during winter 2017-18.

The experiment consists of eleven treatments having different combinations of N, P and K fertilizers(Kg/ha) which was fitted to RBD replicated thrice Among all the treatments ,Treatment T_{10} having a fertilizer combinations of $N_{120}P_{125}K_{140}$ Kg/ha i.e. the optimum dose of fertilizer higher than that of the RDF found to be effective in producing luxuriant vegetative growth such as plant height (66.253cm),East-West spread (34.333cm),North-South spread(32.526cm) as well as other floral attributes i.e. minimum days taken for flower bud appearance(48.267 days),minimum days taken for flower bud opening (61.4days),maximum flower diameter(5.847cm), dry(1.173g)and fresh (3.256g)weights of flower , number of flowers(67.733), flowering duration (74.333days)and vase life period.(20.000days).

So ,it can be recommended that for obtaining optimum growth, desired flowering and yield attributes Treatment T_{10} having fertilizer combinations of $N_{120}P_{125}K_{140}$ Kg /ha is suggested for Chrysanthemum crop in Bhubaneswar condition.

INTRODUCTION

Chrysanthemum (*Chrysanthemum morifolium* Ramat**)** is one of the most important flowering plant, commercially grown in different parts of the world. It is a native of northern hemisphere mainly Europe and Asia. It belongs to family Asteraceae and is commonly called as the "Queen of the East". Flowers symbolize purity, peace, love, beauty and passion. It was first cultivated in China and then spread to Japan. Hence, Chrysanthemum became the floral emblem of the imperial family of Japan and subsequently regarded as the National flower of Japan. Chrysanthemum flowers have diverse and beautiful range of colour shades and shapes making it suitable for every purpose conceivable for a flower crop. Apart from being used as cut and loose flowers, the plant grows erect and tall making it suitable for border plants as well.

Chrysanthemums are divided into two basic groups, garden hardy mums and exhibition type. Garden hardy mums are new perennials capable of wintering in most northern latitudes. Exhibition varieties are not usually as sturdy. Garden hardies are defined by their ability to produce an abundance of small blooms with little if any mechanical assistance, such as staking, and withstanding wind and rain. Exhibition varieties, though, require staking; overwintering in a relatively dry, cool environment, and sometimes the addition of night lights. The exhibition varieties can be used to create many amazing plant forms, such as large disbudded blooms, spray forms, and many artistically trained forms, such as thousand-bloom standard (trees), fans, hanging baskets, topiary, bonsai and cascades.

Chrysanthemum blooms are divided into 10 different bloom forms by the US National Chrysanthemum Society, which is in keeping with the international classification system. Irregular incurves are bred to produce a giant head called an *ogiku*. The disk florets are concealed in layers of curving ray florets that hang down to create a 'skirt'. Regular incurve are similar, but usually with smaller blooms and in a dense, globular form and disc is not visible in this type as all ray florets tend to grow and bend inwards and covered the disc florets. In Intermediate incurve blooms ray florets are narrow,broad and usually shorter and disc is visible . In the reflex type, the disk florets are concealed and the ray florets reflex outwards to create a mop like appearance. The decorative form is similar to reflex blooms, but the ray

florets usually do not radiate at more than a 90° angle to the stem. The pompon type is fully double ball shaped Chrysanthemum and very globular in form. Single and semi double blooms have exposed disk florets and one to seven rows of ray florets.In the anemone type , the disk florets are prominent, often raised and the ray florets are flat and twisted. The spoon-form disk florets are visible and the long, tubular ray florets are spatulate and central disc is not visible.In the spider form, the disk florets are concealed, and the ray florets are tube-like with hooked or barbed ends, hanging loosely around the stem. In the brush and thistle variety, the disk florets may be visible.

In India, chrysanthemum occupies a place of pride, both as commercial flower crop and as a popular exhibition flower. It is very popular as loose flower, cut flower as well as pot plant (Kher, 1988). Chrysanthemum is mostly used in our country for making garlands, *veni*, bracelets and in flower decoration and religious offerings. Due to wide range of colours, shapes and size of flowers it has earned tremendous popularity. Moreover, the utility and popularity of chrysanthemum has increased greatly with the technique of year-round blooming habit due to its ability to produce flowers round the year using cultivars based on their sensitivity to photoperiods. Apart from these, Chrysanthemum can be used in different purposes in different regions. Yellow or white chrysanthemum flowers of the species *C. morifolium* are boiled to make a tea in some parts of Asia. The resulting beverage is known simply as chrysanthemum tea or Pinyin. In Korea, a rice wine flavoured with chrysanthemum flowers is called *gukhwaju* . Chrysanthemum leaves are steamed or boiled and used as greens, especially in Chinese cuisine. The flowers may be added to dishes such as mixian in broth, or thick snake meat soup to enhance the aroma. Small chrysanthemums are used in Japan as sashimi garnish.

Chrysanthemum is among the more popular flowers grown in our country for its diversified beauty of colours, shapes, shades and keeping quality. It is highly suitable for beds, pots and for floral arrangement. Its bloom last over a short period of 1 to 2 months. Hence, they command remunerative price in the market. On account of its good, keeping quality flowers can be transported to a distant market easily.

Now a days large number of varieties are available such as Yellow gold,Red gold, Chandrika ,Nilima, Baggi, Birbal Sahni ,Shanti ,Sadbhavana ,Bindiya, Appu ,Pusa Centenary and natural blooming period of November to December has been extended from September to December by just selecting suitable varieties and planting on different dates. Himanshu ,Jawala, Jyoti ,Phuhar, Maghi, Jaya and Sharda like off season blooming cultivars of Chrysanthemum are available. Many factors influence successful production of chrysanthemum just like soil fertility, irrigation, plant density, plant protection measures, etc. but manurial schedule plays a major role in crop production. The crops grown in such soil without fertilization usually suffer from nutrient deficiency and the application of fertilizers becomes an essential tool to boost up the yield. Improper nutrition leading towards nutrient imbalance in plant is a major factor contributing to low yield of flower. Under normal Agro-climatic conditions, the deficiency of major nutrients viz., N, P and K is common and causes serious problems in flower production.

Lunt and Kofranek (1958) claimed that maintaining higher levels of nitrogen in the growing media during the first seven weeks was very important. They also suggested that moderate deficiency developed during that period, subsequent N fertilization would not recapture the flower quality lost and also would not compensate for the growth retardation of the plants. Root activity of a plant depends upon the P fertilization rate and it led to increased root respiration. Reduced root respiration indicated changes in the source-sink relationship during the transition from vegetative to reproductive growth, making the roots less competitive than the developed flowers (Hansen and Lynch., 1998).

Potassium improves the general vigour of the plant and is essential for the nitrate changes which occur in the plant .It is absorbed in the form of ions- K^+ and essentially it plays a major role in plant physiological processes. Therefore, it is required in higher amounts for proper growth and reproduction in plants. Out of all mineral nutrients, Potassium plays a particularly critical role in plant growth and metabolism and it contributes greatly to the survival of plants that are under various biotic and abiotic stresses. It acts as a catalyst in the manufacture and translocation of carbohydrates and also increases resistance to certain diseases. Really, role of Potassium is highly important from bud initiation to seed formation. The deficiency is

characterized by scorching of leaf blade. In severe cases white spots on foliage appear below the flower resulting in disfigured or malformed flowers, loss of petal colour and yellowing of the calyx are observed.

So, Horticultural production in general and floriculture in particular has increased with the proper nutrient management .But very little work has been done in nutrient management in chrysanthemum. So, keeping in view the importance of chrysanthemum in present scenario, an experiment entitled "Nutrient management in chrysanthemum(*Chrysanthemum morifolium* Ramat) cv. Bidhan Madhuri" was undertaken in Bhubaneswar condition with the following objective.

-To standardize the optimum combination of fertilizers for maximum flower production

REVIEW OF LITERATURE

Although commercial cultivation of Chrysanthemum is getting popular now a days but it is comparatively of recent origin. So no more research has not been done on nutritional requirement of chrysanthemum in India or abroad. However, the work done on this crop as well as seasonal flowering crops belongs to Asteraceae like marigold, gaillardia, aster, gerbera etc. has been reviewed with the objectives of standardizing the agro techniques for cultivation of chrysanthemum.. The brief summary of the research works done by various scientists on manurial composition for maximizing flower production in chrysanthemum and other flower crops are presented as under:

2. 1 EFFECT OF NITROGEN

Nitrogen is the most commonly used mineral nutrient. As most of the Indian soils are low to medium in Nitrogen, it is regarded as most important element limiting the production of flowers. It is an important building block of protein, nucleic acids and other cellular constituents. This element encourages above ground vegetative growth and gives a deep green colour to the leaves It plays a pivotal role in many critical functions(such as photosynthesis)in the plant and is a major component of amino acid, the critical element constituent components of proteins. Nitrogen deficiency is found when the older leaves of plants turn yellow or pale green and tend to drop off. It causes chlorosis of leaves due to decreased levels of chlorophyll. Nitrogen deficient plants tend to be stunted, grow slowly. When too much nitrogen is applied, excess vegetative growth occurs and the plants lodge, flower maturity is delayed, besides reduction in yield. Its effect on growth, yield attributes, and quality of flowers are discussed as below.

2.1.1 EFFECT OF NITROGEN ON GROWTH

a) Chrysanthemum

The importance of maintaining higher nitrogen levels in the growing media during the first week of chrysanthemum growth was highly emphasized by Lunt and Kofranek (1958). They also stated that if moderate deficiency developed during that period, subsequent nitrogen fertilization would not recapture the flower quality loss and also would not compensate for the growth retardation of chrysanthemum plants.

At low levels of root N, there was a growth response to foliar application of urea, but it decreased with increased root nitrogen in chrysanthemum (Meyer and Boodely, 1964).

Chi (1974) reported that Ammonical nitrogen during summer promoted better vegetative growth and quality flowers as compared to winter months by studying the differential effect of nitrogen nutrition on chrysanthemum

Elliot and Nelson (1983) suggested that NH_4 added to NO_3 might stimulate growth by increasing transport of reduced nitrogen from roots to the shoots, thus increasing the supply of reduced nitrogen available to support growth of shoot meristem. Optimum fertilizer rates of 80 kg N/ ha ,shortened the time required for plant growth and produced high quality flowers of chrysanthemum as reported by Samoilenko (1985).

Strojny (1985) suggested that with the application of nitrogen at 5 g per meter square monthly good plant growth and flower production were obtained in chrysanthemum. Likewise, maximum plant height was recorded with the application of 250 kg N+150 kg P_2O_5 / ha in chrysanthemum (Rachyanavar, 1985).

Chezhiyan et al.(1986) reported highest increase in plant height under N:P:K at 20:20:20 g /m^2 during two years in chrysanthemum. But the lowest plant height was obtained at 0 level of nitrogen during both the years.

Jayanthi and Gowda (1988) suggested that 30 g N and 40 g P2O5 /m^2 increased plant height.

Singhlodhi and Tiwari (1993) observed there was an significant increase in plant height with the application of 45g nitrogen per meter square in chrysanthemum plant as compared to rest of the nitrogen levels (0,15 and 30g/m^2) but it was found that significant increase in plant spread found in 30 g N/m^2. Belgaonkar et al. (1996) observed that with the application of 200 kg N / ha in chrysanthemum the maximum plant height was obtained.

Baboo and Sharma (1997) reported augmentation in plant height and number of primary branches of *Chrysanthemum coronarium* cv. Nivea with increasing nitrogen application rates from 0 to 300 kg/ ha. Similarly, *in Chrysanthemum*

morifloium, plant height and leaves per plant were significantly increased with 15-20 g N per meter square as reported by De and Barman in 1997.

A basal dose of 5kg FYM ,40kg N,20kg P_2O_5 and K_2O /m^2 each was recommended by Tripathi (1997) for enhancing the various growth and harvesting parameters in chrysanthemum. Patel (1998)also observed that maximum plant height was obtained with an application of 200Kg N / ha in Chrysanthemum .Dahiya et al.(1998)recorded maximum plant height and number of branches per plant with application of N at 240 ppm. Barman and Pal (1999) suggested that a considerable and significant improvement in vegetative and flowering attributes of chrysanthemum cv. Chandrama with application of 30 g N /m^2.

Sawwan et al. (1999) reported that *Chrysanthemum morifolium* Ram. fertilized with 50 ppm N as Ca $(NO_3)_2$ gave maximum plant height and stem diameter.

Growth characters such as plant height, number of branches per plant and stem girth of chrysanthemum cv. IIHR-6 were significantly influenced by higher dose of nitrogen (150 kg /ha) under north Gujarat conditions as reported by Joshi in 2002.

Karavadia and Dhaduk (2002) reported that with the application of higher dose of N (150 kg/ ha) there was significant growth of plant height (97.89 cm), number of branches (34.00) per plant, plant spread (0.1680 meter square), and main stem diameter (1.32 cm) when conducting an experiment on annual chrysanthemum cv. Local White at Navsari. Patel (2004) carried out an experiment at College of Agriculture, Junagadh during 2002-03 on chrysanthemum cv. IIHR-6 and revealed that growth characters such as plant height, number of branches per plant and leaf area were significantly improved by highest dose of nitrogen (200 kg/ ha) from urea sources as compared to lower nitrogen doses.

Sharma et al.(2006) reported that in Chrysanthemum cultivar Snowball with application of N,P and K at 30g /m^2 each was found to be best with regard to vegetative growth(plant height, stem length, number of leaves per stem, leaf area and plant spread)parameters.

Different concentrations of Nitrogen and Potassium at vegetative stage were evaluated by S.K. Azeezahmed, R.K. Dubey,S.S. Kukal and V.P.Sethi in 2014 to optimizing their levels for high quality performance of *Chrysanthemum morifolium* Ramat. cv.

Mother Teresa grown in soilless media mixture. The performance of chrysanthemum improved with increasing levels of N-K concentration. The nutrient concentration of N_{250} +K_{200} during vegetative plant height (31.5cm), plant canopy (35cm) per plant proved to be the best treatment.

The application of all nitrogen levels(@0,100,200,300,400 and 500 mg Urea per pot) had significant effect on the vegetative and floral parameters like plant height, number of primary branches, leaves, root suckers as reported by H.S. Grewal and Tanya Thakur in 2016.

b) Marigold:-Ravindra et al.(1986)observed that plant height was maximum i.e. 101.72 cm and maximum number of primary branches i.e. 14.91 were obtained in marigold while it receiving highest dose of Nitrogen.(90Kg / ha).

Halepyati et al.(2001)reported that nitrogen levels had significant influence on growth, dry matter production, flower yield and floral parameters in marigold.

Jamod (2001) recorded maximum plant height (69.07 cm) at full bloom stage, plant spread (42.22 cm), and number of branches (7.07) at the highest level of nitrogen (200 kg/ ha) while conducting a field experiment on medium black soils at Department of Horticulture, College of Agriculture, Junagarh during the rabi season of 1999-2000 with different levels of spacing and nitrogen (50 to 200 kg/ha) in marigold cv. Local Orange.

Another field trial was conducted by Joshi and Barad (2002) to study the influence of N and P_2O_5 and pinching on African marigold cv. Crackerjack during the winter season of 1999-2000 in medium black clayey soil at College of Agriculture, JAU, Junagadh and they reported that application of N at 200 kg/ ha significantly increased the plant height (85.79 cm), plant spread (69.53 cm) and number of branches per plant (16.86).However, the plant height remained at par with 150 kg N /ha.

Rathi et al. (2003) reported that nitrogen at 30 g /m^2 gave maximum plant height (73.08 cm) and branches per plant (71.30) but there was no significant difference between 30 g and 20 g N/ m^2 by conducting a field trial with four different levels of N and methods of irrigation on yield and quality of African marigold .

Sharma et al.(2006) reported that in African marigold ,the optimum levels of nitrogen, phosphorus and pinching were assessed to be 200kg N /ha ,100 kg P_2O_5 /ha and pinching at 40 days after transplanting for maximum growth and flower production. Singh et al.(2009) revealed that an application of Nitrogen i.e. 100 Kg urea /ha increased plant height(67.76cm),plant spread(49.88cm) but maximum number of primary branches per plant i.e. 18.15 was observed at higher level of Nitrogen i.e. 150 Kg urea /hectare in African Marigold.

c) China aster

The effect of five levels of N (100,150,200,250 and 300 kg/ ha) and four levels of P (0,100,150 and 200 kg /ha) were studied in China aster cv. Kamin by Singh and Sangama, (2000) and they observed that maximum plant height (51.91 cm) and plant spread (21.27 cm) were obtained with highest levels of N, though N at 200, 250 and 300 kg/ ha were at par with each other. Kumar et al.(2002) conducted a trial with N (0,100,150,200,250 and 300 kg/ ha) and P (0,100,150 and 200kg/ ha) requirement of China aster at Meerut and reported that 300 kg /ha gave positive effect on plant height (34.80 cm) and number of branches (4.43) as compared to lower levels of Nitrogen.

d) Gaillardia

Maximum plant height, and number of primary and secondary branches per plant with application of nitrogen at 200 kg ha-1in gaillardia, but, it was at par with 160 and 120 kg N/ ha as obtained by Tosar (1989) .Similar results were also obtained by Singatkar et al.(1995) at Department of Horticulture, Agriculture college, Pune in gaillardia cv. Yellow Double with application of nitrogen at 200 kg/ ha. Mishra (1998) reported that maximum plant height and number of branches per plant were obtained at 30g N followed by 20 g N /m^2 in gaillardia.

e) Other flower crops

Bose and Das (1966) while working in Calcutta reported that among the nutrient elements nitrogen deficiency showed maximum adverse effects greatly affecting growth of aster, and zinnia. The effect however, was most marked in salvia, as there was great reduction in number of branches under the lowest N treatment.

2.1.2 EFFECT OF NITROGEN ON FLOWERING AND OTHER FLOWERING ATTRIBUTES

a) Chrysanthemum

Carter and Dermott (1966) obtained earlier flowering in chrysanthemum grown in unheated glass house with the application of N 224 kg to 896 kg/ ha and Similarly application of nitrogen at 224 and 560 kg/ ha enhanced earliness of flowering and size of flower in August flowering varieties of chrysanthemum (Jubb and Johnson, 1966).

Rahane (1975) reported that the number of days required for emergence of flower bud was significantly reduced in 75 kg N/ha and 100 kg N /ha over no nitrogen in chrysanthemum.

Gilley (1977) observed that deficiency of N in chrysanthemum induced small flowers and short pedicel. Early flowering, high weight of 100 flowers and yield of flower were also recorded by Vijay kumar and Shanmugavelu (1978) with increased level of nitrogen. On the other hand, Kumar et al.(1982) reported that maximum flower yield was obtained with 20:120:20 kg NPK / ha.

The flower size was higher with the fertilizer application of 250 kg N/ha + 150 kg P_2O_5 /ha as reported by Rachayanavar (1985) in chrysanthemum. Strojny (1985) reported that good flower production was obtained with N at 5 g/ m2 applied monthly with K_2O at 24 g /m2 as a single dose in chrysanthemum. Samoilenko (1985) suggested best quality flowers in chrysanthemum was obtained with the application of optimum fertilizer rate 80 kg/ ha .

Jayanthi and Gowda (1988) stated that the .chrysanthemum cv. Local White was fertilized with N and P, each at 0-40 g /m^2 while K was applied at 20 g /m^2 as basal dose and the highest flower yield (8.23 t/ha) was obtained with N at 30 g per meter square and P at 40 g/m^2.. Yang et al. (1989) observed that there was an increase in flower yield of chrysanthemum with nitrogen treatment up to 100 kg N/ ha.

Khader et al.(1990)reported that an application of FYM @ 50 t/ha and 200:200:200 NPK/ha had resulted into maximum flower yield in Chrysanthemum cv. Co-1,Co-2 andMDU-1. Singh et al. (1990) observed that in Chrysanthemum

morifolium cv. Flirt, the days to complete bud formation and days to complete flowering were delayed by increasing N rates from 0 to 60 g/$m^{2.}$ In contrast to this, the P2O5 improved the earliness with increasing level from 0 to 45 g P_2O_5 /m^2.

Lodhi et al. (1991)reported that vase life of chrysanthemum cut flowers was decreased with increasing N application rate from control. The flowers of the plant which received 15 g K_2O /m^2 obtained longest vase life, whereas the shortest vase life was obtained with 60 g N per meter square and 15 g P_2O_5 per meter square. Rao et al. (1992)noticed that maximum number of flowers per plant and maximum flower yield obtained at 200 kg N /ha in chrysanthemum. Belorkar et al. (1992) revealed that the greatest flower diameter i.e. 6.52 cm and flower yield i.e. 83.92 q/ha were obtained with 90 Kg N /ha in marigold. Hwang et al. (1992) stated that in *Chrysanthemum morifolium* Ram., the maximum cut flower weight was obtained with N, P and K at 20.9, 17.6 and 14.3 kg/acre, respectively.

Lodhi and Tiwari (1993) claimed that the chrysanthemum cv. Flirt gave maximum number of flowers per plant (49.83), highest flower yield per plant (134.85 g) and dry weight of flowers per plant (18.21 g) at 30 g N /m^2 and 45 g P_2O_5 /m^2 treatment. Belgaonkar et al.(1996) obtained maximum flower yield with 200 kg N /ha in chrysanthemum.

De and Burman (1997) suggested that in chrysanthemum cv. Yellow Anemone, Yellow Pompon, Maharaja and Bajoria Red, the early flowering, number of flowers per plant and flower yield were improved significantly under 15-20 g N/ m^2. Vaghasia (1997) observed that maximum flower yield in chrysanthemum obtained with the application of 200 kg N/ ha over rest of the levels viz., 50, 100, 150 kg/ ha . Damke et al. (1997) reported that increase in levels of nitrogen decreased the vase life and the control gave maximum vase life of chrysanthemum cv. Yellow Bijali. Patel (1998) reported that an application of 200Kg N/ha and 100Kg P /ha through chemical fertilizers were found to be optimum for maximum flower flower production in Chrysanthemum cv. IIHR-6.

Barman and Pal (1999) reported appreciable improvement in the vegetative and flowering attributes of chrysanthemum cv. Chandrama with application of 30 g N/m^2.. However, vase life of cut flower decreased with increasing levels of nitrogen from 50 to 150 kg/ha.

Pilanali and Keplan in 1999 reported that the highest stem dry mass was produced in chrysanthemum with 160 mg N/liter. *Chrysanthemum morifolium* Ram. well responded for number of flowers per plant, flower size, and 100 flower weight with 10 g N and 10 g P /m^2(Jhon and Paul (1999)treatment.

Sawwan et al.(1999) reported that *Chrysanthemum morifolium* Ram. well responded to N at 50 ppm as $Ca(NO_3)_2$,which gave the greatest fresh weight and dry weight, but inflorescence diameter and the peduncle length were not significantly affected by N form and concentration. Full bloom was significantly delayed as N rate was increased.

Joshi (2002) reported that, flowering and quality characters such as size of flowers, fresh weight of flowers, and appearance of first flower bud were significantly affected at 150 kg N/ ha in chrysanthemum cv. IIHR-6 under North Gujarat conditions.

Karavadia and Dhaduk (2002) observed maximum fresh weight (585.56 g), dry weight (143.89 g), flower yield per plant (316.67 g)and flower yield per hectare (357.86 q), in annual chrysanthemum cv. Local White under Navsari condition of Gujarat at 150 kg N/ ha.

Sharma et al. (2006) reported that in Chrysanthemum cultivar Snowball that application of N,P and K at 30g/m^2 each was found to be best with regard to flowering parameters such as-number of days to flowering, size of flowers and vase life. S.L.Chawala and S.Mohammed in 2007 found that application of nitrogen and phosphorus @300 and 150 kg /ha respectively in chrysanthemum cv.Nilima bring the higher flower yield per hectare.

Parekh et al. (2010) reported that significantly maximum flower yield that is 12.9 and 11.0 t/ha was recorded with 200 kg N/ha during first and second year respectively in chrysanthemum.

Patel and Chaudhari(2011)observed that Flirt variety of chrysanthemum performed better with 200 kg N/ha by recording maximum number of flowers per plant,flower yield per hacter, fresh weight of flower and stalk length .While size of flower was maximum in IIHR-6 with 200kg N/ha and maximum vase life with 100kg N/ha.

Dorajeerao et al. (2012) reported in chrysanthemum that number of flowers per plant was found highest at 150 kg N /ha, 100kg P/ha and 100kg K /ha during both kharif and rabi season. With every increase in nitrogen level at a constant of phosphorus there was increase in plant height.

V. P. Satar and D. M. Panchbhai in 2012 reported that an application of 200 kg N and 150 kg P2O5 per hectare significantly produce maximum flower yield,weight of flower,flower yield per plant and flower yield per hectare.

Different concentrations of Nitrogen (N) and Potassium (K) at flowering stages were evaluated by S .K .Azeezahmed ,R .K .Dubey ,S.S. Kukal and V.P.Sethi in 2014 to optimizing their levels for high quality performance of *Chrysanthemum morifolium* Ramat. cv. 'Mother Teresa' grown in soilless media mixture. The performance of chrysanthemum improved with increasing levels of N-K concentration. The nutrient concentration of N_{200} + K_{260} during reproductive stage produced highest (153) number of flowers, and flower sprays (21) per plant proved to be the best treatment.

The application of all nitrogen levels (@0,100,200,300,400 and 500 mg Urea per pot) had significant effect on the vegetative and floral parameters like plant height,number of primary branches,leaves,root suckers,flower per plant,size of flower and delays date taken to full bloom,however doses beyond 300 mg urea per pot with respect to duration of flowering as reported by H.S. Grewal and Tanya Thakur in 2016.

b**) Marigold**: Belorkar et al. (1992) revealed that the greatest flower diameter i.e. 6.52 cm and flower yield i.e. 83.92 q/ha were obtained with 90 Kg N /ha in marigold .Hameed and Sekar (1999)reported that maximum flower diameter i.e. 6.35 cm,single flower weight i.e. 6.26g and flower yield per plant (211.30g) in African marigold cv. Dindigul with the application of 150 Kg N/ha + 120 Kg P_2O_5/ha and the same treatment produced 50 percentage earliest flowering i.e. 42.66 days in marigold.

Mohanty et al.(2002), in African marigold cv. African yellow recommended 20 g N /m^2 for maximum yield of flowers at Bhubaneswar condition.

Desai et al.(2002) conducted a field trial to optimize time pinching (20,30 and 40 days after transplanting) and nitrogen (20, 30 and 40 g per meter

square)requirement in marigold cv. Pusa Narangi during 1998-99 and revealed that nitrogen @ 30 g /m^2 significantly increased the number of flowers per plant, flower size, flower yield and earliness in flowering when pinching was done at 30 DAT. Jadhav et al.(2002) revealed that earliest buttoning (40.40 days)and flower opening (8.75 days) in control (without nitrogen), while late buttoning (43.66 days) and late flower opening (10.56 days) was noted at higher level of N (100 kg ha-1). The days from flower opening to harvest (10.33 days) and duration of flowering (46.64 days) were maximum in higher level of N and minimum in the control (8.30 and 40.86 days, respectively).

Rathi et al. (2003) carried out a field trial with four different levels of N and methods of irrigation on yield and quality of African marigold and observed that nitrogen at 20 g/ m^2 increased weight of flower (7.60 g), flower duration and vase life Whereas, nitrogen at 30 g /m^2 produced only early flower initiation.

Sehrawat et al.(2003) reported that the flowering was significantly delayed by application of nitrogen in African marigold cv. African Giant Double Orange and maximum number of flowers per plant i.e. 31.86 was obtained with application of fertilizer combination of N300P200K200 Kg per hectare in marigold as compared to control.(200 Kg P_2O_5 and K_2O/ha).

M.Raja Naik(2015) while studying the interaction effect of nitrogen and phosphorus the combination of highest level of nitrogen (200kg N/ha) without phosphorus recorded early flowering.(50days)Number of flower heads per plant (75.13g) and yield (11.65 t/ha)were higher in treatment combination of 200 Kg N/ha and 200 Kg P/ha.

A field experiment was carried by G. R. Kishore in 2016 at Muzaffarnagar,U.P.on African marigold and reported that most of the flowering characters were found increased at higher level of N,P and K. He suggested that 150 Kg /ha Nitrogen ,100 Kg /ha P_2O_5 and 30 kg /ha K_2O were found suitable dose for commercial cultivation of African marigold.

c) Gaillardia

Highest yield and number of flowers per plant obtained in gaillardia with the application of 200 kg N/ ha but there was no significant difference among 200,160

and 120 kg N/ha(Tosar (1989)) Similarly, an application of nitrogen at 200 kg/ ha gave maximum number of flowers per plant, yield per hectare as well as weight of flowers per plant in gaillardia cv. Yellow Double (Singatkar et al., 1995).Karetha et al.(2008)concluded that an application of 200 Kg N,75 Kg P_2O_5 and 75 Kg K_2O /ha increased flower yield in variety Local Double of gaillardia.

d) China Aster

Singh and Sangama (2000) reported that at 300 kg N/ ha, maximum length of flower stalk (27.27 cm) and number of flowers per plant (35.22) were observed in China aster cv. Kamini on sandy loam soil which was at par with 200 and 250 kg N/ ha and other characters such as number of days taken for 100 per cent flowering, diameter of flower and weight of 5 flowers and post-harvest quality of cut flowers were not significantly influenced by graded level of nitrogen. Kumar et. al. (2002) conducted a trial with N (0,100,150,200,250 and 300 kg/ ha) and P (0,100,150 and 200 kg/ ha) requirement of China aster and revealed that 300 kg/ha gave positive response towards flower diameter (5.13 cm) and duration of flowering (37.45 days). However, minimum number of days (52.36 days) to first flower bud appearance was recorded where no nitrogen was applied. Chavan et. al.(2010) reported that an application of 200 Kg N /ha recorded maximum number of days to open first flower (68.48 days)and maximum number of flowers per plant.(24.02)

2.2 EFFECT OF PHOSPHORUS

This is one of the major elements limiting the growth, quality and yield of flowers and plays an important role in photosynthesis, respiration, energy storage and transfer, cell division, cell enlargement and several other processes in plants. When P is limiting, the most striking effects are a reduction in leaf expansion and leaf surface area, as well as number of leaves and shoot growth is highly affected than the root growth. A reduction in size of new leaves is one of the first symptoms of P deficiency although leaf colour remained green. As the deficiency progressed, growth of main stem slowed down and finally stopped.

The need of P during the period of initiation and development of chrysanthemum flower evaluated by Joiner (1967). An increase in P levels from lower to medium resulted in increased stem length and flower diameter. He also observed increased potassium absorption with more levels of phosphorus.

2.2.1 EFFECT OF PHOSPHORUS ON GROWTH

a) Chrysanthemum

Kumar et al. (1982) reported that plant height and plant spread were maximum at fertilizer combination of 20: 120: 20 kg NPK/ ha. Chezhiyan et al. (1986) observed highest plant height and maximum number of branches per plant during both seasons under $N_{20}P_{20}K_{20}$ g per meter square in chrysanthemum. Jayanthi and Gowda (1988) reported that in chrysanthemum, 30 g N and 40 g P /m^2 increased plant height significantly.

Lodhi and Tiwari (1993) reported that, height of plant (47.43 cm) and spread of plant (24.98 cm) were significantly increased with the application of 45 g N along with 45 g P /m^2 over control, while maximum branches were recorded with 30 g N along with 15 g P /m^2 while conducting a trial at Faizabad

Joshi (2002) showed that at higher level of phosphorus (100 kg/ ha) application there is significant growth in height, number of branches per plant and stem girth in chrysanthemum cv. IIHR-6 .

Dorajeerao et al. (2012) observed that with the application of 150 kg nitrogen+100kg phosphorus/ha, number of branches, number of leaves, leaf area per plant were maximum in chrysanthemum.

b) Marigold

Arulmozhiyan and Pappaiah (1989) observed significantly more plant height (59.8 and 106.3 cm) and number of laterals (10.34 and 20.78) at vegetative and flowering stage obtained respectively with application of phosphorus 90 Kg/ ha in African marigold cv. MDU-1.

Joshi and Barad (2002) reported that phosphorus showed no significant influence on plant growth characters except plant spread, which was maximum (62.21 cm) with higher level of phosphorus (100 kg/ha) while conducting an experiment on African marigold cv. Crackerjack in medium black clayey soil during the winter season of 1999-2000 at College of Agriculture, Junagarh .

c) China aster

Singh and Sangama (2000) suggested that vegetative growth of China aster cv. Kamini in terms of plant spread was not influenced by graded levels of P on sandy loam soil.

Kumar et al.(2002) found among all the different doses of phosphorus, application of P at 200 kg/ ha recorded maximum plant height (35.29 cm) and number of branches (4.43) while conducting a field trial on requirement of N(0,100,150,200,250 and 300 kg/ ha) and P (0,100,150 and 200 kg/ha) for China aster . Gaikwad et al.(2004) recorded maximum plant height (99.25 cm) and spread of plant in East-West and North-South direction (28.54 cm and 30.06 cm, respectively) with the application of phosphorus @ 150 kg/ ha while studying on effect of different levels of nitrogen (150,200 and 250 kg/ ha) and phosphorus (100,125 and 150 kg /ha) on growth and flower production of China aster cv. Phule Ganesh White**.**

d) Other flower crops

Sigedar et al. (1991) found that plant height and number of branches were significantly greater at higher levels of phosphorus (50 kg/ ha) as compared to control in *Calendula officinalis* Linn. during kharif(1986-87)in medium black soil.

2.2. EFFECT OF PHOSPHORUS ON FLOWERINGAND OTHER FLORAL CHARACTERS

a) Chrysanthemum

Jayanthi and Gowda (1988) obtained highest flower diameter and flower yield (8.23 t/ha) with the application of Nitrogen and Phosphorus at 30+40 g/m^2.

Lodhi et al.(1991) reported that longest vase life was obtained in control (14.47 days) and shortest vase life (8.3 days) was obtained with highest N level (60 g) + 15 g P treatment. . Lodhi et al.(1993) carried out a trial in chrysanthemum cv. Flirt with N (0,15,30,45 or 60 g per square meter) and P (0,15,30 or 45 g per square meter) in all possible combinations + K_2O at 15g /m^2 as a basal dressing and FYM at

5 kg per meter square. They suggested that increased nitrogen rates, delayed for days taken to visible bud, days to complete bud formation, and days to complete flowering but increasing levels of P improved earliness.

Lodhi and Tiwari (1993) obtained highest plant height (47.43 cm) and spread (24.98 cm) with 45 g N + 45 g P /m2 whereas, highest number of branches (6.73) per plant and maximum size (8.32 cm) and number of flowers (49.83) per plant were obtained with 30 g N + 15 g P per square meter. Highest yield of flowers (134.85 g) and dry weight (18.21 g) per plant were obtained with 30 g N and 45g P /m^2 respectively.

Belgaonkar et al. (1996) observed the tallest plant (118.89 cm), maximum primary and secondary branches (34.47 and 182.95, respectively) and minimum days to open the flower (25.55 days) at 200 kg N and 200 kg P/ ha treatment. Belgaonkar et al. (1997) observed that 100 kg N and 200 kg P/ ha produced flowers with the longest vase life (7.33 days). The highest weight of flowers/plant and diameter of flower were recorded with 45 X 45 cm spacing and 200 kg/ ha each of N and P.

Damke et al. (1997) reported that treatment with nitrogen (0 g/ m^2) or phosphorus (40 g/ m^2) resulted in the longest vase life (6.37 and 5.76 days, respectively) while conducting a trial at Akola during 1994-95, to determine the effect of various fertilizers rates on the vase life of chrysanthemum cv. Yellow Bijali.

Khankhane et al. (1997) reported that by applying 30 g N and 20 g P/ m^2 he found the maximum growth and highest yield (8.65 t/ ha and 7.32 t/ ha, respectively) and best quality flowers in Yellow Bijali under the irrigated condition in a medium deep black soil. Patel (1998) found increased size of flower in chrysanthemum with the application of P2O5 at 100 kg/ha, while, non-significant results were noted in case of vase-life at all levels of phosphorus.

Jhon and Paul (1999) claimed that Chrysanthemum *morifolium* Ram. well responded for number of flowers per plant, flower size and 100 flower weight with 10 g N and 10 g P/ m^2 treatment.

Joshi (2002) reported that flowering and quality of flowers (appearance of first flower bud, size of flower, fresh weight of flower and vase life of cut flower) were

improved significantly with higher dose of phosphorus (100 kg/ha) than lower dose (50 kg/ ha) in chrysanthemum cv. IIHR-6 under North Gujarat condition.

Beniwal et.al,(2005) reported that he found significant improvement in flowering [days to bud initiation ,days to first flowering ,duration of flowering ,size of flower]and yield parameters [number of flowers and flower yield]in chrysanthemum c.v. Flirt with the application of N and P at 20 g/m^2.

b) Marigold

Anuradha et al.,1990 reported that size of flower as well as number of ray florets were significantly influenced by P_2O_5 application from 0 to 90 kg/ ha. However, the number of days required for 50 per cent flowering was reduced with increasing level of P_2O_5, whereas, increasing level of P_2O_5 had no significant effect on vase life of flowers.

Joshi and Barad (2002)found out that application of 100 kg P_2O_5 /ha produced significantly higher flower diameter (6.68 cm) and maximum number of ray florets per flower (124.92) than 50 kg P_2O_5 /ha in African marigold cv. Crackerjack. They also reported that different levels of phosphorus failed to influence the earliness of flowering and vase life of cut flowers.

c) China Aster

Singh and Sangama (2000) reported that Floral parameters i.e. number of days taken to 100 % flowering, flower diameter, stalk length of flower, number of flowers per plant and post-harvest life of cut flower were not affected due to different levels of phosphorus in China aster cv. Kamini. Kumar et al.(2002) observed that among the different doses of phosphorus, 200 kg P_2O_5 /ha proved effective towards number of days to first flower bud appearance (54.05 days)and flower diameter but maximum duration of flowering (36.99 days) was observed where no P_2O_5 was applied in China aster. Gaikwad et al.(2004) observed that flower diameter and duration of flowering were significantly increased with application of 125 kg phosphorus /ha in China aster cv. Phule Ganesh White. at Modibaugh Garden, College of Agriculture, Pune during 1999-2000 .

d) Other flower crops

Sigedar et al.(1991) observed that the phosphorus application had significantly increased number and weight of flowers per plant in *Calendula officinalis* Linn.. All these characters were found maximum at highest level of phosphorus (50 kg/ ha). Singatka et al. (1995) carried out an experiment to study the effect of different levels of N, P and K on growth and flower production of gaillardia cv. Yellow Double. Their results indicated that phosphorus (125 kg/ ha) had significant and beneficial effects on the yield in terms of number and weight of flowers per plant and per hectare over control.

2.3 EFFECT OF POTASH

Kazimirova (1975) determined K requirement in chrysanthemum and observed that with vigorous growth, requirement of this nutrient is increased and remains high till flowering. Potassium is necessary for many plant functions including carbohydrate metabolism, enzyme activation, osmotic regulation and efficient use of water, N uptake and protein synthesis and translocation of assimilates .Marginal browning and reduction of leaf size are the characteristic deficiency symptoms of K nutrient. Flowering is delayed and keeping quality gets impaired.

2.3.1 EFFECT OF POTASH ON GROWTH

a) Chrysanthemum

Johnson (1975) observed there was a significant increase in overall growth of various chrysanthemum cultivars of summer and autumn planted crop with the application of potassium in combination with nitrogen.

Kumar et al. (1982) conducted a trial for two years on soil with medium to high available N and low P and K. NPK were applied at 20: 40-120: 20 kg/ ha , and it was found that plant height and plant spread were greatest at 20: 120: 20 kg/ ha.

Samoilenko (1983) recommended optimum fertilizer rate of 80 kg N, 160 kg P2O5, and 80 kg K2O/ ha for good plant growth .Strojny (1983) found that, maximum plant growth and flower production were obtained with application of N at 5 g/ m^2 and K2O at 24 g/ m^2.

Chezhiyan et al.(1986)observed that at N_{20} P $_{20}K_{20}$ g/ m^2 fertilizer combination highest plant height was obtained in chrysanthemum.

Baboo and Sharma (1997) stated that with increasing the rate of K, the increase in plant height and number of primary branches were observed while they carried out an experiment, to determine the effects of N (0,100,200 or 300 kg/ ha) or K fertilizer (0, 80 or 160 kg/ha) on the growth of *Chrysanthemum coronarium* cv.Nivea . De and Dhiman (1998) at Tripura, studied the effect of potash on growth of chrysanthemum cv. Chandrama and recommended that application of 200 kg K_2O /ha was the optimum dose for growth.

b) Other crops

Saud and Sarmah (1995) at Karimganj, Assam conducted a trial on French marigold and reported that plant height was increased with increasing the levels of NPK. Plant height was found maximum at 150 kg each of N, P and K. Singatkar et al.(1995) observed in gaillardia var. Orenziana, at Kolhapur that the application of 125 kg potassium /ha was comparatively superior for growth as compared to other treatments of K at early stage.

2.3.2 EFFECT OF K IN FLOWERING AND OTHER FLORAL CHARACTERS

a) Chrysanthemum

Komosa (1978) studied a pot experiment on peat substance in which K was applied at 0-5.32 g/ kg and N at 0-3 g/ kg and recommended optimum rates of K_2O (0.17-1.33 g/ kg).He further observed that deficiency or excess K_2O reduced the flowering period.

Strojny (1982) through a three years trial on N at 1.25 - 7.5 g/ m^2 and K_2O at 2 - 24 g /m^2 various combinations applied every two or four weeks. The recommended treatment for flower production and economy of labour was N at 5 g /m^2 applied monthly plus K_2O at 24 g /m^2 as a single dose.

Kumar et al. (1982) tested NPK in two years trials, and found that flower yield was greatest at 20: 120: 20 NPK/ha.

Chezhiyan et al.(1986) applied N : P_2O_5 : K_2O at 0-40 : 0-40 : 20 g m-2 + 5 kg FYM /m^2 while conducting a field trial for two years, and recorded that flower yield in both years was highest (16.85 and 16.77 t/ ha , respectively) on plots which receiving N : P2O5 : K_2O at 20 : 20 : 20 g/ m^2 + 5 kg FYM/ m^2.

Four rates of N (0, 10, 20 and 30 g/ m^2), and three rates of K_2O (0, 10 and 20 g/ m^2) were tried for optimum rates of N and K in cut chrysanthemum cv. Chandrama by Barman and Pal (1992.) and he found that the dose N 30 g /m^2 and K 20 g/ m^2appreciably improved the flowering attributes. Moustafa (1996) observed that application of K_2O 19.2 g/plant increased stem dry weight and vase life of the flowers, but addition of N in combination with K reduced vase life in chrysanthemum cv. Wilson‟s white. . Baboo and Sharma (1997) stated that when the level of K was increased from 0 to 160 kg, the number of flowers and flower size were markedly increased and significantly increased flower yield and net return compared to the control. De and Dhiman (1998) carried out an experiment to study the effect of different levels of N, P and K on the growth and flowering of chrysanthemum cv. Chandrama under Tripura conditions during 1997-98 and concluded that the application of 200 kg K_2O /ha was the optimum dose for the production of good quality cut flowers. Joshi (2002) conducted an experiment and found that all the flowering parameters, yield and quality of flower remained non-significant with K application.

b) Other crops

In a trial on gaillardia, potassium had significant effects on the yield in terms of number and weight of flowers/plant and per hectare (Singatkar et al., 1995). They also observed that the application of 75 kg K/ ha resulted in increased number and weight of flowers. However, at higher level (125 kg/ ha), maximum diameter of flower was recorded. Saud and Sarmah (1995) observed that fertilizer dose of NPK at 100 kg/ ha each was superior to other three levels in terms of yield per hectare (165.50 q/ ha) in French marigold .A field experiment was conducted with different levels of Potassium (40,80,120,160,200 and 240 kg /ha) with control in African marigold cv. Maxima Yellow during kharif 2014-15 by M. Sanghamitra, V.Vijaya Bhaskar and P. Subbaramamma at Venkataramannagudem and claimed that a

gradual increase in the level of Potassium application from 0 to 240 kg /ha significantly increased the flower yield.

MATERIALS AND METHODS

The field experiment entitled "Nutrient Management in Chrysanthemum (*Chrysanthemum morifolium* Ramat) cv. Bidhan Madhuri" was conducted at Biotechnology cum tissue culture center(BTCC) of O.U.A.T, Bhubaneswar. The details of the materials used and techniques applied during the course of the present study are narrated in this chapter.

3.1 EXPERIMENTAL SITE

The experimental site is located at Biotechnology cum tissue culture centre (BTCC) of, Bhubaneswar, Odisha where adequate facility for irrigation and drainage existed.

3.2 GEOGRAPHICAL LOCATION

Bhubaneswar is in Khorda district of Odisha and a part and partial of eastern coastal plains along the axis of the Eastern Ghats .The city has an average altitude of 45 meters above sea level, is located at the latitude of 20.27 degree north and longitude of 85.84 degree east. It lies southwest of the Mahanadi river.

3.3 CLIMATE

Bhubaneswar has a tropical savanna climate, designated AW under the Koppen climate classification .The city enjoys rainy season from June to October having mild winter for 4 months after which summer season starts .The source of rain fall is South-West summer monsoon. It received an average annual rainfall of 1,542 mm most of which received between June to September.

3.4 WEATHER DURING CROP GROWTH PERIOD

To know the weather condition, during the crop growth period meteorological data pertaining to monthly mean rain fall, sun shine hours, average minimum and maximum temperatures and relative humidity were represented in Appendix-1.

3.5 SOIL CHARACTERISTICS OF THE EXPERIMENTAL FIELD

The soil sample was collected from eight different places of the experimental field before layout of experiment. The sample was mixed thoroughly and a uniform

sample was analysed for assessing the initial status of the soil as presented in following table.

Texture class of soil sample	EC (dSm^{-1})	OC (g/kg soil)	pH	Available N(Kg/ha)	Available P(Kg/ha)	Available K(Kg/ha)
Sandy loam	0.27	4.8	8.09	353.0	101.0	1474.0

3.6 OUTLINE OF PROGRAMME

Location	BTCC, OUAT, Bhubaneswar
Crop	Chrysanthemum
Design	Randomized Block Design
Number of replications	3
Number of variety	1
Number of treatments	11
Statistical design used	Randomized Block Design (RBD)

3.7 OBSERVATIONS TO BE RECORDED

i. Plant height
ii. Plant spread
iii. Number of sprays per plant
iv. Number of days taken for flower bud appearance
v. Number of days taken for flower bud opening
vi. Flower type
vii. Flower diameter
viii. Number of flowers per plant
ix. Weight of flowers per plant
x. Length of pedicel of flower
xi. Duration of flowering
xii. Vase life

R_3T_7	R_3T_9	R_3T_4	R_3T_{11}
Blank	R_3T_1	R_3T_5	R_3T_8
R_3T_3	R_3T_7	R_3T_{10}	R_3T_6
R_2T_8	R_2T_3	Blank	R_2T_5
R_2T_{10}	R_2T_7	R_2T_9	R_2T_1
R_2T_{11}	R_2T_6	R_2T_4	R_2T_2
Blank	R_1T_{11}	R_1T_{10}	R_1T_9
R_1T_8	R_1T_7	R_1T_6	R_1T_5
R_1T_4	R_1T_3	R_1T_2	R_1T_1

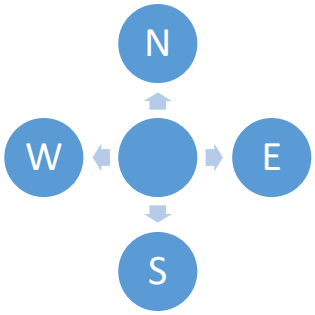

Fig 3.1: Layout plan of the experimental field

3.8 TREATMENT DETAILS (NPK Kg/ha)

Name of the variety - Bidhan Madhuri

N P K

T_1 –100-125-125(RDF)

T_2 – 80-125-100

T_3 –80-125-120

T_4 – 80-125-140

T_5 –100-125-100

T_6 – 100-125-120

T_7 – 100-125-140

T_8- 120-125-100

T_9- 120-125-120

T10-120-125-140

RDF-Recommended Dose of Fertilizer

N-Nitrogen

P-Phosphorus

K-Potash

3.9 FIELD PREPARATION:

The experimental field was ploughed well with the help of mould board plough followed by two harrowing and a planking to gain final tilth. The experiment was laid out in field as per lay out plan with the help of rope, measuring tape and bamboo pegs.

3.10 PREPARATION OF CUTTING:

The actively growing herbaceous top portion of stem was selected for cutting. The cuttings were taken from the healthy and disease free mother plants. The cuttings

were obtained from the chrysanthemum var. Bidhan Madhuri. The terminal herbaceous cuttings of 4-5 cm length were taken from the mother plants by giving a cut just below a node with a sharp knife .All the leaves were removed by keeping only terminal bud on the cutting and the end of cuttings were dipped in rooting hormones, i.e., rootex. After preparing the cutting ,they were inserted up to two third of its length in to fine sand medium .The healthy one month old rooted cuttings were transplanted in polythene bags consisting of soil. During the rooting , sufficient humidity was maintained in media by watering. The frequency of watering was reduced after root emergence.

3.11 PINCHING:

Pinching; one of the most important operations in chrysanthemum was also done .Pinching was done for the removal of the growing tips of the plant to induce the growth of vegetative laterals which reduced the plant height, promoted axillary branching, delayed flowering. It was done with thumb and forefinger. Pinching was done when the plants reach a height of 15-20 cm with 3-4 pairs of leaves.

3.12 **TRANSPLANTING:**

The well sprouted, rooted and healthy cuttings were uplifted from nursery beds and carefully transplanted in each plot at the spacing of 30× 30 cm after 45 days on November 5,2017.

3.13 **IRRIGATION:**

First light irrigation was given immediately after transplanting and then the crop was irrigated twice a week at initial stage. The irrigation was extended up to seven to eight days in later stage depending upon soil moisture condition and stage of crop growth as it requires frequent and thorough irrigation.

3.14 **WEEDING:**

Weeding is one of the most important inter cultural operation of chrysanthemum as weeds are heavy competitors of plant in up taking of nutrients .Weeds just like *Cyperus rotundus* ,*Cirsium arvense* ,*Amaranthus albus, Buckhorn plantain* etc. found in chrysanthemum field. So, hand weeding was carried out regularly in order to keep the entire plots weed free throughout the crop period.

3.15 **FERTILIZER APPLICATION:**

Fertilization was done according to treatment. Nitrogen was applied in two splits i.e. ½ at planting and rest ½ at 30 DAP. All Potassium and Phosphorus in all treatments were applied as basal.

3.16 **PEST MANAGEMENT:**

The incidence of termite attack was observed in initial stage for which drenching with chloropyriphos is done at interval of ten days, which gave successful control of this pest. White fly also observed in chrysanthemum field for which metasystox was sprayed.

OBSERVATIONS RECORDED:

a) PLANT HEIGHT (cm)

The plant height of five randomly selected plants from each plot was measured from the ground level to the tip of the plant with the help of meter scale and the average height was calculated by dividing the summation with five.

b) PLANT SPREAD (cm)

The plant spread was measured in five tagged plants with the help of meter scale in North-South and East-West direction and the average value was worked out.

c) NUMBER OF SPRAYS PER PLANT

The total number of sprays of five randomly selected plants from each plot was counted and average was then calculated by dividing the summation with five.

d) NUMBER OF DAYS TAKEN FOR FLOWER BUD APPEARANCE

Numbers of days were counted from the date of transplanting to first flower bud initiation in randomly selected five plants and average was computed for each treatment.

e) NUMBER OF DAYS TAKEN FOR FLOWER BUD OPENING

Numbers of days were counted from the date of transplanting to first flower opening in randomly selected five plants and average was computed for each treatment.

f) FLOWER TYPE

Flower type is determined according to bloom characters and arrangement of ray florets and disk florets.

g) FLOWER DIAMETER (cm)

Diameter of five randomly selected flowers from each net plot was measured at full bloom stage. The data obtained were averaged and computed.

h) WEIGHT OF THE FLOWERS PER PLANT (g)

From the five randomly selected plants the fresh weight of the flowers was taken with the help of electrical balance. The recorded data were summed up and averaged and expressed in gram. The flowers selected for fresh weight was taken and air dried and the average dry weight of flowers per plant was worked out.

i) LENGTH OF THE PEDICEL OF CUT FLOWER (cm)

The length of the flower stalk from flower (flower of selected plant) base to maximum length was measured in centimetre with the help of scale, when plants were at full bloom stage .The obtained data were averaged and computed.

j) TOTAL NUMBER OF FLOWERS PER PLANT

Total number of flowers of each selected plant of each plot was calculated in flowering stage and the obtained data were averaged and computed.

k) DURATION OF FLOWERING (days)

Number of days taken from the first flowering to the last flowering per plant was recorded as total duration of flowering in each treatment.

l) VASE LIFE (days)

Flowers of tagged plant from each plot were plucked at fully open stage and kept in water. Vase life was recorded in room temperature and the number of days was counted till the colour of petals faded for shelf life.

3.17 **STATISTICAL ANALYSIS**:

The data was subjected to statistical analysis as per RBD designs suggested by Panse and Sukhatme(1978).The variance was tested at 5% level of significance. Standard error of mean and critical difference (0.05) was calculated for comparing the mean value. The significance of difference between any two means tested through computation of Critical difference (CD).

a. S.E.(m)± = Standard error of mean= $\sqrt{EMS/r}$

Where, EMS= Error Mean of square

r=Number of replications

b .C.D.=Critical Difference =SEd× t value at 5% at error degree of freedom

SEd=$\sqrt{}$ 2EMS/r

Where SEd=standard error of difference between two treatments
EMS=Error Mean of square
r=no. of replications

Fig. 3.2: During planting of Chrysanthemum in field

Fig.3.3: Preparation of planting materials

Fig.3.4: Vegetative stage of Chrysanthemum

Fig.3.5: Bud appearance stage

Fig.3.6: Full bloom stage of Chrysanthemum

Fig.3.6: During taking observation of flower diameter of Chrysanthemum flower

Fig.3.7: During taking observation of vase life period of flowers

Fig.3.9: Over all view of field in full blooming stage

RESULTS

The data recorded on various characters during the course of investigation entitled "Nutrient Management in Chrysanthemum (*Chrysanthemum morifolium* Ramat) cv. Bidhan Madhuri" has been presented in this chapter along with appropriate tables, figures and illustrations under following heads.

PLANT HEIGHT: Data recorded on the effect of nutrient management on plant height of chrysanthemum are presented in Table no -4.1. It is evident from the table no-4.1 that maximum plant height of chrysanthemum(66.253cm)was obtained in treatment number T_{10} having fertilizer combination of N_{120} P_{125} K_{140}kg/ha and this was closely followed by treatment numbers T_9 and T_8 where plant heights of 64.807 cm and 63.547 cm were obtained having fertilizer combinations of N_{120} P_{125} K_{120} Kg / ha and N_{120} P_{125} K_{100} Kg/ ha respectively which were significantly superior to all other treatments. However, minimum plant height (46.093cm) was noted in control treatment (T_{11}) having fertilizer combination $N_0P_0K_0$.

PLANT SPREAD: It is evident from the table no -4.2 that maximum East-west plant spread (34.333cm)was obtained in treatment T_{10} having fertilizer combinations of N_{120} P_{125} K_{140} kg/ ha and which was followed by treatment numbers T_9 (33.686 cm) , T_8(32.633 cm) and T_7 (31.633cm)respectively having fertilizer combinations of N_{120} P_{125} K_{120} kg /ha, N_{120} P_{125} K_{100} kg /ha and N_{100} P_{125} K_{140} kg /ha respectively which were significantly higher than all other treatments. However, minimum East-west plant spread (21.301cm)was noted in control treatment(T_{11}) having fertilizer combination $N_0P_0K_0$.Similarly, It is observed from the table no -4.3 that maximum North-south plant spread (32.526cm)was obtained in treatment number T_{10} having fertilizer combinations of N_{120} P_{125} K_{140} kg /ha and followed by treatment numbers of T_9,T_8, T_1 and T_7 which produced north-south plant spreading of 31.480cm,30.473cm,30.100cm and 29.886 cm respectively having fertilizer combinations of $N_{120}P_{125}K_{120}$ kg / ha , $N_{120}P_{125}K_{100}$ kg /ha , $N_{100}P_{125}K_{125}$ kg /ha, $N_{100}P_{125}K_{140}$ Kg /ha respectively which were significantly superior over all other treatments. However, minimum North-south plant spread (18.553cm) was noted in control treatment (T_{11}) having fertilizer combination of $N_0P_0K_0$.

Effect of different levels of nutrients on plant height (cm)(Table no-4.1)

TREATMENT NUMBERS	FERTILIZER COMBINATIONS(NPK IN Kg/ha)	MEAN
T1	100-125-125(RDF)	61.393
T2	80-125-100	55.647
T3	80-125-120	56.767
T4	80-125-140	58.500
T5	100-125-100	59.793
T6	100-125-120	59.827
T7	100-125-140	62.053
T8	120-125-100	63.547
T9	120-125-120	64.807
T10	120-125-140	66.253
T11	Control	46.093

S.E.(m)±	0.912
CD at 5%	2.710

Effect of different levels of nutrient on E-W spread (cm) (Table no-4.2)

TREATMENT NUMBERS	FERTILIZER COMBINATIONS(NPK Kg/ha)	MEAN
T1	100-125-125(RDF)	29.920
T2	80-125-100	26.040
T3	80-125-120	27.340
T4	80-125-140	28.186
T5	100-125-100	28.593
T6	100-125-120	29.600
T7	100-125-140	31.633
T8	120-125-100	32.633
T9	120-125-120	33.686
T10	120-125-140	34.333
T11	CONTROL	21.301

S.E.(m)±	1.423
C.D.at 5% level	4.228

Effect OF different levels of nutrients on N- S spread (cm) (Table no-4.3)

TREATMENT NUMBERS	FERTILIZER COMBINATIONS (NPK Kg/ha)	MEAN
T1	100-125-125(RDF)	30.100
T2	80-125-100	25.393
T3	80-125-120	26.846
T4	80-125-140	26.246
T5	100-125-100	27.973
T6	100-125-120	28.033
T7	100-125-140	29.886
T8	120-125-100	30.473
T9	120-125-120	31.480
T10	120-125-140	32.526
T11	Control	18.553

S.E.(m)±	1.403
C.D. at 5% level	4.169

NUMBER OF SPRAY PER PLANT:

Data recorded on the effect of nutrient management on number of spray of chrysanthemum are presented in Table no-4.4.

It was found out from the table no-4.4 that maximum number of spray (3.467cm) was obtained in treatment T9 having fertilizer combinations of $N_{120}P_{125}K_{120}$ kg / ha which was significantly superior over all other treatments. Minimum number of spray (0. 667cm) was noted in control plot (T_{11}) having fertilizer combination $N_0P_0K_0$.

NUMBER OF DAYS TAKEN FOR FLOWER BUD APPEARANCE:

The data taken on number of days for flower bud appearance as influenced by different levels of nutrients has been shown in table no -4.5.

It was observed from the table no -4.5 that earliest days taken for flower bud appearance was 48.267 days obtained in treatment T_{10} having fertilizer combination of $N_{120}P_{125}K_{140}$ Kg / ha and the effect of this treatment was significantly superior over the rest treatment. Maximum days taken for flower bud appearance was 58.933 days found in control treatment that is T_{11} having fertilizer combination of $N_0P_0K_0$.

NUMBER OF DAYS TAKEN FOR FLOWER BUD OPENING:

It was observed during experimentation that flower bud opening was influenced by different levels of Nitrogen, Phosphorus and Potash applied which has been shown in table no -4.6

It was evident that earliest days taken for flower bud opening was 61.4 days obtained in treatment T_{10} having fertilizer combination of $N_{120}P_{125}K_{140}$ Kg/ha which was significantly superior over the rest treatments. However, maximum days taken for flower bud appearance was 77.666 days found in control treatment T_{11} having fertilizer combination of $N_0P_0K_0$.

FLOWER TYPE:

Flower type is double Korean type. It is similar to single Korean type, except that, the number of whorls of ray florets is more than four. Disc is large and conscipious and bloom is flat.

Effect of different levels of nutrient on number of spray (Table no-4.4)

TREATMENT NO	FERTILIZER COMBINATIOS(NPK Kg/ha)	MEAN
T1	100-125-125(RDF)	2.133
T2	80-125-100	1.400
T3	80-125-120	1.733
T4	80-125-140	1.000
T5	100-125-100	1.933
T6	100-125-120	2.667
T7	100-125-140	2.400
T8	120-125-100	3.000
T9	120-125-120	3.467
T10	120-125-140	2.933
T11	Control	0.667

S.E.(m) ±	0.075
C.D.at 5% level	0.223

Effect of different levels of nutrient on number of days taken for flower bud appearance (Table no-4.5)

TREATMENT NUMBERS	FERTILIZER COMBINATIONS (NPK In Kg/ha)	MEAN
T1	100-125-125(RDF)	53.267
T2	80-125-100	56.933
T3	80-125-120	56.600
T4	80-125-140	56.267
T5	100-125-100	52.467
T6	100-125-120	52.200
T7	100-125-140	51.733
T8	120-125-100	51.133
T9	120-125-120	50.333
T10	120-125-140	48.267
T11	Control	58.933

SE(m)±	0.358
C.D. at 5%	1.064

Effect of different levels of nutrient on number of days taken for flower bud opening (Table no-4.6)

TREATMENT NUMBERS	FERTILIZER COMBINATIONS(NPK Kg/ha)	MEAN
T1	100-125-125(RDF)	67.866
T2	80-125-100	72.6
T3	80-125-120	72.266
T4	80-125-140	70.866
T5	100-125-100	67.533
T6	100-125-120	66.866
T7	100-125-140	66
T8	120-125-100	65.733
T9	120-125-120	64.6
T10	120-125-140	61.4
T11	Control	77.666

S.E.(m) ±	0.711
C.D. at 5% level	2.113

FLOWER DIAMETER

The data recorded on flower diameter influenced by nutrient management was given in table no -4.7 revealed that maximum flower diameter(5.847cm) was obtained in treatment number T_{10} having fertilizer combination of $N_{120}P_{125}K_{140}$ Kg /ha followed by treatment number of T_9 (5.667cm) having fertilizer combinations of $N_{120}P_{125}K_{120}$ Kg /ha which were significantly superior over the rest treatments. However, minimum flower diameter i.e. 4.313 cm was found in control (T_{11}) treatment having fertilizer combinations of $N_0P_0K_0$.

NUMBER OF FLOWERS PER PLANT:

Data taken on number of flowers per plant as influenced by different nutrient levels has been shown in table no-4.8.

It revealed that maximum flower per plant (67.733) was obtained in treatment T_{10} having fertilizer combination of $N_{120}P_{125}K_{140}$ Kg / ha which was followed by treatment T_7(64.867) having fertilizer combination of $N_{100}P_{125}K_{140}$ Kg / ha and the effect of these treatments were significantly higher than all other treatments.. However, minimum number of flowers per plant was 42 found in control (T11) treatment having fertilizer combinations $N_0P_0K_0$.

WEIGHT OF FLOWERS PER PLANT:

Data recorded on the effect of different levels of nutrient on fresh and dry weight of chrysanthemum flowers are presented in Table no -4.9 and 4.10 respectively. It was evident from table number 4.9 that maximum fresh weight (3.256g)was obtained in treatment number T_{10} having fertilizer combinations of $N_{120}P_{125}K_{140}$ kg/ ha , which significantly superior to all other treatments. However, Minimum fresh weight (1.766g) was noted in control treatment (T_{11}) having fertilizer combination $N_0P_0K_0$.similarly, It was evident from the table no 4.10 that maximum dry weight (1.173g)was recorded in treatment combination of T10 having fertilizer combinations $N_{120}P_{125}K_{140}$ Kg/ ha which was followed by the treatment number T_7(1.163g) having fertilizer combination of $N_{100}P_{125}K_{140}$ Kg / ha and these treatments are significantly superior over other treatments .However, Minimum dry weight (0.627g)was obtained in control treatment(T_{11}) where no fertilizer was applied.

Effect of different levels of nutrient on flower diameter (cm) (Table no-4.7)

TREATMENT NO.	FERTILIZER COMBINATIONS(NPK Kg/ha)	MEAN
T1	100-125-125(RDF)	4.987
T2	80-125-100	4.580
T3	80-125-120	4.633
T4	80-125-140	4.740
T5	100-125-100	4.913
T6	100-125-120	5.180
T7	100-125-140	5.233
T8	120-125-100	5.500
T9	120-125-120	5.667
T10	120-125-140	5.847
T11	Control	4.313

S.E.(m)±	0.104
C.D. at 5% level	0.308

Effect of different levels of nutrients on number of flowers per plant (Table no-4.8)

TREATMENT NO.	FERTILIZER COMBINATIONS (In Kg /ha)	MEAN
T1	100-125-125(RDF)	58.367
T2	80-125-100	48.267
T3	80-125-120	56.067
T4	80-125-140	62.400
T5	100-125-100	45.600
T6	100-125-120	55.133
T7	100-125-140	64.867
T8	120-125-100	50.400
T9	120-125-120	57.367
T10	120-125-140	67.733
T11	CONTROL	42.000

S.E.(m) ±	1.534
C.D. at 5% level	4.556

Effect of different levels of nutrients on fresh weight of flower (g)(Table no-4.9)

TREATMENT NUMBERS	FERTILIZER COMBINATIONS (In NPK Kg/ha)	MEAN
T1	100-125-125	2.875
T2	80-125-100	2.578
T3	80-125-120	2.735
T4	80-125-140	3.016
T5	100-125-100	2.548
T6	100-125-120	2.695
T7	100-125-140	3.052
T8	120-125-100	2.568
T9	120-125-120	2.733
T10	120-125-140	3.256
T11	Control	1.766

S.E.(m)±	0.053
C.D. at 5% level	0.159

Effect of different levels of nutrient on flower dry weight in gram (Table no-4.10)

TREATMENT NO	FERTILIZER COMBINATIONS In NPK Kg/ha	MEAN
T1	100-125-125	0.960
T2	80-125-100	0.700
T3	80-125-120	0.853
T4	80-125-140	1.033
T5	100-125-100	0.683
T6	100-125-120	0.733
T7	100-125-140	1.163
T8	120-125-100	0.727
T9	120-125-120	0.780
T10	120-125-140	1.173
T11	Control	0.627

S.E.(m)±	0.038
C.D. at 5%	0.113

DURATION OF FLOWERING:

The data recorded on the effect of nutrient management on flowering duration of chrysanthemum presented in Table no-4.11 revealed that maximum flowering duration (74.333days)was obtained in treatment T_{10} having fertilizer combination of $N_{120}P_{125}K_{140}$ kg /ha followed by treatment T_4(72.200) having fertilizer combinations of $N_{80}P_{125}K_{140}$ kg / ha which were significantly higher than all other treatments. .However, minimum flowering duration (59.400) was obtained in control treatment (T_{11}) where no fertilizer was applied.

VASE LIFE:

The data presented in Table no -4.12 showed significant results. It is evident from the table no -4.12 that maximum vase life period (20days) was observed in treatment combination T_{10} having fertilizer combinations of $N_{120}P_{125}K_{140}$ kg / ha and followed by the treatment combinations T_4 (19.667days) and T_7 (19.333 days) having fertilizer combinations of $N_{80}P_{125}K_{140}$ kg /ha and $N_{100}P_{125}K_{140}$ kg /ha respectively and significantly superior over other treatments. Minimum vase life period (14.333days) was obtained in control treatment (T_{11}) having fertilizer combination $N_0P_0K_0$ Kg / ha.

LENGTH OF PEDICEL:

The data recorded on the effect of different nutrient levels on length of pedicel of chrysanthemum flower showed in Table no -4.13

The data revealed that maximum pedicel length (14.737 cm)was obtained in treatment number T_9 having fertilizer combinations of $N_{120}P_{125}K_{120}$ kg / ha and this is significantly superior over all other treatments. Minimum pedicel length (11.250 cm) was produced in control treatment (T_{11}) having fertilizer combination of $N_0P_0K_0$ Kg/ ha.

Effect of different levels of nutrient on duration of flowering (Table 4.11):

TREATMENT NO	FERTILIZER COMBINATIONS (NPK In Kg/ha)	MEAN
T1	100-125-125(RDF)	66.733
T2	80-125-100	63.933
T3	80-125-120	68.267
T4	80-125-140	72.200
T5	100-125-100	62.467
T6	100-125-120	65.933
T7	100-125-140	71.000
T8	120-125-100	64.867
T9	120-125-120	68.800
T10	120-125-140	74.333
T11	Control	59.400

S.E.(m)±	0.827
C.D. at 5%	2.136

Effect of different levels of nutrient on vase life period (Table no-4.12)

TREATMENT NUMBERS	FERTILIZER COMBINATIONS(NPK Kg/ha)	MEAN
T1	100-125-100	16.667
T2	80-125-100	17.335
T3	80-125-120	17.667
T4	80-125-140	19.667
T5	100-125-100	16.000
T6	100-125-120	17.667
T7	100-125-140	19.333
T8	120-125-100	16.667
T9	120-125-120	18.000
T10	120-125-140	20.000
T11	Control	14.333

S.E.(m)±	0.052
C.D. at 5% level	0.154

Effect of different levels of nutrients on length of pedicle (cm) (Table no-4.13)

TREATMENT NO	FERTILIZER COMBINATIONS (NPK Kg/ha)	MEAN
T1	100-125-125(RDF)	13.197
T2	80-125-100	12.690
T3	80-125-120	12.973
T4	80-125-140	12.583
T5	100-125-100	13.647
T6	100-125-120	14.067
T7	100-125-140	14.213
T8	120-125-100	13.833
T9	120-125-120	14.737
T10	120-125-140	14.443
T11	Control	11.250

S.E. (m)±	0.052
C.D. at 5% level	0.154

DISCUSSION

Growth and development of chrysanthemum plant is attributed to the co-ordinated interplay of the nutrients in plant body. It appreciably governs the growth and yield when applied in optimum amount, proper proportion and in a balanced manner as it is evident from the following results and discussion.

a) Plant height:

Treatment T_{10} having fertilizer combination of $N_{120}P_{125}K_{140}$ Kg/ha produced maximum plant height (66.253cm) due to application of highest level of N.

The increase in plant height is due to the higher dose of nitrogen which might be due to nitrogen increases the transport of metabolites and rate of photosynthates in plant furthering as the rate of photosynthesis. Hence, it enables the plant to have quick and better upward vegetative growth. These results are in agreement with the findings of Lodhi and Tiwari(1993),Belgaonkar et. al(1996), Joshi(2002) and Patel(2004). A minimum plant height (46.093cm)was obtained in control treatment (T_{11}) having fertilizer combination $N_0P_0K_0$ due to zero level application of Nitrogen and this result is in conformity with the finding of Chezhiyan et al. (1986).

b) Plant spread:

Maximum East-west plant spread (34.333cm) and North-south plant spread (32.527cm)was obtained in treatment T_{10} having fertilizer combinations of N_{120} P_{125} K_{140} kg / ha and this is due to the effect of Nitrogen on growth or spreading of plant as Nitrogen is an elementary constituent of amino acid, nucleic acid, proteins, proteids and nucleotides ,chlorophyll and numerous secondary substances such as alkaloids which is an important constituent of the protoplasm and it involves in all enzymatic reactions taking place in cells and photosynthates transported to site of growth are used predominately in synthesis of nucleic acid and protein which enhances the cell expansion and that results in maximum spreading . Due to zero level application of nitrogenous fertilizer, minimum East-west plant spread (21.301cm) and North-south plant spread (18.553cm) was obtained in control treatment (T_{11}).These results are in agreement with the finding of Singlodhi and Tiwari(1993),Sharma et al.(2006).

c) **Number of Sprays per Plant:**

Maximum number of spray (3.467cm) was obtained in treatment T9 having fertilizer combinations $N_{120}P_{125}K_{120}$ kg/ ha which was significantly superior over all other treatments due to the higher level of Nitrogen. Here, with the increase in level of Nitrogen, there is increase in number of sprays per plant as Nitrogen being a constituent of protoplasm, it involves in basic reaction of photosynthesis providing its role in total biomass production that bring significant growth in branching and secondly, the nitrogen supply to the roots is responsible to stimulate the production and export of cytokinin to the shoots (Wagner and Michael,1971).The increased level of cytokinin in plants due to higher nitrogen application rate might have caused the lateral buds to sprout producing more number of sprays per plant. Minimum number of spray (0. 223cm) was noted in control plot (T_{11}) having fertilizer combination $N_0P_0K_0$ due to zero level application of Nitrogen. These results are in agreement with the findings of Rachayanwar (1985),Baboo and Sharma(1997), Joshi(2002) and Patel(2004).

d) Number of days taken for flower bud appearance and number of taken for flower bud opening:

Earliest days taken for flower bud appearance was 48.267 days and earliest days taken for flower bud opening was 61.4 days obtained in treatment T_{10} having fertilizer combination of $N_{120}P_{125}K_{140}$ Kg/ ha. As higher level of nitrogen, early flowering occur and terminal vegetative bud converted to flower breaking down the apical dominance of plant, thus resulting in number axillary shoots. These resuls are in conformity with findings of Rahane(1975),Vijay kumar and Shanmugavelu(1978). It is also suggested that Potassium plays an important role in formation and translocation of carbohydrates at the site of formation of axillary shoots resulting in more number.

However, maximum days taken for flower bud appearance and also maximum days taken for flower bud initiation found in control treatment T_{11} having fertilizer combination of $N_0P_0K_0$ due to nil nitrogen application.

e**) Diameter of flowers:**

It is revealed from table no-4.7 that maximum flower diameter(5.847cm) was obtained in treatment number T_{10} having fertilizer combination of $N_{120}P_{125}$ K_{140} Kg / hectare due to adequate application of nutrients particularly Nitrogen which might have stimulated cell elongation, which would have been resulted to an increase in diameter of flower. However, minimum flower diameter i.e. 0.104 cm was found in control (T_{11}) treatment having fertilizer combinations of $N_0P_0K_0$ due to no application of Nitrogen and Potash. This can be illustrated by sink-source relationship, where the growth of sink tissues (here flowers) can be limited by supply of photosynthates from source leaves. The higher nitrogen level might have accelerated the photosynthetic activities by increasing the source size (number of branches and leaf area) thereby developing flowers with more photosynthates, which might have resulted in increased cell division and cell expansion of flower tissues that enhanced the flower size in term of flower diameter. The results are in agreement with findings of Singh and Sangama(2000)and Kumar et. al.(2002) in China aster.

f) **Number of flowers per plant:**

Experimental results showed that maximum number of flowers per plant were obtained in treatment T10 having fertilizer combinations of $N_{120}P_{125}K_{140}$ Kg /ha which is influenced by the nutrients Nitrogen and Potassium. Interaction had showed a significant influence on number of flowers per plant as in one hand, Nitrogen played a vital role in diverting food reserves to the site of flower bud differentiation which resulted in more number of flowers per plant. On other hand, Potassium also involved in acceleration of many enzymatic reactions which led to the more number of flowers per plant. Minimum number of flowers per plant was obtained in control treatment (T_{11}) due to the zero level application of Nitrogen and Potassium. The results are in agreement with findings of Barman and Pal(1992), Baboo and Sharma(1997)and De and Dhiman(1998) and Dorajeerao et.al.(2012).

g) **Weight of flowers**:

The data recorded on fresh and dry weight of flowers per plant as influenced by nitrogen, potassium .The data showed that maximum fresh weight was obtained in treatment T_{10} due to the effect of Nitrogen and Potassium as role of Potassium in plants includes cation transport across the membrane, energy metabolism and enzyme

activity as stated by Mengel and Kirby(1980).Potassium increases carbon exchange and enhances carbohydrate movement and consequently stimulating weight of flower(Collins and Duke,1981).This result may be also due to the role of nitrogen as abundant supply of Nitrogen at higher level might have accelerated the photosynthetic activities of plants and thus, more assimilates might have been available for flowers to develop ,resulting in increased the weight of flowers .The results are in agreement with findings of Hwang et. al.(1992), Barman and Pal (1992) and Sharma et. al.(2006).Minimum dry and fresh weight are obtained in control treatment i.e. T_{11} due to zero application of Nitrogen and Potassium.

h) **Duration of flowering**:

Maximum duration of flowering (74.333days) was obtained in treatment combination of T_{10} having fertilizer combination of $N_{120}P_{125}$ K_{140} Kg/ha due to application of adequate nutrients particularly Nitrogen and Potassium that enhances all vegetative parameters including flower size and weight and results luxuriant growth of plant, so definitely duration of flowering is more in treatment combination of T_{10}.However, duration of flowering is least found in treatment T_{11} due to zero application of Nitrogen and Potash. The results are in agreement with findings of Sharma et. al.(2006) in Chrysanthemum, Jadhav et. al. (2002),Rathi et.al.(2003)and Sehrawat et.al.(2003) in marigold.

i) Vase life:

It is evident from experimental findings that maximum vase life period i.e. 20 days was obtained in treatment T_{10} having fertilizer combination of $N_{120}P_{125}K_{140}$ Kg / hectare .This improvement in vase life period due to the Nitrogen which produces carbohydrates that extend the vase life period .Subsequently with increase in Nitrogen depletion of carbohydrates causing digestion of proteins resulting in reduction of sugar content ,thus extending the vase life .

j) **Length of pedicel:**

It is observed from the experiment that maximum length of pedicel i.e. 14.443 cm was obtained in treatment T_{10} having fertilizer combination of $N_{120}P_{125}K_{140}$ Kg / ha .The enhanced pedicel length is due to higher level application of Nitrogen that causes improvement in plant metabolism i.e. higher amino acid production, chlorophyll

formation at faster rate, transformation of carbohydrates, translocation of phytohormones more quickly and efficiently .Minimum length of pedicel (11.250cm)was obtained in T_{11} due to zero application.

SUMMARY AND CONCLUSION

The present investigation entitle 'Nutrient management in Chrysanthemum(*Chrysanthemum morifolium* Ramat)cv. Bidhan Madhuri' was conducted at B.T.C.C.,O.U.A.T. ,Bhubaneswar during the year 2017-18.There were eleven treatment combinations which were replicated three times.Total number of plots were 33 and the experiment was laid out in Randomized Block Design(RBD).

The observations on vegetative growth parameters like plant height in cm, plant spread(Both east-west and north-south spread)in cm, number of sprays per plant and flowering attributes such as number of days taken for flower bud appearance , number of days taken for flower bud opening, flower diameter in cm ,number of flowers per plant ,average flower weight per plant in gram, length of pedicel in cm, duration of flowering(in days),vase life(in days) were recorded.

The results of investigations are summarized as follows:-

1. Maximum plant height of chrysanthemum (66.253cm) was obtained in treatment T10 having fertilizer combination N_{120} P_{125} K_{140}kg/ha and followed by treatment numbers T9 (64.807cm) and T_8 (63.547cm) having fertilizer combinations N_{120} P_{125} K_{120} Kg/ ha and N_{120} P_{125} K_{100} Kg / ha respectively which were significantly superior to all other treatments. However, minimum plant height (46.093cm) was noted in control treatment (T_{11}) where no fertilizer was obtained.
2. Maximum East-west plant spread (34.333cm) was obtained in treatment T10 having fertilizer combinations of N_{120} P_{125} K_{140} kg /ha and minimum East-west plant spread (21.301cm)was noted in control treatment(T_{11}) where no fertilizer was applied. Similarly, It is observed that maximum North-south plant spread (32.526cm) was obtained in treatment number T_{10} having fertilizer combinations of N_{120} P_{125} K_{140} kg / ha and minimum North-south plant spread (18.553cm)was noted in control treatment(T_{11}) where no fertilizer was applied.
3. Maximum number of spray (3.467cm) was obtained in treatment T9 having fertilizer combinations $N_{120}P_{125}K_{120}$ kg / ha which was significantly superior

over all other treatments. Minimum number of spray (0. 667cm)was found in control plot(T_{11}) having no fertilizer application.

4. Earliest days taken for flower bud appearance was 48.267 days obtained in treatment T_{10} having fertilizer combinations of $N_{120}P_{125}K_{140}$ Kg /ha and the effect of this treatment was significantly superior over the rest treatments. Maximum days taken for flower bud appearance was 58.933 days found in control treatment that is T_{11} having no fertilizer application.
5. Earliest days taken for flower bud opening was 61.400 days obtained in treatment T_{10} having fertilizer combination of $N_{120}P_{125}K_{140}$ Kg / ha and found to be significantly higher than that of rest treatments. However, maximum days taken for flower bud opening were 77.666 days found in control treatment T_{11} where no fertilizer is applied.
6. Maximum flower diameter (5.847cm) was obtained in treatment T_{10} having fertilizer combination of $N_{120}P_{125}$ K_{140} Kg / ha and minimum flower diameter was 4.313 cm found in treatment number T_{11} where no fertilizer was applied.
7. Maximum flower per plant (67.733) was obtained in treatment T_{10} having fertilizer combination of $N_{120}P_{125}K_{140}$ Kg /ha. However, minimum number of flowers per plant was 42 found in control (T_{11}) treatment having no fertilizer application.
8. Maximum fresh weight (3.256g) was obtained in treatment number T_{10} having fertilizer combinations of $N_{120}P_{125}K_{140}$ kg /ha, which significantly superior over all other treatments. However, Minimum fresh weight (1.766g) was noted in control treatment (T_{11}) where no fertilizer was applied. Similarly, maximum dry weight (1.173g) was obtained in treatment number T10 having fertilizer combinations $N_{120}P_{125}K_{140}$ kg /ha. However, Minimum dry weight (0.627g) was obtained in control treatment (T_{11}) where no fertilizer was applied.
9. Maximum flowering duration of 74.333days was obtained in treatment number T_{10} having fertilizer combination of $N_{120}P_{125}K_{140}$ kg /ha. However, minimum flowering duration (59.400) was obtained in control treatment (T_{11}) where no fertilizer was applied.
10. Maximum vase life (20days) was also obtained in treatment number T_{10} having fertilizer combinations of $N_{120}P_{125}K_{140}$ kg /ha .However, Minimum

vase life (14.333days) was obtained in control treatment (T_{11}) where no fertilizer was applied.

11. Maximum pedicel length (14.737 cm) was obtained in treatment number T9 having fertilizer combinations of $N_{120}P_{125}K_{120}$ kg /ha and this is significantly superior over all other treatments. Minimum pedicel length (11.250 days) was obtained in control treatment (T_{11}) where no fertilizer was applied.

CONCLUSION:

Treatment T_{10} having a fertilizer combination $N_{120}P_{125}K_{140}$ Kg/ha was found to be more effective in increasing both the vegetative growth parameters (plant height ,plant spread)as well as flowering attributes such as number of days taken for flower bud appearance ,number of days taken for flower bud opening, flower diameter, number of flowers per plant, flower weight per plant, length of pedicel, duration of flowering and vase life period of flowers .So ,it can be concluded that the optimum dose of fertilizer higher than the RDF where Phosphorus remains constant has resulted in incorporating a sound and luxuriant vegetative growth subsequently increasing the flower yield in Chrysanthemum in Bhubaneswar.

REFERENCES

Anuradha K,Pampapathy K and and Narayana N. 1990. Effect of nitrogen and phosphorus on flowering,yield and quality of marigold, *Indian J.Hort*,**47**(3):357-363

Arulmozhiyan R and Pappaiah CM.1989.Studies on the effect of nitrogen, phosphorus and ascorbic acid on the growth and yield of marigold (*Tagetes erecta* L.). cv. MDU 1, South Indian Hort. **37** (3): 169-172.

Azeezahmed SK, Dubey RK, Kukal SS and Sethi VP .2016.Effect of different Nitrogen Potassium concentrations on growth and flowering of chrysanthemum in a drip hydroponic system, **39**(13):1891-1898

Baboo R and Shrama KSK.1997.Effect of nitrogen and potash fertilization on growth and flowering of annual chrysanthemum (*Chrysanthemum coronarium*), *J. Ornamental Hort.,* **5** (1-2): 44-45.

Barman D. and Pal P. 1996 . Influence of planting dates on macro and micronutrients composition of leaves of chrysanthemum cv. Chandrama at different stages of growth, *J. Hill Res*. **9**(1): 40-42.

Barman D. and Pal P. 1992.Effect of nitrogen, potassium and spacing on growth and flowering of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Chandrama, *Hort. J.*, **12** (1): 51-59.

Belgaonkar DV ,Bist MA and Wankade MB.1997.Influence of nitrogen, phosphorus and different spacing on quality of annual chrysanthemum, *J. Soils and Crops*,.**12** (1):90-92.

Belgaonkar DV ,Bist MA and Wankade MB. 1996 .Effect of levels of nitrogen and phosphorus with different spacing on growth and yield of annual chrysanthemum ,*J.. Soils and Crops***, 6** (2): 154-158.

Belorkar PV,Patil BN, Golliwar VJ and Kothare A J. 1992.Effect of nitrogen levels and spacing on growth and yield of African marigold (*Tagetes erecta*), *J. Soils and Crops***, 2** (1): 62-64.

Bose TK and Das SM. 1966.Studies on the nutrition of ornamental plants. I. Effects of nitrogen, phosphorus and potassium on growth and flowering of China aster, salvia and zinnia, *Indian J. Hort.* ,**23** (1&2): 88-97.

Carter AR and Dermott W.1996.Nitrogen manuring of early flowering chrysanthemum an outdoor crop converted at flowering,.*Expt. Hort***.16**:12-18

Chavan MP,Jadhav PB and Rugge VC .2010.Performance of china aster varieties and their response to different level of nitrogen,*Indian J. of Hort*.,**67**:378-381

Chawla SL, Mohammed S , Mahawer LN and Jain MC 2007.Effect of Nitrogen and Phosphorus on vegetative growth and flower yield of *Chrysanthemum morifolium* cv. Nilima ,*Annals of Agricultural Research*.**28**(1):25-28

Chezhiyan N, Nanjan K and Abdul Khadar. 1986. Studies on nutrient requirements of *Chrysanthemum indicum* cv. Co. 1, *South Indian Hort*., **34** (3): 173-178.

Chi NY. 1974.Effect of nitrate N and ammonical N on the organic nitrogen fraction and free ammonia in the green house chrysanthemum, *Hort. Sci*., **2**:294.

Collins M and Duke SH .1981.Influence of potassium fertilizer rate on photosynthesis and N fixation of alfalfa,.*J.crop sci*.,**21**:481-485

Dahiya SS, Singh N and Singh S.1998.Effect of nitrogen and phosphorus on growth ,flowering and yield of marigold, *Environment and Ecology*,**16**(4):855-857

De LC and Barman D. 1997.Growth and flowering of chrysanthemum (*Chrysanthemum morifolium* Ramat.) as affected by nitrogen and genotypes, Ind. J. Hill Farming, **10** (1-2): 51-55.

De LC and Dhiman KR .1998. Effect of N, P and K on the production of cut flowers of chrysanthemum cv. Chandrama under Tripura condition, *Prog. Hort*. **30**(3- 4):111-114.

Desai JR, Patel BM and Patel BN. 2002.Effect of N and pinching time on African marigold, Paper presented in National Symposium on Indian Floriculture in the New Millennium, 25-27 Feb., Bangalore, pp. 35.

Dorajeerao AVD, Mokashi AN, Patil VS,Venugopal CK, Lingaraju S and Koti RV.2012.Effect of graded levels of nitrogen and phosphorus on growth and yield of garland Chrysanthemum(*Chrysanthemum coronarium* L.),*Karnataka J. Agric.Sci* ,**25**(2):224-228

Elliot GC and Nelson PV. 1983.Relationships among nitrogen accumulation, nitrogen assimilation and plant growth in chrysanthemums, *Physiol. Plant***,** **57**(2): 250-259.

Gaikwad SA, Dumbre Patil SS and Patil GD. 2004.Effect of different levels of nitrogen and phosphorus on the growth and flower production of China aster *(Callistephus chinensis* (L.) Nees), *J. Maharashtra Agric. Univ.,* **29** (2): 140-142.

Grewal HS and Thakur Tanya.2016.Effect of Nitrogen application on growth and flowering in Chrysanthemum, *Agricultural Research Journal*.**53**(4):505-508

Gilly G. 1977. Morphological, histological and chemical disorders due to miner deficiencies in *Chrysanthemum morifolium, Annals Agronomiques* ,**28** (6): 637-650.

Hameed AS and Sekar K .1999.Effect of graded levels of nitrogen and phosphorus on yield and quality of African marigold (*Tagetes erecta* L.*),South Indian Hort* **,4**(1-6):339-341.

Hansen CW and Lynch J. 1998.Response to phosphorus availability during vegetative and reproductive growth of chrysanthemum:II, Biomass sand Phosphorus dynamis,.*j.AmericanSoci.Hort.Sci.,***123**(2):223-229

Hwang KS,Yoon JH and Park YD.1992.The effects of NPK fertilizer application rate and soil nutrient content on the growth and flower quality of *Chrysanthemum morifolium* Ramat. Res. Rep. Rural Development Administration, *Soil and Fertilizer*. **34**(1);44-50

Jamod PP. 2001.Influence of plant population and levels of nitrogen on growth and yield of African marigold (*Tagetes erecta* L.) cv. Local Orange. M.Sc. Thesis submitted to Gujarat Agricultural University, Sardar Krushinagar.

Jayanthi R and Gowda JVN .1988.Effect of nitrogen and phosphorus on growth and flowering of chrysanthemum cv. “Local White“. ,*Current Res. Uni. Agril. Sci. Bangalore*. **17** (8): 104-106.

Jhon AQ and Paul TM. 1999. Response of *chrysanthemum morifolium* Ramat to different levels of nitrogen and phosphorus, *App. Biol. Res*., **1** (1): 35-38.

Johnson CR. 1975. Symptomatology and analysis of nutrient deficiencies on flowering annual plants, *Commun. Soil Sci. Plant Anal*, **4** (3): 185-196

Joiner JN.1967..Effect of nitrogen on nutrient content of chrysanthemum, *Proc.Amer.Soc.Hort.Sci.* **90**:389

Joshi AS and Barad AV. 2002.Effect of N, P and pinching on growth, yield and quality of African marigold (*Tagetes erecta* L.) cv. Crackerjack, *Gujarat J. Applied Hort*., **1** (1): 57-65.

Joshi VK. 2002.Nutritional requirement of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. IIHR-6 under North Gujarat conditions, Thesis Submitted to Gujarat Agricultural University, Sardar Krushinagar.

Kazimirova RN. 1970.Nutrient content and ratios in chrysanthemums in relation to productivity, *Byullenten Gosudarstvennogo Nikitskogo Botanicheskogo Sada*,**3**:74-77

Karetha KM,Gajipara NN,Joshi NS and Deshmukh HN.2008. Response of gaillardia (*Gaillardia pulchellavar*. Lorenziana) cv. Local Double to different levels of Nitrogen,Phosphorus and Potassium,. *National symposium on Recent Advances in Floriculture,Navsari*,pp-**62**

Karavadia BN and Dhaduk BK. 2002. Effect of spacing and nitrogen on annual chrysanthemum (*Chrysanthemum coronarium*) cv. Local White. *J. Ornamental Hort*, **5**(1): 65-66.

Khankhane RN, Damke MM, Jadhao BJ and Hedau CV.1997. Growth, flowering and yield of chrysanthemum cv. Yellow Bijali as influenced by nitrogen and phosphorus fertilization.*P.K.V. Res. J.* **21** (1): 48-52

Komosa A. 1978.Indices of nitrogen and phosphorus nutrition in the chrysanthemum variety Balcombe Perfection. I. Effect of different rates of nitrogen and

phosphorus fertilizers on the growth and flowering of chrysanthemums .*Prace Komis, Nauk Rol, iKomis Nauk Les. PTPN*.. **45**: 145-155.

Kumar N, Arumugam R. and Kandaswamy OS. 1982. Effect of NPK on flower production of pyrethrum (*C. cinerarifolium* Vis.. *South Indian Hor,*. **30**(2): 99-103.

Kumar Jitendra, Chauhan SS and Singh PV. 2002. Response of N and P fertilization on China aster. *Paper presented in National Symposium on Indian Floriculture in the New Millennium*, 25-27 Feb., Bangalore, pp. 38.

Lodhi AKS, Tiwari GN and Pathak RK. 1991.Effect of nitrogen and phosphorus application on vase-life of cut flowers of chrysanthemum {*Chrysanthemum morifolium* Ramat *(Dendranthema morifolium)}*, *Hort. J*.,**4** (1): 49-51.

Lunt OR and Kofranek AM. 1958 .Nitrogen and potassium nutrition of chrysanthemum. *Proc. Amer. Soc. Hort. Sci*., **72**: 487-497.

Meyer Jr MM and Boodley JW. 1964.Interaction of root and foliar applied nitrogen on the growth of *Chrysanthemum morifolium*, *Proc. Amer. Soci. Hort. Sci.* **85** : 564-567.

Mishra HP .1998.Effect of nitrogen and planting density on growth and flowering of gaillardia, .*Journal of Ornamental Horticulture(New series)*.**1**(2):41-47

Mohanty CR, Mishra NK and Patnaik Padmaja. 2002.Effect of nitrogen and phosphorus on flower production in marigold. *J. Ornamental Hort., New Series*. ,**5** (1): 67-68.

Moustafa AT and Morgan JV. 1983.Influence of solution concentration on growth, flower quality and nutrient uptake in spray chrysanthemum,. *Acta Hort.* No. **133**, pp.13-24.

Patel AP. 2004.Effect of nitrogen through urea and castor cake on growth, flowering and yield of chrysanthemum (*Chrysanthemum morifolium* Ram.) cv. IIHR-6, Thesis submitted to Junagadh Agricultural University, Junagadh.

Patel BS.1990.Influence of plant density and nitrogen fertilizer on growth and flower production of African marigold *(Tagetes erecta* L.), M.Sc. Thesis submitted to Gujarat Agricultural University, Sardar Krushinagar, Gujarat.

Patel HC.1998.Response of nitrogen,phosphorus and pinching on growth, flower production and vase life of chrysanthemum.Ph.D thesis submitted to Gujarat Agricultural University,SK Nagar,Gujurat.

Pilanali N. and Kaplan M. 1999.Investigation of macronutrients absorption in two chrysanthemum cultivars (Yellow Delta and Cerise Delta) grown under greenhouse conditions, *Turkish J. Agric. Forestry*, **23** (Supp. 3): 721-727.

Rachayanavar CS. 1985.Studied on the influences of intra spacing with different levels of nitrogen and phosphorus on growth and flower production in chrysanthemum (*Chrysanthemum morifolium* Ram.) cv. Mattur, Thesis Abst., 1987, 11 (4) : 279-280.

Rao DVR, Balasubramanyam SA, Reddy KB and Suryanarayana V. 1992. Effect of different spacings and nitrogen levels on growth and flower yield of chrysanthemum (Chrysanthemum indicum L.) cv. Kastur,. *South Indian Hort.*. **40** (6): 323-328.

Rao Manohar A and Pratap M.2002. Evaluation of chrysanthemum varieties for commercial cultivation under Andhra Pradesh condition,. *J. Ornamental Hort*., **7** (2):277-278.

Rathi, Soniya, Kumar, Vijay and Sindhu SS. 2003.Effect of different levels of nitrogen and methods of irrigation on yield and quality of marigold *(Tagetes erecta* L.). Paper presented in 2nd International Congress of Plant Physiology, 8-12 Jan. 2003 New Delhi, pp. 313.

Ravindra DVL, Rao RR and Reddy EN.1986.Effect of spacing and nitrogen levels on growth, flowering and yield of African marigold (*Tagetes erecta* L.).*South Indian Hort.* **34**(5):320-323

Samoilenko NI.1983.Effect of nitrogen, phosphorus and potassium on the growth and development of large flowered chrysanthemum using a coal based growth substance. *Introduktsiya ta Akalimatizatsiya Roslin na Ukrainin*. **23** : 66-69.

Sanghamitra M, Bhaskar Vijay V and Subbaramamma P.2013.Effect of different sources and levels of Potassium on vegetative, Reproductive Parameters of

African Marigold (*Tagetes erecta* Linn.)cv.Maxima Yellow, *Journal of Ornamental Horticulture*,**16**(1-2):86-94

Satar VP ,Panchbhai DM, Thakre Seema and Shivankar Sushma.Effect of Nitrogen and Phosphorus levels on flower yield and quality of Annual chrysanthemum, .*Asian Journal of Horticulture*.**17**(2)343-346

Saud BK and Sarmah AC.1995.Effect of spacing and fertilizer on French marigold. Paper presented in National Symposium on Indian Floriculture in the New Millennium, 25-27 Feb., Bangalore, pp. 34.

Sawwan J, Abu-Zahra T, Khadar S and Basher EA. 1999. Effect of different nitrogen amounts and forms on growth and flowering of *Chrysanthemum morifolium* Ramat. under glasshouse conditions. *Agril. Sci.* **26** (3): 364-370.

Sigedar PD, Anserwadekar KW and Rodge BM. 1991. Effect of different levels of nitrogen, phosphorus and potassium on growth and yield of *Calendula officinalis* Linn.,*South Indian Hort.* , **39** (4): 308-311.

Singatkar SS, Sawant RB and Ranpise SA. 1995.Effect of different levels of NPK on growth and flower production of gaillardia, *J. Maharashtra Agril. Uni*., **20** (3): 392-394.

Singh Lodhi AK and Tiwari GN. 1993.Nutritional requirement of chrysanthemum under filed condition. *Fertilizer News*. **38** (3): 39-45.

Singh Lodhi AK, Tiwari GN, Pathak RK and Lodhi AKS. 1990. Effect of various levels of nitrogen and phosphorus on flowering of chrysanthemum (*Chrysanthemum morifolium* Ram.*), Hort. J.* **3** (1-2): 56-58.

Singh KP. and Sangama .2000. Effect of graded level of N and pruning on China aster (*Callistephus chinensis*) cutivar Kamini, *Indian J. Hort.* ,**57** (1): 87-89.

Singh,Rajbeer J and Kumar J.2009.Effect of nitrogen and pinching on growth and flowering in African marigold.(*Tagetes erecta* Linn.)cv. Pusa Narangi Gainda, *Annals of Horticulture.* **2**(2):226-227

Strojny Z. 1982. Top dressing the border chrysanthemum Lucida with nitrogen and potassium Prace., *InstytutuSadownictwa Kwiaciarstwa-w-Skeierniewicach B Rosliny Ozdobne*, **7** : 67-73.

Strojny Z. 1985.Top dressing the border procedure for the estimation of available nitrogen in soil, *Current Sci*., **7**: 67-70

Tosar MV. 1989.Effect of spacing with different levels of nitrogen on growth and flower production of gaillardia (*Gaillardia pulchella*), M.Sc. Thesis submitted to Gujarat Agricultural University, Navsari Campus.

Tripathi D.1997.Essential nutrients in floricultural crops in Eliminatory course on commercial floriculture for horticultural development officers(ed. S.V. Chaudhery,.Dr. YSP university of Horticulture and Forestry, Nauni, Solan

Vaghasia MV .1997.Effect of spacing and nitrogen on chrysanthemum (*Chrysanthemum morifolium*) flower production cv. Local White, M.Sc. Thesis submitted to Gujarat Agricultural University, S.K. Nagar, Gujarat, (2003).

Vijayakumar M. and Shanmugavellu KG. 1978.Studies on the effect of nitrogen and phosphorus on chrysanthemum (*C. indicum* L.) cv. Yellow I. Flowering and yield. *Madras Agric. J.*. **65** (4): 247-252.

Yang SB, Park KW and Chiang MH. 1989.The effects of fertilizer application, spacing and sowing date on the growth and quality of *Chrysanthemum coronarium* L. *Abstracts of Communicated Papers Horticulture Abstracts, Korean Society Hort.,-Sci.*,**7**: 1, 72-73

APPENDIX-1

Year	Month	T_{max}	T_{min}	Actual	RH1	RH2	Wind Velocity	BSH	Evaporation
		^{0}C	**^{0}C**	**(mm)**	**%**	**%**	**km/hr**	**hrs**	**(mm)**
2017	**Sep**	**33.6**	**25.7**	**245.2**	**92**	**70**	**2.4**	**4.7**	**3.4**
2017	**Oct**	**32.2**	**24.3**	**204.5**	**93**	**69**	**2.5**	**6.0**	**3.3**
2017	**Nov**	**29.6**	**18.7**	**55.2**	**89**	**56**	**3.0**	**7.1**	**3.3**
2017	**Dec**	**28.2**	**14.4**	**36.3**	**92**	**48**	**1.9**	**7.0**	**3.4**
2018	**Jan**	**28.0**	**12.0**	**0.0**	**92**	**35**	**1.8**	**7.3**	**3.7**
2018	**Feb**	**33.7**	**15.9**	**0.0**	**91**	**29**	**2.5**	**8.4**	**4.2**
2018	**Mar**	**36.9**	**22.2**	**0.0**	**92**	**33**	**3.8**	**6.6**	**5.4**
2018	**Apr**	**37.3**	**24.7**	**43.9**	**87**	**47**	**7.1**	**8.4**	**7.2**