

**Standardization of Different Concentrations of Plant Growth
Regulators and Levels of Nitrogen, Phosphorus on Growth,
Flowering, Yield and Quality of China Aster (*Callistephus chinensis*
(L.) Nees) Under Chhattisgarh Conditions**

Ph.D. (Hort.) Thesis

By

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INDIRA GANDHI KRISHI VISHWAVIDYALAYA

RAIPUR (Chhattisgarh)

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Thesis

**Submitted to the
Indira Gandhi Krishi Vishwavidyalaya, Raipur**

**By
SUNNA DEEPTI**

**IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
Doctor of Philosophy
In
Horticulture
(Floriculture and Landscape Architecture)**

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CERTIFICATE – I

This is to certify that the thesis entitled “**Standardization of Different Concentrations of Plant Growth Regulators and Levels of Nitrogen, Phosphorus on Growth, Flowering, Yield and Quality of China Aster (*Callistephus chinensis* (L.) Nees) Under Chhattisgarh Conditions.**” submitted in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Horticulture** in the Department of **Floriculture and Landscape Architecture** of the **Indira Gandhi Krishi Vishwavidyalaya, Raipur**, is a record of the bonafide research work carried out by **Sunna Deepti** under my guidance and supervision. The subject of the thesis has been approved by the Student’s Advisory Committee and the Director of Instructions.

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

Date: 27/10/2021


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THESIS APPROVED BY THE STUDENT’S ADVISORY COMMITTEE

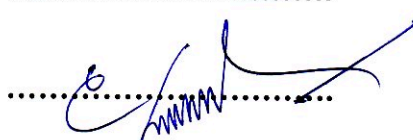
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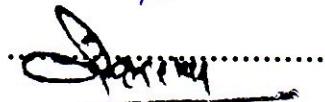
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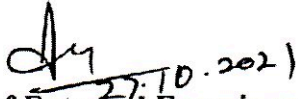


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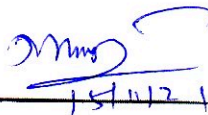
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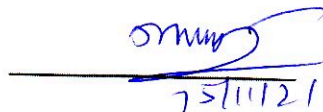
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*Raipur
April, 2021*


(Sunna Deepti)

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LIST OF ABBREVIATIONS

Abbreviations	Description
%	Per cent
°C	Degree Celsius
@	At the rate of
ANOVA	Analysis of variance
B:C	Benefit : cost ratio
CCC	Cycocel
CD	Critical difference
cm	Centimetre
cm ²	Centimetre square
Cv	Cultivar
DAT	Days after transplanting
df	Degree of freedom
<i>et. al.</i>	And others/ co-workers
Fig.	Figure
FYM	Farm yard manure
G	Gram
GA ₃	Gibberellic acid
ha	Hectare
ha ⁻¹	Per hectare
Hrs	Hours
hr ⁻¹	Per hour
i.e.	That is
IGKV	Indira Gandhi Krishi Vishwavidyalaya
kg.	Kilogram
m	Metre
m ²	Meter square
MOP	Muriate of potash
NAA	Napthalene acetic acid
NPK	Nitrogen, Phosphorous, Potassium
No.	Number
NS	Non-significant
Ppm	Part per million
q	Quintal
q/ha	Quintal per hectare
RDF	Recommended dose of fertilizers
RH	Relative humidity
S.Em	Standard error mean
SSP	Single super phosphate
Viz.	For example

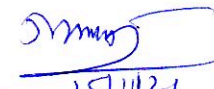
THESIS ABSTRACT

- a) Title of the Thesis : “Standardization of Different Concentrations of Plant Growth Regulators and Levels of Nitrogen, Phosphorus on Growth, Flowering, Yield and Quality of China Aster (*Callistephus chinensis* (L.) Nees) Under Chhattisgarh Conditions”
- b) Full Name of the Student : Sunna Deepti
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Signature of the Student


Signature of Major Advisor

Date: 27/10/21


Signature of Head of the Department

ABSTRACT

The present investigation entitled “**Standardization of different concentrations of plant growth regulators and levels of nitrogen, phosphorus on growth, flowering, yield and quality of China Aster (*Callistephus chinensis* (L.)Nees) under Chhattisgarh conditions**”was conducted at the College of Agriculture, IGKV, Raipur (C.G.).The Experiment-I entitled “**Effect on different concentrations of plant growth regulators on growth, flowering, yield and quality of China Aster**” was conducted during winter season of 2018-19 and 2019-20. The experimental field was laid out in FRBD with 3 replications. There were 14 treatment combinations of two cultivars viz. Arka Shashank and Arka Archana as factor A and 3 plant growth regulators with 2 levels each i.e, Cycocel @ 1500, 1000 ppm, NAA @ 50, 100 ppm and GA₃ @150, 200 with water spray as (control) in factor B. whereas, Experiment-II entitled “**Effect on different levels of nitrogen and phosphorus on growth, flowering, yield and quality of China Aster**” The experiment was conducted in FRBD with 24 treatments comprising of two varieties viz. Arka Shashank and Arka Archana as factor A and four levels of Nitrogen, i.e, (120, 140, 160, 180 kg/ha), and 3 levels of

Phosphorus (100, 120, 140 kg/ha) as factor B. The doses of Nitrogen were applied in two splits with full dose of phosphorus and potassium (60kg/ha) were applied in the field.

The result of experiment- I, were indicated that China aster cv. Arka Archana performed superior as compare to Arka Shashank and the PGR treatment P₆ (GA₃ @ 200 ppm) performed significantly better in growth characters viz. height of plant(cm), spread of plant(cm), maximum number of branches per plant, leaf area, total dry matter production (g) and flowering and yield attribute viz. days to bud initiation, days to 1st flowering, flowering duration and number of flowers per plant, flower yield per plant (g), flowers yield plot⁻¹ (kg), flowers yield ha⁻¹ (qt/ha) as well as quality attributes like, stalk length of flowers (cm), fresh and dry weight of 10 flowers (g), total weight of fresh and dry flower per plant (g), chlorophyll content before and after flowering (mg/g) and vase life of flower (days) during both the years and on pooled mean basis. The minimum result was recorded in P₀ (Control). The interactions between two cultivar and growth regulators were found mostly non- significant for different growth and flowering and yield characters of China aster. This may be due to the similar effect of plant growth regulator on both the varieties of China aster.

The results of experiment-II were indicated that China aster cv. Arka Archana performed superior as compare to Arka Shashank and as far as nutrient application the treatment F₁₂ (N₁₈₀: P₁₄₀) performed significantly better in growth characters viz. height of plant (cm), spread of plant (cm), maximum number of per plant, leaf area and flowering and yield attribute viz. days to bud initiation, days to 1st flowering, flowering duration and number of flowers per plant, flowers yield per plant (g), flowers yield per plot (kg), flowers yield per hectare (qt/ha) as well as quality attributes like, stalk length of flowers (cm), fresh and dry weight of 10 flowers (g), total weight of fresh and dry flower per plant (g), chlorophyll content before and after flowering (mg/g) and vase life of flower (days) during both the years and on pooled mean basis. The minimum result was recorded in treatment F₁ (N₁₂₀: P₁₀₀). The interactions between two cultivar and application of nitrogen and phosphorus were found mostly non- significant for different growth and flowering and yield characters of China aster. This may be due to the similar effect of plant growth regulator on both the cultivars of China aster.

On the basis of experimental finding it is concluded that the application of treatment F₁₂ (N₁₈₀: P₁₄₀) kg./ha was suitable doses and plant growth regulator (GA₃@ 200 ppm) for better plant growth, flowering and yield of China Aster.

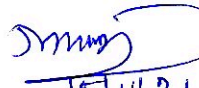
शोध ग्रंथ सारांश

- (अ) शोध ग्रंथ का शीर्षक : "छत्तीसगढ़ की परिस्थितियों में प्लांट ग्रोथ रेगुलेटर के अलग-अलग सांद्रण और नाइट्रोजन के लेवल, ग्रोथ, फॉस्फोरस की ग्रोथ, फ्लावरिंग, यील्ड और क्वालिटी ऑफ चाइना एस्टर (कैलिस्टेफस चिनेंसिस (स्प) नीस))
- (ब) छात्र का पूर्ण नाम : सुन्ना दीप्ती
- (स) प्रमुख विषय : पुष्प विज्ञान एवं भुदृश्य वास्तुकला
- (द) प्रमुख सलाहकार : डॉ. टी. टिरके, सह- प्राध्यापक, पुष्प विज्ञान एवं भुदृश्य वास्तुकला विभाग, कृषि महाविद्यालय, इंदिरा गांधी कृषि विश्वविद्यालय, रायपुर (छ.ग.)
- (इ) उपाधि : पी. एच.डी. (उद्यानिकी), पुष्प विज्ञान एवं भुदृश्य वास्तुकला


प्रमुख सलाहकार के हस्ताक्षर


छात्र/छात्रा के हस्ताक्षर

दिनांक : 27/10/21


विभागाध्यक्ष के हस्ताक्षर

सारांश

"छत्तीसगढ़ की परिस्थितियों में प्लांट ग्रोथ रेगुलेटर के अलग-अलग सांद्रण और नाइट्रोजन के लेवल, ग्रोथ, फॉस्फोरस की ग्रोथ, फ्लावरिंग, यील्ड और क्वालिटी ऑफ चाइना एस्टर (कैलिस्टेफस चिनेंसिस (L.) नीस)) की वर्तमान जांच का श्रेय बागवानी अनुसंधान सह पर दिया गया।" इंस्ट्रक्शनल फार्म, डिपार्टमेंट ऑफ फलोरीकल्चर एंड लैंडस्केप आर्किटेक्चर, कृषि महाविद्यालय, रायपुर (CG.) 2018-19 और 2019-20 का सर्दियों का मौसम। प्रायोगिक क्षेत्र को 3 प्रतिकृति के साथ (फैक्टरियल रैंडमाइज्ड ब्लॉक डिजाइन) (FRBD) में रखा गया था। 2 किस्मों के 14 उपचार संयोजन थे। अरका शशांक और अरका अर्चना फैक्टर ए के रूप में और 3 प्लांट ग्रोथ रेगुलेटर 2 खुराक के साथ अर्थात साइक्लोसेल / 1500, 1000 पीपीएम, एनएए / 50, 100 पीपीएम और जीए 3 / 150, 200 के साथ पानी स्प्रे (नियंत्रण) के रूप में फैक्टर बी।, प्रयोग- II का शीर्षक "चाइना एस्टर के विकास, फूल, उपज और गुणवत्ता पर नाइट्रोजन और फास्फोरस के विभिन्न स्तरों पर प्रभाव" प्रयोग 2 उपचार अर्थात 24 किस्मों के साथ FRBD में आयोजित किया गया था। कारक ए के रूप में अर्का शशांक और अर्का अर्चना, और नाइट्रोजन के 4 स्तर, यानी (120, 140, 160, 180 किलोग्राम/हेक्टेयर), और

फास्फोरस के 3 स्तर (100, 120, 140 किलोग्राम/हेक्टेयर) के रूप में कारक बी। खुराक। नाइट्रोजन और फास्फोरस को दो खण्डों में पोटेशियम की निरंतर खुराक के साथ (60 किग्रा/हे) खेत में लगाया गया।

“प्रयोग -1 के परिणाम से संकेत मिलता है कि चीन एस्टर सी.वी. अर्का शशांक की तुलना में अर्का अर्चना ने बेहतर प्रदर्शन किया और उपचार P6 (GA₃/200 पीपीएम) ने विकास चरित्रों में काफी बेहतर प्रदर्शन किया। पौधे की ऊंचाई (सेमी), पौधे का प्रसार (सेमी), अधिकतम संख्या में प्राथमिक और माध्यमिक शाखाएं संयंत्र -1, पत्तियों की संख्या/पौधे, पत्ती क्षेत्र सूचकांक, शुष्क पदार्थ उत्पादन (पत्ते, उपजी और जड़ें) और कुल शुष्क पदार्थ उत्पादन (छ) और फूल और उपज कली दीक्षा के दिन, पहली पुष्पन के दिन, फूल की अवधि और फूलों के पौधे की संख्या -1, फूलों की उपज पौधे -1 (जी), फूलों की उपज प्लॉट -1 (किग्रा), फूलों की पैदावार एच 1 (जी) और साथ ही गुणवत्ता के गुण जैसे , फूलों की लंबाई (सेमी), 10 फूलों का ताजा और सूखा वजन (छ), पौधे के ताजे और सूखे फूल का कुल वजन (छ), डंठल (जी) के साथ फूल का वजन, डंठल की लंबाई, फूल का व्यास (सेमी)), दोनों वर्ष (2018-19 और 2019-20) के दौरान और पूल किए गए औसत आधार और न्यूनतम परिणाम P0 (नियंत्रण) में दर्ज किए गए (फूल / दिन) और फूल (दिनों) के फूल जीवन के बाद क्लोरोफिल सामग्री। । दो कल्टीवेटर और विकास नियामकों के बीच बातचीत को ज्यादातर गैर-महत्वपूर्ण पाया गया और चीन एस्टर के फूलों और उपज पात्रों के लिए महत्वपूर्ण है। यह चीन एस्टर की दोनों किस्मों पर संयंत्र विकास नियामक के समान प्रभाव के कारण हो सकता है।

प्रयोग -2 के परिणामों से संकेत मिलता था कि चीन एस्टर सी.वी. अर्का शशांक और उपचार F12 (N180:P140) की तुलना में अर्का अर्चना ने बेहतर प्रदर्शन किया और ग्रोथ कैरेक्टरों में बेहतर प्रदर्शन किया। पौधे की ऊंचाई (सेमी), पौधे का प्रसार (सेमी), अधिकतम संख्या में प्राथमिक और माध्यमिक शाखाएं संयंत्र -1, पत्तियों की संख्या/पौधे, पत्ती क्षेत्र सूचकांक, शुष्क पदार्थ उत्पादन (पत्ते, उपजी और जड़ें) और कुल शुष्क पदार्थ उत्पादन (छ) और फूल और उपज विशेषता अर्थात्। कली दीक्षा के दिन, पहली पुष्पन के दिन, फूल की अवधि और फूलों के पौधे की संख्या -1, फूलों की उपज पौधे -1 (जी), फूलों की उपज प्लॉट -1 (किग्रा), फूलों की पैदावार एच 1 (जी) और साथ ही गुणवत्ता के गुण जैसे , फूलों की लंबाई (सेमी), 10 फूलों का ताजा और सूखा वजन (छ), पौधे के ताजे और सूखे फूल का कुल वजन (छ), डंठल (जी) के साथ फूल का वजन, डंठल की लंबाई, फूल का व्यास (सेमी)), क्लोरोफिल से पहले और बाद में फूल (मिलीग्राम ६ जी) और फूल (दिन) दोनों वर्षों (2018-19 और 2019-20) के दौरान फूल और पूलित माध्य आधार पर। न्यूनतम परिणाम F1 (N120: P100) में दर्ज किया गया था। नाइट्रोजन और फास्फोरस के दो कल्टीवेटर और अनुप्रयोग के बीच की बातचीत को चीन के तार के विभिन्न विकास और फूलों और उपज पात्रों के लिए ज्यादातर गैर-महत्वपूर्ण पाया गया। यह चीन एस्टर की दोनों किस्मों पर संयंत्र विकास नियामक के समान प्रभाव के कारण हो सकता है।

प्रायोगिक खोज के आधार पर यह निष्कर्ष निकाला गया है कि (N180: P140)किग्रा/है के आवेदन में बेहतर पौध विकास, फूल और चीन एस्टर की पैदावार के लिए उपयुक्त खुराक और पौधों की वृद्धि नियामक (जीए3/200 पीपीएम) थी।

CHAPTER- I

INTRODUCTION

Floriculture is a dynamic global enterprise in today's world and is day by day expanding because of its importance from birth to death. Demands for floricultural products are steadily increasing both in the domestic as well as export markets. In last two decades with changing lifestyle and rapid urbanization, floriculture assumed a definite commercial status. Loose flowers are mostly used for worship, garland making, decoration, and extraction of essential oils, pigments and dyes. All type of flowers which have commercial importance are grown in India and the cultivated area under floriculture in India is 313 thousand hectares with a production of 2059 thousand MT of loose flowers and 807 lakh cut flowers (Anonymous, 2018-2019). The domestic industry is growing at an annual growth rate of 10-20 percent per year. The overall export of floriculture produces from India soared to Rs. 42,345 lakhs during the year 2018 (Anonymous, 2018).

China aster (*Callistephus chinensis* (L.) Nees) belongs to the family compositae and its origin is China. China aster is one of the most important annual flower crops used commercially as cut flower, and for interior decoration. It is also used for bedding and potting purpose. Flowers are used for decoration, landscaping, in window boxes and used as loose flower in worship. China aster is usually propagated by seeds. seedlings are raised in seed beds. The plants need rich porous well drained loamy soil. It loves the sun and hence it should be grown in an open sunny environment. Proper fertilizer applications help in better growth and flowering, watering should be done in the morning or in the evening. The flowers of aster have wide range of type, size, shape, colour and have good keeping quality. Most of the colours except pure yellow are present in aster. The latest variations of pink, primrose, light blue, mauve, black, scarlet, creamy white, plain white and violet are available in different sizes, styles and a wide variety of colour ranges (Dua and Pal. 2003). The Genus *Callistephus* derived from two Greek words, '*Kalistos*' and '*Steophos*' which means beautiful and crown respectively. It

was introduced in Europe in 1731 by Jesuit missionary. French florist contributed much in development of quilled flowers. The comet type introduced in 1886 subsequently replaced by quilled flowers. China aster is short day plant and it requires less than 12 hrs light for improved vegetative growth and early flowering. Flower initiation took place at a temperature of 15°C above. Flowers show geitonogamous type of self-pollination.

Asters have been developed from a single form of wild species. The evolution of China aster was a record of remarkable variations. The original plant had single flowers with blue, violet or white-ray florets in two or four rows. The height was 18 to 24 inches long or medium tall. The prolongation or development of the central florets and the creation of quilled flowers were the first developments in this type of flower (Emsweller *et al.*, 1937). During the 18th century, Germans produced dual forms of aster so they, often referred to as “German asters”. This was attributed to the success of the growth of asters and the cultivation of large seeds by the Germans. The introduction of branching forms, tall types, medium tall and dwarf types resulted in the great evolutionary improvement of the aster. Branching forms were introduced in USA, which was the main hub for the growth of this plant as well as for the development of seeds

In India, it is being grown on a large scale in Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and West Bengal. The exact area of its cultivation and production are not available. However, it is evident from the statistics that Karnataka alone has a production of about 20,846 Mt from 2,199 ha with a productivity of 9.45 t ha⁻¹ (Anonymous 2018). Aster is also an important commercial flower crop of Siberia, Russia, Japan, North America, Switzerland and Europe.

The commercial importance of China aster is growing day by day in India, particularly in Karnataka, Tamil Nadu, West Bengal and Maharashtra. It was discovered that its cultivation was a profitable venture for eastern Uttar Pradesh. It is cultivated in an area of 500 and 400 ha, respectively, in the peri-urban areas of Bangalore (Karnataka) and Pune (Maharashtra) alone (Sonu kumar *et al.*, 2018).

The balanced nutrition is very critical in the midst of various factors affecting China aster's growth and flowering. In the growth and development of plants, fertilizers such as nitrogen, phosphorus and potassium play a crucial role. The chemical and biological properties of the soil are enhanced by these essential nutrients, thus increasing plant yields. Silberbush *et al.* (2003), Kim *et al.* (1998) and Engelbrecht (2004) have emphasized the need to supply nutrients to the soil during plant development to enhance their efficiency or productivity. Generally growth, development and production rely on their judicious feeding habits. In particular, the focus should be on nitrogen during the early stage (vegetative growth). Plants require phosphorus and it should be applied as a basal dose throughout the growing cycle. The plant needs potassium till flowering.

Nitrogen is the most vital nutrient and has the fastest and most obvious impact for plants. Nitrogen is an essential component of chlorophyll, protoplasm, nucleic acids, nucleotides, phosphatides, alkaloids, enzymes, hormones and vitamins etc. It is a portion of the chlorophyll molecule that gives plants their green colour and, its involved in the production of food for the plant through photosynthesis.

Phosphorus is a structural component of the cell membrane system, the chloroplast and the mitochondria. It plays a crucial role in living plants for photosynthesis, respiration, energy storage, transfer, cell division, cell elongation. Early root forming and development are encouraged by the application of phosphorus. It induces early flowering and thus brings about early maturity. It is the 2nd important nutrient component after nitrogen, which is in high demand for growth of the plants. Phosphorus does not only affect flowering, but also restricts growth either alone or with other nutrient elements in combination. Plants often use it to assist in the war against disease. it increases the N fixing ability of legumes, improved crop quality and increased stalk and stem length, lead to more uniform and earlier crop maturity.

Potassium is the third major ingredient for all living things. In plant physiology, it is most important cation not only in terms of its quality in plant tissues, but also in terms of its physiological and biochemical functions. By

maintaining the protoplasm in an acceptable degree of hydration, potassium retains the turgor strain. It increases plant resistance to moisture stress, sun, frost, lodging, and insect pests and diseases (Singh *et al.*, 2014). Potassium in photosynthesis controls the opening and closing of stomata and thus regulates the absorption of CO₂. It also assists in the regulation of plant water (osmo-regulation). Potassium plays an important role in the activation of several enzymes related to development of plant.

Over the last three quarters of a century, technical developments relating to growth regulators have advanced rapidly. Plant growth regulators when used in small amounts, alter or monitor physiological processes in the plant. Plant growth regulators are found to be absorbed easily by the various parts of the plant. In practice, there are different strategies for using growth regulators. The foliar application is the most common because it is simple, convenient, inexpensive and economical. By modifying the growth, flowering, seed set and seed yield of plants, it has played a significant role. The different researchers have reported that the use of growth regulators and chemicals helps produce good quality seeds of China aster. Gibberellic acid has been reported to increase plant height, stimulate flowering (Palei *et al.*, 2016) and increase China aster seed yield (Sharma and Joshi, 2015), (Kumar *et al.*, 2015).

Growth regulators are categorized into different classes, such as auxins, gibberellins, cytokine's, retardants and inhibitors etc. Their effect varies with plant, organisms, variety, the quantities used, the method of application, the frequency of applications and the different factors affecting the chemicals absorption and translocation. GA₃ is usually referred to as gibberellic acid. It is a plant hormone that is found in roots, shoots, buds, leaves, floral apices, root nodules, fruits and callus tissues in a number of organs and tissues. This facilitates stem elongation and germination of seeds or buds that are dormant. The initiation of floral senescence is retarded, and the consistency of the flowers is retained. It can substitute the need for long days and can also overcome the need for an inductive cold time. Gibberellic acid has become very effective in manipulating China aster growth and flowering. Naphthalene Acetic Acid is a synthetic auxin

and serves as a promoter for root growth that enhances plant growth. It also induces cell division, cell enlargement and inhibition of lateral buds in the apical area (Gautam *et al.*, 2006)

Plant growth regulators are unique in action, i.e., the behaviour and reaction of each type of plant according to the concentration and composition of compounds is found to be highly variable. Many products with active ingredients have been produced as commercial products and, in compliance with the instructions, may be used for specific purposes. It has been found that plant growth regulators are rapidly absorbed into the various parts of the plant. There are different methods for using plant growth regulators. The most widespread is foliar use. It is simple, convenient, cheap and economical.

While flower yield and quality are primarily varietal characteristics, they are greatly influenced by climatic factors such as photoperiod, temperature, relative humidity, and soil moisture that affect both the plant's vegetative and reproductive phases, ultimately leading to genotype performance variations. So that, plants have to be exposed to proper climatic factors in order to get optimum and economic flower yields. Therefore, under transitional Chhattisgarh plains, there is a need to standardize production technology involving systematic research to evaluate acceptable variety, standardize fertilizer levels and evaluate the effect of plant growth regulators on growth, flowering, yield and quality of China aster flower production under the Chhattisgarh plains. Therefore, the present investigation was planned with the following objectives:

- 1) To find out the effect of PGR and NP on vegetative growth and flowering of China aster.
- 2) To study the effect of PGR and NP on flower yield, quality & post-harvest life of China aster.
- 3) To find the best combination of PGR and NP for these cultivars of China aster.
- 4) To work out the economics of PGR and NP in China aster

Chapter- II

REVIEW OF LITERATURE

China aster is one of the main annual commercial crops for both loose and cut flowers, cultivated for its attractive coloured flowers. An important factor for successful China aster cultivation is the selection of cultivars. Several new China aster cultivars with a wide variety of colours have entered into the market in recent years. However, their output in terms of yield, quality and vase life varied significantly in different regions. This is because, due to variations in agro-climatic conditions, a variety that performs well in a specific region can't perform well in other regions. Since the output information of China aster cultivars is meagre, the information on other related crops is reviewed and provided in this chapter as below, along with the China aster literature.

2.1 Experiment–I: Effect on different concentrations of plant growth regulators on growth, flowering, yield and quality of China aster (*Callistephus chinensis* (L.) Nees).

2.1.1 Effect of plant growth regulators on vegetative growth

Girwani *et al.* (1990) conducted an experiment at College of Agriculture, Andhra Pradesh Agricultural University, Hyderabad (A.P.) during 1987 to study the response of growth regulators on marigold cv. African Giant and reported that, GA₃ 100 ppm was more effective in inducing plant height than GA₃ 50 ppm.

Mukhopadhyay (1990) carried out two separate experiments to study the response of foliar application of NAA and GA₃ on carnation cv. Marguerite Crimson at IIHR, Bangalore (Karnataka) and observed that GA₃ @ 100 ppm recorded maximum plant height as compared to other treatments viz. GA₃ 10 and 50 ppm, while, NAA at higher concentration i.e. 500 ppm inhibited linear growth. However, a marked increase in lateral branching was noticed under spraying of GA₃ 100 ppm.

Talukdar and Paswan (1994) conducted an experiment at Department of Horticulture, Assam Agricultural University, Jorhat Assam) to study the effect of GA₃ on growth of chrysanthemum (*Dendranthema grandiflora* T.) cv. Tumruli and observed that GA₃ at 20 ppm produced tallest plants as compared to GA₃ at 10 and 40 ppm.

Sharma *et al.* (1995) studied that the effect of two growth regulator on growth of chrysanthemum and found that plant height was directly proportional to the NAA concentrations (25-100 ppm) as compare to CCC and control.

Dutta and Seemanthi Ramdas, (1997) observed that the highest plant height, and highest number of laterals were recorded in treatment GA₃ 150 ppm in chrysanthemum.

Dutta *et al.* (1998) reported that the significant increase in plant height, number of leaves and number of laterals per plants compared with control by all levels of NAA sprays (50,75,100 ppm) in chrysanthemum.

Talukdar and Paswan (1998) noticed the greatest plant height with 40 ppm GA₃ in chrysanthemum cv. Grape bowl under Assam conditions.

Dabas *et al.* (2001) studied the response of *T. erecta* cv. Yellow Treasure” by spraying of gibberellic acid (100,150, 200 and 250 ppm) and NAA (20, 40, 60 and 80 ppm) application (spraying) and found that, gibberellic acid significantly increased the number of primary branches plant⁻¹ and the highest number of secondary branches plant⁻¹ was obtained with 100 ppm concentration.

Gupta and Datta (2001) conducted an experiment at Floriculture Section, National Botanical Research Institute, Lucknow (U.P.) to study an influence of gibberellic acid on growth in chrysanthemum (*Chrysanthemum morifolium* R.) cv. Jayanti and reported that GA₃ was effective at all concentrations (50, 100 and 200 ppm) in increasing the plant height, while, optimum increase in plant height was observed at GA₃ @100 ppm.

Kadam *et al.* (2002) conducted an experiment at Department of Horticulture, Marathwada Agriculture University, Parbhani (M. S.) to study the effect of growth regulators on growth of China aster (*Callistephus chinensis* L.) and reported that GA₃ at 200 ppm resulted in the tallest plants with maximum number of leaves and branches plant⁻¹, while, NAA at higher concentration (60 ppm) reduced the plant height as compare to GA₃.

Patil (2002) reported that spraying of NAA at 50 ppm significantly increased plant height but no significant effect in number of branches with an application of 50, 150 and 250 ppm in gaillardia cv. 'Lorenzia'

Mohariya *et al.* (2003) conducted a field experiment at College of Agriculture, Nagpur during 2000-01 to study the effect of GA₃ on growth of different varieties of chrysanthemum viz. Sonali Tara, Birbal Sahani, Sharad Shrungar and Julia and noticed that, GA₃ increased plant height and the highest plant height was recorded with 150 ppm GA₃ as compared to other levels of GA₃.

Singh (2004) conducted an experiment to study the influence of plant bio-regulators on growth in French marigold (*Tagetes patula* L.) during 2001-02 at Department of Horticulture, College of Agriculture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttaranchal) and reported the greatest plant height was obtained with spraying of GA₃ at 200 ppm with respect to other treatments.

Gautam *et al.* (2006) evaluated a trial during 2002-03, at Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan) to investigate the study the effect of plant growth regulators i.e. GA₃ (50, 100, 150 and 200 ppm) and NAA (50, 100, 150 and 200 ppm) on the growth of chrysanthemum cv. Nilima and they revealed that GA₃ exhibited the highest plant height at all concentrations and NAA at 100 ppm. However, number of branches and plant spread were positively influenced by all the treatments of GA₃ and NAA.

Tyagi and Kumar (2006) conducted an experiment in Meerut (U.P.) during 2004-05 to study the response of GA₃ (50, 100, 150 and 200 ppm) on the growth

and flowering of African marigold cv. Cupid and they noticed that GA₃ recorded the highest plant height, plant spread and number of primary branches plant⁻¹ at 200 ppm.

Sunitha *et al.* (2007) conducted a field experiment at Dharwad (Karnataka) to study the effect of GA₃ (100 and 200 ppm) and NAA (30 and 60 ppm) on the performance of African marigold (*Tagetes erecta* cv. Orange Double) and reported that spraying of GA₃ recorded the greatest plant height and number of primary branches plant⁻¹ at 200 ppm followed by NAA at 60 ppm.

Pandey and Chandra (2008) conducted an experiment on the effect of GA₃ and NAA on growth and flowering of French marigold (*Tagetes patula*) in Department of Horticulture, Janta P.G. College, Bakewar, Etawah (U.P.) reported that GA₃ significantly increased plant height (22.59 cm), number of branches (14.87), diameter of main stem (0.61 cm) and number of leaves at 450 ppm as compared to other treatments. The minimum plant height (19.34 cm) was recorded in plant treated with NAA 100 ppm.

Tyagi *et al.* (2008) carrying out an experiment to study the effect of GA₃ on growth of calendula cv. Red Orange” at Machhra, Meerut (U.P.) during winter of 2006-07 and reported that GA₃ resulted in the maximum plant height, number of leaves and branches per plant, leaf fresh weight and leaf area at 200 ppm.

Delvadia *et al.* (2009) conducted a field experiment at the Horticultural Instructional Farm, Department of Horticulture, J.A.U, Junagadh during the winter 2004-05 to study the effect of different GA₃ concentration and frequency on growth, flowering and yield in gaillardia and concluded that GA₃ 250 ppm single spray recorded maximum plant height (45.20 cm) and plant spread (39.10 cm), number of branches per plant (24.33) was the highest under two sprays of GA₃ at 50 ppm.

Nandre *et al.* (2009) conducted an experiment at the Floriculture Unit, University Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *rabi* season of the year 2005-06 to study the effect of growth regulators on growth of China aster and noticed that growth in respect to

plant height (50.43 cm), branches plant⁻¹ (14.60), leaves plant⁻¹ (80.60) and diameter of stem (1.72 cm) were found maximum in those plants which were sprayed with GA₃ at 200 ppm.

Ghadge *et al.* (2010) conducted a field experiment at Satpuda Botanic Garden, College of Agriculture, Nagpur during 2006-07 to study the effect of foliar application of plant growth regulators on growth of gaillardia cv. Yellow dusty and recorded that foliar application of GA₃ @200 ppm resulted in maximum plant growth with regard to plant height (50.47 cm) and leaves per plant (714.23) compared to other treatments, while maximum plant spread (68.05 cm) was recorded with NAA 100 ppm.

Shinde *et al.* (2010) also conducted a field experiment at College Nursery, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University Anand (Gujarat) during *kharif-rabi* season of the year 2009-10 to study the different levels of GA₃ on growth of chrysanthemum cv. IIHR-6 and noted that significantly maximum number of branches, plant spread and leaves plant⁻¹ were obtained with the treatment GA₃ 200ppm.

Sharifuzzaman *et al.* (2011) conducted an experiment to evaluate the three different concentrations of GA₃, CCC and MH on the vegetative growth, yield and quality of chrysanthemum and concluded that, maximum spread of plant (24.0 cm) and leaf length (8.35 cm) obtained with the spray of GA₃ 150 ppm.

Kumar *et al.* (2012) carried out an investigation on African marigold at Horticulture Research Farm, Department of Horticulture, Choudhary Charan Singh University, Meerut (U.P.) during the year 2007-2008 and noted that application of gibberellic acid at 350 ppm increased plant height (66.96 cm) and maximum number of branches of plant⁻¹ (12.30) in African marigold at various GA₃ levels (200, 250,300 and 350 ppm).

Sainath *et al.* (2012) conducted a field experiment at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (Karnataka) during Kharif 2008 to study the effect of growth regulators on growth of annual

chrysanthemum (*Chrysanthemum coronarium* L.)” and registered that, significantly higher plant height (97.28 cm), number of branches (27.32) and leaf area (4497.24 cm²) were found in GA₃ @ 200 ppm as compared to other treatments.

Patil *et al.* (2014) studied to study the influence of growth regulators on growth, flowering and seed yield of African marigold revealed that the treatment of NAA 400 ppm followed by NAA 300 ppm was significantly reported with maximum flower diameter (7.39 cm), plant spread (34.90 cm) and flowers per plant (22.80).

Gupta *et al.* (2015) reported that maximum plant height (95.17 cm) was observed when the plants of China aster cv. Kamini were planted in the month of June and sprayed with GA₃ 200 ppm.

Kumar *et al.* (2015^a) carried out a field experiment during *rabi* (winter) season of 2012-13 at Faizabad (U. P.) to find out the effect of various growth regulators on growth and flowering behavior of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gaiinda and revealed that GA₃ 300 ppm recorded maximum plant height (75.93 cm) and plant spread (50.07 cm) in African marigold.

Sharma and Joshi (2015) carried out a field experiment to study the effect of plant growth regulator foliar spray viz., GA₃ and NAA on China aster yield and quality and reported that GA₃ @ 250 ppm foliar spray significantly increased plant height (56.18 cm) and leaf area plant⁻¹ (3968.88 cm²).

Palei *et al.* (2016) studied on the effect of plant growth regulators on growth, flowering and yield attributes of African marigold and revealed that the maximum plant height (36.55 cm), the number of branches (35.22) and the minimum plant girth (2.6 cm) of the plant sprayed with NAA 100 ppm were recorded for plants treated with GA₃ 100 ppm.

Sajid *et al.* (2016) revealed that an application of GA₃ at the rate of 250 mg L⁻¹ has maximum plant height (62.0 cm), number of branches (8.65) and leaf area (122.35 cm²) in *Chrysanthemum morifolium*.

Vijayakumar *et al.* (2017^b) studied on the effect of plant growth regulators on vegetative and physiological parameters of China aster (*Callistephus chinensis* L. Nees.) cv. Local and reported that spraying of GA₃ at 150 ppm showed increased plant height (69.03 cm), plant spread (37.64 cm) and number of branches plant⁻¹ (9.25).

Shukla *et al.* (2020) investigated on the effect of plant growth regulators on growth, flower yield and quality of African marigold (*Tagetes erecta* L.) cv Pusa Narangi Gaiinda and Pusa Basanti Gaiinda under the Chhattisgarh plains. The experiments involved a combination of 14 treatments with two plant growth regulators, GA₃ (200 ppm and 300 ppm) and CCC (1000 ppm and 1500 ppm). The results showed that an application of GA₃ 200 ppm + CCC 1000 ppm showed a significantly higher plant height, while GA₃ 300 ppm + CCC 1500 ppm showed the highest plant spread, stem diameter, number of primary and secondary branches per plant.

2.1.2 Effect of plant growth regulators on flowering characters

Girwani *et al.* (1990) reported that all the levels of GA₃ (50 and 100 ppm) reduced the number of days to flowering as compared to the control. However, plants sprayed with GA₃ 50 ppm induced earlier flowering in marigold under Hyderabad conditions.

Dutta *et al.* (1993) carried out an experiment to study the regulation of flowering by growth regulators in chrysanthemum (*Chrysanthemum indicum* L.) cv. Co.1 at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore and reported that GA₃ treatments significantly advanced the formation of flower buds and commencement of flowering. They also noticed that, all the treatments of GA₃ (50, 100 and 150 ppm) significantly increased the duration of flowering which was the longest with the GA₃ @50 ppm.

Deotale *et al.* (1994) carried out an experiment to study the effect of foliar spray of GA₃ on flowering of chrysanthemum during 1993 in *kharif* and *rabi* seasons and they reported that maximum flowering was obtained when the plants were sprayed with 100 ppm GA₃ under Nagpur conditions.

Katkar *et al.* (2005) Spraying of NAA @ 45, 60 and 75 ppm delayed first bud emergence and days to 50 per cent flowering as compare to GA₃ in china aster cv California Giant mix.

Gautam *et al.* (2006) observed that GA₃ (i.e. 50, 100, 150 and 200 ppm) at all levels and NAA at 50 ppm quoted earlier flowering than control. However, extremely early flowering and longest flowering phase were recorded with GA₃ at 150 ppm in chrysanthemum.

Delvadia *et al.* (2009) conducted a field experiment at the Horticultural Instructional Farm, Department of Horticulture, J.A.U, Junagadh during the winter 2004-05 to study the effect of different GA₃ concentration and frequency on growth, flowering and yield in gaillardia and concluded that GA₃ 250 ppm single spray recorded longest flowering duration (91.33 days).

Ghadge *et al.* (2010) reported that, foliar application of GA₃ 200 ppm resulted as lesser number of days required for opening of flower buds (4.01 days) in gaillardia.

Shinde *et al.* (2010) reported that minimum number of days for initiation of flowering and that for peak flowering and maximum duration of flowering were obtained in chrysanthemum plants sprayed with 150 ppm GA₃ under middle Gujarat conditions.

Sharifuzzaman *et al.* (2011) conducted an experiment to evaluate the three different concentrations of GA₃, CCC and MH on the vegetative growth, yield and quality of chrysanthemum” and concluded that, GA₃ reduced the number of days to initiation of flowering (55 days).

Kumar *et al.* (2012) reported that, application of gibberellic acid at 350 ppm resulted in earlier flower bud initiation (40.17 days) and days taken for first flower initiation (58.35 days) in African marigold under Meerut conditions.

Sharma and Joshi (2015) conducted a field experiment to study the effect of foliar spray of plant growth regulators viz., GA₃ and NAA on yield and quality parameters of China aster and reported that GA₃ 250 ppm foliar spray significantly

induced early emergence of flower bud (52.78 days), earliest full blooming of flowers (67.44 days) and longer duration of flowering (82.68 days).

Palei *et al.* (2016) studied on the effect of plant growth regulators on growth, flowering and yield attributes of African marigold and revealed that minimum number of days taken to opening of first flower (83.26 days) was observed with the application of GA₃ 100 ppm and maximum number of days taken to opening of first flower (108.46 days) were found from the plant treated with NAA 100 ppm. GA₃ 100 ppm was found most effective in extending the flower duration (53.16 days) and spray of NAA 100 ppm reduces the duration of flowering.

Sharma *et al.* (2016) studied on the effect of plant growth regulators on growth and flower yield of petunia (*Petunia hybrid L.*) var. Picourty and observed that number of days required for first flower bud emergence (49.87 days) from transplanting was recorded by spray of NAA 45 ppm.

Maurya *et al.* (2017) studied on the effect of GA₃, NAA and CCC on flowering and vase life in China aster (*Callistephus chinensis*) and revealed that spraying of GA₃ 150 ppm resulted in early flowering (62.80 days) as compare to NAA and CCC.

Vijayakumar *et al.* (2017) studied on the effect of plant growth regulators on flower quality, yield and post-harvest shelf life of China aster (*Callistephus chinensis* L. Nees.) cv. Local and evaluated that, spraying of GA₃ at 150 ppm promoted early bud initiation (65.45 days), days taken for first flowering (72.47 days) and days taken for full flowering (88.20 days).

2.1.3 Effect of plant growth regulators on yield characters

Singh *et al.* (1991) conducted an experiment at C. S. Azad University of Agriculture and Technology, Kanpur (U.P.) to study the effect of GA₃ (100 to 500 ppm) on flowering of African marigold (*Tagetes erecta* L.) cv. Sunset Giant and quoted that higher concentrations of GA₃ increased flower yield significantly and also increased the number of flowers plant⁻¹. They also reported that, as compared to control treatment (sprayed with water) flower yield was more in double spraying of GA₃ 400 ppm as compared to control treatment (sprayed with water).

Ashwath *et al.*, (1993) recorded that in China aster growth retardants CCC @ 1500 ppm decreased the plant height and increased the number of main branches.

Dutta *et al.* (1993) obtained highest flower yield with GA₃ at 150 ppm in chrysanthemum.

Deotale *et al.* (1994) studied the effect of foliar spray of GA₃ on yield of chrysanthemum under Nagpur conditions and observed that, flower yield plant⁻¹ increased due to spraying with 150 ppm GA₃.

Talukdar and Paswan (1994) observed that GA₃ at 100 ppm resulted in significantly more flowers plant⁻¹ than the control in chrysanthemum under Assam conditions.

Gupta and Datta (2001) observed maximum flower yield with GA₃ at 100 ppm in chrysanthemum under Lucknow conditions.

Kadam *et al.* (2002) also reported that, GA₃ at 200 ppm resulted in maximum flower yield in China aster under Parbhani conditions.

Kore *et al.* (2003) conducted an experiment at Dr. B.S.K.K.V. Dapoli, Maharashtra (India) during *rabi* 2001-02 to study the effect of gibberellic acid (GA₃) on yield of China aster under Konkan agro- climatic conditions reported that GA₃ at 200 ppm produced the highest flower yield ha⁻¹ than the other treatments of GA₃ i.e. 100 and 300 ppm.

Mohariya *et al.* (2003) found that gibberellic acid at 150 ppm recorded the highest flower yield by weight per plant in different varieties of chrysanthemum.

Tripathi *et al.* (2003) conducted a field trial during the winter season of the year 1998-99 at Society for the Advancement of Horticulture, Etawah, (Uttar Pradesh) to determine the optimum concentration of gibberellic acid (GA₃) for application on French marigold and they reported that, spraying of GA₃ at 400 ppm resulted in the highest number of flowers and flower yield plant⁻¹.

Singh (2004) reported that GA₃ at 200 ppm increased the number of flowers per plant, followed by GA₃ at 100 ppm in French marigold.

Singhrot *et al.* (2004) conducted an experiment at Hisar, (Haryana) during 1999-2000 and 2000-01 to determine “The effect of GA₃ (0, 50, 100, 150 and 200 ppm) on the yield and quality of Chrysanthemum cultivars Flirt and Gauri and concluded that the yield of flowers plant⁻¹ was the highest in plants sprayed with 200 ppm GA₃ in both the cultivars.

Moond and Rakesh (2006) carried out an experiment on chrysanthemum to study growth and flowering response of GA₃ (50, 100, 150, 200 and 250 ppm) under field conditions and noted that the highest flower yield plant⁻¹ as well as plot⁻¹ were recorded with GA₃ at 150 ppm.

Tyagi and Kumar (2006) recorded that GA₃ at 200 ppm gave maximum number of flowers plant⁻¹ and yield of flowers per plant in African marigold under Meerut conditions.

Pandey and Chandra (2008) conducted an experiment on the effect of GA₃ and NAA on growth and flowering of French marigold (*Tagets patula*) in Department of Horticulture, Janta P.G. College, Bakewar, Etawah (U.P.) concluded that, GA₃ 450 ppm significantly increased number of flowers (55.67) and yield of flowers plant⁻¹ (89.23 g) as compared to other treatments.

Delvadia *et al.* (2009) conducted a field experiment at the Horticultural Instructional Farm, Department of Horticulture, J.A.U, Junagadh during the winter 2004-05 to study the effect of different GA₃ concentration and frequency on growth, flowering and yield in gaillardia and concluded that GA₃ 250 ppm single spray recorded maximum number of flowers (150.48) and highest flower yield ha⁻¹ (18.06 t).

Ramdevputra *et al.* (2009) recorded that, 100 ppm GA₃ resulted in maximum number of flowers plant⁻¹ and flower yield plant⁻¹ in African marigold under Junagadh (Gujarat) conditions.

Kumar *et al.* (2012) reported that gibberellic acid application at 350 ppm was found most effective as it gave the highest flower yield plant⁻¹ and the highest number of flowers plant⁻¹ in African marigold.

Kumar *et al.* (2014) carried out experiment in Department of Horticulture, R.K. (P.G.) College, Shamli, (U.P.) to study the response of GA₃ and NAA on growth and flowering of Calendula (*Calendula officinalis*) concluded that maximum number of flowers plant⁻¹ (19.50) recorded by application of GA₃ 160 ppm.

Sharma and Joshi (2015) conducted a field experiment to study the effect of foliar spray of plant growth regulators viz., GA₃ and NAA on yield and quality parameters of China aster and reported that, GA₃ @ 250 ppm foliar spray significantly enhanced flower yield in terms of number of flowers per plant (55.78).

Palei *et al.* (2016) studied on the effect of different plant growth regulators on growth, flowering and yield attributes of African marigold and revealed that maximum number of flowers per plant (65.76) obtained with the spray of GA₃ 100 ppm.

Sharma *et al.* (2016) studied on the effect of plant growth regulators on growth and flower yield of petunia (*Petunia hybrid L.*) var. Picourty and observed that an application of GA₃ 200 ppm has maximum number of flowers per plant (54.47) and significantly yield of flowers per plant (105.73 g), per plot (951.60 g) and per hectare (3524.09 t).

Vijayakumar *et al.* (2017^a) studied on the effect of plant growth regulators on flower quality, yield and post-harvest shelf life of China aster (*Callistephus chinensis* L. Nees.) cv. Local and evaluated that spraying of GA₃ increased number of flowers plant⁻¹ (52.20) at 150 ppm.

2.1.4 Effect of plant growth regulators on quality characters

Katkar *et al.* (2005) reported that foliar spray with GA₃ @ 200 ppm recorded maximum vase life followed by 500 ppm in china aster.

Ramdevputra *et al.* (2009) recorded that 100 ppm GA₃ resulted in maximum weight of flowers plant⁻¹ in African marigold.

Sharma and Joshi (2015) conducted a field experiment to study the effect of foliar spray of plant growth regulators viz., Gibberellic acid (GA₃) and 1-

Naphthaleneacetic acid (NAA) on yield and quality parameters of China aster and reported that GA₃ @ 250 ppm foliar spray enhanced flower fresh and dry weight, flower diameter (5.73 cm) and flower weight per plant (117.97 g).

Sajid *et al.* (2016) revealed that an application of GA₃ at the rate of 200 mg L⁻¹ exhibited maximum flower size (5.49 cm) and flower fresh weight (3.44 g) in *Chrysanthemum morifolium*.

Maurya *et al.* (2017) studied on the effect of GA₃, NAA and CCC on flowering and vase life in China aster (*Callistephus chinensis*) and revealed that spraying of GA₃ 150 ppm resulted in increased number of flowers per plant (75.73).

Vijayakumar *et al.* (2017) studied on the effect of plant growth regulators on flower quality, yield and post-harvest shelf life of China aster (*Callistephus chinensis* L. Nees.) cv. Local and evaluated that spraying of GA₃ at 150 ppm increased and flower weight (3.92 g).

Pragnya Parmita Mishra *et al.* (2018) evaluated that influence of various concentrations of gibberellic acid and spraying frequencies on growth, flowering and post harvest parameters of China Aster (*Callistephus chinensis* L. Nees) cv. Arka Archana and Arka Shashank” observed that thrice application of GA₃ @ 200 ppm recorded the best result to the shelf life of flowers.

Sindhuja *et al.* (2018) studied on the effect of different plant growth regulators and their levels on floral yield and vase life of China aster (*Callistephus chinensis* L. Nees) cv. Shashank and concluded that the maximum vase life of flowers were noticed from the plants grown in plots by receiving GA₃ @ 200 ppm.

2.2 Experiment–II: Effect on different levels on nitrogen and phosphorus on growth, flowering, yield and quality of China aster (*Callistephus chinensis* (L.) Nees).

2.2.1 Effect of Nitrogen and Phosphorus levels on vegetative growth.

Mokashi *et al.* (1988) reported that the highest plant height, number of branches and number of leaves was obtained with increased levels of N and P was noticed in *Gaillardia*.

Arulmozhiyan and Pappaiah (1989) reported that higher plant height of the marigold was obtained by adding 120 kg N and 90 kg P₂O₅ per ha.

Venugopal (1991) concluded that the increased in plant height, number of branches, number of leaves, leaf area and development of dry matter production in everlasting flowers were observed, with an increase in nitrogen levels of up to 200 kg/ha.

Raghuraja (1992) evaluated that increased plant height, number of leaves and total production of dry matter at the expense of flower yield by applying higher nitrogen levels (150 and 200 kg/ha).

Ryagi (1994) investigated that the higher plant height, number of leaves, leaf area and total dry matter production were observed due to increased nitrogen application levels.

Rajadurai *et al.* (2000) carried out an experiment on the effect of application of NPK on growth flowering yield of China aster at 45: 45: 37.5 kg ha⁻¹ exhibited increased growth with respect to plant height (144.50 cm), number of leaves (156.20) and lateral branches per plant (28.30). The plants treated with 45 mg N and 45 mg P₂O₅ kg⁻¹ with recorded a leaf area of 106.70, 55.70, and 96.70 cm² at 30, 60 and 90 days after planting respectively.

Venugopal and Patil (2000) investigated on the effect of graded levels of nitrogen on growth and flowering of everlasting flower (*Helichrysum bracteatum*) cv. 'Tall Double Mixed' at Dharwad, Karnataka and found that plant height, number of branches and leaves per plant were highest with 200 kg N ha⁻¹.

Kaur and Kumar (2001) studied on the effect of different levels of N on verbena under Ludhiana conditions and found that plant height, number of primary and secondary branches, number of leaves and plant spread increased significantly with the application of N at 20 gm⁻² and 30 gm⁻².

Birade *et al.* (2003) carried out an experiment to examine the effects of graded levels of NPK on the growth of China aster (*Callistephus chinensis* L.Nees) cv.

‘Alandi Local’ under Maharashtra condition. An application of 150:100:75 kg NPK ha⁻¹ were found to be beneficial for growth and development of China aster.

Acharya and Dashora (2004) observed that plant height, plant spread and number of branches were recorded highest with an application of 200 kg N and 200 kg P₂O₅ ha⁻¹.

Gaikwad *et al.* (2004) investigated to study the different levels of nitrogen (150, 200 and 250 kg/ha as urea) and phosphorus (100, 125 or 150 kg/ha as single superphosphate) rates on the performance of *C. chinensis* (cv. Phule ganesh white). Among the Nitrogen rates, 250 kg/ha resulted in the tallest plants (100.28) and plant spread (31.17 and 27.77 cm), number of branches per plant (22.51 and 21.01), flowering duration (28.62 & 27.77 days). Flower per plants (1754.91 & 1726.06) and weight of flower per plot (9.95 & 9.90) and weight of flower per hectare (29.61 & 29.48 t) and number of days of flowering (76.31 and 77.01)

Yadav *et al.* (2004) concluded that an application of 180 kg N ha⁻¹ recorded the highest plant height (70.10 cm), plant spread (48.37 cm), number of leaves (177.62) and number of primary (16.44) and secondary (79.28) branches in marigold (*Tagetes erecta* L.) was recorded under Raipur, Chhattisgarh condition.

Pandey *et al.* (2005) carried out a study on the effects of sowing date and nitrogen rate on the growth of aster (*Callistephus chinensis*) at Jabalpur, Madhya Pradesh. The treatments comprised of four nitrogen rates *i.e.* 0, 100, 200 and 300 kg ha⁻¹. The results revealed that an application of 300 kg N ha⁻¹ was found the best for growth of China aster.

Sharma *et al.* (2006) added four nitrogen levels, *i.e.* 50, 100, 150 and 200 kg ha⁻¹ and two phosphorus levels each, *i.e.* 50 and 100 kg ha⁻¹. The results showed that the application of 200 kg N ha⁻¹ and 100 kg P₂O₅ ha⁻¹ at 40 days after transplantation resulted in maximum growth of plants, number of branches, plants spread,

Gani (2007) reported that an increasing of N and P₂O₅ levels have significantly increased the spread of the plant, the number of leaves, the height of the plant and the number of branches per plant. The better growth and dahlia

production were reported by the combination of 80 kg N and 60 kg P₂O₅ ha⁻¹.

Kishan *et al.* (2007) studied on the influence of nitrogen and phosphorus on growth of African marigold (*Tagetes erecta* L.) cv. 'Pusa Narangi Gaiinda' at IARI, New Delhi". There were four doses of nitrogen and phosphorus each *i.e.* 0, 40, 80 and 120 kg N and 0, 25, 50 and 75 kg P₂O₅ ha⁻¹, respectively. An increase in plant height (67.91 cm), plant spread (65.16 cm), number of primary (16.50) and secondary branches (56.83) were estimated for the application of 120 kg N ha⁻¹. In addition, an application of 75 kg of P₂O₅ ha⁻¹ recorded the maximum height of the plant (59.75 cm) and number of secondary branches (43.25).

Pushkar *et al.* (2008) conducted an experiment on the effect of N and phosphorus on growth of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gaiinda during the winter season. An application of chemical fertilizer (200 kg N, 80 kg P₂O₅, 80 kg K₂O) recorded the maximum value of growth characteristics, namely, plant height, main stem diameter, number of primary branches per plant, length of primary branches and number of leaves among the different treatments.

Ahmad *et al.* (2010) studied on the effects of various NPK levels on growth of African marigold (*Tagetes erecta* L.) cv. 'Double Eagle' and French marigold (*Tagetes patula* L.) cv. Yellow and results were outlined as the plant height, number of branches per plant and leaf area (cm²) found maximum with 15:10:10 g per m² NPK application.

Rupa (2010) noted that the China aster plants supplied with 180 kg N ha⁻¹ were dominant in terms of plant characteristics, plant height, number of primary and secondary branches, number of leaves and spread of plants.

Dorajeerao *et al.* (2012) investigated on the effect of nitrogen and phosphorus levels on growth and yield of garland chrysanthemum. The study revealed that number of flowers per plant was found maximum at 150 kg nitrogen and 100 kg phosphorus per ha during both *kharif* and *rabi* seasons.

Wani *et al.* (2013) investigated on influence of nitrogen and phosphorus on growth of China aster (*Callistephus chinensis* L. Nees) cv. 'American beauty' at Bandipora, Jammu and Kashmir. The experiment consisted of four nitrogen levels

(i.e. 0, 20, 25, 30 g m⁻²) and three phosphorus levels (i.e. 0, 15, 20 g m⁻²). The findings showed that increased nitrogen and phosphorus levels reacted significantly with growth characteristics such as plant height, plant spread, number of China aster's primary and secondary branches, etc.

Chandana and Dorajeerao (2014) studied on the effect of graded doses of nitrogen and phosphorus on growth and yield of gladiolus at Horticultural College and Research Institute, Venkataramannagudem and it showed that, with a nitrogen dose of 300 kg ha⁻¹, the highest spike yield was obtained with application of phosphorus dose @ 200 kg ha⁻¹, both individually and in combination. The highest dose of nitrogen was exhibited maximum vegetative parameters such as plant height, number of leaves and leaf area were reported at 300 kg ha⁻¹ and phosphorus at 200 kg ha⁻¹.

Sajid and Amin (2014) conducted an experiment to evaluate the impact of various N, P and K combinations on enhancing the flowering time in chrysanthemum (*Chrysanthemum morifolium*) at Hazara Agriculture Research Station Abbottabad, Pakistan. They observed that an application of fertilizer with N+P+K combination was significantly increased the plant height and leaf area.

Kumar *et al.* (2016) reported that the growth characters viz. plant height (54.48 cm), spread of the plant (19.50 cm), girth of the stem (22.68 cm) and number of secondary branches (22.20 cm) and floral characters such as early flowering, length of the flower stalk increased (34.00 cm), flower diameter (46.58 cm) number of flowers bud per plant (26.80) duration of flowering (21.40 days) as well as field life influenced by 150 kg N/ha. The days to flower initiation (67.20 days) significantly decreases with treatment of N 150 kg/ha. However, maximum dry weight of single flower (0.42 g) was noticed with treatment of N 175 kg/ha in China aster.

Maheta *et al.* (2016) reported that an application of N (300 kg ha⁻¹), both the highest level of N and P₂O₅ significantly improved growth parameters in China aster, i.e. plant height (51.56 cm), plant spread (328.67 cm²) and number of secondary branches per plant (17.67), whereas with phosphorus, the plant height

(47.08 cm), plant spread (316.00 cm²) and number of secondary branches per plant (16.92) was observed highest with application of P₂O₅ @200 kg ha⁻¹.

Ghormade *et al.* (2018) studied on effect of Nitrogen and Phosphorous on Growth of China Aster [*Callistephus chinensis* (L.) Nees] carried out at experimental farm of department of Floriculture and Landscaping, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) during the years 2012-2013. The China aster cv. 'Kamini' was selected and maximum number of branches per plant (7.01) recorded with 30 g N/m² that proved superior over other treatments including control. The largest leaf area (21.72 cm²) found with a combined application of 30 g N/m² and 25 g P₂O₅/m². However, minimum leaf area (9.82 cm²) recorded in plants supplied with 40 g N/m² and 25 g P₂O₅/m².

2.2.2. Effect of Nitrogen and Phosphorus levels on flowering, yield and quality attributes.

Waters (1967) reported that an application of reduced nitrogen fertilizers or complete fertilizers throughout later part of the growing season enhanced the holding efficiency. It was appropriate to apply a 1:1 ratio of nitrogen and potash during the initial one-third season and a 0:2 or 1:2 ratio during the later one-third season to produce flowers of excellent chrysanthemum quality.

Mantur (1988) reported that the higher flower yield was obtained by using higher fertilizer doses of 180 kg N, 120 kg P₂O₅ and 75 kg K₂O.

Sharanabasappa (1990) observed with an application of N and P₂O₅, the maximum flower yield in *Helichrysum* was 150 kg and 100 kg per hectare respectively.

Jana and Pal (1991) observed that the flower diameter increased significantly at higher levels of N and P in the *Cosmos*.

Agrawal *et al.* (2002) conducted an experiment on the effect of nitrogen and potassium on African marigold (*Tagetes erecta*). The treatment consisted of 4 nitrogen doses, i.e. 0, 100, 200 and 300 kg ha⁻¹, and 3 potassium levels, i.e. 0, 100

and 200 kg ha⁻¹. An increase in nitrogen and potassium levels (300 kg ha⁻¹ and 200 kg ha⁻¹ respectively) have been found to increase the number of flowers per plant, the diameter of the flowers and the yield of the flowers.

Jayaprabha and Shakila (2002) delineated the flower yield was found to be maximum with application of 150 kg of nitrogen ha⁻¹ in the case of Cockscomb. Birade *et al.* (2003) carried out an experiment to examine “The effects of graded levels of NPK (00:00:00; 100:75:50; 150:100:75; and 200:125:100 kg NPK ha⁻¹.) on the quality and flower production of China aster (*Callistephus chinensis* L. Nees) cv. ‘Alandi Local ‘under Maharashtra conditions’. The application of 150:100:75 kg NPK ha⁻¹ were found to be beneficial for profuse quality and flower production of China aster.

Kumar *et al.* (2003) conducted an experiment on six-week-old China aster seedlings. The treatments included fertilizers containing 4 levels of nitrogen (0, 100, 200, 250 and 300 kg/ha) and 3 levels of phosphorus (0, 100, 150 and 200 kg/ha) in split and maximum doses, respectively. Days to first flower bud (60.50), flowers per plant (35.22), flower diameter (5.13 cm) and flowering duration (37.45 days) were found highest with application of 300 kg N/ha. Similar results were observed with 200 kg P/ha treatments.

Gaurav *et al.* (2004) reported the interaction of NPK applied @ 20:20:15 gm⁻² per month to the gerbera cv. ‘Sunway’. The nutritional treatment produced significantly more flowers per plant with a large flower diameter compared to other different nutritional levels.

Grewal *et al.* (2004) the nutritional studied on chrysanthemum cv. ‘Flirt’ and reported that maximum number of flower per plant with an application of 30 g N m⁻².

Sreekanth *et al.* (2006) conducted field studied to determine the yield and quality of African marigold (*Tagetes erecta* L.)” at Hyderabad, Andhra Pradesh and the results showed that plants applied with 100 kg N ha⁻¹ had highest flower diameter and yield per plant.

Monish *et al.* (2008) observed that the higher concentrations of nitrogen and phosphorus *i.e.* 300 Kg N and 200 Kg P₂O₅ respectively. The maximum number of flowers, the largest flower size, the longest flowering period, the maximum weight

of fresh and dry flower and the highest flower yield in China aster.

Sonawane *et al.* (2008) concluded that an application of nitrogen at 200 kg ha⁻¹ and phosphorus at 75 kg ha⁻¹ was found to be effective in China to achieve a significant maximum flower yield over other nitrogen and phosphorus levels.

Baloch *et al.* (2010) investigated on the effect of different nitrogen and phosphorus levels on the growth and flower production of *Zinnia elegans* L.) and evaluated nitrogen (10, 30 and 50 g, 1.5 m⁻²) and phosphorus (10 and 20 g, 1.5 m⁻²) increased flower yield and yield attributes.

Wen Jun *et al.* (2010) studied on the effects of nitrogen, phosphorus and potassium fertilizer on the growth, blossom and N, P, K uptake in (*calendula officinalis* L.)". Data indicated that the recommended fertilizers doses (using N-P₂O₅-K₂O: (0.4-0.2-0.3) g kg⁻¹) significantly promoted flowering during the growing period in comparison to the control (no fertilization).

Pushkar and Rathore (2011) studied on the effect of chemical fertilizers on yield of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi gainda" and reported increased in flower size and yield per plant with 200 kg N, 80 kg P₂O₅ and 80 kg K₂O ha⁻¹.

Maharnor *et al.* (2012) investigated on the effect of nitrogen on yield and quality of African marigold" was investigated at Nagpur, India. The treatments consisting of four doses of nitrogen *i.e.* 0, 50, 100 and 150 kg N ha⁻¹ respectively and a cumulative total flowering time were noted at 150 kg N ha⁻¹.

Mohammadreza *et al.* (2012) studied on the effect of various levels of nitrogen, phosphorus and potassium fertilizers on German chamomile. The three levels each of nitrogen, phosphorus and potassium *i.e.*, 0, 25 and 50 kg ha⁻¹ were tested and maximum yield of flowers (1368.4 kg ha⁻¹) was obtained using 100 kg N ha⁻¹ and 50 kg P₂O₅ ha⁻¹.

Amin *et al.* (2013) investigated on the effect of potassium levels on flowering of tuberose. The experiment consists of four levels of potassium *i.e.* 0, 170, 180 and 190 kg K₂O ha⁻¹. The data showed that the higher flower yield (16.4 t ha⁻¹) was observed with application of 190 kg K₂O ha⁻¹.

Wani *et al.* (2013) conducted an experiment to determine the influence of nitrogen and phosphorus on flower production of China aster (*Callistephus*

chinensis L. Nees) cv. American beauty” at Bandipora, Jammu and Kashmir and noted that increased in the level of nitrogen as well as phosphorus had a significant response on the flowering of China aster.

Kumar and Kumar (2014) found that the application of 300 kg N + 200 kg P_2O_5 was the most suitable combination with respect to number of flowers per plant, flower diameter, flower weight and flower yield per plant.

Kumar and Kumar (2014) conducted a field experiment to study the effect of nitrogen and phosphorus levels on growth, flowering and yield of China aster (*Callistephus chinensis* (L). Nees)” At kumarganj, Faizabad (UP), India during the year 2012-13 with four levels nitrogen @ 0,100,150,200 Kg/ha. The number of flowers per plant, flower diameter, flower weight and flower yield per plant and per hectare.

Kishore (2015) studied on the effect of different levels of nitrogen, phosphorus and potassium on flowering of African marigold cv. Pusa Narangi” at Muzaffarnagar (UP) during the winter season and reported that 150 kg N ha⁻¹, 100 kg P_2O_5 ha⁻¹ and 30 kg K_2O ha⁻¹ were found suitable for higher yield of African marigold in western plain zone of UP.

Kumar *et al.* (2016) studied that an application of Nitrogen @ 150 kg ha⁻¹ treatment revealed early flowering, increased flower stalk length, flower diameter, ray florets, number of flower buds per plant, flower period and increased yield. However, maximum dry weight of single flower was noticed with treatment of N 175 kg ha⁻¹ in China aster cv. ‘Kamini’.

Maheta *et al.* (2016) conducted an experiment at Horticulture Research Station, Jambavati Farm, Junagadh Agricultural University, Gujarat and reported that in China aster. The maximum flowering span (79.11 days), number of flowers per plant (24.78) and yield of flowers (22.67 t ha⁻¹) were reported for the treatment with application of 300 kg N ha⁻¹.

Ahmed *et al.* (2017) evaluated that the highest number of flowers /plant, flower diameter and individual flower weight was recorded by the application of nitrogen at 150kg/ha, in combination with 75 kg/ha phosphorus and 135 kg/ha potassium in chrysanthemum.

Teja *et al.* (2017) studied on the effect of graded levels of nitrogen and potassium on growth and flower yield of annual chrysanthemum (*Chrysanthemum coronarium* L.) at Dr. YSR Horticultural University, Venkataramannagudem. The study had revealed that number of flower per plant or per plot or per hectare was found significantly maximum with the application of nitrogen @ 200 kg/ha in combination with the potassium applied @ 100 kg/ha.

Ashish S. Ghormade *et al.* (2018) studied on the effect of Nitrogen and Phosphorous on Growth of China Aster [*Callistephus chinensis* (L.) Nees] at experimental farm of department of Floriculture and Landscaping, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) during the years 2012-2013. The China aster cv. 'Kamini' was selected for conducting the investigation and the maximum number of flowers per plot, yield per plant, yield per plot and yield per hectare recorded with a combined application of 30 g N/m² and 20 g P₂O₅/m².

MATERIALS AND METHODS

The present investigation was carried out to study on the “**Standardization of Different Concentrations of Plant Growth Regulators and Levels of Nitrogen, Phosphorus on Growth, Flowering, Yield and Quality of China Aster (*Callistephus chinensis* (L.) Nees) Under Chhattisgarh Conditions**” at the Horticulture Research cum Instructional Farm, Department of Floriculture and Landscape Architecture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G) during two *Rabi* seasons of 2018-19 and 2019-20. The details of materials used and methods adopted during the course of investigations are presented below.

3.1 Geographical location of the experimental site

The experimental site is situated in the agro-climatic region of Chhattisgarh. Geographically, Raipur is situated in the transitional tract of Chhattisgarh at 21°29' North latitude and 81° 82' East longitude at an altitude of 250-300 m above the mean sea level.

3.2 Agro - Climate condition

The experimental area comes under the 7th Agro - climatic region of India *i.e.* “Eastern Plateau and Hills” which is classified as sub-humid with hot summer and cold winter. The climate of Chhattisgarh is tropical. It is hot and humid because of its proximity to the Tropic of Cancer and its dependence on the monsoons for rains. Summer temperatures in Chhattisgarh can reach up to 45 °C (113 °F). The atmospheric relative humidity is relatively high during the months of June - October. Chhattisgarh receives an average of 1,29 millimetres (50.9 in) of rain. Winter is from November to January. Winters are pleasant with low temperatures and less humidity.

3.2.2 Weather conditions during crop growing period

Meteorological data on temperature, rainfall, relative humidity and sunshine hours was recorded during the cropping period at the Meteorological Observatory Unit, Department of Agro-meteorology, IGKV, Raipur. All the meteorological data are presented in Appendix I and II and illustrated graphically in Fig. 3.1 and 3.2.

During the cropping season namely *Rabi season* during two consecutive years *i.e.*, (2018-19) and (2019-20) the total amount of annual rainfall received was 83.40 mm and 309.40 mm, respectively. The maximum and minimum temperatures were 40.8°C in 3rd week of April and 8.5°C in 1st week of January respectively during the year (2018-19). The maximum and minimum temperatures were 35.1°C in 4th week of April and 10.8°C in 2nd week of January, respectively during the year (2019-20). The average wind velocity ranges from 3.8-4.4 (Kmph) during (2018-19) and 3.9-4.5 (Kmph) during (2019-20) respectively, Apart from this, other weather parameters were recorded in respective seasons of both years. Relative humidity was ranged from 71.00 to 92.00 per cent during first year (2018-19) and 76.00 to 94 per cent second during year (2019-20). During the experimentation no define pattern was observed both the years regarding sunshine hours. The weather conditions during the course of investigation remained favourable for the growth, development and production of China Aster.

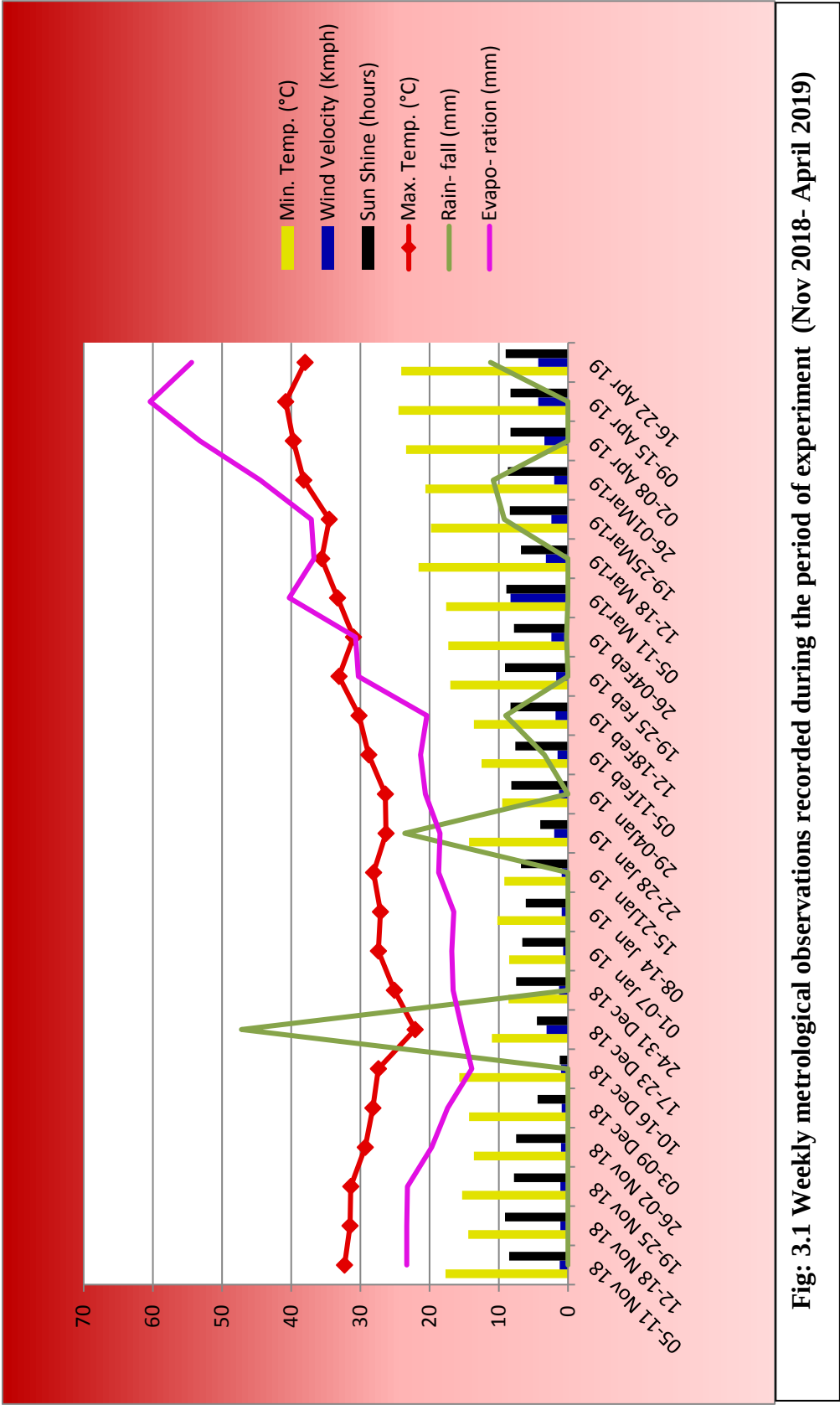
3.3 Physico-chemical properties of soils

During both the years of study composite soil samples from 0-15 cm soil depth were collected before start of experiment. After crop harvesting during both the years of experimentation soil samples from 0-15 cm soil depth from each plot were collected to ascertain the effect of NPK levels on pH, electrical conductivity, organic carbon, available N, P, K. Collected soil samples were air dried in shade and ground with the help of pestle and mortar, passed through 2 mm sieve and stored in polythene bags for further analysis as per the method given in Table 3.1.

The obtained status of soil physio-chemical property is presented in Table 3.1. The soil of the experimental field was clay-loam in texture (*Vertisols*), having good drainage capacity and locally known as “Kanhari”. The soil was neutral in reaction and available nitrogen, phosphorus and potassium content were low, medium and high, respectively.

Table 3.1: Physio-chemical properties of the soil (0-30 cm soil depth) during year 2018-19 and 2019-20

	Values		Rating	Method followed
	2018-19	2019-20		
A. Physical properties				
1. Mechanical composition			Clay loam	International Pipette method (Black, 1965)
Sand (%)	32.16	29.33		
Silt (%)	34.24	31.13		
Clay (%)	41.12	40.51		
B. Chemical properties				
1. Organic carbon (%)	0.62	0.54	Medium	Walkley and Blacks rapid titration method (Jackson, 1967)
2. Available N (kg ha ⁻¹)	237.41	232.18	Low	Alkaline permanganate method (Subbiah and Asija, 1956)
3. Available P (kg ha ⁻¹)	18.02	19.04	Medium	Olsen“s” method (Olsen, 1954)
4. Available K (kg ha ⁻¹)	332.31	325.17	Medium	Flame photometric method (Hanway and Heidal (1952)
5. pH (1:2.5 soil: water)	7.01	7.29	Neutral	Glass electrode pH meter (Piper, 1967)
6. EC (dSm ⁻¹ at 25°C)	0.39	0.37	Normal	Solubridge conductivity method (Black, 1965)



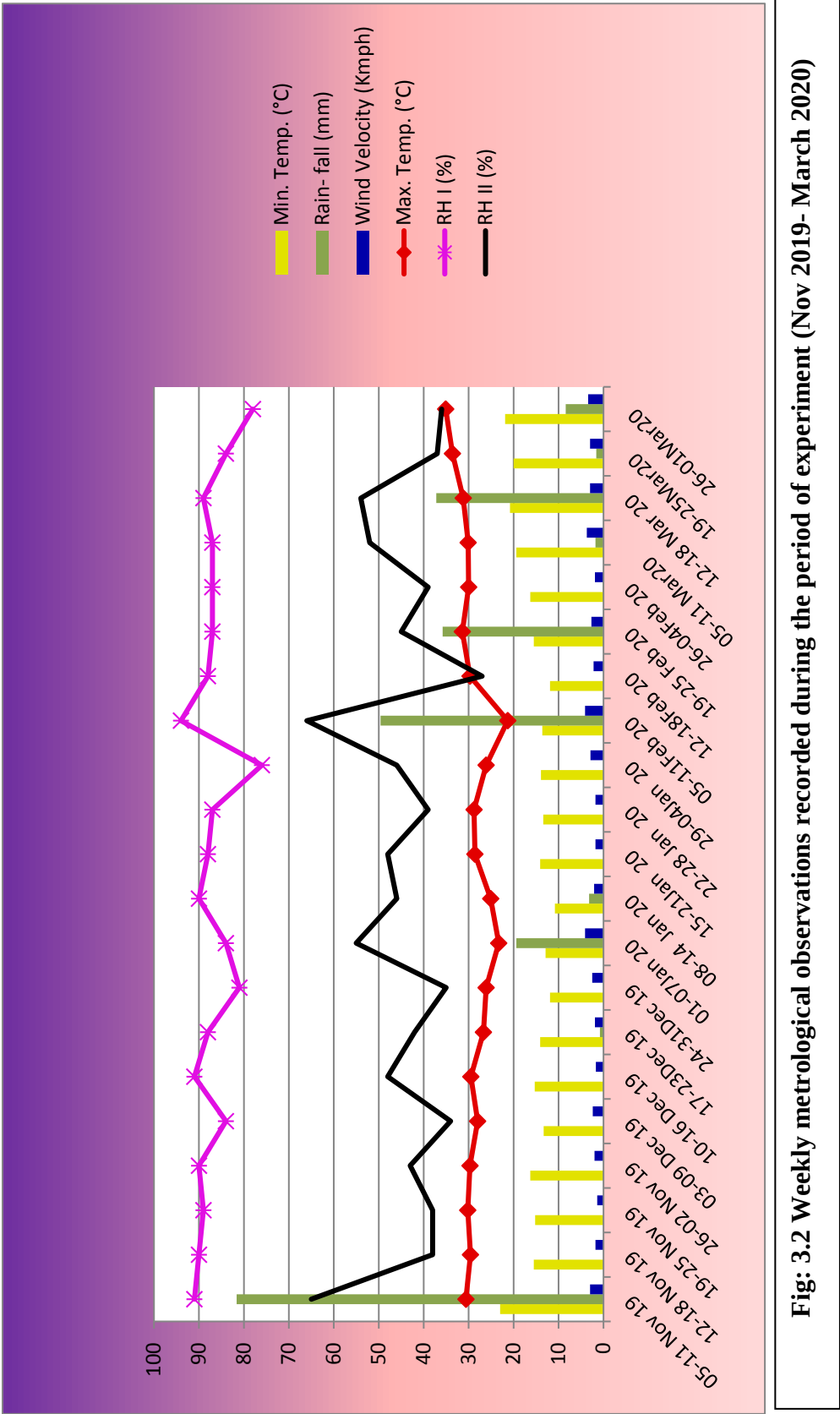


Fig: 3.2 Weekly meteorological observations recorded during the period of experiment (Nov 2019- March 2020)

3.4 Details of Experiment

3.4.1 Experiment I: Effect on different concentrations of plant growth regulators on growth, flowering, yield and quality of China aster (*Callistephus chinensis* (L.) Nees).

The experimental field was laid out in *Factorial* Randomized Block Design (FRBD) with three replications. There were 14 treatment combinations of two varieties viz. Arka Shashank and Arka Archana as factor A and three plant growth regulators with two doses each i.e., Cycocel @ 1500, 1000 ppm, NAA @ 50, 100 ppm and GA₃ @150, 200 along with water spray (control) as factor B. The experiment details and treatments details are given below:

Experimental details

Crop	:	China Aster
Planting material	:	By seed
Number of varieties	:	02
Number of treatments	:	14
Number of replications	:	03
Number of plots	:	42
Number of seasons	:	02 (2018-2019 and 2019-2020)
Spacing	:	30 × 30 cm
Gross plot size	:	1.5 × 1.5 m
Design of the experiment	:	<i>Factorial</i> Randomized Block Design

Treatment details

Factor A			
		Variety	Notation
		Arka Shashank	V ₁
		Arka Archana	V ₂
Factor B			
		Plant growth regulator	Notation
	Control	No PGR (Water spray)	P ₀

	Cycocel	1000 ppm	P ₁
		1500 ppm	P ₂
	NAA	50 ppm	P ₃
		100 ppm	P ₄
	GA ₃	150 ppm	P ₅
		200 ppm	P ₆

Treatment combinations

There were seven PGR doses which were applied in two varieties of China aster; hence there are 14 treatments combinations.

T ₁	V ₁ P ₀	Arka Shashank + Control
T ₂	V ₁ P ₁	Arka Shashank+ Cycocel @ 1000ppm
T ₃	V ₁ P ₂	Arka Shashank+ Cycocel @ 1500 ppm
T ₄	V ₁ P ₃	Arka Shashank+ NAA @ 50 ppm
T ₅	V ₁ P ₄	Arka Shashank+ NAA @ 100 ppm
T ₆	V ₁ P ₅	Arka Shashank+ GA ₃ @ 150 ppm
T ₇	V ₁ P ₆	Arka Shashank + GA ₃ @ 200 ppm
T ₈	V ₂ P ₀	Arka Archana + Control
T ₉	V ₂ P ₁	Arka Archana + Cycocel @ 1000ppm
T ₁₀	V ₂ P ₂	Arka Archana + Cycocel @ 1500 ppm
T ₁₁	V ₂ P ₃	Arka Archana + NAA @ 50 ppm
T ₁₂	V ₂ P ₄	Arka Archana + NAA @ 100 ppm
T ₁₃	V ₂ P ₅	Arka Archana + GA ₃ @ 150 ppm
T ₁₄	V ₂ P ₆	Arka Archana + GA ₃ @ 200 ppm

3.4.2 Experiment II: Effect on different levels on nitrogen and phosphorus on growth, flowering, yield and quality of China aster (*Callistephus chinensis* (L.) Nees).

The experiment was conducted in *Factorial* Randomized Block Design with 24 treatments comprising of two varieties viz. Arka Shashank and Arka Archana as factor A and four levels of Nitrogen, i.e, (120, 140, 160, 180 kg/ha), and three levels of Phosphorus (100, 120, 140 kg/ha) as factor B. The doses of

Nitrogen and Phosphorus were applied in two splits with constant dose of potassium (60kg/ha) were applied in the field. The experiment details and treatments details are given below.

Experimental details

Crop	: China Aster
Planting material	: By seed
Number of varieties	: 02
Treatments	: 24
Number of replications	: 03
Number of plots	: 72
Number of seasons	: 02 (2018-2019 and 2019-2020)
Spacing	: 30 × 30 cm
Plot size	: 1.5 × 1.5 m
Design of the experiment	: <i>Factorial</i> Randomized Block Design

Treatment details

Factor A	Name of the variety	Notation
	Arka Shashank	V ₁
	Arka Archana	V ₂
Factor B	Fertilizer	Notation
	N ₁₂₀ : P ₁₀₀	F ₁
	N ₁₂₀ : P ₁₂₀	F ₂
	N ₁₂₀ : P ₁₄₀	F ₃
	N ₁₄₀ : P ₁₀₀	F ₄
	N ₁₄₀ : P ₁₂₀	F ₅
	N ₁₄₀ : P ₁₄₀	F ₆
	N ₁₆₀ : P ₁₀₀	F ₇
	N ₁₆₀ : P ₁₂₀	F ₈
	N ₁₆₀ : P ₁₄₀	F ₉
	N ₁₈₀ : P ₁₀₀	F ₁₀
	N ₁₈₀ : P ₁₂₀	F ₁₁
	N ₁₈₀ : P ₁₄₀	F ₁₂

Treatment combinations

There were 12 fertilizers doses which were applied in two variety of China aster; hence there are 24 treatment combinations.

Symbol	Treatment	Combination
T ₁	V ₁ F ₁	Arka Shashank+ N ₁₂₀ : P ₁₀₀
T ₂	V ₁ F ₂	Arka Shashank+ N ₁₂₀ : P ₁₂₀
T ₃	V ₁ F ₃	Arka Shashank+ N ₁₂₀ : P ₁₄₀
T ₄	V ₁ F ₄	Arka Shashank+ N ₁₄₀ : P ₁₀₀
T ₅	V ₁ F ₅	Arka Shashank+ N ₁₄₀ : P ₁₂₀
T ₆	V ₁ F ₆	Arka Shashank+ N ₁₄₀ : P ₁₄₀
T ₇	V ₁ F ₇	Arka Shashank+ N ₁₆₀ : P ₁₀₀
T ₈	V ₁ F ₈	Arka Shashank+ N ₁₆₀ : P ₁₂₀
T ₉	V ₁ F ₉	Arka Shashank+ N ₁₆₀ : P ₁₄₀
T ₁₀	V ₁ F ₁₀	Arka Shashank+ N ₁₈₀ : P ₁₀₀
T ₁₁	V ₁ F ₁₁	Arka Shashank+ N ₁₈₀ : P ₁₂₀
T ₁₂	V ₁ F ₁₂	Arka Shashank+ N ₁₈₀ : P ₁₄₀
T ₁₃	V ₂ F ₁	Arka Archana + N ₁₂₀ : P ₁₀₀
T ₁₄	V ₂ F ₂	Arka Archana + N ₁₂₀ : P ₁₂₀
T ₁₅	V ₂ F ₃	Arka Archana + N ₁₂₀ : P ₁₄₀
T ₁₆	V ₂ F ₄	Arka Archana + N ₁₄₀ : P ₁₀₀
T ₁₇	V ₂ F ₅	Arka Archana + N ₁₄₀ : P ₁₂₀
T ₁₈	V ₂ F ₆	Arka Archana + N ₁₄₀ : P ₁₄₀
T ₁₉	V ₂ F ₇	Arka Archana + N ₁₆₀ : P ₁₀₀
T ₂₀	V ₂ F ₈	Arka Archana + N ₁₆₀ : P ₁₂₀
T ₂₁	V ₂ F ₉	Arka Archana + N ₁₆₀ : P ₁₄₀
T ₂₂	V ₂ F ₁₀	Arka Archana + N ₁₈₀ : P ₁₀₀
T ₂₃	V ₂ F ₁₁	Arka Archana + N ₁₈₀ : P ₁₂₀
T ₂₄	V ₂ F ₁₂	Arka Archana + N ₁₈₀ : P ₁₄₀

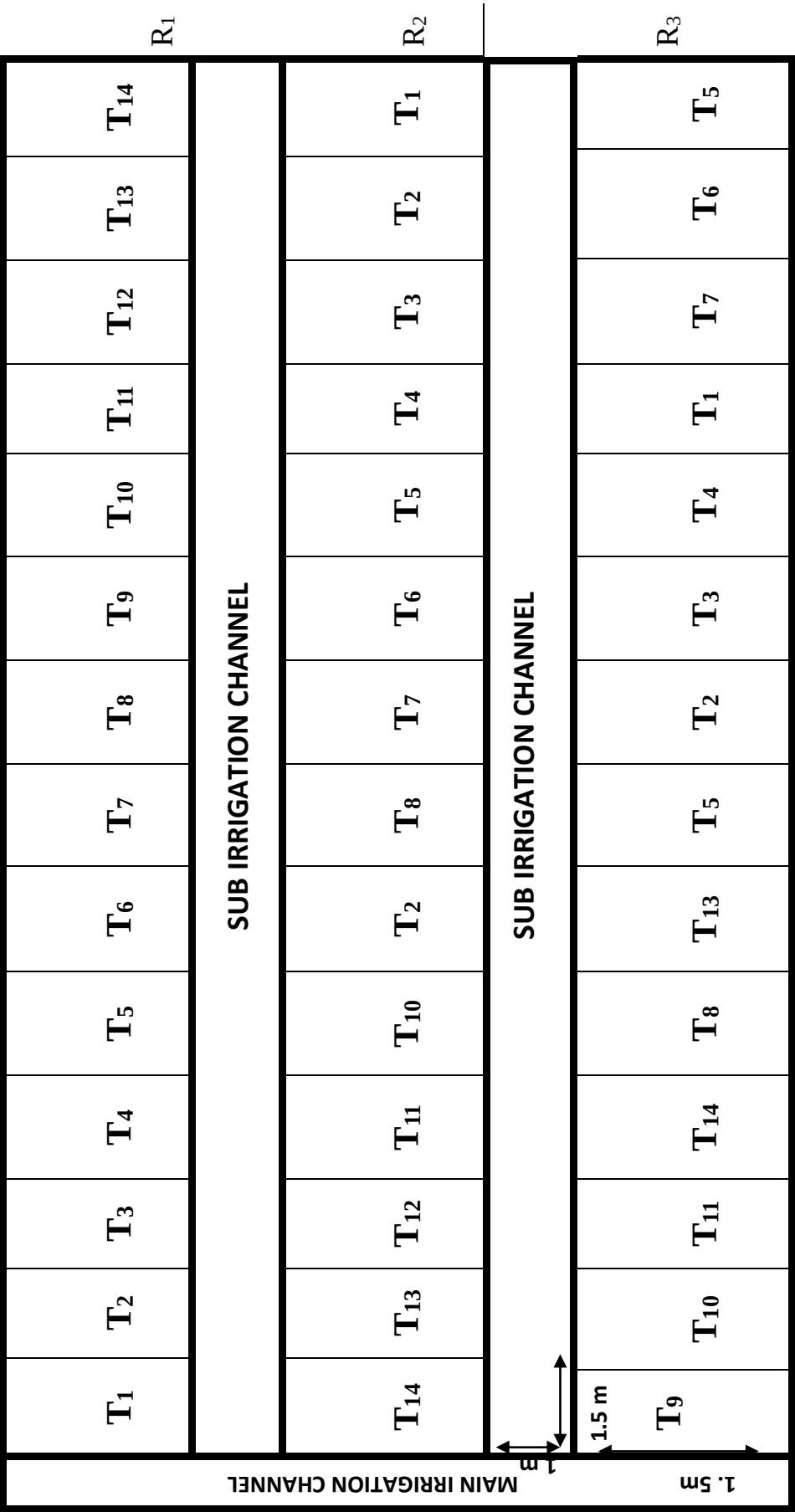


Fig.-3.3: Layout plan of the Experiment No. 1

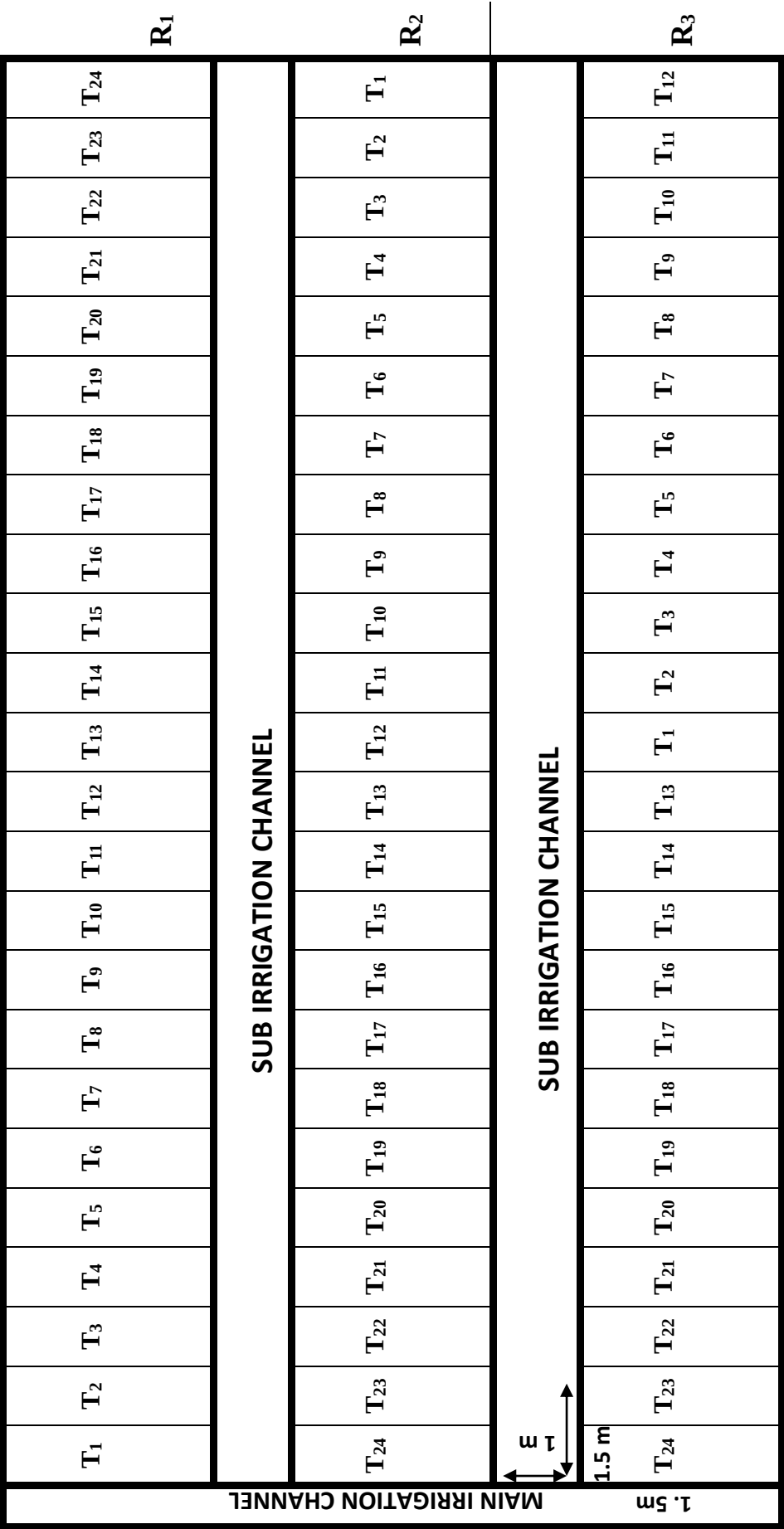


Fig.-3.4: Layout plan of the Experiment No. 2



Plate 1: Sowing of seedlings in portrays at Center Of Excellence, IGKV, Raipur



Plate 2: 45 days old healthy and uniformly grown seedlings ready for transplanting

3.5 Cultural practices

Details of the different cultural operations carried out during the course of the investigation are given below:

3.5.1 Nursery operations

Sowing the treated seeds in portrays @1 seed per cell. Cover the seed with the coco peat and keep the trays one over the other and cover with a polythene sheet before germination begins. After 6 days, place the portrays individually on the raised beds within the shade net with germinated seeds. The seedlings were irrigated twice daily for the first 10 days and once daily for the remainder of the time. Hand weeding was done thrice when the seedlings were 15 days, 25 days and 35 days old. The seedlings were ready for transplanting at 45 days after sowing.

3.5.2 Preparation of experimental land and plots

By repeated ploughing and harrowing, the land was carried to a fine tilth. A spacing of 0.50 m between two replications and 1.00 m between two plots was provided for lying out of irrigation channels and bunds respectively. The entire experimental land was divided into plots measuring 1.5 m x 1.5 m there were totally 42 plots for the first experiment and 72 plots for the second experiment.

3.5.3 Layout and randomization

Field was divided into 3 replications, and each replication was divided into 14 plots in which number of treatments was randomly allocated, separately and independently for each of the 3 replications. Layout and randomization of Experiment I and Experiment II are depicted in fig. 3.3. and fig. 3.4. respectively.

3.5.4 Transplanting

45 days old healthy and uniformly grown seedlings were used for transplanting. The first season seedlings were transplanted on 20-12-2018 and the second season seedlings were transplanted on 01.12.2019 with a spacing of 30 cm x 30 cm @ one seedling per hill.

3.5.5 Fertilizer application

Nitrogen, phosphorus and potassium were added in the form of urea, single super-phosphate and murate of potash respectively. At the time of transplantation, half a dose of N and the full dose of P and K were applied in a circular band of approximately 3-4 cm around

each plant and after 30 days of transplantation, the crop was top-dressed with the remaining half a dose of N.



Plate 3: Preparation of experimental field for transplanting



**Plate 4: Spraying of plant growth regulator at 30
DAT (ExperimentNo.1)**



Plate 5: General view of China aster at flowering stage (Experiment No.1)

3.5.6 Weeding and irrigation

By periodic hand weeding, the plots were kept free from weeds. Depending on the soil moisture status and climatic conditions, irrigation was provided at an interval of 5-6 days during the time of experimentation.

3.5.7 Plant protection

Timely and effective plant protection steps have been taken to protect experimental plants from pest and disease attacks.

3.5.8 Harvesting

Harvesting the flowers for the purpose of observation on flower and yield components was commenced after 100 days of transplanting and only two harvestings were done.

3.5.9 Collection of experimental data

The data were collected on various parameters of vegetative and flowering plants from the five randomly tagged plants in each plot.

3.6 OBSERVATIONS RECORDED

3.6.1 Vegetative characters

3.6.1.1 Plant height (cm)

From the base to the rising tip of the plant, the plant height of cultivars was measured at 45, 75, 105 days after transplantation from the tagged plants and the average was worked out and expressed in centimetres.

3.6.1.2 Spread of the plant (cm)

It was determined by adding the tagged plants North-South and East-West directions and the average plant spread was worked out.

3.6.1.3 Number of primary and secondary branches per plant

The number of main branches arising from the main stem were counted and recorded as the primary branches and branches emerging from the primary branches have been recorded and counted as secondary branches. This was achieved from the observation plants at 75 and 105 DAT.

3.6.1.4 Number of leaves per plant

The number of leaves per plant was counted at 45, 75 and 105 DAT for each of the randomly selected plants for individual treatment. The mean value was recorded as number of leaves per plant.

3.6.1.5 Leaf area per plant (cm²)

With the help of the leaf area meter, the leaf area was recorded, and its mean values were expressed in centimetre square.

3.6.1.6 Leaf area index (LAI)

Leaf area index was calculated by using the formula suggested by sestak *et al.* (1971)

$$LAI = A/P$$

Where, A=Area of leaf

P= Ground area covered by plant or spacing provided

LAI= Leaf area index

3.6.1.7 Dry matter production (g/plant)

Dry matter production was determined at all the four stages (includes leaves+ stems + roots). At each stage three plants per plot were uprooted randomly and from each plant, leaves, stems along with flower head and roots were separated. These parts were oven

dried separately at 60°C till they attained constant weight. Dry matter accumulation in different parts of the plant at all the three stages was recorded and expressed in grams. Total dry matter production was calculated by adding dry weight of different parts at respective stages.

3.6.2 Flowering and yield characters

3.6.2.1 Days to bud initiation

Numbers of days required for bud initiation were counted from transplanting up to the stage until the first flower bud on a plant becomes visible.

3.6.2.2 Days for first flowering

This was recorded by counting the number of days from the date of transplanting to the stage at which the first flower was formed.

3.6.2.4 Flowering duration

Duration of flowering was recorded from peak flowering when 60-70% flowers were fully open up to the stage till it remained in presentable form.

3.6.2.5 Number of flowers per plant

The number of flowers produced from the five observation plants was recorded and the average number of flowers per plant was calculated.

3.6.2.6 Flower yield per plant (g)

The yield per plant was determined by recording the fresh weight of flowers from the tagged plants and the mean value was worked out and expressed in grams.

3.6.2.7 Flower yield per plot (kg)

The yield per plot was determined from the tagged plants by recording the fresh weight of flowers and the mean value was worked out and expressed in kg.

3.6.2.8 Flower yield per hectare (qt/ha)

Flower yield per hectare was worked out by adding up the weight of flowers recorded for different cultivars from the net plots.

3.6.3 Quality parameters

3.6.3.1 Stalk length of flowers (cm)

The length of the stalk, represented in centimetres, should be calculated by scale.

3.6.3.2 Fresh weight of 10 flower weight (g)

Ten fresh flowers were picked, each from the net plot area, and the average weight was recorded in grams.

3.6.3.3 Total weight of fresh flower per plant (g)

When all the buds on a plant were fully open and the average weight was recorded in grams, the number of flowers per plant was counted.

3.6.3.4 Dry weight of 10 flower (g)

Dry weight of ten flowers, 10 flowers should be taken for drying at 60 ° C by using the oven dry method until constant weight has been achieved.

3.6.3.5 Total weight of dry flowers per plant (g)

It was appropriate to take the total weight of dry flowers per plant and record the mean weight in grams.

3.6.3.6 Weight of flowers with stalk (g)

At the full flower stage, ten flowers with stalk were randomly selected and the weight of these flowers with stalk was recorded and the average weight of a flower with stalk was recorded.

3.6.3.7 Diameter of flowers (cm)

Diameter of the flower was measured at the point of maximum breadth. This was measured by using Vernier callipers and average diameter in centimetres was worked out.

3.6.3.8 Chlorophyll content before flowering (mg/g)

Chlorophyll content before flowering was measured by using SPAD meter which is the most commonly used diagnostic tools to measure crop nitrogen status.

3.6.3.9 Chlorophyll content after flowering (mg/g)

Chlorophyll content after flowering was measured by using SPAD meter which is the most commonly used diagnostic tools to measure crop nitrogen status.

3.6.3.10 Vase life of flowers

From the first sign of wilting or fading to the death of flowers, the point of termination of vase life varies. For this reason, as one whorl of outer ray florets was opened, flowers were harvested. The stems in all cultivars were cut to a uniform length and the lower leaves were removed, leaving only a few upper leaves. The stems were dropped in the bucket immediately after cutting, with clean water. The three cut stems were then placed in a 250 ml conical flask that contained distilled water. Wilting of one or two petals was taken as the end of vase life.

Number of days at which flowers in different cultivars were found unfit for continuing in the vase was recorded as vase life and the average vase life of each flower was worked.



Plate 6: Estimation of dry matter production of stems, roots and leaves



Plate 7: Vase life of flowers



Plate 8: General view of China aster at 45 DAT (Experiment No.2)



Plate 9: ARKA SHASHANK



Plate 10: ARKA ARCHANA

3.7 Economics of cultivation

3.7.1 Cost of cultivation (Rs. /ha)

The cost of the inputs prevailing at the time of cultivation was considered to work out the cost of cultivation which is given in rupees per hectare (Appendix – III for Experiments 1 and 2)

3.7.2 Gross income

Gross income was calculated on the prevailing market price for the produce.

3.7.3 Net income

The net income per hectare was calculated on the basis of gross income and cost of cultivation per hectare as follows:

Net income = Gross income - Cost of cultivation

3.7.4 Benefit to cost ratio

The benefit to cost ratio was worked out by using the following formula:

$$\text{Benefit: Cost ratio} = \frac{\text{Net income (Rs. /ha)}}{\text{Cost of cultivation (Rs. /ha)}}$$

3.7.5 Statistical analysis of data

The recent experimental data was analysed statistically by the techniques of analysis of variance as applicable to factorial randomized block design given by Panse and Sukhatme (1985). The significance of the treatment was tested by “F” test value. Critical difference (CD) at 5% level of significance was worked out for comparison and statistical interpretations of significant treatment means. The standard error of difference was given in each case for significant treatment effect. Critical difference (CD) of different treatment and their interaction at 5% level of probability was calculated, wherever “F” test was significant.

Table 3.2: Anova table

Source of variation	Df	SS	MSS	Fcal	F tab (5%)
Replication	r-1	SSr	MSr	MSr/ MSE	
Factor (a)	a-1	SSa	MSa	MSa/ MSE	

Factor (b)	b-1	SSb	MSb	MSb/ MSE
Interaction Axb	(a-1) (b-1)	SSab	MSab	MSab/ MSE
Error	(r-1) (ab-1)	SSE	MSE	MSE/ MSE
Total	rab-1	TSS		

To compare the mean value of treatment, standard error and critical values were calculated as follows:

Calculation of SEm, SEd, CD and CV:

Factor A

$$\begin{aligned} \text{SEm} &= \sqrt{EMS/rb} \\ \text{SEd} &= \sqrt{(2 EMS)/rb} \\ \text{CD} &= \text{SEd} \times t \text{ Value at 5\% at error degree of freedom} \end{aligned}$$

Factor B

$$\begin{aligned} \text{SEm} &= \sqrt{EMS/ra} \\ \text{SEd} &= \sqrt{(2 EMS)/ra} \\ \text{CD} &= \text{SEd} \times t \text{ Value at 5\% at error degree of freedom} \end{aligned}$$

Factor AB

$$\begin{aligned} \text{SEm} &= \sqrt{EMS/r} \\ \text{SEd} &= \sqrt{(2 EMS)/r} \\ \text{CD} &= \text{SEd} \times t \text{ Value at 5\% at error degree of freedom} \end{aligned}$$

CV

$$= \sqrt{EMS / \text{GM}} \times 100 \text{ (Gm = General mean)}$$

Where,

r	=	Replication
SSr	=	Sum of square for replication
SSa	=	Sum of square for factor a
SSb	=	Sum of square for factor b
SSab	=	Sum of square for Interaction ab
SSE	=	Sum of square for Error
MSr	=	Mean sum of square for replication
MSa	=	Mean Sum of square for factor a
MSb	=	Mean sum of square for factor b
MSab	=	Mean Sum of square for factor ab
MSE	=	Mean sum of square for error
GM	=	General Mean

RESULT AND DISCUSSION

The present chapter deals with the findings of vegetative growth, flowering, yield and quality of China aster cv. Arka Shashank and Arka Archana as influenced by different plant growth regulators. The study was carried out during *rabi* season of the years 2018-19 and 2019-20 at the Horticulture Research cum Instructional Farm, Department of Floriculture and Landscape Architecture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G). The data for two years including pooled mean basis has been presented in tabular form as well as supported by graphical representation, wherever necessary. Data recorded on various aspects during the course of investigation revealed interesting facts, which are briefly described in the following heads.

The results pertaining to the effect of Cultivars and growth regulators on growth, flowering yield and quality of China aster (*Callistephus chinensis* (L.) Nees) at 45, 75 and 105 days after transplanting during two years apart with pooled mean data are presented in the Tables.

Experiment I: Effect on different concentrations of plant growth regulators on growth, flowering, yield and quality of China aster (*Callistephus chinensis* (L.) Nees).

4.1 Growth parameters

4.1.1 Plant height (cm)

The data on plant height at 45, 75 and 105 DAT influenced by Cultivars of China aster and plant growth regulators are presented in Table 4.1.1, 4.1.1 a and Fig.4.1.1a, 4.1.1 b and 4.1.1 c

Cultivars show significant difference in plant height at 45 DAT, during both the years as well as on pooled mean basis. The maximum plant height (18.30, 18.80 and 18.60 cm) respectively was observed in cultivar (V₁) Arka Shashank. Whereas,

the minimum plant height (17.50, 17.80 and 17.6 cm) respectively was found in cultivar (V₂) Arka Archana.

The perusal of the data reveals that at 45 DAT there was significant difference on plant height due to plant growth regulators during both the years and on pooled mean basis. The maximum plant height (22.60, 22.10 and 22.30 cm) respectively was recorded under the treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) during second year only. However it was found significant difference with rest of the other treatments during both the years and on pooled mean basis. The minimum plant height (13.90, 14.20 and 14.00 cm) respectively was noticed in treatment P₂ (CCC 1500 ppm) under this investigation. At 45 days, the interactions between cultivar and growth regulators were found significant during first year only. The maximum plant height (23.90 cm) was found in treatment combination (V₁P₆) and it was found significant difference with rest of the other treatment. The minimum plant height (13.83 cm) was observed in treatment combination (V₂P₂). However in second year as well as on pooled mean basis it was showed non-significant effect among different treatment combinations under this investigation.

In case of cultivars, it showed significant response in plant height at 75 DAT. The maximum plant height (46.90, 48.00 and 47.50 cm) respectively was observed in cultivar (V₁) Arka Shashank during both the years as well as on pooled mean basis which is superior over as compared to cultivar (V₂) Arka Archana (36.80, 37.50 and 37.20 cm) respectively.

At 75 DAT, there was significant difference in plant height due to plant growth regulators during both the year and on pooled mean basis. It clearly showed that the maximum plant height (54.7, 54.6 and 54.6 cm) respectively was recorded under the treatment P₆ (GA₃ 200 ppm), which was found statistically *at par* with treatment P₅ (GA₃150 ppm). However, it was found significant difference with remaining other treatments. The minimum plant height (32.10, 34.60 and 33.30 cm) was noticed in the treatment P₂ (CCC 1500 ppm).

The interaction between cultivars and plant growth regulators at 75 DAT was found significant, during both the years as well as on pooled mean basis. The maximum plant height (63.63, 65.63, 64.63 cm) respectively was observed in

treatment combination (V₁P₆) which was found statistically *at par* with treatment combination (V₁P₅) and it was showed significant difference with rest of the other treatment combinations and the minimum plant height (31.83, 30.73 and 31.28 cm) respectively was observed in treatment combination (V₂P₁).

At 105 DAT, it was showed significant response with plant height, maximum plant height (54.30 and 54.40 and 54.30 cm) were observed in cultivar (V₁) Arka Shashank and the minimum plant height (47.50, 46.80 and 47.10 cm) respectively was noticed in cultivar (V₂) Arka Archana during both the tested years and on pooled mean basis.

It is vivid from the data presented in the table 4.1.1 that the plant height at 105 DAT was significantly influenced by plant growth regulator during both the years and on pooled mean basis. The maximum plant height (64.50, 65.50 and 65.0 cm) respectively was observed under treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) and it was showed significant difference with rest of the other treatments. Whereas, minimum plant height (41.00, 41.30 and 41.10 cm) respectively was recorded under treatment P₂ (CCC 1500 ppm).

The interaction between cultivars and plant growth regulators at 105 DAT was found non-significant, during both the years as well as on pooled mean basis.

Maximum plant height was noticed in Arka Archana as compare to Arka Shashank. The variation in plant height between China aster Cultivars might be due to congenial environment to plant that express the dominant genes in the genotypes and different genetic makeup of the Cultivars. The observations are in conformity with the findings of Bhanu Pratap *et al.* (1999), Sreekala *et al.* (2002), Rao *et al.* (2005), Nursude *et al.* (2010) in African marigold and Namita *et al.* (2008)) in French marigold.

The maximum plant height was obtained by spraying with GA₃@ 200 ppm. This might be due to the fact that an application of gibberellic acid at different concentrations might have enhanced the plant height by increasing the internodal length as a result of increased cell elongation and faster cell division which may be enhance the plant growth and ultimately increases the plant height. The results are in conformity with the findings of Kadam *et al.* Nandre *et al.* (2009), Gupta *et al.* (2015) and Kumar *et al.* (2015) in China aster, Palei *et al.* (2016) in African marigold and Sajid *et al.* (2016) in *Chrysanthemum morifolium*.

Table 4.1.1: Effect of Cultivars and Plant growth regulators on Plant height

Treatment		Plant height(cm)								
		45 days			75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	18.30	18.80	18.60	46.90	48.00	47.50	54.30	54.40	54.30
V ₂	Arka Archana	17.50	17.80	17.60	36.80	37.50	37.20	47.50	46.80	47.10
SEm SEm±		0.24	0.28	0.17	0.52	0.57	0.57	0.55	0.65	0.69
CD at 5%		0.7	0.83	0.5	1.53	1.67	1.67	1.61	1.89	2.02
PGR										
P ₀	(Control)	15.60	16.80	16.20	34.70	36.00	35.30	44.10	43.90	44.00
P ₁	(CCC 1000 ppm)	15.40	16.00	15.70	33.50	34.00	33.70	42.00	41.80	41.90
P ₂	(CCC 1500 ppm)	13.90	14.20	14.00	32.10	34.60	33.30	41.00	41.30	41.10
P ₃	(NAA 50 ppm)	17.90	18.20	18.10	41.80	42.90	42.30	49.90	48.90	49.40
P ₄	(NAA 100 ppm)	19.00	19.60	19.30	44.20	44.30	44.30	51.00	49.60	50.30
P ₅	(GA ₃ 150 ppm)	20.80	21.40	21.10	52.20	53.30	52.70	63.80	63.20	63.50
P ₆	(GA ₃ 200 ppm)	22.60	22.10	22.30	54.70	54.60	54.60	64.50	65.50	65.00
SEm SEm±		0.45	0.53	0.32	0.98	1.07	1.07	1.03	1.22	1.3
CD at 5%		1.32	1.56	0.93	2.87	3.12	3.13	3.01	3.55	3.78

Table 4.1.1 a: Interaction effect of Cultivars and Plant growth regulators on plant height

Treat.			Plant height (cm)								
			45 Days			75 Days			105 Days		
			2018-19	2019-20	Pool ed	2018-19	2019-20	Pooled	2018-19	2019-20	Pool ed
V₁P₀	Arka Shashank	(Control)	15.13	17.36	16.25	36.17	36.43	36.30	42.60	44.40	43.50
V₁P₁	Arka Shashank	(CCC 1000 ppm)	14.90	16.13	15.51	35.13	37.17	36.15	40.53	42.40	41.47
V₁P₂	Arka Shashank	(CCC 1500 ppm)	13.93	14.36	14.15	32.90	34.73	33.82	39.80	40.10	39.95
V₁P₃	Arka Shashank	(NAA 50 ppm)	18.50	18.53	18.51	48.10	48.33	48.22	53.53	52.40	52.97
V₁P₄	Arka Shashank	(NAA 100 ppm)	20.26	20.16	20.21	51.10	50.17	50.63	55.00	54.33	54.67
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	21.26	22.23	21.75	61.50	63.87	62.68	73.93	72.37	73.15
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	23.90	23.13	23.51	63.63	65.63	64.63	74.50	74.93	74.72
V₂P₀	Arka Archana	(Control)	16.06	16.26	16.16	33.17	35.47	34.32	45.57	43.30	44.43
V₂P₁	Arka Archana	(CCC 1000 ppm)	15.80	15.86	15.83	31.83	30.73	31.28	43.50	41.23	42.37
V₂P₂	Arka Archana	(CCC 1500 ppm)	13.83	13.93	13.88	31.90	34.40	32.85	42.23	42.43	42.33
V₂P₃	Arka Archana	(NAA 50 ppm)	17.23	17.93	17.58	35.97	37.43	36.45	46.23	45.47	45.85
V₂P₄	Arka Archana	(NAA 100 ppm)	17.73	19.03	18.38	37.27	38.50	37.88	46.97	44.80	45.88
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	20.36	20.46	20.41	42.80	42.67	42.73	53.67	54.07	53.87
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	21.33	21.00	21.16	45.77	43.47	44.62	54.43	56.13	55.28
SEm±			0.64	0.76	0.45	1.39	1.52	1.52	1.46	1.72	1.84
CD at 5%			1.86	NS	NS	4.06	4.42	4.43	NS	NS	NS

Fig 4.1.1 a : Effect of Cultivars and Plant growth regulators on Plant height at 45 days

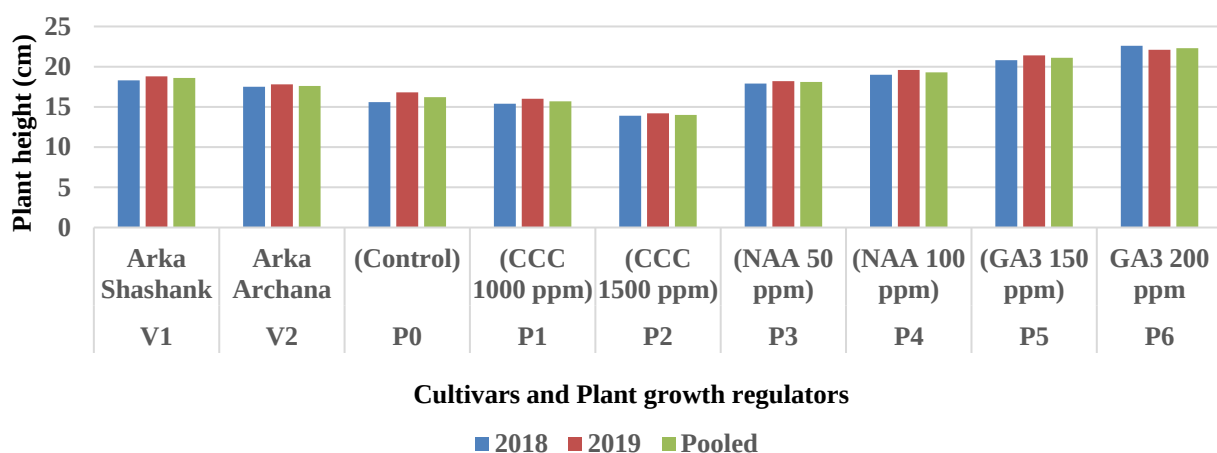


Fig 4.1.1 b : Effect of Cultivars and Plant growth regulators on Plant height at 75 Days

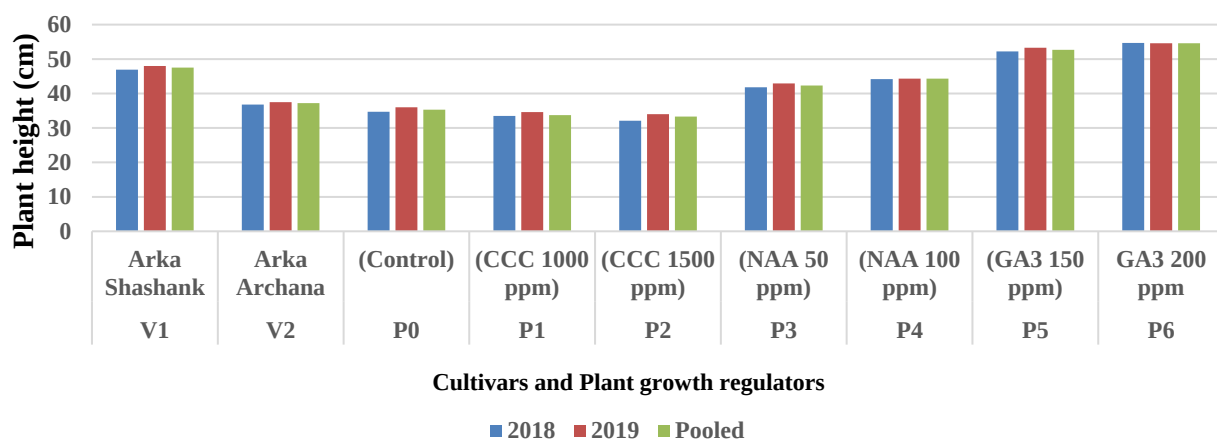
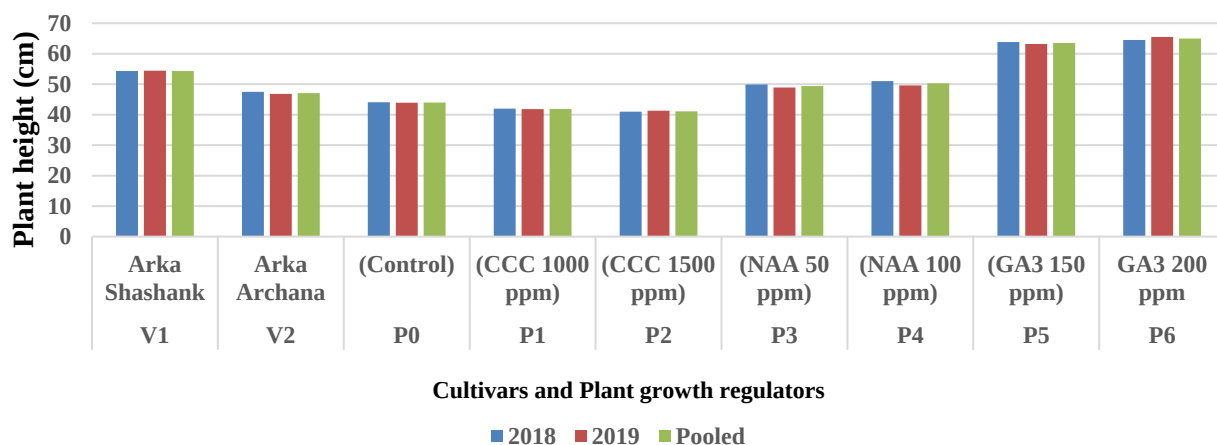


Fig 4.1.1 c : Effect of Cultivars and Plant growth regulators on Plant height at 105 Days



4.1.2 Plant spread (cm)

The result on plant spread was influence by cultivars and plant growth regulators are presented in Table 4.1.2, 4.1.2 a and Fig 4.1.2 a, 4.1.2 b and 4.1.2 c

At 45 DAT cultivar showed significant influence on plant spread during both the years as well as on pooled mean basis. The greater plant spread (21.69, 21.74 and 21.72 cm) respectively were found in cultivar (V₂) Arka Archana during both the years and on pooled mean basis. However, minimum plant spread (17.60, 17.93 and 17.77 cm) respectively was found in cultivar (V₁) Arka Shashank.

In case of PGR, at 45 DAT it was showed significant impact between the treatments for plant spread. Maximum plant spread (23.20, 23.56 and 23.38 cm) respectively was observed in treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) and P₂ (CCC 1500 ppm) during first year and second year. Whereas, during pooled mean basis P₅ (GA₃ 150 ppm) is found statistically similar and it was showed significant difference with rest of the other treatments. The minimum plant spread (15.20, 14.98, and 15.09 cm) was found in the treatment P₀ (control).

At 75 DAT, data clearly showed that the maximum plant spread (27.92, 28.10 and 28.01 cm) respectively was recorded under cultivar (V₂) Arka Archana in both the years and on pooled mean basis and the minimum plant spread (22.10, 21.60 and 21.85 cm) respectively was found in cultivar (V₁) Arka Shashank under this investigation.

The data revealed that the plant spread at 75 DAT was significantly influenced by plant growth regulator. The maximum plant spread (29.03, 29.33 and 29.18 cm) respectively was recorded under treatment P₆ (GA₃ 200 ppm) which were found statistically *at par* with treatment P₅ (GA₃ 150) and P₂ (CCC 1500 ppm) in first year whereas, in second year and on pooled mean basis it was found statistically similar with the treatment P₅ (GA₃150 ppm) and it was showed significant difference with rest of the other treatments. However minimum plant

spread (18.66, 18.16 and 18.42 cm) were recorded under P₀ (control) during this investigation.

The interactions between cultivar and growth regulators were found non-significant at 45 DAT and 75 DAT for plant spread.

Table 4.1.2: Effect of Cultivars and Plant growth regulators on Plant Spread

Treat.		Plant spread (cm)								
		45 days			75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	17.60	17.93	17.77	22.10	21.60	21.85	25.97	26.49	26.23
V ₂	Arka Archana	21.69	21.74	21.72	27.92	28.10	28.01	36.48	36.40	36.45
SEm SEm±		0.50	0.63	0.40	0.50	0.55	0.37	0.52	0.53	0.37
CD at 5%		1.03	1.29	0.80	1.02	1.13	0.74	1.06	1.08	0.74
PGR										
P ₀	(Control)	15.20	14.98	15.09	18.66	18.16	18.42	22.90	22.76	22.83
P ₁	(CCC 1000 ppm)	20.18	20.30	20.24	25.61	26.21	25.92	31.93	30.43	31.18
P ₂	(CCC 1500 ppm)	21.46	21.25	21.36	27.16	26.86	27.02	33.25	31.88	32.57
P ₃	(NAA 50 ppm)	16.28	17.03	16.66	22.81	22.05	22.43	27.9	27.86	27.88
P ₄	(NAA 100 ppm)	18.98	19.43	19.21	24.00	23.35	23.68	28.98	29.7	29.34
P ₅	(GA ₃ 150 ppm)	22.22	22.33	22.28	27.81	27.98	27.90	36.16	37.80	37.30
P ₆	(GA ₃ 200 ppm)	23.20	23.56	23.38	29.03	29.33	29.18	37.46	39.70	38.58
SEm SEm±		0.94	1.17	0.75	0.93	1.03	0.69	0.97	0.98	0.69
CD at 5%		1.92	2.41	1.50	1.92	2.11	1.39	1.99	2.02	1.38

Table 4.1.2a: Interaction effect of Cultivars and plant growth regulators on plant Spread

Table 1: Main interaction effect of cultivars and plant growth regulators on plant spread											
Tre at.	Plant Spread (cm)										
	45 Days					75 Days			105 Days		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled		
V₁P₀	Arka Shashank	(Control)	12.30	12.03	12.17	15.53	15.06	15.30	19.16	19.26	19.22
V₁P₁	Arka Shashank	(CCC 1000 ppm)	18.56	18.96	18.77	23.40	22.36	22.88	26.73	26.20	26.47
V₁P₂	Arka Shashank	(CCC 1500 ppm)	20.00	19.80	19.90	24.43	23.26	23.85	28.46	27.86	28.17
V₁P₃	Arka Shashank	(NAA 50 ppm)	13.73	14.93	14.33	20.5	19.63	20.07	23.46	23.3	23.38
V₁P₄	Arka Shashank	(NAA 100 ppm)	16.63	17.03	16.83	21.63	20.33	20.98	24.23	23.43	23.83
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	20.33	20.86	20.60	24.00	24.36	24.18	28.80	31.83	30.32
V₁P₆	Arka Shashank	GA ₃ 200 ppm	21.66	21.93	21.80	25.26	26.16	25.72	30.93	33.53	32.23
V₂P₀	Arka Archana	(Control)	18.10	17.93	18.02	21.80	21.26	21.53	26.63	26.26	26.45
V₂P₁	Arka Archana	(CCC 1000 ppm)	21.80	21.63	21.72	27.83	30.06	28.95	37.13	34.66	35.90
V₂P₂	Arka Archana	(CCC 1500 ppm)	22.93	22.70	22.82	29.90	30.46	30.18	38.03	35.90	36.97
V₂P₃	Arka Archana	(NAA 50 ppm)	18.83	19.13	18.98	25.13	24.46	24.8	32.33	32.43	32.38
V₂P₄	Arka Archana	(NAA 100 ppm)	21.33	21.83	21.58	26.36	26.36	26.37	33.73	35.96	34.85
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	24.13	23.80	23.97	31.63	31.60	31.62	43.53	43.76	43.65
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	24.73	25.20	24.97	32.80	32.50	32.65	44.00	45.86	44.93
SEm±			1.32	1.66	1.06	1.32	1.45	0.98	1.37	1.39	0.98
CD at 5%			NS	NS	NS	NS	NS	NS	2.81	2.86	1.96

Fig 4.1.2 a: Effect of Cultivars and Plant growth regulators on Plant Spread at 45 Days

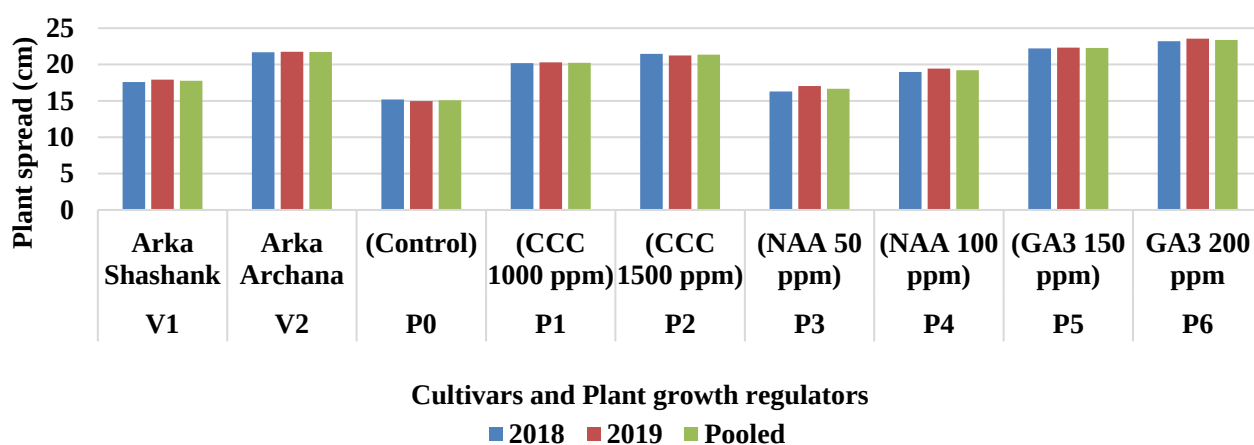


Fig 4.1.2 b: Effect of Cultivars and Plant growth regulators on Plant Spread at 75 Days

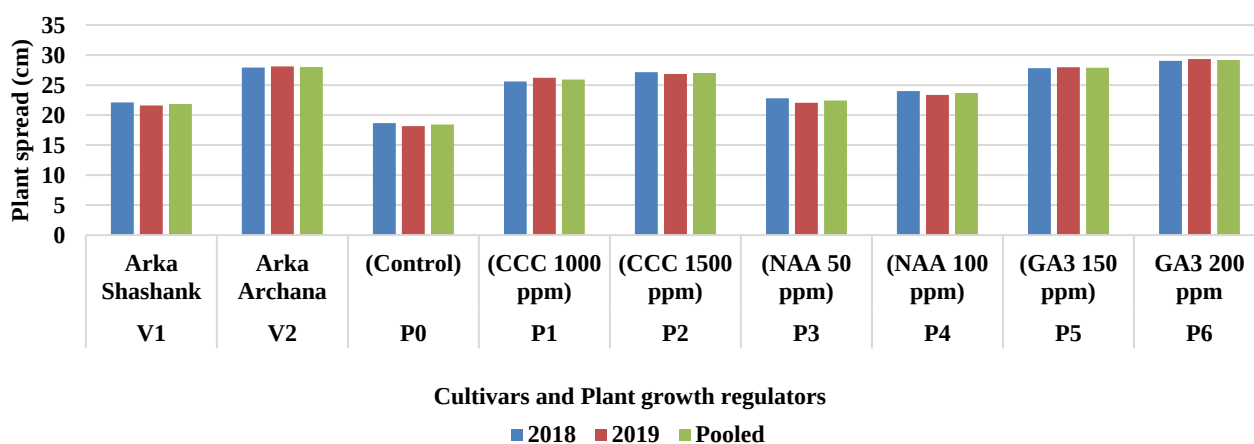
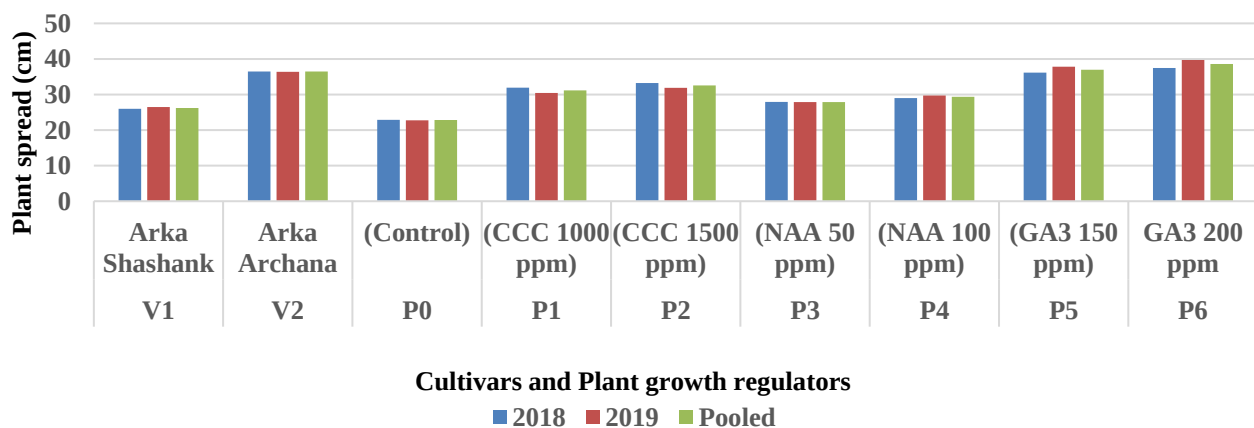


Fig 4.1.2 c: Effect of Cultivars and Plant growth regulators on Plant Spread at 105 Days



However, in respect to cultivars at 105 DAT it was exhibited significant impact on plant spread, the maximum plant spread (36.48, 36.40 and 36.45 cm) respectively were found in cultivar (V₂) Arka Archana as compared to plant spread (25.97, 26.49 and 26.23 cm) respectively obtained from (V₁) Arka Shashank during both the tested years as well as on pooled mean basis.

As far as, the plant spread showed significant impact by the spraying of plant growth regulators at 105 DAT. The plant spread (37.46, 39.70 and 38.58 cm) respectively was recorded maximum in treatment P₆ (GA₃ 200) and it was found statistically *at par* with treatment P₅ (GA₃ 150) in both the years and on pooled mean analysis, and it was showed significant difference with rest of the other treatments. Whereas minimum plant spread (22.90, 22.76 and 22.83 cm) were recorded under treatment P₀ (control) during this investigation.

The interaction between plant growth regulators and cultivars at 105 days was found significant, during both the years as well as on pooled mean basis. The maximum plant spread (44.00, 45.86 and 44.93 cm) respectively was found with treatment combination (V₂P₆) during this investigation which was found statistically *at par* with (V₂P₅) and it was showed significant difference with remaining of the other treatment combinations. The minimum plant spread was observed under treatment combination (V₁P₀) during this investigation.

Cultivar Arka Archana having more plant spread than Arka Shashank. The difference in plant spread per plant is a varietal trait as it is governed by the genetical makeup of the plant. Similar variations in plant spread among varieties were also observed in China aster reported by Rao and Negi (1990) and Ravikumar (2002).

Increased concentration of CCC increases the plant spread as compare to NAA. This might be due to retardation of cell multiplication, elongation and thereby it increased the lateral growth and decreases the apical dominance of the plant leading to higher spread of the plants. The results are in conformity with those reported by Shivangowda (2000) in China aster. Similar observations were recorded by Mamilla Sindhuja, VM Prasad and Devi singh *et.al* (2018-19) in China aster.

Foliar spray of GA₃ at 200 ppm recorded maximum plant spread at 45,

75, and 105 DAT. Maximum spread of plant might be due to the favorable environment to express the dominant genes in the genotypes and different genetic makeup of the variety. The chlorophyll content in leaves might have increased the synthesis of carbohydrates, amino acids etc. from which phytochrome may have been synthesized resulting in increase in vegetative characters. The present research work confirms with the findings of Bhanu Pratap *et al.* (1999), Nand-Kishore and Mohanti (2002), Sreekala *et al.* (2002), Rao *et al.* (2005) and Nursude *et al.* (2010) in African marigold.

4.1.3. Number of primary branches per plant

The results on number of primary branches per plant were significantly influenced by Cultivars and application of growth regulators are presented in Table 4.1.3, 4.1.3 a and Fig 4.1.3 a, 4.1.3 b

The perusal of data on the influence of cultivars on number of primary branches plant per plant revealed that at 75 DAT, it showed significant effect during both the years as well as on pooled mean basis. The maximum number of primary branches per plant were recorded under cultivar (V₂) Arka Archana (17.88, 17.78 and 17.83) respectively as compared to cultivar (V₁) Arka Shashank (15.11, 15.13 and 15.12) respectively.

In case of plant growth regulators showed significant impact on number of primary branches per plant at 75 DAT. The greater number of primary branches per plant (20.85, 21.63 and 21.24) respectively was observed in treatment P₆ (GA₃ 200 ppm) which was showed statistically *at par* with treatment P₅ (GA₃ 150 ppm) during first year only and it was showed significant differences during second year and on pooled mean basis. However it was showed significant difference with rest of the other treatments during both the years and on pooled mean basis. Lowest number of primary branches per plant (11.86, 11.60 and 11.73) respectively was recorded under treatment P₀ (Control) during the investigation.

In respect to plant growth regulators, the number of primary branches per plant at 105 DAT was significantly influenced by plant growth regulator during both the year and on pooled mean basis. The maximum number of primary branches (31.20, 31.81 and 31.51) respectively was observed under treatment P₆

(GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) in first year only and it was showed significant difference with rest of the other treatments during both the tested year and on pooled mean basis. Whereas,

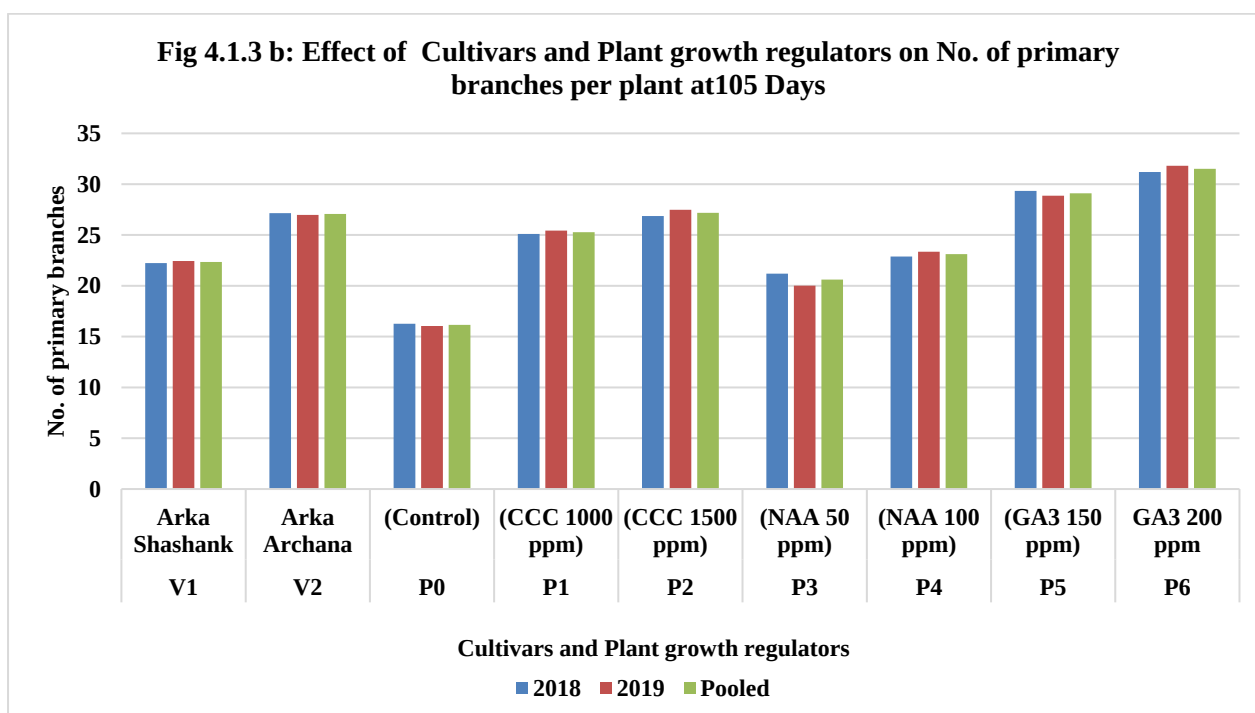
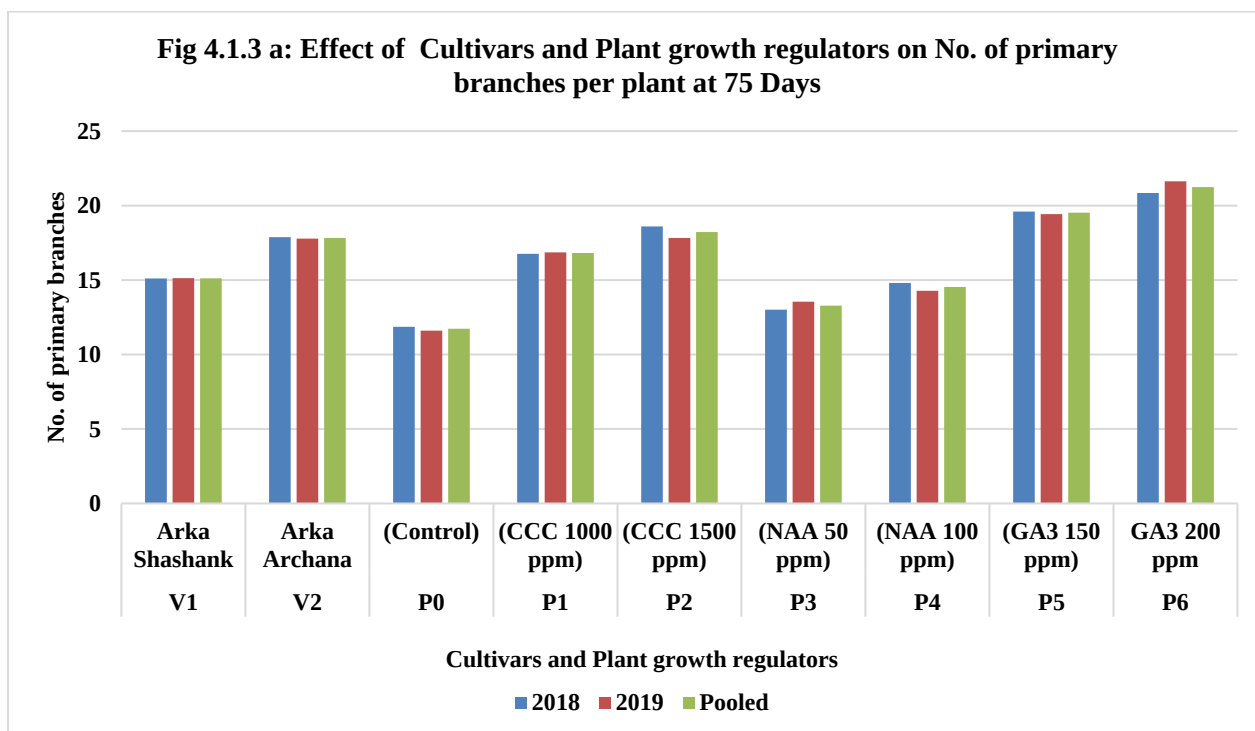
It is vivid from the data presented in the table 4.1.3 at 105 DAT, the number of primary branches per plant indicated significant impact, highest number of primary branches per plant (27.15, 26.98 and 27.07 cm) were observed in cultivar (V₂) Arka Archana and the minimum number of primary branches per plant (22.23, 22.44 and 22.34 cm) respectively was recorded in cultivar (V₁) Arka Shashank during both the tested years and on pooled mean basis.

Table 4.1.3: Effect of Cultivars and Plant growth regulators on No. of primary branches per plant

Treat.		No. of primary branches					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	15.11	15.13	15.12	22.23	22.44	22.34
V ₂	Arka Archana	17.88	17.78	17.83	27.15	26.98	27.07
SEm SEm±		0.38	0.55	0.34	0.55	0.59	0.40
CD at 5%		0.77	1.14	0.67	1.13	1.22	0.81
PGR							
P ₀	(Control)	11.86	11.60	11.73	16.26	16.05	16.16
P ₁	(CCC 1000 ppm)	16.76	16.86	16.82	25.10	25.43	25.27
P ₂	(CCC 1500 ppm)	18.60	17.83	18.22	26.86	27.48	27.18
P ₃	(NAA 50 ppm)	13.01	13.55	13.28	21.2	20.01	20.61
P ₄	(NAA 100 ppm)	14.80	14.28	14.54	22.88	23.35	23.12
P ₅	(GA ₃ 150 ppm)	19.60	19.43	19.52	29.33	28.86	29.10
P ₆	(GA ₃ 200 ppm)	20.85	21.63	21.24	31.20	31.81	31.51
SEm SEm±		0.71	1.04	0.63	1.03	1.11	0.76
CD at 5%		1.45	2.13	1.26	2.11	2.28	1.52

Table 4.1.3 a: Interaction effect of Cultivars and Plant growth regulators on No. of primary branches per plant

Treat.			No. of primary branches					
			75 Days			105 Days		
			2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	10.90	11.50	11.20	15.76	14.86	15.32
V₁P₁	Arka Shashank	(CCC 1000 ppm)	15.23	15.16	15.20	21.70	22.63	22.17
V₁P₂	Arka Shashank	(CCC 1500 ppm)	16.66	15.70	16.18	22.83	24.46	23.65
V₁P₃	Arka Shashank	(NAA 50 ppm)	12.03	12.96	12.5	18.86	17.5	18.18
V₁P₄	Arka Shashank	(NAA 100 ppm)	13.83	13.83	13.83	19.9	20.8	20.35
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	17.63	16.83	17.23	27.10	26.66	26.88
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	19.50	19.93	19.72	29.46	30.20	29.83
V₂P₀	Arka Archana	(Control)	12.83	11.70	12.27	16.76	17.23	17.00
V₂P₁	Arka Archana	(CCC 1000 ppm)	14.00	14.13	14.07	23.53	22.53	23.03
V₂P₂	Arka Archana	(CCC 1500 ppm)	15.76	14.73	15.25	25.86	25.9	25.88
V₂P₃	Arka Archana	(NAA 50 ppm)	18.30	18.56	18.43	28.50	28.23	28.37
V₂P₄	Arka Archana	(NAA 100 ppm)	20.53	19.96	20.25	30.90	30.50	30.70
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	21.56	22.03	21.80	31.56	31.06	31.32
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	22.20	23.33	22.77	32.93	33.43	33.18
SEm±			1.00	1.47	0.89	1.45	1.57	1.07
CD at 5%			NS	NS	NS	NS	NS	NS



minimum number of primary branches (16.26, 16.05 and 16.16) respectively was recorded under treatment P₀ (Control) under this investigation. The interaction

between the cultivars and plant growth regulators shows non significant impact on number of primary branches per plant at 75 and 105 DAT during both the tested years as well as on pooled mean analysis.

From the above findings, significantly maximum number of primary branches per plant was observed in Arka Archana at all the growth stages, and the increasing in primary branches might be due to the pleasant environment to express the dominant genes in the genotypes and different genetic makeup of the variety. The present research work confirms with the findings of Bhanu Pratap *et al.* (1999), Nand- Kishore and Mohanti (2002), Sreekala *et al.* (2002), Rao *et al.* (2005) and Nursude *et al.* (2010) in African marigold.

Maximum number of branches per plant were found with the application of GA₃ at 200 ppm as compared to all other treatments. The increase in number of primary branches per plant with application of GA₃ seems to be due to enhanced cell division and cell enlargement, promotion of protein synthesis coupled with higher dry matter accumulation in the plant. Similar results were reported by Lal and Mishra (1986) in aster and marigold, Shivaprasad Shetty (1995) and Doddagoudar (2002) in China aster.

The physiology involved in increasing the number of branches per plant by cycocel was that, it checks the apical dominance which could be due to lower levels of endogenous production of auxins. There by increasing basipetal flow of auxins to various degrees (axillary buds) and induce sprouting of vegetative buds and it also might be due to the suppression of terminal bud which favoured diversion of metabolites to the axillary buds and thus might have resulted in more number of branches (Hugar and Nalawadi, 1999) (Cathey and Stuart, 1961).

4.1.4. Number of secondary branches per plant

The data pertaining to the number of secondary branches per plant were significantly influenced by Cultivars and application of growth regulators are presented in Table 4.1.4, 4.1.4 a and Fig 4.1.4 a and 4.1.4 b

It is evident from the data that the influence of Cultivars on number of secondary branches at 75 DAT, during both the years as well as pooled mean basis of investigation showed significant effect. The maximum number of secondary branches per plant was recorded under cultivar (V₂) Arka Archana (22.48, 22.60 and 22.54) respectively as compared to cultivar (V₁) Arka Shashank (19.30, 19.80 and 19.55) respectively under this investigation.

In case of PGR, the number of secondary branches per plant at 75 DAT varied significantly due to different plant growth regulators. The maximum number of secondary branches per plant (24.06, 24.05 and 24.06) respectively was observed in treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) and P₂ (CCC 1500 ppm) during both the years and it was showed significant difference with rest of the other treatments. The lowest number of secondary branches (16.28, 15.85 and 16.07) respectively was recorded in treatment P₀ (Control) in both the years and on pooled mean basis.

Among the cultivars at 105 DAT showed significant response. The highest number of secondary branches per plant (30.07, 31.70 and 31.39) respectively was observed in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank (27.84, 28.57 and 28.21) during both the tested years and on pooled mean basis respectively.

As far as at 105 DAT, the plant growth regulator exhibited significant influence on number of secondary branches per plant during both the years as well as on pooled mean basis. The maximum number of secondary branches (34.78, 37.28 and 36.03) respectively was observed under treatment P₆ (GA₃ 200 ppm), which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) in first year only and it was showed significant difference with rest of the other treatments. Whereas minimum number of secondary branches (23.05, 22.95 and 23.00) respectively was found under treatment P₀ (Control) during this investigation.

The interaction between the Cultivars and plant growth regulators shows non-significant effect on number of secondary branches per plant at 75 and 105 DAT in both the tested year as well as on pooled mean basis.

Arka Archana showed maximum number of secondary branches per plant as compared to Arka Shashank. The difference in branches among the Cultivars could be due to the influence of genetically framework of the Cultivars. Similar variations for number of branches were also observed in China aster (Rao and Negi, 1990 and Ravikumar, 2002) and in chrysanthemum (Chezhian *et al.*, 1985a and Kanamadi and Patil, 1993).

The increase in number of secondary branches per plant with application of GA₃ seems to be due to enhanced cell division and cell enlargement, promotion of protein synthesis coupled with higher dry matter accumulation in the plant. Whereas the role of CCC in producing short saturated plants may be because of inhibitory activity on cell elongation thus shortening the length of internodes leading to short saturated plants. Because of short saturated plants leading to diversion of flow of photosynthesis towards their growth and development. Similar results were reported by (Doddagoudar *et al.*, 2002), (Padma priya and Chezhiyan 2003), (Gupta *et al.*, 2015), (Munikrishnappa *et al.*, 2014), (Ramesh *et al.*, 2001), (Nandre *et al.*, 2009)

Table 4.1.4: Effect of Cultivars and Plant growth regulators on No. of secondary branches per plant

Treat.		No. of secondary branches					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	19.30	19.80	19.55	27.84	28.57	28.21
V ₂	Arka Archana	22.48	22.60	22.54	30.07	31.70	31.39
SEm SEm±		0.43	0.45	0.31	0.65	0.69	0.47
CD at 5%		0.89	0.93	0.63	1.33	1.42	0.95
PGR							
P ₀	(Control)	16.28	15.85	16.07	23.05	22.95	23.00
P ₁	(CCC 1000 ppm)	21.10	21.42	21.26	29.82	30.43	30.13
P ₂	(CCC 1500 ppm)	22.43	23.50	22.97	30.82	31.37	31.09
P ₃	(NAA 50 ppm)	19.05	19.72	19.38	25.85	26.78	26.32
P ₄	(NAA 100 ppm)	20.07	20.43	20.25	27.92	28.28	28.10
P ₅	(GA ₃ 150 ppm)	23.27	23.43	23.35	33.97	33.88	33.93
P ₆	(GA ₃ 200 ppm)	24.07	24.05	24.06	34.78	37.28	36.03
SEm SEm±		0.81	0.84	0.58	1.21	1.29	0.89
CD at 5%		1.66	1.74	1.17	2.49	2.66	1.78

Table 4.1.4 a: Interaction effect of Cultivars and Plant growth regulators on No. of secondary branches per plant

Treat			No. of secondary branches					
			75 Days			105 Days		
			2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	15.83	16.36	16.10	21.70	22.43	22.07
V₁P₁	Arka Shashank	(CCC 1000 ppm)	19.43	20.20	19.82	27.46	28.46	27.97
V₁P₂	Arka Shashank	(CCC 1500 ppm)	20.36	21.76	21.07	28.03	29.90	28.97
V₁P₃	Arka Shashank	(NAA 50 ppm)	17.56	17.93	17.75	25.66	25.26	25.47
V₁P₄	Arka Shashank	(NAA 100 ppm)	18.56	18.5	18.53	26.56	27.06	26.82
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	21.26	22.23	21.75	32.16	32.16	32.17
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	22.13	21.60	21.87	33.30	34.73	34.02
V₂P₀	Arka Archana	(Control)	16.73	15.33	16.03	24.40	23.46	23.93
V₂P₁	Arka Archana	(CCC 1000 ppm)	20.53	21.50	21.02	26.03	28.30	27.17
V₂P₂	Arka Archana	(CCC 1500 ppm)	21.56	22.36	21.97	29.26	29.50	29.38
V₂P₃	Arka Archana	(NAA 50 ppm)	22.76	22.63	22.70	32.16	32.40	32.28
V₂P₄	Arka Archana	(NAA 100 ppm)	24.50	25.23	24.87	33.60	32.83	33.22
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	25.26	24.63	24.95	35.76	35.60	35.68
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	26.00	26.50	26.25	36.26	39.83	38.05
SEm±			1.15	1.19	0.83	1.71	1.83	1.25
CD at 5%			NS	NS	NS	NS	NS	NS

Table 4.1.4 a: Effect of Cultivars and Plant growth regulators on No. of secondary branches per plant at 75 Days

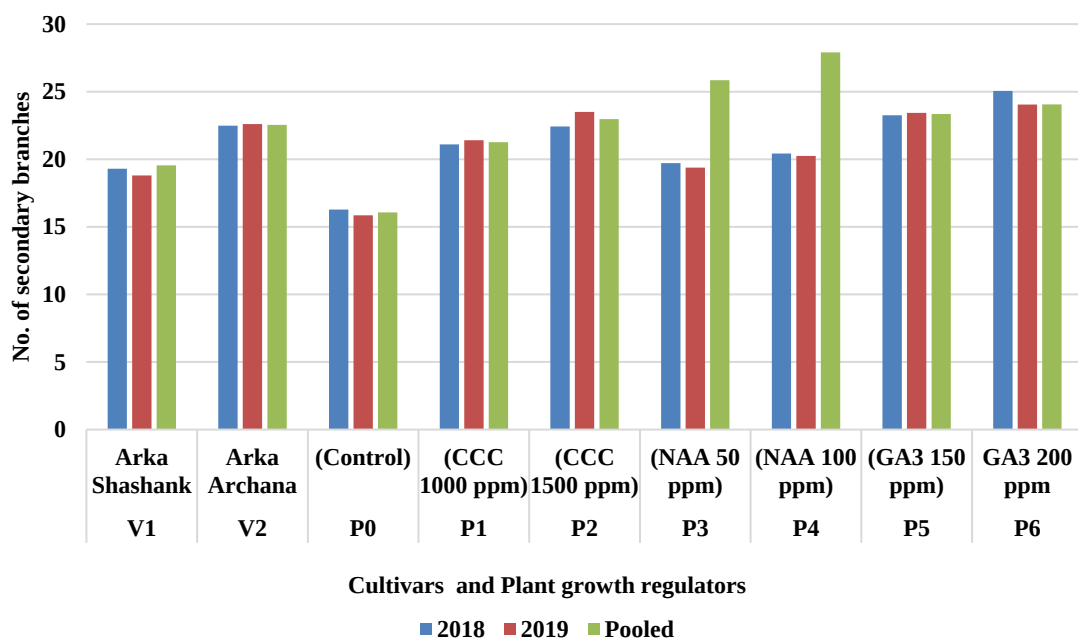
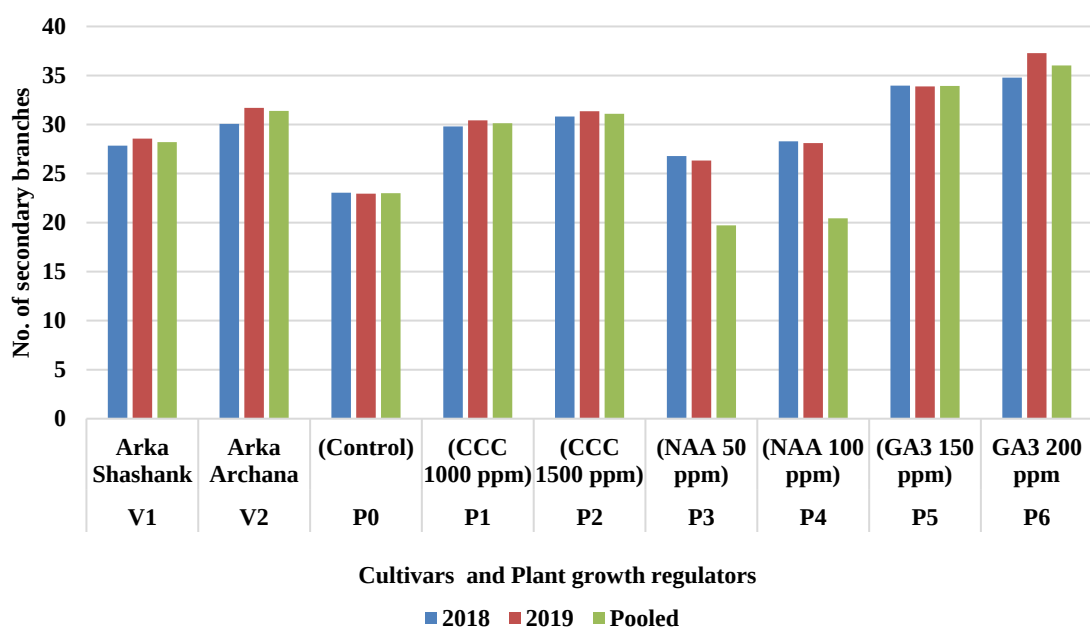


Table 4.1.4 b: Effect of Cultivars and Plant growth regulators on No. of secondary branches per plant at 105 Days



4.1.5 Number of leaves per plant

The data on number of leaves per plant at different growth stages are presented in Table 4.1.5, 4.1.5 a and Fig 4.1.5 a, 4.1.5 b and 4.1.5 c

The perusal of the data revealed that at 45 DAT there was significant response on number of leaves per plant due to cultivars during both the years and on pooled mean basis. The maximum number of leaves was observed in cultivar (V₂) Arka Archana (25.11, 25.00 and 25.06) respectively as compared to cultivar (V₁) Arka Shashank (19.36, 19.43 and 19.40) respectively during this investigation.

At 45 DAT there was significant variation in number of leaves per plant due to plant growth regulators. The maximum number of leaves per plant (30.58, 31.06 and 30.83) respectively was recorded in treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) during the first year only and it was found significant difference with rest of the other treatments during both the years as well as on pooled mean basis. The minimum number of leaves (14.03, 13.85 and 13.94) respectively was found under treatment P₀ (Control).

The interaction effect at 45 DAT between the cultivars and plant growth regulators showed significant difference during both the years and on pooled mean basis. The maximum number of leaves per plant was observed in (33.43, 32.93 and 33.18) respectively with treatment combination (V₂P₆) which was found statistically *at par* with (V₂P₅) and it was showed significant difference with remaining all the other treatment combinations during both the years and on pooled mean basis. Further, minimum number of leaves per plant (13.03, 12.90 and 12.97) respectively was observed in treatment combination (V₁P₀) under this investigation.

At 75 DAT cultivars exhibited significant differences on number of leaves per plant during both the years as well as on pooled mean analysis. The highest number of leaves per plant (103.02, 104.16 and 103.60) respectively was noticed in cultivar (V₂) Arka Archana under this investigation which is superior over as compared to cultivar (V₁) Arka Shashank (75.56, 75.75 and 75.66) respectively.

The data on number of leaves per plant at 75 DAT showed the significant difference with the application of PGR. It was clearly showed that the maximum number of leaves per plant (118.45, 120.65 and 119.55) respectively was recorded under the treatment P₆ (GA₃ 200 ppm), which was found statistically *at par* with treatment P₅ (GA₃150 ppm) and it was observed significant variation with rest of the other treatments. While, minimum number of leaves (50.56, 49.73, and 50.15) respectively was noticed in treatment P₀ (Control) during this investigation.

The interaction between cultivars and plant growth regulators at 75 DAT were found significant during the period of investigations. The maximum number of leaves per plant (125.86, 126.50 and 126.68 cm) respectively was observed in in treatment combination (V₂P₆) which was found statistically *at par* with (V₂P₅) and (V₂P₄) and it was found significant difference with rest of the other treatment combinations. The minimum number of leaves per plant (34.23, 33.56 and 33.90) respectively was observed in treatment combination (V₁P₀).

The number of leaves per plant at 105 DAT exerts significant impact. The maximum number of leaves (240.35, 238.64 and 239.50) was observed in cultivar (V₂) Arka Archana as compared to (V₁) Arka Shashank (167.88, 173.73 and 170.81) during both the tested years and on pooled mean analysis respectively.

The data pertaining at 105 DAT revealed that that there was significantly impact on number of leaves due to plant growth regulator during this investigation. The highest number of leaves (269.45, 283.85 and 276.65) respectively was observed under treatment P₆ (GA₃ 200 ppm), which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) during first year only and the rest of the other treatments showed significant variations during both the years as well as on pooled mean basis. Further, minimum number of leaves per plant (135.10, 132.45 and 133.78) respectively was recorded under treatment P₀ (Control) during both the year and on pooled mean basis.

The interaction between cultivars and plant growth regulators at 105 DAT was found significant, during both the years as well as on pooled mean basis. The highest number of leaves per plant (305.86, 303.63 and 304.75) respectively was

observed in treatment combination (V₂P₆) which was statistically *at par* with treatment combination (V₂P₅) and lowest number of leaves (110.85, 109.46 and 110.16) respectively was observed in treatment combination (V₁P₀).

Maximum number of leaves was found with the treatment GA₃ at 200 ppm as compared to all other treatments and this may be due to the increase in plant height and number of branches per plant. Similar results were recorded by earlier research workers (Lal and Mishra, 1986 and Shyamal *et al.* (1990) in aster.

The reduction in number of leaves by CCC treatments might be due to its inhibitory and metabolic activity on sub apical meristematic tissues and also due to its antagonist effects on endogenous production of auxins. Reduction in number of leaves due to CCC in this trial is in contrary with the findings of Shyamal *et al.* (1990) in China aster.

Table 4.1.5: Effect of Cultivars and Plant growth regulators on Number of Leaves

Treat.	Number of Leaves											
	45 days					75 days					105 days	
	CULTIVAR	2018-19	2019-20	Pooled		2018-19	2019-20	Pooled		2018-19	2019-20	Pooled
V ₁	Arka Shashank	19.36	19.43	19.40		75.56	75.75	75.66		167.88	173.73	170.81
V ₂	Arka Archana	25.11	25.00	25.06		103.02	104.16	103.60		240.35	238.64	239.50
SEm SEm±												
		0.51	0.51	0.68		1.80	1.61	2.26		4.70	3.28	5.36
CD at 5%												
		1.06	1.04	1.35		3.70	3.31	4.53		9.66	6.74	10.76
PGR												
P ₀	(Control)	14.03	13.85	13.94		50.56	49.73	50.15		135.10	132.45	133.78
P ₁	(CCC 1000 ppm)	16.20	16.41	16.31		64.90	65.56	65.23		166.08	162.31	164.20
P ₂	(CCC 1500 ppm)	19.86	20.05	19.96		73.28	72.28	72.78		172.41	171.76	172.09
P ₃	(NAA 50 ppm)	21.21	21.78	21.50		96.70	97.50	97.10		206.65	207.98	207.32
P ₄	(NAA 100 ppm)	24.63	23.96	24.30		105.55	106.61	106.08		217.88	216.61	217.25
P ₅	(GA ₃ 150 ppm)	29.13	28.41	28.78		115.6	117.36	116.49		261.25	268.35	264.80
P ₆	(GA ₃ 200 ppm)	30.58	31.06	30.83		118.45	120.65	119.55		269.45	283.85	276.65
SEm SEm±												
		0.96	0.95	0.68		3.37	3.01	2.26		8.80	6.13	5.36
CD at 5%												
		1.98	1.95	1.35		6.92	6.19	4.53		18.08	12.61	10.76

Table 4.1.5 a: Interaction effect of Cultivars and plant growth regulators on Number of Leaves

Treat t.		Number of leaves								
		45 Days			75 Days			105 Days		
		2018- 19	2019- 20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V₁P₀	Arka Shashank (Control)	13.03	12.90	12.97	34.23	33.56	33.90	110.85	109.46	110.16
V₁P₁	Arka Shashank (CCC 1500 ppm)	14.36	14.36	14.37	46.40	48.16	47.28	122.93	120.83	121.88
V₁P₂	Arka Shashank (CCC 1000 ppm)	16.76	16.66	16.72	54.03	51.53	52.78	128.66	127.86	128.27
V₁P₃	Arka Shashank (NAA 50 ppm)	16.90	18.40	17.65	82.93	82.80	82.87	162.46	164.13	163.30
V₁P₄	Arka Shashank (NAA 100 ppm)	21.00	19.70	20.35	93.06	92.33	92.70	176.33	175.56	175.95
V₁P₅	Arka Shashank (GA ₃ 150 ppm)	25.73	24.83	25.28	108.26	107.06	107.67	240.93	254.23	247.58
V₁P₆	Arka Shashank (GA ₃ 200 ppm)	27.73	29.20	28.47	110.03	114.80	112.42	233.03	264.06	248.55
V₂P₀	Arka Archana (Control)	15.03	14.80	14.92	66.90	65.90	66.40	159.36	155.43	157.40
V₂P₁	Arka Archana (CCC 1500 ppm)	18.03	18.46	18.25	83.40	82.96	83.18	209.23	203.80	206.52
V₂P₂	Arka Archana (CCC 1000 ppm)	22.96	23.43	23.20	92.53	93.03	92.78	216.16	215.66	215.92
V₂P₃	Arka Archana (NAA 50 ppm)	25.53	25.16	25.35	110.46	112.20	111.33	250.83	251.83	251.33
V₂P₄	Arka Archana (NAA 100 ppm)	28.26	28.23	28.25	118.03	120.90	120.47	259.43	257.66	258.55
V₂P₅	Arka Archana (GA ₃ 150 ppm)	32.53	32.00	32.27	122.96	125.66	125.32	281.56	282.46	282.02
V₂P₆	Arka Archana (GA ₃ 200 ppm)	33.43	32.93	33.18	125.86	126.50	126.68	305.86	303.63	304.75
SEm±		1.36	1.34	0.95	4.76	4.26	3.20	12.44	8.67	7.58
CD at 5%		2.79	2.76	1.92	9.79	8.76	6.41	25.57	17.83	15.22

Fig 4.1.5 a: Effect of Cultivars and Plant growth regulators on Number of Leaves at 45 Days

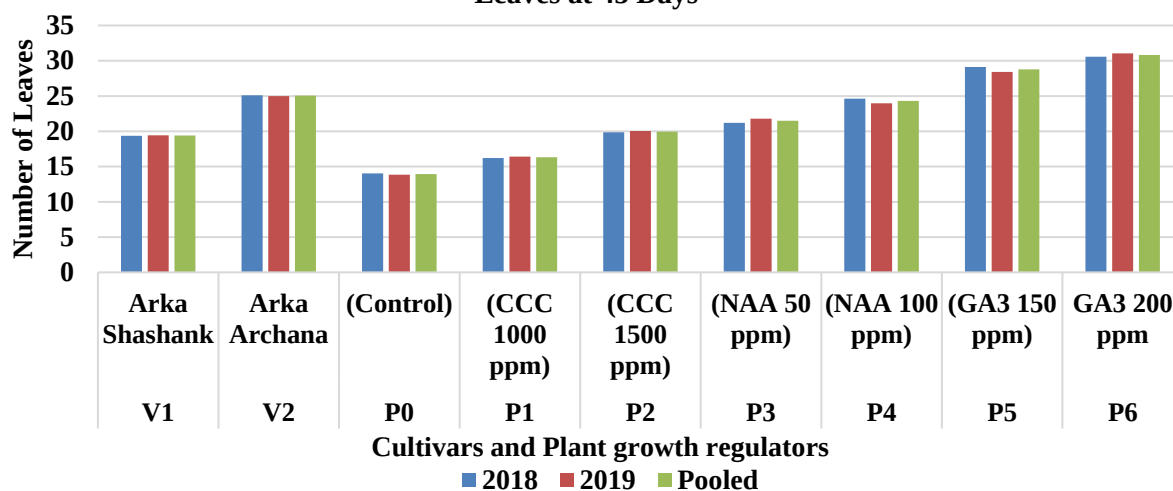


Table 4.1.5 b: Effect of Cultivars and Plant growth regulators on Number of Leaves at 75 Days

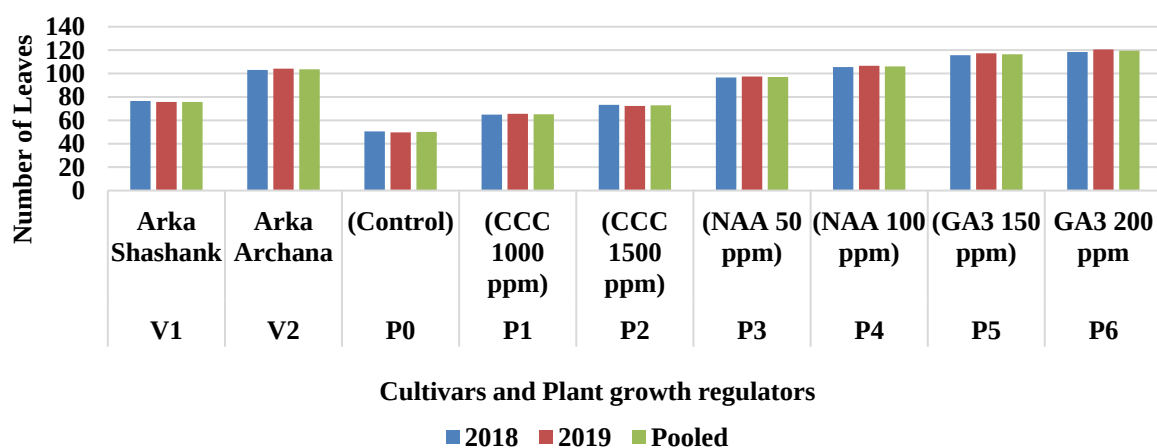
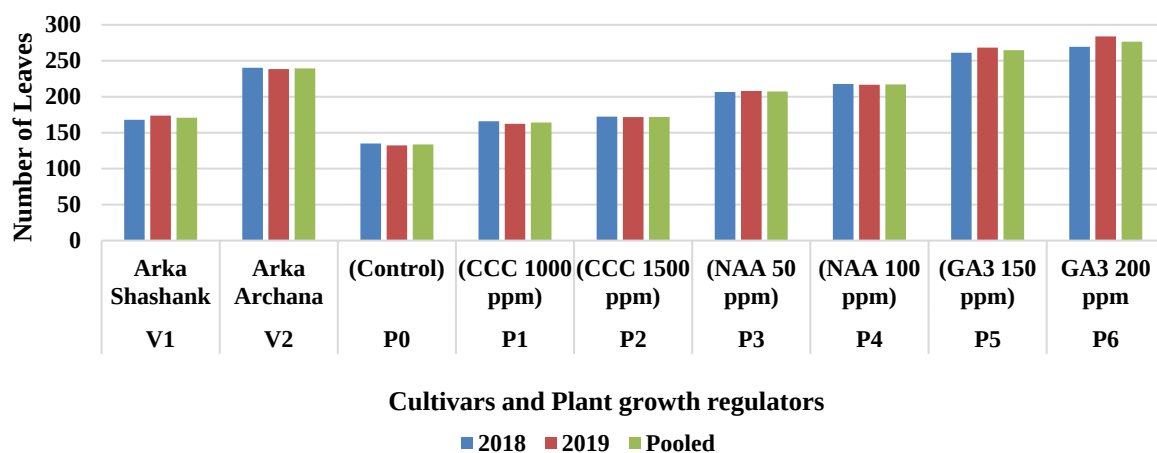


Table 4.1.5 c: Effect of Cultivars and Plant growth regulators on Number of Leaves at 105 Days



4.1.6 Leaf area per plant (cm²)

It is clear from the data presented in Table 4.1.6, 4.1.6 a and graphically presented in Fig 4.1.6 a and 4.1.4 6 that the leaf area per plant was significantly influenced by cultivars and different levels of plant growth regulators.

The perusal of the data revealed that at 75 DAT there was significant response in leaf area per plant due to cultivars during both the year and on pooled mean basis. The maximum Leaf area per plant (18.35, 18.81 and 18.59 cm²) respectively was observed in cultivar (V₂) Arka Archana and the minimum leaf area per plant (16.10, 15.59 and 15.85 cm²) respectively was noticed in cultivar (V₁) Arka Shashank.

At 75 DAT there was significant difference in Leaf area per plant due to plant growth regulators. The maximum Leaf area per plant (22.30, 21.76, 22.04 cm²) respectively was recorded in treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) during the second year only and it was found significant difference with remaining of the other treatments during both the years as well as on pooled mean basis. The minimum leaf area per plant (11.33, 11.47, 11.40 cm²) respectively was found under treatment P₀ (Control) during both the years and on pooled mean analysis.

The interaction effect between the cultivars and plant growth regulators showed significant difference during first year and on pooled mean basis except second year. The maximum leaf area per plant was observed in (23.29 and 23.43 cm²) respectively in treatment combination (V₂P₆) which was found statistically *at par* with treatment combination (V₂P₅) in first year and on pooled mean basis and it was observed significant difference with rest of other treatment combinations. The minimum leaf area per plant (11.29 and 11.32 cm²) respectively was observed in treatment combination (V₁P₀). However, during second year the interaction effect was found non significant.

The data pertaining on cultivars exhibited significant differences on leaf area per plant at 105 DAT during both the years as well as on pooled mean analysis. The

highest leaf area per plant (26.85, 26.80 and 26.83 cm²) respectively was observed in cultivar (V₂) Arka Archana which is superior over as compared to cultivar (V₁) Arka Shashank (22.37, 21.89 and 22.14 cm²) respectively.

In case of plant growth regulator, leaf area per plant at 105 DAT showed significant difference during both the years and on pooled mean basis. It clearly showed that the maximum Leaf area per plant (30.39, 29.78 and 30.09 cm²) respectively was recorded under the treatment P₆ (GA₃ 200 ppm), which was found statistically *at par* with treatment P₅ (GA₃150 ppm) during second year only and it was observed significant difference with rest of the other treatments during both the years as well as on pooled mean analysis. While, minimum leaf area per plant (17.75, 17.83, and 17.80 cm²) respectively was noticed under treatment P₀ (Control).

The interaction between cultivars and plant growth regulators at 105 DAT was found significant impact during first year and on pooled mean basis. The maximum leaf area per plant (36.26 and 33.51 cm²) respectively was obtained with the treatment combination (V₂P₆) and it was showed significant difference with remaining of the other treatment combinations during first year and on pooled mean basis. The minimum leaf area per plant (20.28 and 16.55 cm²) respectively was observed in treatment combination (V₁P₀). The interaction effect was found non- significant during second year.

Table 4.1.6: Effect of Cultivars and Plant growth regulators on Leaf Area

Treat.		Leaf area (cm ²)					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V₁	Arka Shashank	16.10	15.59	15.85	22.37	21.89	22.14
V₂	Arka Archana	18.35	18.81	18.59	26.85	26.80	26.83
SEm SEm±		0.38	0.51	0.32	0.72	0.47	0.30
CD at 5%		0.77	1.04	0.63	1.47	0.96	0.60
PGR							
P₀	(Control)	11.33	11.47	11.40	17.75	17.83	17.80
P₁	(CCC 1000 ppm)	14.09	14.53	14.31	20.94	20.80	20.87
P₂	(CCC 1500 ppm)	15.25	15.51	15.38	22.49	22.29	22.39
P₃	(NAA 50 ppm)	18.04	17.88	17.96	24.79	24.81	24.80
P₄	(NAA 100 ppm)	18.78	18.80	18.79	27.31	26.87	27.10
P₅	(GA ₃ 150 ppm)	20.80	20.45	20.63	28.63	28.05	28.34
P₆	(GA ₃ 200 ppm)	22.30	21.76	22.04	30.39	29.78	30.09
SEm SEm±		0.70	0.95	0.59	0.38	0.87	0.56
CD at 5%		1.47	1.95	1.19	0.79	1.79	1.13

Table 4.1.6 a: Interaction effect of Cultivars and Plant growth regulators on Leaf Area

Treat.			Leaf Area (cm ²)					
			75 Days			105 Days		
			2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	11.29	11.34	11.32	20.28	19.16	16.55
V₁P₁	Arka Shashank	(CCC 1000 ppm)	13.75	13.51	13.64	20.56	20.01	19.72
V₁P₂	Arka Shashank	(CCC 1500 ppm)	14.26	13.86	14.07	21.72	21.34	20.29
V₁P₃	Arka Shashank	(NAA 50 ppm)	16.24	15.60	15.93	24.53	24.29	21.53
V₁P₄	Arka Shashank	(NAA 100 ppm)	16.51	16.15	16.33	25.88	25.70	24.42
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	19.36	18.68	19.02	26.87	26.44	25.79
V₁P₆	Arka Shashank	GA ₃ 200 ppm	21.32	19.96	20.64	18.71	19.37	26.66
V₂P₀	Arka Archana	(Control)	11.38	11.59	11.49	21.60	22.44	19.04
V₂P₁	Arka Archana	(CCC 1000 ppm)	14.43	15.55	14.99	24.42	24.57	22.02
V₂P₂	Arka Archana	(CCC 1500 ppm)	16.24	17.15	16.70	27.87	28.28	24.50
V₂P₃	Arka Archana	(NAA 50 ppm)	19.84	20.15	20.00	30.09	29.45	28.08
V₂P₄	Arka Archana	(NAA 100 ppm)	21.05	21.45	21.25	31.39	30.39	29.78
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	22.25	22.22	22.24	33.91	33.11	30.90
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	23.29	23.56	23.43	36.26	39.83	33.51
SEm±			0.99	1.34	0.84	1.01	1.23	0.80
CD at 5%			2.04	NS	1.68	2.08	NS	1.60

Fig 4.1.6 a: Effect of Cultivars and Plant growth regulators on Leaf Area at 75 Days

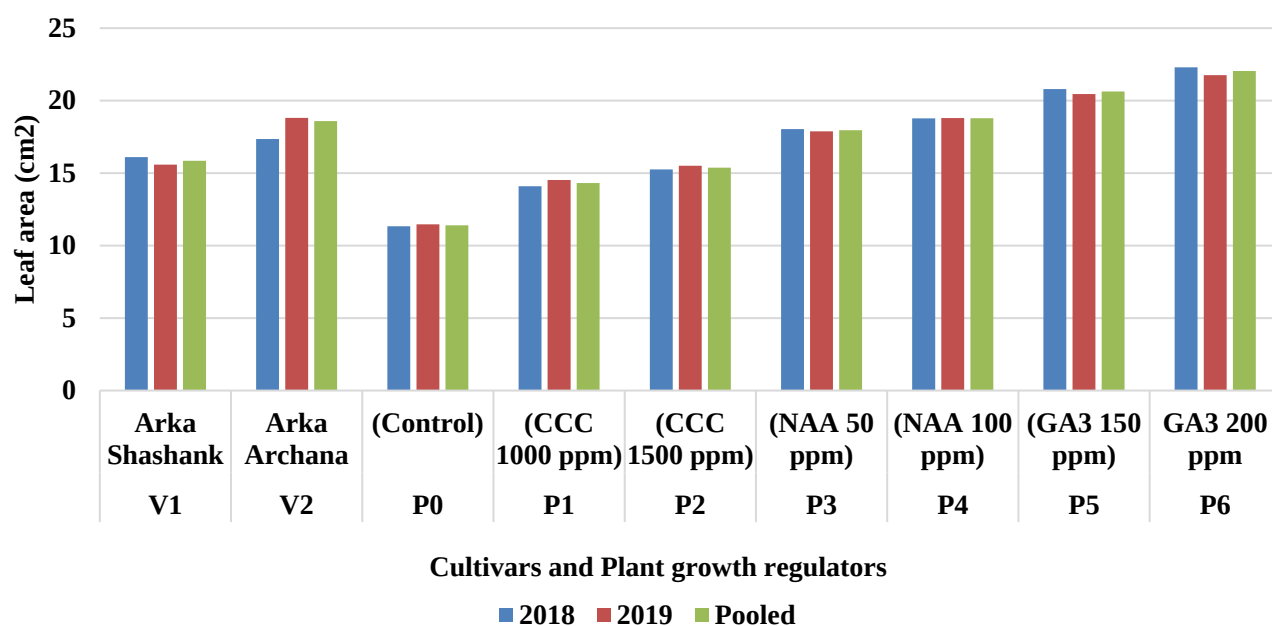
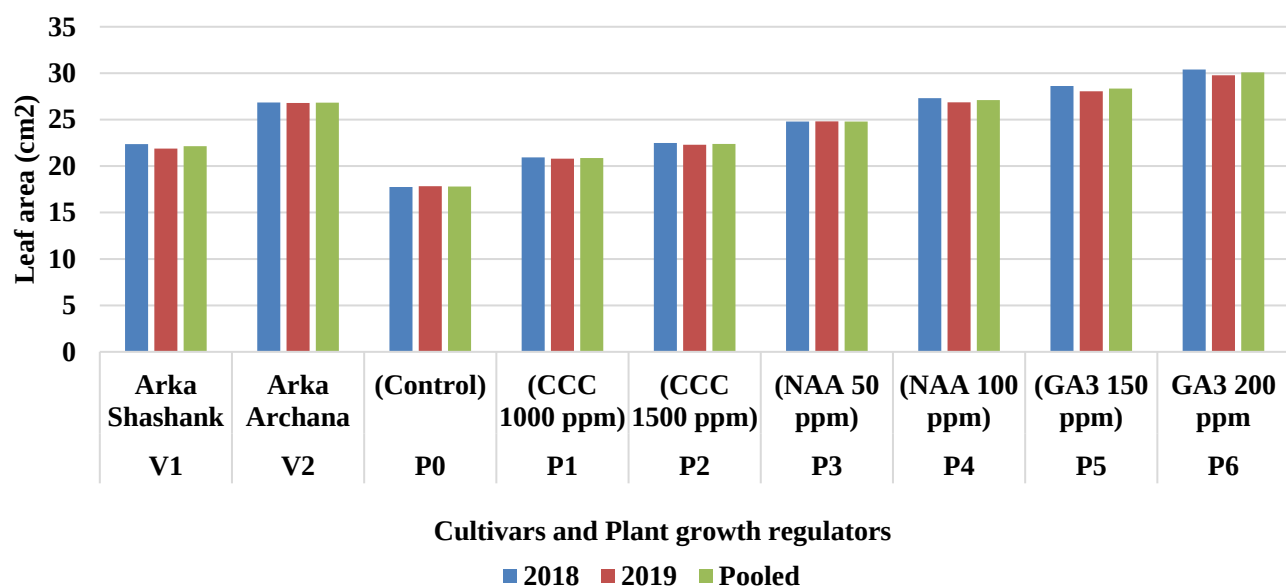


Fig 4.1.6 b: Effect of Cultivars and Plant growth regulators on Leaf Area at 105 Days



4.1.7 Leaf area index

It is clear from the data presented in Table 4.1.7, 4.1.7 a and graphically presented in Fig 4.1.7 a and 4.1.7 b that the leaf area index was significantly influenced by different levels of plant growth regulators and cultivars.

The perusal of the data revealed that at 75 DAT there was significant response in leaf area index due to cultivars during both the year and on pooled mean basis. The highest leaf area index (0.019, 0.020 and 0.020) respectively was observed in cultivar (V₂) Arka Archana and the lowest leaf area index (0.017, 0.017 and 0.017) respectively was noticed in cultivar (V₁) Arka Shashank

At 75 DAT there was significant difference in Leaf area index due to plant growth regulators during the investigation. The maximum Leaf area index (0.025, 0.023, and 0.024) respectively was recorded in treatment P₆ (GA₃ 200 ppm). The minimum leaf area index (0.010, 0.013, 0.011 cm²) respectively was found under treatment P₀ (Control) during both the years and on pooled mean analysis.

The interaction effect between the cultivars and plant growth regulators was showed non-significant effect during both the tested years and on pooled mean basis

The data pertaining on cultivars exhibited significant differences on leaf area index at 105 DAT during both the years as well as on pooled mean analysis. The highest leaf area index (0.030, 0.029 and 0.029) respectively was observed in cultivar (V₂) Arka Archana which is superior over as compared to cultivar (V₁) Arka Shashank (0.24, 0.24 and 0.24) respectively.

In case of plant growth regulator on leaf area at 105 DAT showed significant difference during both the year and on pooled mean basis. It was clearly showed that the maximum Leaf area index (0.035, 0.033 and 0.034) respectively was recorded under the treatment P₆ (GA₃ 200 ppm), which was found statistically *at par* with treatment P₅ (GA₃150 ppm). While, minimum leaf area index (0.020, 0.019, and 0.019) respectively was noticed under treatment P₀ (Control) during this investigation.

The interaction effect between the cultivars and plant growth regulators at 75 and 105 DAT was showed non-significant effect during both the tested years and on pooled mean basis.

Maximum leaf area per plant and leaf area index was recorded in Arka Archana and was followed by Arka Shashank. it was due to the increased size of leaf. Lesser leaf size resulted in minimum leaf area since the Cultivars varied for their number of leaves. Variations in leaf production could be expected among the varieties due to genetic character. The similar finding was also reported by Ravikumar (2002), marigold (Nalawadi, 1982) in China aster and also reported by Nalawadi (1982) in marigold.

Maximum leaf area per plant and Leaf area index was reported with the application of GA₃ at 200 ppm than all other treatments, this may be due to the increase in number of branches due to the fact that, gibberellic acid plays a vital role in improvement of vegetative growth characters of the plants as it enhances the cell division by promoting the DNA synthesis in the cells. Further, GA₃ is also known to increase the sink strength of the actively growing plant parts. This would have resulted into the better leaf area of China aster plants. The results are in close agreement with the findings of Sainath *et al.* (2012) in annual chrysanthemum, Badge *et al.* (2014) in African marigold, Sharma and Joshi (2015) in China aster and Sajid *et al.* (2016) in *Chrysanthemum morifolium*., Kirad *et al.* (2001), Umrao *et al.* (2007) and Kumar *et al.*(2008).

Table 4.1.7: Effect of Cultivars and Plant growth regulators on Leaf Area Index

Treat.		Leaf area Index					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V₁	Arka Shashank	0.017	0.017	0.017	0.024	0.024	0.024
V₂	Arka Archana	0.019	0.020	0.020	0.030	0.029	0.029
SEm SEm±		0.00	0.00	0.00	0.00	0.00	0.00
CD at 5%		0.002	0.003	0.00	0.001	0.001	0.001
PGR							
P₀	(Control)	0.010	0.013	0.011	0.020	0.019	0.019
P₁	(CCC 1000 ppm)	0.015	0.016	0.015	0.021	0.023	0.024
P₂	(CCC 1500 ppm)	0.016	0.017	0.016	0.025	0.024	0.022
P₃	(NAA 50 ppm)	0.020	0.020	0.020	0.026	0.027	0.027
P₄	(NAA 100 ppm)	0.020	0.020	0.020	0.030	0.029	0.029
P₅	(GA ₃ 150 ppm)	0.021	0.023	0.022	0.033	0.030	0.031
P₆	(GA ₃ 200 ppm)	0.025	0.023	0.024	0.035	0.033	0.034
SEm SEm±		0.002	0.001	0.001	0.001	0.001	0.001
CD at 5%		0.004	0.001	0.002	0.003	0.002	0.001

Table 4.1.7 a: Interaction effect of Cultivars and Plant growth regulators on Leaf Area Index

Treat.			Leaf Area Index					
			75 Days			105 Days		
			2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	0.010	0.013	0.011	0.020	0.018	0.019
V₁P₁	Arka Shashank	(CCC 1000 ppm)	0.013	0.014	0.014	0.020	0.021	0.020
V₁P₂	Arka Shashank	(CCC 1500 ppm)	0.013	0.015	0.014	0.020	0.022	0.021
V₁P₃	Arka Shashank	(NAA 50 ppm)	0.020	0.018	0.019	0.023	0.023	0.023
V₁P₄	Arka Shashank	(NAA 100 ppm)	0.020	0.017	0.018	0.030	0.026	0.028
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	0.020	0.021	0.020	0.030	0.027	0.028
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	0.023	0.021	0.022	0.030	0.029	0.029
V₂P₀	Arka Archana	(Control)	0.010	0.013	0.011	0.020	0.021	0.020
V₂P₁	Arka Archana	(CCC 1000 ppm)	0.016	0.017	0.016	0.023	0.024	0.024
V₂P₂	Arka Archana	(CCC 1500 ppm)	0.020	0.019	0.019	0.030	0.027	0.028
V₂P₃	Arka Archana	(NAA 50 ppm)	0.020	0.022	0.021	0.030	0.031	0.030
V₂P₄	Arka Archana	(NAA 100 ppm)	0.020	0.023	0.021	0.030	0.032	0.031
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	0.023	0.025	0.024	0.036	0.033	0.035
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	0.026	0.024	0.025	0.040	0.036	0.038
SEm±			0.003	0.001	0.001	0.002	0.001	0.001
CD at 5%			NS	NS	NS	NS	NS	NS

Fig 4.1.7 a: Effect of Cultivars and Plant growth regulators on Leaf Area Index at 75 Days

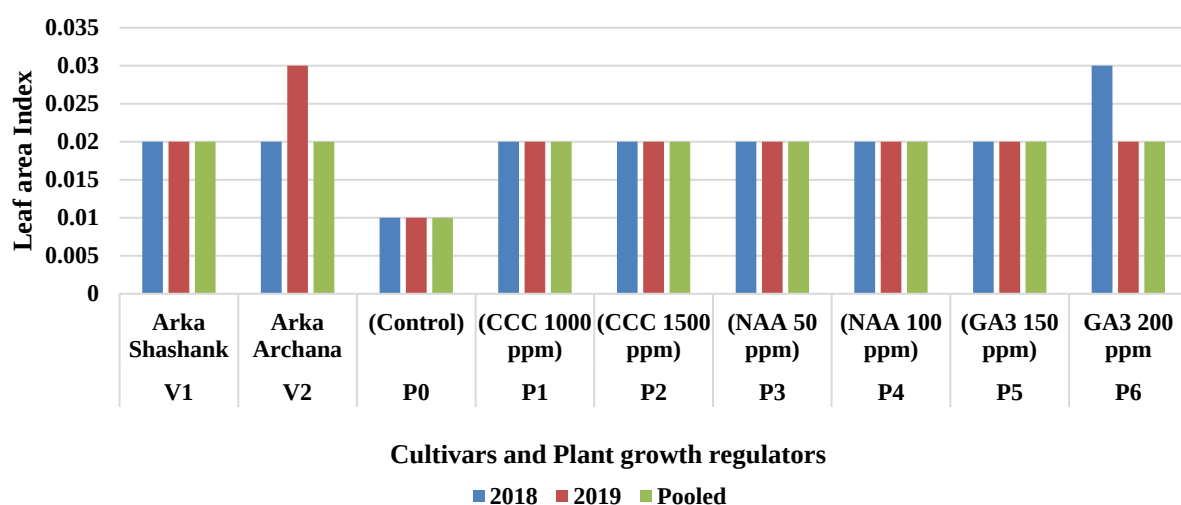
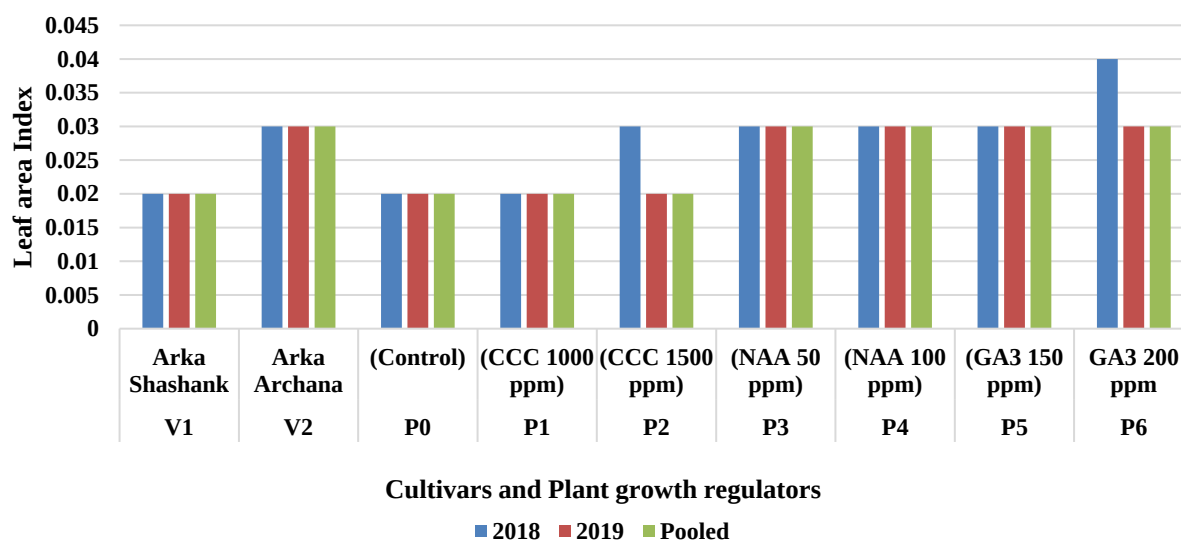


Fig 4.1.7 b: Effect of Cultivars and Plant growth regulators on Leaf Area Index 105 Days



4.1.8 Dry Matter Production of Leaves (g/plant)

The result on dry matter production of leaves was influence by cultivars and plant growth regulators are presented in Table 4.1.8, 4.1.8 a and Fig 4.1.8a and 4.1.8 b

In case of cultivars at 75 DAT, cultivar showed significant influence on dry matter production of leaves during both the years as well as on pooled mean basis. Maximum dry matter production of leaves (7.31, 7.24 and 7.28 g/plant) respectively were found in cultivar (V₁) Arka Archana during the investigation and minimum the dry matter production of leaves was found in cultivar (V₂) Arka Shashank (5.69, 5.68 and 5.69 g/plant) respectively.

In respect to plant growth regulators, the results revealed that the dry matter production of leaves at 75 DAT was significantly influenced by plant growth regulator during both the year as well as on pooled mean basis. The maximum dry matter production of leaves (10.62, 11.17, 10.90 g/plant) respectively was recorded under treatment P₆ (GA₃ 200 ppm) and it was observed significantly differ with rest of the other treatments. However, minimum dry matter production of leaves (2.78, 2.68 and 2.73 g/plant) was recorded under treatment P₀ (control).

The interactions between two cultivar and growth regulators at 75 DAT were found significant during second year only. The maximum dry matter production (12.58 g/plant) was obtained from treatment combination (V₂P₆) and it was observed significantly difference with the rest of the other treatment combinations. The minimum dry matter production (2.22 g/plant) was recorded under treatment combination (V₁P₀) under this investigation. Whereas, it was found non-significant during first year as well as on pooled mean basis under this investigation.

Among the cultivars at 105 DAT, the dry matter production of leaves (15.39, 15.39 and 15.40 g/plant) were found highest in cultivar (V₂) Arka Archana in both the years as well as on pooled mean basis as compared to dry matter production of leaves (12.67, 12.44 and 12.56 g/plant) respectively obtained from cultivar (V₁) Arka Shashank.

Table 4.1.8: Effect of Cultivars and Plant growth regulators s on Dry Matter Production of Leaves

Treat.		Dry Matter Production of Leaves (g/plant)					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	5.69	5.68	5.69	12.67	12.44	12.56
V ₂	Arka Archana	7.31	7.24	7.28	15.39	15.39	15.40
SEm SEm±		0.28	0.28	0.20	0.31	0.40	0.25
CD at 5%		0.57	0.58	0.40	0.64	0.82	0.51
P ₀	(Control)	2.78	2.68	2.73	7.28	6.52	6.90
P ₁	(CCC 1000 ppm)	4.61	4.24	4.43	10.37	11.48	10.93
P ₂	(CCC 1500 ppm)	5.14	4.77	4.96	12.35	12.96	12.66
P ₃	(NAA 50 ppm)	6.07	6.16	6.12	15.07	15.19	15.13
P ₄	(NAA 100 ppm)	7.49	7.36	7.43	16.60	15.34	15.97
P ₅	(GA ₃ 150 ppm)	8.80	8.81	8.81	17.54	16.88	17.21
P ₆	(GA ₃ 200 ppm)	10.62	11.17	10.90	19.03	19.05	19.04
SEm SEm±		0.52	0.53	0.37	2.73	0.75	0.47
CD at 5%		1.06	1.09	0.74	1.20	1.53	0.95

Table 4.1.8 a: Interaction effect of Cultivars and Plant growth regulators on Dry Matter Production of Leaves

Treat.			Dry Matter Production of Leaves (g/plant)					
			75 Days			105 Days		
			2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V₁ P₀	Arka Shashank	(Control)	2.32	2.22	2.28	6.48	6.04	6.26
V₁ P₁	Arka Shashank	(CCC 1000 ppm)	3.97	3.98	3.98	10.23	11.80	11.02
V₁ P₂	Arka Shashank	(CCC 1500 ppm)	3.73	4.08	3.91	11.85	11.46	11.66
V₁ P₃	Arka Shashank	(NAA 50 ppm)	5.43	5.93	5.68	13.41	13.28	13.35
V₁ P₄	Arka Shashank	(NAA 100 ppm)	6.66	6.76	6.71	14.82	13.50	14.17
V₁ P₅	Arka Shashank	(GA ₃ 150 ppm)	7.62	7.00	7.31	15.69	14.72	15.21
V₁ P₆	Arka Shashank	(GA ₃ 200 ppm)	10.12	9.77	9.95	16.24	16.28	16.26
V₂ P₀	Arka Archana	(Control)	3.24	3.14	3.19	8.08	7.01	7.55
V₂ P₁	Arka Archana	(CCC 1000 ppm)	5.26	4.51	4.89	10.51	11.16	10.84
V₂ P₂	Arka Archana	(CCC 1500 ppm)	6.55	5.46	6.01	12.85	14.46	13.66
V₂ P₃	Arka Archana	(NAA 50 ppm)	6.72	6.40	6.56	16.72	17.10	16.92
V₂ P₄	Arka Archana	(NAA 100 ppm)	8.32	7.96	8.15	18.38	17.17	17.78
V₂ P₅	Arka Archana	(GA ₃ 150 ppm)	9.98	10.63	10.31	19.38	19.03	19.21
V₂ P₆	Arka Archana	(GA ₃ 200 ppm)	11.12	12.58	11.85	22.83	21.82	21.83
SEm±			0.73	0.75	0.52	0.83	1.06	0.67
CD at 5%			NS	1.54	NS	1.70	2.17	1.34

Fig 4.1.8 a: Effect of Cultivars and Plant growth regulators on Dry Matter Production of Leaves at 75 days

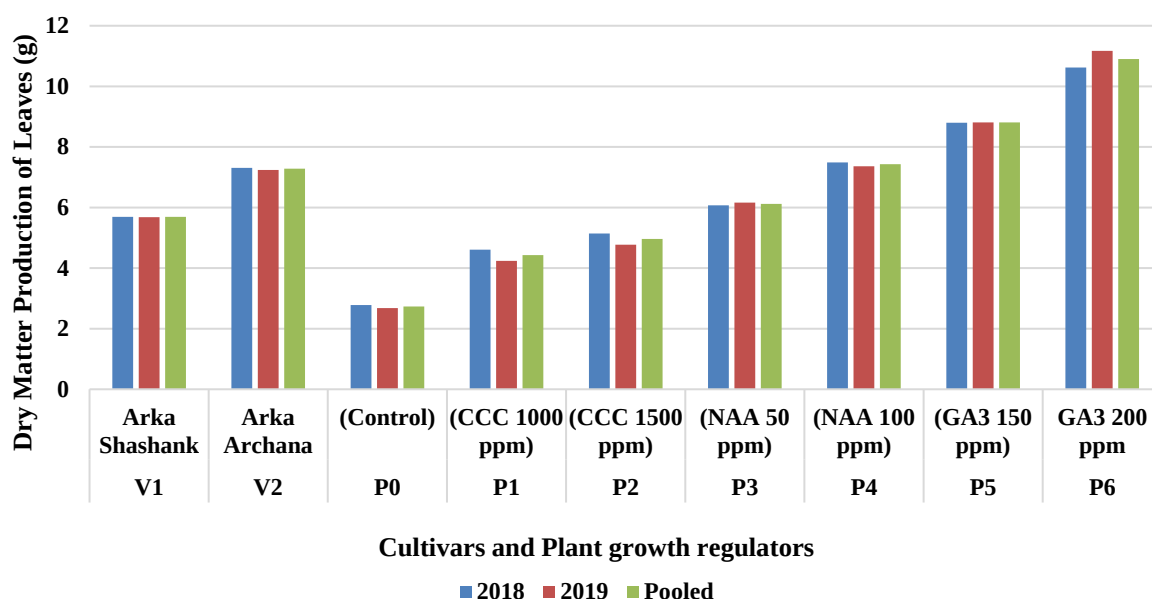
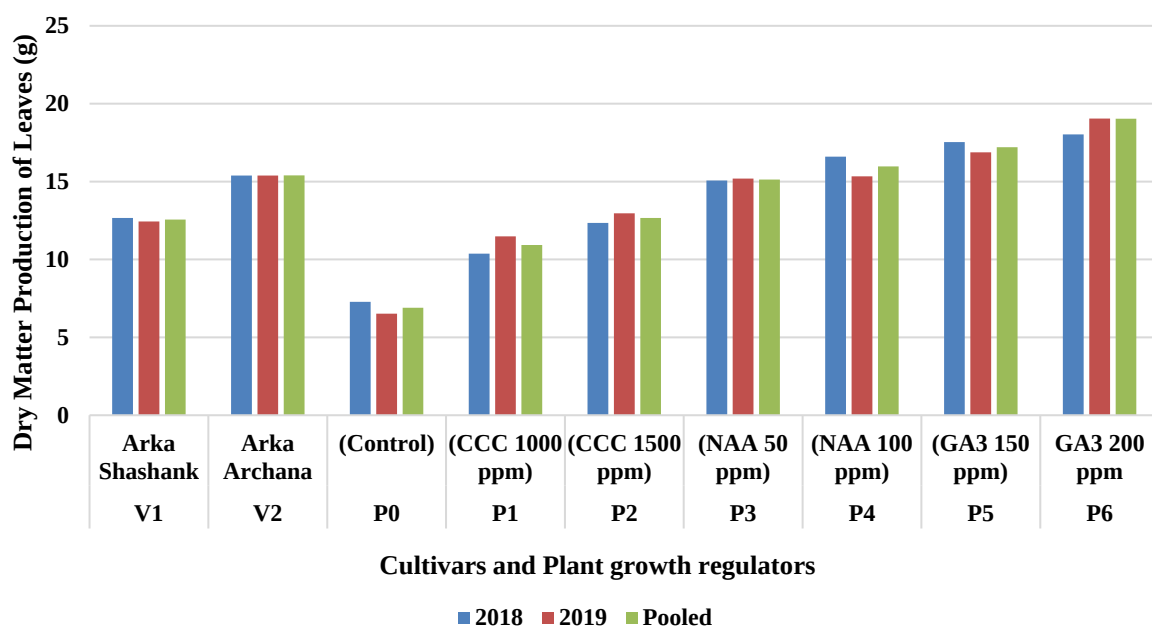


Fig 4.1.8 b: Effect of Cultivars and Plant growth regulators on Dry Matter Production of Leaves at 105 days



As far as at 105 days, the results on dry matter production of leaves shows significant response between treatments during first year and second year as well as on pooled mean basis. The dry matter production of leaves (19.03, 19.05 and 19.04 g/plant) respectively was also recorded maximum in treatment P₆ (GA₃ 200 ppm) and it was observed significant difference with rest of the other treatments. Whereas, minimum dry matter production of leaves (7.28, 6.52 and 6.90 g/plant) respectively were recorded under treatment P₀ (control) during this investigation.

The interaction between plant growth regulators and cultivars at 105 days was found significant, during both the years as well as on pooled mean basis. The maximum dry matter production of leaves (22.83, 21.82, 21.83 g/plant) respectively was found in treatment combination (V₂P₆) during the investigation and it was observed significant difference with remaining of the other treatments. The minimum dry matter production of leaves (6.48, 6.04, 6.26 g/plant) respectively was observed in treatment combination (V₁P₀).

4.1.9 Dry Matter Production of Stems (g/plant)

The data on dry matter production of stems as influence by cultivars and plant growth regulators are presented in Table 4.1.9, 4.1.9 a and Fig 4.1.9 a and 4.1.9 b

The evident data showed that at 75 DAT, cultivar showed significant influence on dry matter production of stems during both the years as well as on pooled mean basis. At 75 DAT, the dry matter production of stems (30.83, 31.33, and 31.08 g/plant) respectively were found maximum in cultivar (V₂) Arka Archana during this investigation and minimum dry matter production of stems (12.59, 13.07 and 12.83 g/plant) respectively was found in cultivar (V₁) Arka Shashank during both the tested year as well as on pooled mean data.

The application of plant growth regulators on dry matter production of stems at 75 DAT was significantly influenced during both the year as well as on pooled mean basis. The maximum dry matter production of stems (28.47, 29.42 and 28.95 g/plant) respectively was recorded under treatment P₆ (GA₃ 200 ppm) and it was observed significant difference with rest of the other treatments. However,

minimum dry matter production of stems (12.75, 13.30 and 13.03 g/plant) was recorded under treatment P₀ (control).

The interactions between cultivar and growth regulators at 75 DAT were found significant during both the year as well as on pooled mean basis for dry matter production of stems, the maximum dry matter production of stems (39.41, 40.46 and 39.94 g/plant) respectively were obtained from treatment combination (V₂P₆) and it was observed significant variation with rest of the other treatments. The minimum dry matter production for stems (5.70, 6.25 and 5.98 g/plant) obtained from treatment combination (V₁P₀).

The data in respect to cultivars at 105 DAT, the dry matter production of stems (38.55, 39.12, and 38.84 g/plant) respectively were found highest in cultivar (V₂) Arka Archana in first and second year as well as on pooled mean analysis with respect to dry matter production of stems (19.69, 19.92 and 19.81g/plant) respectively obtained from cultivar (V₁) Arka Shashank.

The results of first year and second year as well as in on pooled mean data of dry matter production of stems at 105 DAT showed significant differences between treatments for plant growth regulators. The dry matter production of stems (35.15, 36.11, and 35.63 g/plant) respectively was also recorded maximum in treatment P₆ (GA₃ 200 ppm) and it was observed significant difference with rest of the other treatment. Whereas, minimum dry matter production of stems (22.06, 22.79 and 22.43 g/plant) respectively were recorded under treatment P₀ (control) during both years as well as on pooled mean analysis.

The interaction between cultivars and plant growth regulators at 105 days was found significant, during both the years as well as on pooled mean basis. The maximum dry matter production of stems (45.08, 47.80 and 46.45 g/plant) respectively was found in treatment combination (V₂P₆) under this investigation and it was observed significant difference with rest of the other treatment combinations. The minimum dry matter production of stems (13.63, 15.07 and 14.35 g/plant) respectively was observed in treatment combination (V₁P₀).

Table 4.1.9: Effect of Cultivars and Plant growth regulators on Dry Matter Production of Stems

Treat.		Dry Matter Production of Stems (g/plant)					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	12.59	13.07	12.83	19.69	19.92	19.81
V ₂	Arka Archana	30.83	31.33	31.08	38.55	39.12	38.84
SEm SEm±		0.31	0.37	0.24	0.45	0.45	0.32
CD at 5%		0.63	0.75	0.48	0.93	0.94	0.64
PGR							
P ₀	(Control)	12.75	13.30	13.03	22.06	22.79	22.43
P ₁	(CCC 1000 ppm)	16.84	17.03	16.94	24.68	24.81	24.75
P ₂	(CCC 1500 ppm)	20.91	21.12	21.02	26.75	27.13	26.95
P ₃	(NAA 50 ppm)	22.72	23.17	22.95	29.97	30.72	30.35
P ₄	(NAA 100 ppm)	24.45	25.27	24.87	31.63	30.70	31.17
P ₅	(GA ₃ 150 ppm)	25.83	26.08	25.96	33.55	34.40	33.98
P ₆	(GA ₃ 200 ppm)	28.47	29.42	28.95	35.15	36.11	35.63
SEm SEm±		0.57	0.69	0.45	0.85	0.85	0.60
CD at 5%		1.17	1.41	0.90	1.74	1.75	1.20

Table 4.1.9 a: Interaction effect of Cultivars and Plant growth regulators on Leaf Dry Matter Production of Stems

Treat.			Dry Matter Production of Stems (g/plant)					
			75 Days			105 Days		
			2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	5.70	6.25	5.98	13.63	15.07	14.35
V₁P₁	Arka Shashank	(CCC 1000 ppm)	8.34	8.45	8.40	16.20	17.04	16.62
V₁P₂	Arka Shashank	(CCC 1500 ppm)	11.66	11.35	11.51	17.84	18.16	18.00
V₁P₃	Arka Shashank	(NAA 50 ppm)	13.18	13.72	13.45	20.90	21.27	21.09
V₁P₄	Arka Shashank	(NAA 100 ppm)	15.36	16.01	15.69	21.64	20.90	21.27
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	16.37	17.32	16.85	22.38	22.62	22.50
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	17.53	18.38	17.96	25.21	24.41	24.82
V₂P₀	Arka Archana	(Control)	19.81	20.34	20.08	30.49	30.52	30.51
V₂P₁	Arka Archana	(CCC 1000 ppm)	25.33	25.61	25.47	33.16	32.59	32.88
V₂P₂	Arka Archana	(CCC 1500 ppm)	30.15	30.90	30.53	35.67	36.11	35.89
V₂P₃	Arka Archana	(NAA 50 ppm)	32.27	32.61	32.45	39.04	40.17	39.61
V₂P₄	Arka Archana	(NAA 100 ppm)	33.54	34.53	34.04	41.63	40.51	41.07
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	35.29	34.85	35.07	44.73	46.18	45.46
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	39.41	40.46	39.94	45.08	47.80	46.45
SEm±			0.81	0.97	0.63	1.20	1.20	0.85
CD at 5%			1.66	2.00	1.27	2.46	2.47	1.70

Fig 4.1.9 a: Effect of Cultivars and Plant growth regulators on Dry Matter Production of Stems at 75 Days

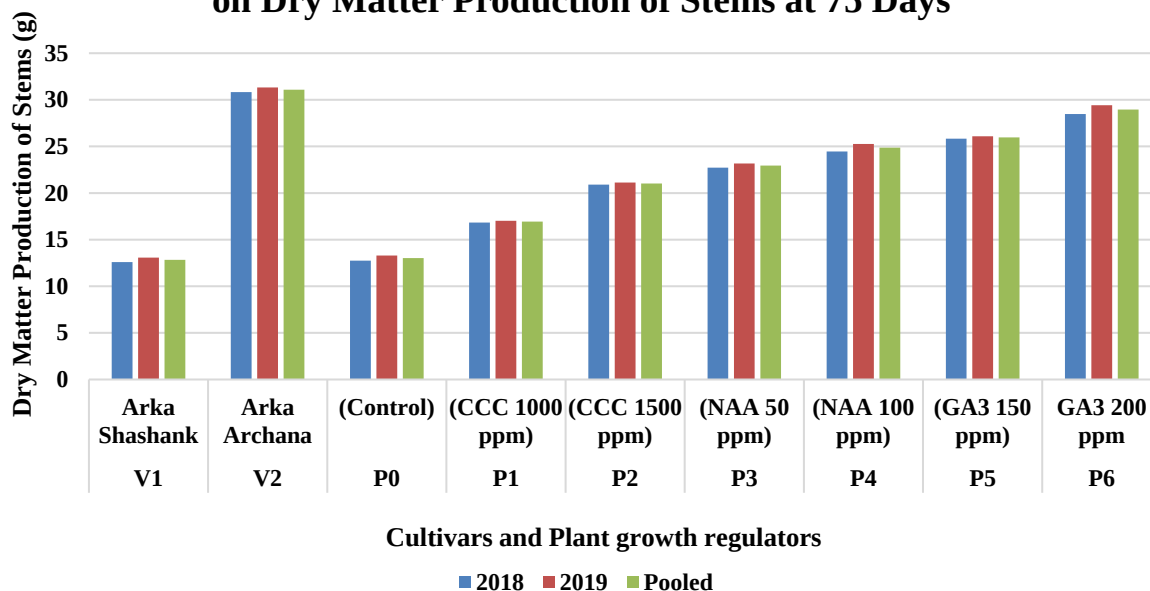
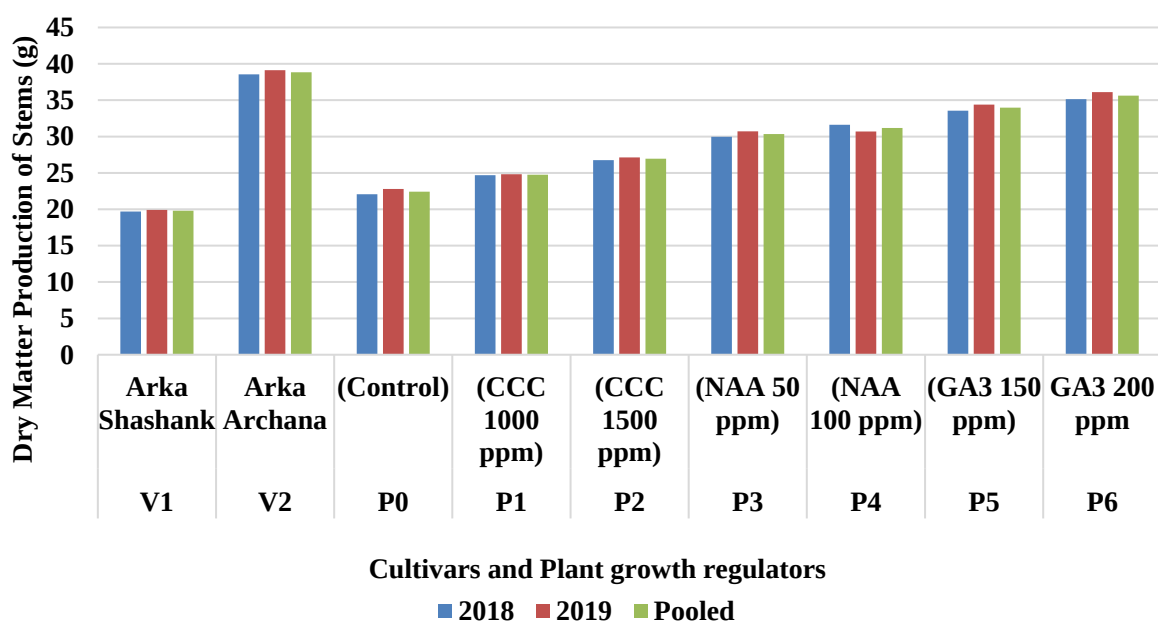


Fig 4.1.9 b: Effect of Cultivars and Plant growth regulators on Dry Matter Production of Stems at 105 Days



4.1.10 Dry Matter Production of Roots (g/plant)

It is clear from the data presented in Table 4.1.10, 4.1.10 a and graphically presented in Fig 4.1.10 a and 4.1.10 b that the dry matter production of roots was significantly influenced by different levels of cultivars and Plant growth regulators..

The cultivar showed significant influence on dry matter production of roots during both the years as well as on pooled mean basis. At 75 DAT, the dry matter production of roots (20.48, 19.78, and 20.13 g/plant) respectively were found maximum in cultivar (V₂) Arka Archana under this investigation and minimum dry matter production of roots (9.14, 9.12 and 9.13 g/plant) respectively was found in cultivar (V₁) Arka Shashank.

In respect to plant growth regulators, the dry matter production of roots at 75 DAT was significantly influenced by plant growth regulator during both the year as well as on pooled mean basis. The maximum dry matter production of roots (19.53, 19.17 and 19.35 g/plant) respectively was recorded under treatment P₆ (GA₃ 200 ppm) which was showed similar trend with treatment P₅ (GA₃ 150 ppm) and it was observed significant difference with respite of the other treatments. However, minimum dry matter production of roots (10.02, 9.21 and 9.62 g/plant) respectively were recorded under treatment P₀ (control) during both years and on pooled mean basis respectively.

The interactions between two cultivar and growth regulators at 75 DAT were found non significant during both the tested years as well as on pooled mean data for dry matter production of roots.

The data in respect to cultivars at 105 DAT, the dry matter production of roots (33.14, 32.26 and 32.71 g/plant) respectively were found highest in cultivar (V₂) Arka Archana in first and second year as well as on pooled mean analysis as compared to dry matter production of roots (19.87, 19.66 and 19.77 g/plant) respectively obtained from cultivar (V₁) Arka Shashank.

In case of plant growth regulators, the results of dry matter production of roots at 105 DAT showed significant effect between treatments during first year and second year as well as on pooled mean data. The dry matter production of roots (35.10, 34.59 and 34.85 g/plant) respectively was also recorded maximum in treatment P₆ (GA₃ 200 ppm) and it was reported significant differences with rest of the other treatments. Whereas, minimum dry matter production of roots (17.71, 16.94 and 17.33 g/plant) respectively were recorded under treatment P₀ (control) during both years and on pooled mean analysis.

The interaction between cultivars and plant growth regulators at 105 days was found significant, during both the years as well as on pooled mean basis. The maximum dry matter production of roots (41.49, 40.80 and 41.16 g/plant) respectively was found in treatment combination (V₂P₆) under this investigation and it was noticed significant variation with rest of the other treatment combinations. The minimum dry matter production of roots (11.34, 11.04 and 11.20 g/plant) respectively was observed in treatment combination (V₁P₀).

Dry matter production of roots (19.53, 19.17 and 19.35 g/plant) respectively was recorded under treatment P₆ (GA₃ 200 ppm) and it was observed significant difference with respite of the other treatment. However, minimum dry matter production of roots (10.02, 9.21 and 9.62 g/plant) respectively were recorded under treatment P₀ (control) during both years and on pooled mean basis respectively.

The interactions between two cultivar and growth regulators at 75 DAT were found non significant during both the tested years as well as on pooled mean data for dry matter production of roots.

The data in respect to cultivars at 105 DAT, the dry matter production of roots (33.14, 32.26 and 32.71 g/plant) respectively were found highest in cultivar (V₂) Arka Archana in first and second year as well as on pooled mean analysis as compared to dry matter production of roots (19.87, 19.66 and 19.77 g/plant) respectively obtained from cultivar (V₁) Arka Shashank.

In case of plant growth regulators, the results of dry matter production of roots at 105 DAT showed significant effect between treatments during first year and second year as well as on pooled mean data. The dry matter production of roots (35.10, 34.59 and 34.85 g/plant) respectively was also recorded maximum in treatment P₆ (GA₃ 200 ppm) and it was reported significant differences with rest of the other treatments. Whereas, minimum dry matter production of roots (17.71, 16.94 and 17.33 g/plant) respectively were recorded under treatment P₀ (control) during both years and on pooled mean analysis.

The interaction between plant growth regulators and cultivars at 105 days was found significant, during both the years as well as on pooled mean basis. The maximum dry matter production of roots (41.49, 40.80 and 41.16 g/plant) respectively was found in treatment

Table 4.1.10: Effect of Cultivars and Plant growth regulators on Dry Matter Production of Roots

Treat.		Dry Matter Production of Roots (g/plant)					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	9.14	9.12	9.13	19.87	19.66	19.77
V ₂	Arka Archana	20.48	19.78	20.13	33.14	32.26	32.71
SEm SEm±		0.52	0.38	0.32	0.35	0.44	0.28
CD at 5%		1.06	0.78	0.64	0.73	0.91	0.57
PGR							
P ₀	(Control)	10.02	9.21	9.62	17.71	16.94	17.33
P ₁	(CCC 1000 ppm)	11.68	10.99	11.34	20.64	20.91	20.78
P ₂	(CCC 1500 ppm)	13.52	12.62	13.07	23.42	22.46	22.94
P ₃	(NAA 50 ppm)	14.40	14.02	14.21	26.90	25.97	26.44
P ₄	(NAA 100 ppm)	16.19	16.94	16.57	28.98	29.42	29.20
P ₅	(GA ₃ 150 ppm)	18.33	18.21	18.27	32.79	31.46	32.13
P ₆	(GA ₃ 200 ppm)	19.53	19.17	19.35	35.10	34.59	34.85
SEm SEm±		0.96	0.71	0.60	0.66	0.82	0.53
CD at 5%		1.98	1.46	1.20	1.36	1.69	1.06

Table 4.1.10 a: Interaction effect of Cultivars and Plant growth regulators on Leaf Dry Matter Production of Roots

Treat.			Dry Matter Production of Roots (g/plant)					
			75 Days			105 Days		
			2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁ P ₀	Arka Shashank	(Control)	4.45	4.52	4.49	11.34	11.04	11.20
V ₁ P ₁	Arka Shashank	(CCC 1000 ppm)	6.29	5.79	6.04	14.71	14.95	14.83
V ₁ P ₂	Arka Shashank	(CCC 1500 ppm)	7.78	7.13	7.46	15.96	15.49	15.73
V ₁ P ₃	Arka Shashank	(NAA 50 ppm)	8.68	8.51	8.60	19.12	18.94	19.04
V ₁ P ₄	Arka Shashank	(NAA 100 ppm)	10.58	10.95	10.77	23.22	23.26	23.24
V ₁ P ₅	Arka Shashank	(GA ₃ 150 ppm)	12.35	13.16	12.76	26.01	25.61	25.81
V ₁ P ₆	Arka Shashank	(GA ₃ 200 ppm)	13.87	13.78	13.83	28.72	28.36	28.54
V ₂ P ₀	Arka Archana	(Control)	15.59	13.91	14.75	24.08	22.84	23.46
V ₂ P ₁	Arka Archana	(CCC 1000 ppm)	17.08	16.19	16.64	26.56	26.88	26.73
V ₂ P ₂	Arka Archana	(CCC 1500 ppm)	19.25	18.11	18.69	30.89	29.42	30.16
V ₂ P ₃	Arka Archana	(NAA 50 ppm)	20.12	19.54	19.83	34.67	32.99	33.84
V ₂ P ₄	Arka Archana	(NAA 100 ppm)	21.80	22.94	22.37	34.74	35.58	35.16
V ₂ P ₅	Arka Archana	(GA ₃ 150 ppm)	24.32	23.25	23.79	39.57	37.31	38.44
V ₂ P ₆	Arka Archana	(GA ₃ 200 ppm)	25.19	24.56	24.88	41.49	40.82	41.16
SEm±			1.36	1.01	0.85	0.94	1.17	0.75
CD at 5%			NS	NS	NS	1.93	2.40	1.50

Fig 4.1.10 a: Effect of Cultivars and Plant growth regulators on Dry Matter Production of Roots at 75 Days

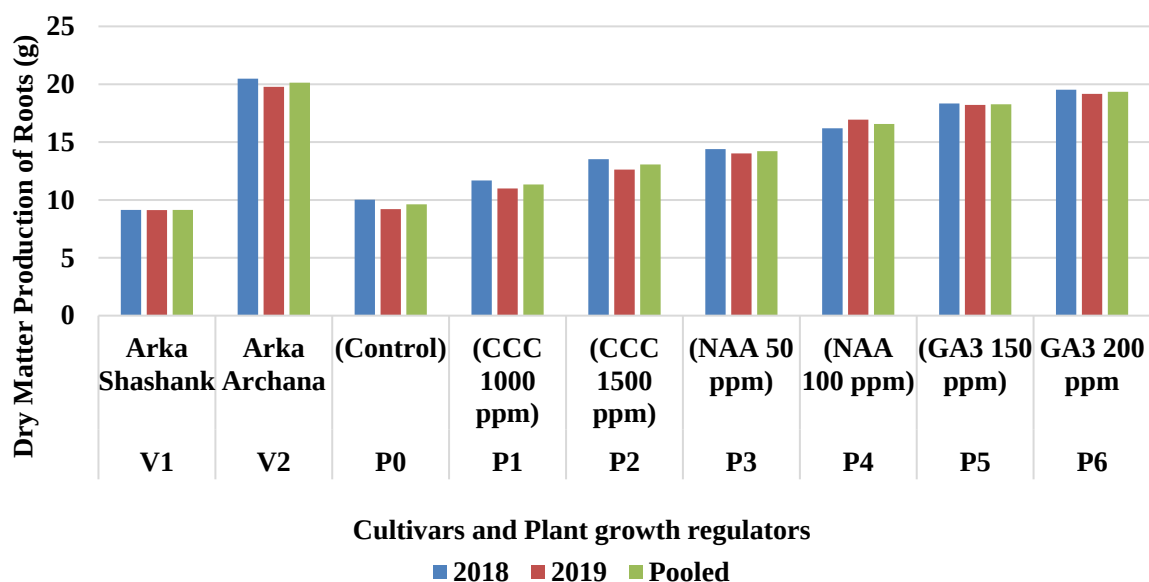
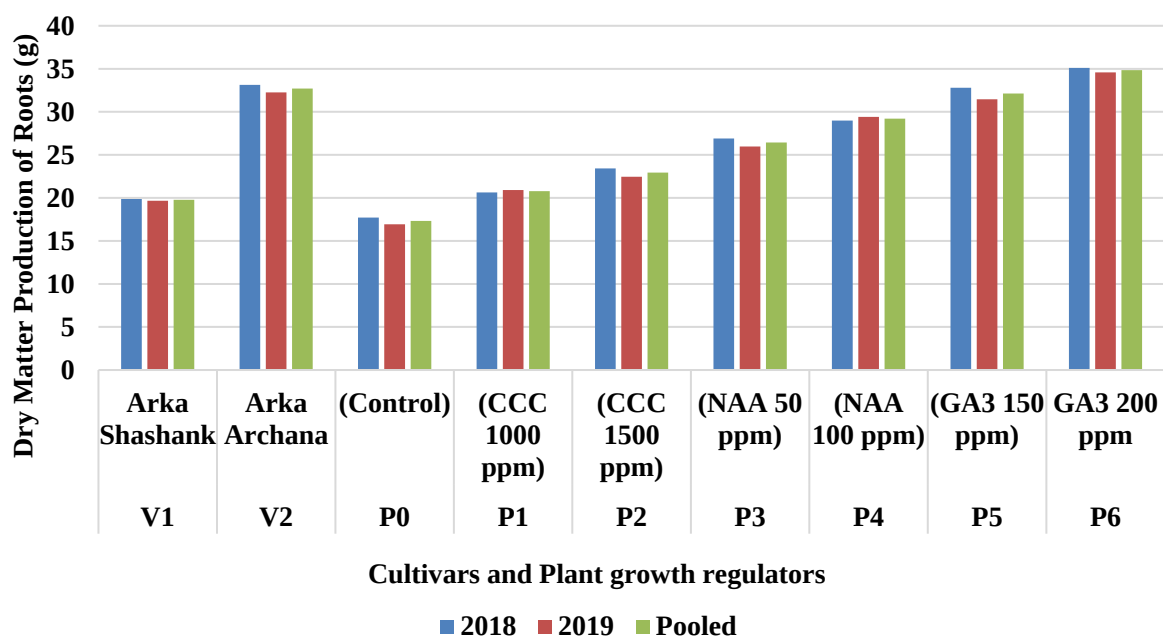


Fig 4.1.10 b: Effect of Cultivars and Plant growth regulators on Dry Matter Production of Roots at 105 Days



combination (V_2P_6) under this investigation and it was noticed significant variation with rest of the other treatment combinations. The minimum dry matter production of roots (11.34, 11.04 and 11.20 g/plant) respectively was observed in treatment combination (V_1P_0).

4.1.11. Total Dry Matter Production (g/plant)

The results on total dry matter production were significantly influenced by cultivars and application of growth regulators are presented in Table 4.1.11, 4.1.11 a and Fig 4.1.11a and 4.1.11 b

The perusal of data on the influence of cultivars on total dry matter production revealed that at 75 DAT, during both the year as well as on pooled mean basis of investigation showed significant effect. The maximum total dry matter production were recorded under cultivar

(V_2) Arka Archana (58.60, 59.40 and 58.50 g/plant) respectively and the minimum total dry matter production was obtained from cultivar (V_1) Arka Shashank (27.40, 27.90 and 27.70 g/plant) respectively under this investigation.

Plant growth regulators showed significant response on total dry matter production at 75 DAT. The maximum total dry matter production (58.60, 59.80 and 59.20 g/plant) respectively was observed in treatment P_6 (GA_3 200 ppm) and it was found significant different with rest of the other treatments. The minimum total dry matter production (25.60, 25.20 and 25.40 g/plant) respectively was recorded under treatment P_0 (Control) under both the years and on pooled mean basis.

The interaction between the Cultivars and plant growth regulators shows significant effect on total dry matter production at 75 DAT. The maximum total dry matter production (77.60 and 76.67 g/plant) respectively was obtained from treatment combination (V_2P_6) during second year and on pooled mean basis and it was found significant different with rest of the other treatments combinations. The minimum dry matter production (13.00 and 12.75 g/plant) respectively is obtained from treatment combination (V_1P_0). During first year the interaction effect was observed non significant.

The resulted data at 105 DAT indicated that significantly maximum total dry matter production (87.10, 86.80 and 86.90 g/plant) respectively were observed in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank (52.20, 52.00 and 52.10 g/plant) during both the tested years and on pooled mean basis respectively.

Table 4.1.11: Effect of Cultivars and Plant growth regulators on Total Dry Matter Production

Treat.		Total Dry Matter Production (g/plant)					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	27.40	27.90	27.70	52.20	52.00	52.10
V ₂	Arka Archana	58.60	59.40	58.50	87.10	86.80	86.90
SEm SEm±		0.71	0.50	0.50	0.61	0.69	0.52
CD at 5%		1.46	1.04	1.04	1.26	1.42	1.08
PGR							
P ₀	(Control)	25.60	25.20	25.40	47.10	46.30	46.70
P ₁	(CCC 1000 ppm)	33.10	32.30	32.70	55.70	57.20	56.50
P ₂	(CCC 1500 ppm)	39.60	38.50	39.10	62.50	62.60	62.50
P ₃	(NAA 50 ppm)	43.20	43.40	43.30	71.90	71.90	71.90
P ₄	(NAA 100 ppm)	48.10	49.60	48.90	77.20	75.50	76.30
P ₅	(GA ₃ 150 ppm)	53.00	53.10	53.00	83.90	82.70	83.30
P ₆	(GA ₃ 200 ppm)	58.60	59.80	59.20	89.30	89.80	89.50
SEm SEm±		1.33	0.95	1.34	1.14	1.29	0.98
CD at 5%		2.74	1.95	2.77	2.36	2.66	2.02

Table 4.1.11 a: Interaction effect of Cultivars and Plant growth regulators on Total Dry Matter Production

Treat.			Total Dry Matter Production (g)					
			75 Days			105 Days		
			2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	12.49	13.00	12.75	31.46	32.16	31.81
V₁P₁	Arka Shashank	(CCC 1000 ppm)	18.61	18.22	18.42	41.14	43.79	42.47
V₁P₂	Arka Shashank	(CCC 1500 ppm)	23.18	22.57	22.88	45.65	45.11	45.38
V₁P₃	Arka Shashank	(NAA 50 ppm)	27.29	28.16	27.73	53.44	53.50	53.47
V₁P₄	Arka Shashank	(NAA 100 ppm)	32.60	33.73	33.17	59.68	57.67	58.68
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	36.35	37.48	36.92	64.09	62.96	63.53
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	41.52	41.93	41.73	70.17	69.06	69.62
V₂P₀	Arka Archana	(Control)	38.65	37.39	38.02	62.65	60.37	61.52
V₂P₁	Arka Archana	(CCC 1500 ppm)	47.67	46.31	47.00	70.24	70.64	70.44
V₂P₂	Arka Archana	(CCC 1000 ppm)	55.96	54.48	55.22	79.42	80	79.71
V₂P₃	Arka Archana	(NAA 50 ppm)	59.11	58.56	58.84	90.44	90.27	90.36
V₂P₄	Arka Archana	(NAA 100 ppm)	63.66	65.44	64.56	94.75	93.26	94.01
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	69.59	68.74	69.17	103.69	102.52	103.11
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	75.72	77.60	76.67	108.40	110.45	109.43
SEm±			1.88	1.34	1.34	1.62	1.83	1.39
CD at 5%			NS	2.77	2.77	3.34	3.76	2.86

Fig 4.1.11 a: Effect of Cultivars and Plant growth regulators on Total Dry Matter Production at 75 Days

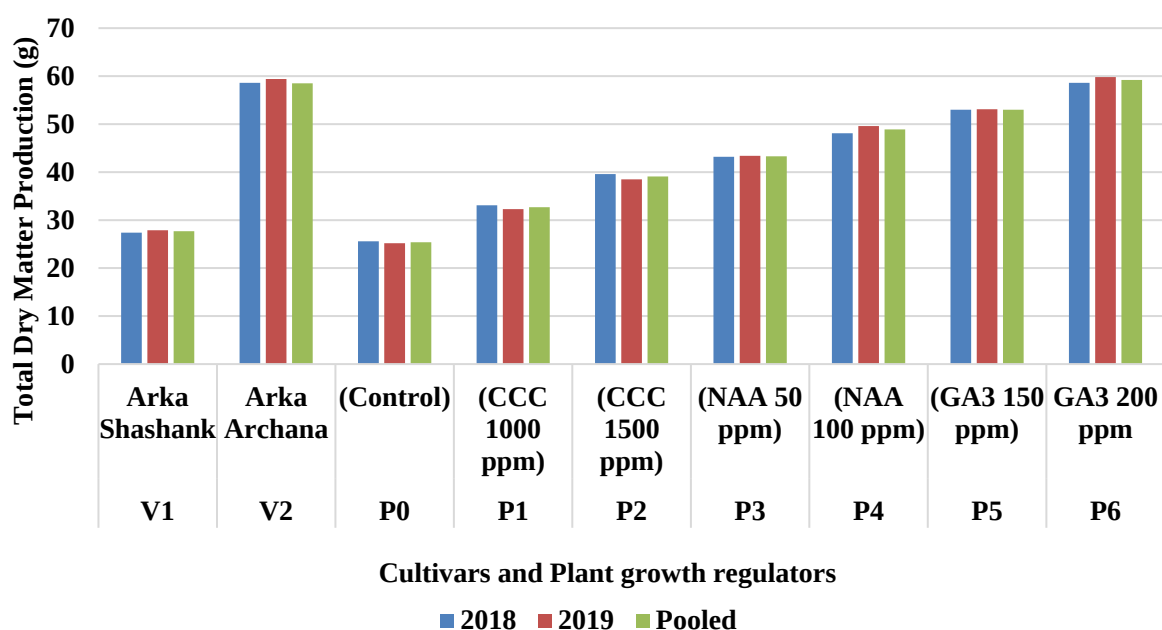
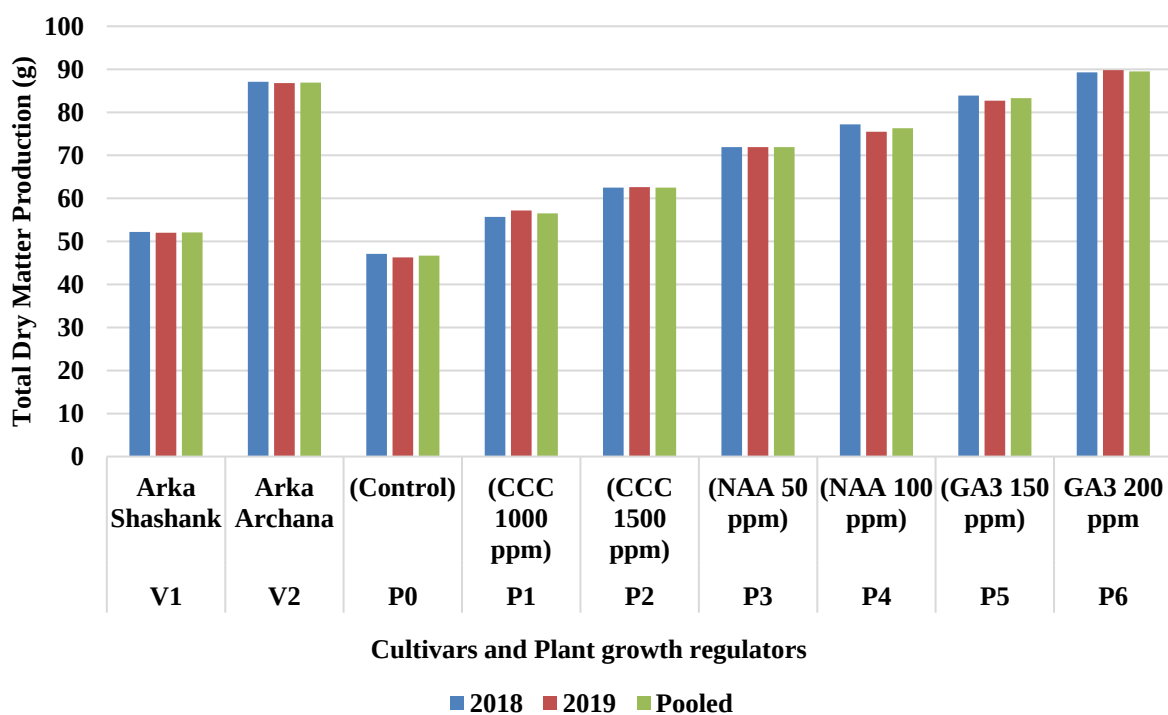


Fig 4.1.11 b: Effect of Cultivars and Plant growth regulators on Total Dry Matter Production at 105 Days



The perusal data showed that the total dry matter production at 105 DAT was significantly influenced by plant growth regulator during both the year and on pooled mean basis. The maximum total dry matter production (89.30, 89.80 and 89.50 g/plant) respectively was observed under treatment P₆ (GA₃ 200 ppm) and it was observed significant variation with remaining of the other treatments. However, minimum total dry matter production (47.10, 46.30 and 46.70 g/plant) respectively was found under treatment P₀ (Control) during the investigation.

The interaction between the Cultivars and plant growth regulators shows significant effect on total dry matter production at 105 DAT. The maximum total dry matter production (108.40, 110.45 and 109.43 g/plant) respectively was obtained from treatment combination (V₂P₆) in both the years and on pooled mean basis it was observed significant difference with remaining of the other treatment's combinations. The minimum dry matter production (31.46, 32.16 and 31.81 g/plant) respectively is obtained from treatment combination (V₁P₀) during this investigation.

The China aster cultivars varied significantly for dry matter accumulation in leaves, stem, root and total dry matter. Arka Archana recorded maximum total dry matter accumulation as compare to Arka Shashank. The increased dry matter accumulation might be due to vigorous growth, a greater number of leaves, higher leaf area and production of fairly more number of primary and secondary branches in these varieties. Particularly, the variety Arka Archana, produced thicker and straight stems compared to other variety. The efficient photosynthetic ability of crop might facilitate the accumulation of more carbohydrates in stems, which in turn increased the dry matter accumulation. Similar results were also observed in China aster (Ravikumar, 2002) and marigold (Nalawadi, 1982 and Vijayalaxmi, 1998).

Dry matter production (g/plant) increased as the crop growth advanced during both the years experimentation. Significantly higher dry matter production was observed with the plants sprayed with GA₃ 200 ppm and it was on par with foliar spray of GA₃ 150 ppm at different stages of plant growth. This may be due to higher dry matter accumulation in different plant parts

(leaves, stems and roots) and total dry matter accumulation in plant. Increased dry matter production due to plant growth regulators was also noticed by Hiremath (1984) in marigold with GA₃ applications. Increase in dry matter production may also be due to increase in leaf size and thicknesses. Research findings of Shi and Li (1987) suggested that spray of CCC increased leaf dry weight and thickness. Shivangouda (2000) also reported the similar findings in China aster cv. Kamini.

4.2. Flowering and Yield attributes

4.2.1. Days to Bud initiation

The data on Days to bud initiation were recorded and are presented in Table 4.2.1 and 4.2.1 a and Fig. 4.2.1

Amongst the cultivars, there were found non significant difference between Cultivars in both the years as well as on pooled mean analysis.

Plant growth regulators showed significant influence on days to bud initiation during both the years and on pooled mean basis. The earlier bud initiation (57.02, 56.53 and 56.78) days respectively was observed in P₆ (GA₃ 200 ppm). Further, it was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) during both the years and on pooled mean basis and it was showed significant difference with rest of the other treatments. The maximum days (74.29, 73.78 and 74.04) required for bud initiation were observed in treatment P₀ (Control)

Interaction between both the cultivars and plant growth regulators showed non significant variation on days to bud initiation in both the years as well as on pooled mean analysis.

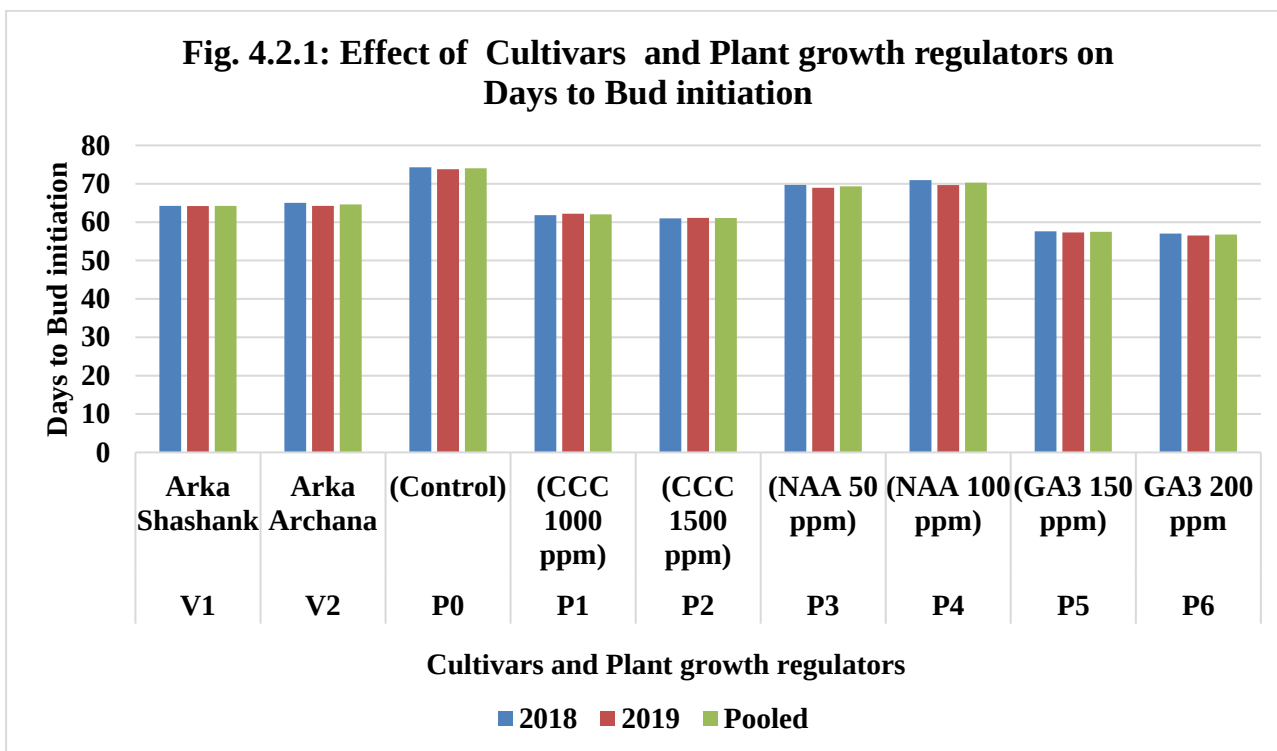
Data on number of days taken to first flower bud initiation indicated that, GA₃ at 200 ppm having early bud initiation as compared to control, CCC and NAA. This might be due to facts that, the synergetic effect of auxin with gibbrellins observed in shoot of plants. These results were in agreement with the findings of Sen and Meharana (1972) in chrysanthemum.

Table 4.2.1: Effect of Cultivars and Plant growth regulators on Days to Bud initiation

Treat.		Days to Bud initiation		
		75 days		
CULTIVAR		2018-19	2019-20	Pooled
V ₁	Arka Shashank	64.24	64.20	64.22
V ₂	Arka Archana	65.02	64.23	64.63
SEm SEm±		0.80	0.98	0.63
CD at 5%		NS	NS	NS
PGR				
P ₀	(Control)	74.29	73.78	74.04
P ₁	(CCC 1000 ppm)	61.83	62.18	62.01
P ₂	(CCC 1500 ppm)	61.00	61.10	61.05
P ₃	(NAA 50 ppm)	69.72	68.96	69.34
P ₄	(NAA 100 ppm)	70.94	69.64	70.30
P ₅	(GA ₃ 150 ppm)	57.62	57.33	57.48
P ₆	(GA ₃ 200 ppm)	57.02	56.53	56.78
SEm SEm±		1.50	1.84	1.19
CD at 5%		3.08	3.77	2.38

Table 4.2.1 a: Interaction effect of Cultivars and Plant growth regulators on Bud initiation

Treat.			Bud initiation		
			2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	73.43	73.32	73.38
V₁P₁	Arka Shashank	(CCC 1000 ppm)	62.20	63.25	62.73
V₁P₂	Arka Shashank	(CCC 1500 ppm)	61.33	61.98	61.66
V₁P₃	Arka Shashank	(NAA 50 ppm)	69.55	68.37	68.96
V₁P₄	Arka Shashank	(NAA 100 ppm)	70.27	70.35	70.31
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	56.29	56.41	56.36
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	56.60	55.75	56.18
V₂P₀	Arka Archana	(Control)	75.15	74.24	74.70
V₂P₁	Arka Archana	(CCC 1000 ppm)	61.47	61.12	61.30
V₂P₂	Arka Archana	(CCC 1500 ppm)	60.67	60.22	60.45
V₂P₃	Arka Archana	(NAA 50 ppm)	69.89	69.55	69.72
V₂P₄	Arka Archana	(NAA 100 ppm)	71.61	68.94	70.28
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	58.95	58.24	58.60
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	57.44	57.31	57.38
SEm±			2.12	2.60	1.68
CD at 5%			NS	NS	NS



4.2.2. Days to 1st Flowering

It is clear from the data presented in Table 4.2.2 and 4.2.2 a. and graphically presented in Fig 4.2.2 that the days to 1st flowering was significantly influenced by cultivars and different levels of Plant growth regulators.

Among cultivars were showed nonsignificant response in both the years as well as on pooled mean analysis on days to 1st flowering.

The perusal data showed that the plant growth regulators showed significant influence on days to 1st flowering during both the years and on pooled mean basis. The minimum days to first flowering (65.77, 64.60 and 65.20) days respectively was observed in treatments P₆ (GA₃ 200 ppm). However, it was found statistically *at par* with treatments P₅ (GA₃ 150 ppm) during both the years and on pooled mean basis and it was showed significant difference with rest of the other treatments. The maximum days (81.03, 82.03 and 81.50) days respectively required for days to first flowering were observed in treatment P₀ (Control).

Interaction between both the cultivars and plant growth regulators showed non significant variation on days to 1st flowering in both the years as well as on pooled mean analysis.

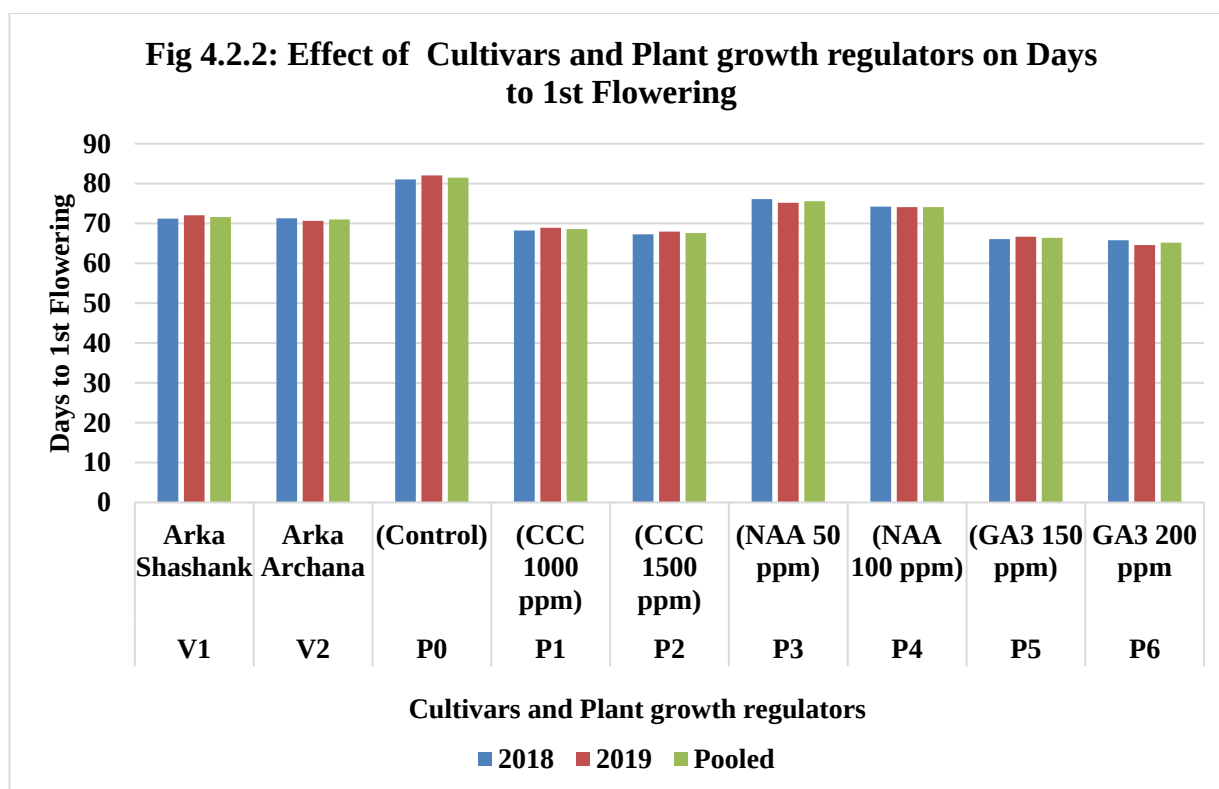
The days taken for commencement of flowering were significantly influenced by growth regulators and organics. The early flowering was noticed in plants with application of GA₃ at 200 ppm. The earliest flowering might be due to increase in cell elongation and rapid mobilization and accumulation of metabolites which properly influences the floral morphogenesis which rendered the early flowering. The results of this study are in close conformity with Anil (2004) in French marigold.

Table 4.2.2: Effect of Cultivars and Plant growth regulators on Days to 1st Flowering

Treat.		Days to 1st Flowering		
	CULTIVAR	2018-19	2019-20	Pooled
V₁	Arka Shashank	71.20	72.04	71.6
V₂	Arka Archana	71.28	70.64	71.0
	SEm SEm±	1.16	0.95	0.89
	CD at 5%	NS	NS	NS
PGR				
P₀	(Control)	81.03	82.03	81.5
P₁	(CCC 1000 ppm)	68.23	68.91	68.6
P₂	(CCC 1500 ppm)	67.29	67.96	67.6
P₃	(NAA 50 ppm)	76.09	75.18	75.6
P₄	(NAA 100 ppm)	74.21	74.09	74.1
P₅	(GA ₃ 150 ppm)	66.06	66.67	66.4
P₆	(GA ₃ 200 ppm)	65.77	64.60	65.2
	SEm SEm±	2.17	1.78	1.67
	CD at 5%	4.47	3.67	3.44

Table 4.2.2 a: Interaction effect of Cultivars and Plant growth regulators on Days to 1st Flowering

Treat.			Days to 1 st Flowering		
			2018-19	2019-20	Pooled
V ₁ P ₀	Arka Shashank	(Control)	80.08	81.37	80.73
V ₁ P ₁	Arka Shashank	(CCC 1000 ppm)	69.76	70.69	70.23
V ₁ P ₂	Arka Shashank	(CCC 1500 ppm)	68.92	69.88	69.40
V ₁ P ₃	Arka Shashank	(NAA 50 ppm)	75.05	75.93	75.49
V ₁ P ₄	Arka Shashank	(NAA 100 ppm)	73.69	74.79	74.24
V ₁ P ₅	Arka Shashank	(GA ₃ 150 ppm)	65.15	66.05	65.60
V ₁ P ₆	Arka Shashank	(GA ₃ 200 ppm)	65.76	65.59	65.68
V ₂ P ₀	Arka Archana	(Control)	81.98	82.69	82.34
V ₂ P ₁	Arka Archana	(CCC 1000 ppm)	66.70	67.12	66.91
V ₂ P ₂	Arka Archana	(CCC 1500 ppm)	65.66	66.03	65.85
V ₂ P ₃	Arka Archana	(NAA 50 ppm)	77.14	74.43	75.78
V ₂ P ₄	Arka Archana	(NAA 100 ppm)	74.73	73.37	74.05
V ₂ P ₅	Arka Archana	(GA ₃ 150 ppm)	66.96	67.28	67.12
V ₂ P ₆	Arka Archana	(GA ₃ 200 ppm)	65.78	63.60	64.69
SEM±			3.07	2.52	2.37
CD at 5%			NS	NS	NS



4.2.3. Flowering Duration

The data on flowering duration were recorded and are presented in Table 4.2.3, 4.2.3 a and Fig. 4.2.3

Significantly, maximum flowering duration (33.24, 33.25, and 33.25) days respectively were recorded in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank (30.53, 30.43 and 30.48) days during both the tested years and on pooled mean data respectively.

It is vivid from the data that the flowering duration was significantly influenced by plant growth regulator during both the year and on pooled mean basis. The longest flowering duration (39.23, 40.52 and 39.88) days respectively was observed under treatment P₆ (GA₃ 200 ppm) and it was observed significant difference with remaining all other treatments. Whereas, minimum flowering duration (23.57, 23.37 and 23.47) days respectively was recorded under treatment P₀ (Control) during both the year of investigation as well as on pooled mean basis respectively.

The interaction between cultivars and plant growth regulators was found significant, during both the years as well as on pooled mean basis under this investigation. The maximum flowering duration (41.13, 42.53 and 41.83) days respectively were recorded in treatment combination (V₂P₆) which was found statistically *at par* with treatment combination (V₂P₅) during first year only. Further, it was found significant difference with rest of all other treatment combination during both the year as well as on mean basis. The minimum flowering duration (24.03, 22.83 and 23.43) days respectively were obtained from treatment combination (V₁P₀) under this investigation.

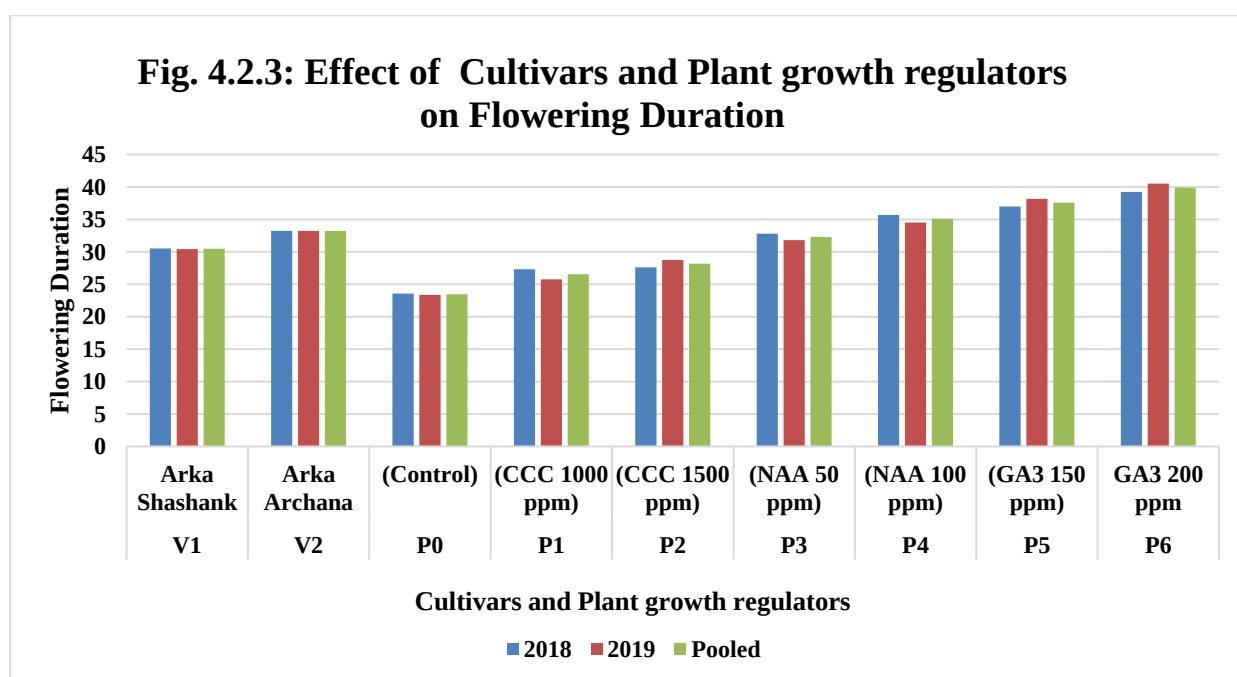
The duration of bloom of individual variety might be due to different genetic makeup of varieties and prevailing favourable environment. Similar findings were also noticed by Pattnaik and Mohanti (2002), Singh *et al.* (2003), Khanvilkar *et al.* (2003), Raet *al.* (2005) in African marigold, and Raghuvanshi and Sharma (2011) in French marigold.

Table 4.2.3: Effect of Cultivars and Plant growth regulators on Flowering Duration

Treat.		Flowering Duration		
	CULTIVAR	2018-19	2019-20	Pooled
V₁	Arka Shashank	30.53	30.43	30.48
V₂	Arka Archana	33.24	33.25	33.25
	SEm SEm±	0.50	0.33	0.30
	CD at 5%	1.02	0.67	0.60
PGR				
P₀	(Control)	23.57	23.37	23.47
P₁	(CCC 1500 ppm)	27.32	25.77	26.54
P₂	(CCC 1000 ppm)	27.62	28.75	28.18
P₃	(NAA 50 ppm)	32.80	31.82	32.31
P₄	(NAA 100 ppm)	35.68	34.52	35.10
P₅	(GA ₃ 150 ppm)	37.00	38.17	37.58
P₆	(GA ₃ 200 ppm)	39.23	40.52	39.88
	SEm SEm±	0.93	0.61	0.55
	CD at 5%	1.91	1.25	1.11

Table 4.2.3 a: Interaction effect of Cultivars and Plant growth regulators on Flowering Duration

Treat.			Flowering Duration		
			2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	24.03	22.83	23.43
V₁P₁	Arka Shashank	(CCC 1000 ppm)	25.37	24.37	24.87
V₁P₂	Arka Shashank	(CCC 1500 ppm)	24.87	26.33	25.60
V₁P₃	Arka Shashank	(NAA 50 ppm)	32.33	30.10	31.22
V₁P₄	Arka Shashank	(NAA 100 ppm)	34.97	33.87	34.42
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	34.83	37.03	35.93
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	37.33	38.50	37.92
V₂P₀	Arka Archana	(Control)	23.10	23.90	23.50
V₂P₁	Arka Archana	(CCC 1000 ppm)	29.27	27.17	28.22
V₂P₂	Arka Archana	(CCC 1500 ppm)	30.37	31.17	30.77
V₂P₃	Arka Archana	(NAA 50 ppm)	33.27	33.53	33.40
V₂P₄	Arka Archana	(NAA 100 ppm)	36.40	35.17	35.78
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	39.17	39.30	39.23
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	41.13	42.53	41.83
SEm±			1.31	0.86	0.78
CD at 5%			2.70	1.77	1.57



Longest duration of flowering recorded with GA₃ @ 200 ppm which might be due to an increased production of flowering shoots. Both long photoperiod and gibberellic acid had an additive effect on flowering duration due to their early induction of flowering. These results are in close agreement with the findings of Gautam *et al.* (2006) and Shinde *et al.* (2010) in chrysanthemum, Sharma and Joshi (2015) in China aster, Palei *et al.* (2016) in African marigold and Vijayakumar *et al.* (2017^b) in China aster.

4.2.4. Number of flowers per plant

The data on number of flowers per plant are presented in table 4.2.4, 4.2.4 a and fig 4.2.4 revealed that the cultivar and plant growth regulator and their interaction exhibited significant impact on number of flower per plant.

In, case of cultivars, they show significant influence on number of flowers per plant. The highest number of flowers per plant (61.64, 61.46 and 61.55) respectively was observed in cultivar (V₂) Arka Archana. The lowest number of flowers per plant (52.92, 50.27 and 51.60) respectively was obtained from cultivar (V₂) Arka Shashank during both the years as well as on pooled mean basis.

Plant growth regulators showed significant response on number of flowers per plant, during both the years as well as on pooled mean analysis. The maximum number of flowers per plant (68.92, 69.71 and 69.32) respectively were recorded under treatment P₆ (GA₃ 200 ppm) which was found significantly *at par* with treatment P₅ (GA₃ 150 ppm) and it showed significant difference with rest of the other treatments. The minimum number of flowers per plant (45.77, 44.01 and 44.89) respectively was recorded under treatment P₀ (Control) during this investigation.

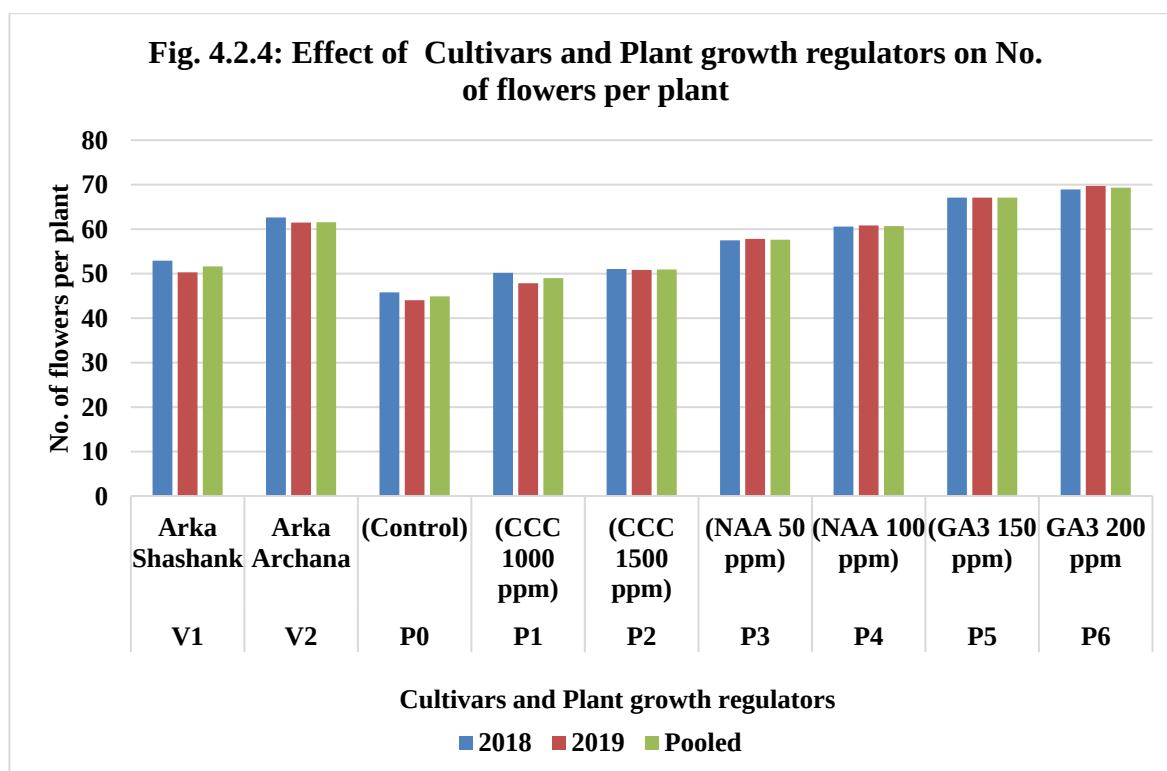
The interaction between cultivar and plant growth regulators was found non-significant during both the years as well as on pooled mean analysis.

Table 4.2.4: Effect of Cultivars and Plant growth regulators on No. of flowers per plant

Treat.		No. of flowers per plant		
	CULTIVAR	2018-19	2019-20	Pooled
V₁	Arka Shashank	52.92	52.27	52.60
V₂	Arka Archana	61.64	61.46	61.55
	SEm SEm±	1.14	0.98	0.75
	CD at 5%	2.35	2.02	1.51
PGR				
P₀	(Control)	45.77	44.01	44.89
P₁	(CCC 1000 ppm)	50.12	47.84	48.98
P₂	CCC 1500 ppm)	51.05	50.84	50.94
P₃	(NAA 50 ppm)	57.47	57.80	57.63
P₄	(NAA 100 ppm)	60.56	60.81	60.69
P₅	(GA ₃ 150 ppm)	67.07	67.08	67.07
P₆	GA ₃ 200 ppm	68.92	69.71	69.32
	SEm SEm±	2.14	1.84	1.41
	CD at 5%	4.39	3.77	2.83

Table 4.2.4 a: Interaction effect of Cultivars and Plant growth regulators on No. of flowers per plant

Treat.			No. of flowers per plant		
			2018-19	2019-20	Pooled
V ₁ P ₀	Arka Shashank	(Control)	41.61	39.10	40.36
V ₁ P ₁	Arka Shashank	(CCC 1000 ppm)	45.40	43.56	44.48
V ₁ P ₂	Arka Shashank	CCC 1500 ppm)	46.45	46.86	46.65
V ₁ P ₃	Arka Shashank	(NAA 50 ppm)	53.35	53.62	53.49
V ₁ P ₄	Arka Shashank	(NAA 100 ppm)	56.71	57.12	56.92
V ₁ P ₅	Arka Shashank	(GA ₃ 150 ppm)	62.53	61.34	61.94
V ₁ P ₆	Arka Shashank	(GA ₃ 200 ppm)	64.38	64.31	64.35
V ₂ P ₀	Arka Archana	(Control)	49.94	48.91	49.42
V ₂ P ₁	Arka Archana	(CCC 1000 ppm)	54.84	52.11	53.48
V ₂ P ₂	Arka Archana	(CCC 1500 ppm)	55.65	54.81	55.23
V ₂ P ₃	Arka Archana	(NAA 50 ppm)	61.58	61.97	61.78
V ₂ P ₄	Arka Archana	(NAA 100 ppm)	64.41	64.50	64.46
V ₂ P ₅	Arka Archana	(GA ₃ 150 ppm)	71.61	72.81	72.21
V ₂ P ₆	Arka Archana	(GA ₃ 200 ppm)	73.46	75.11	74.29
SEm±			3.02	2.60	1.99
CD at 5%			NS	NS	NS



The results indicated that there was highly significant difference in number of flowers per plant within the varieties. The maximum number of flowers per plant was obtained from Arka Archana. It could be stated that variation within the varieties for number of flowers per plant might be due to genotypic and environmental differences. Similar results were reported by Choudhary *et al.* (2013) Nursude *et al.* (2010), Beniwal and Dahiya (2012), Singh *et al.* (2004) and Singh and Mishra (2009) in marigold.

In case of plant growth regulators, the maximum number of flowers was recorded with the GA₃ 200 ppm over all other treatments. This might be due to greater dry matter accumulation which is certainly suggestive to better photosynthetic activity, other metabolic activities and uptake of nutrients from soil. Therefore, the growth promoting substances might have positive influence on the yield of flowers and maximum number of flowers per plant also might be due to production of higher number of lateral branches and buds which uptake higher nutrient.. The present findings are in conformity with the results of Reddy and Sulladmath (1983) and Lal and Mishra (1986) in aster. Similar conformity were found with the research finding of Anuradha *et al.* (1990), Gowda and Jayanti (1991), Sreekala *et al.* (2002) and Rao *et al.* (2005) in African marigold.

4.2.5. Yield of flower per plant (g)

It was evident from data presented in Table 4.2.5, 4.2.5 a and Fig. 4.2.5 that there was a significant difference in respect to Yield of flower per plant due to cultivars and plant growth regulators.

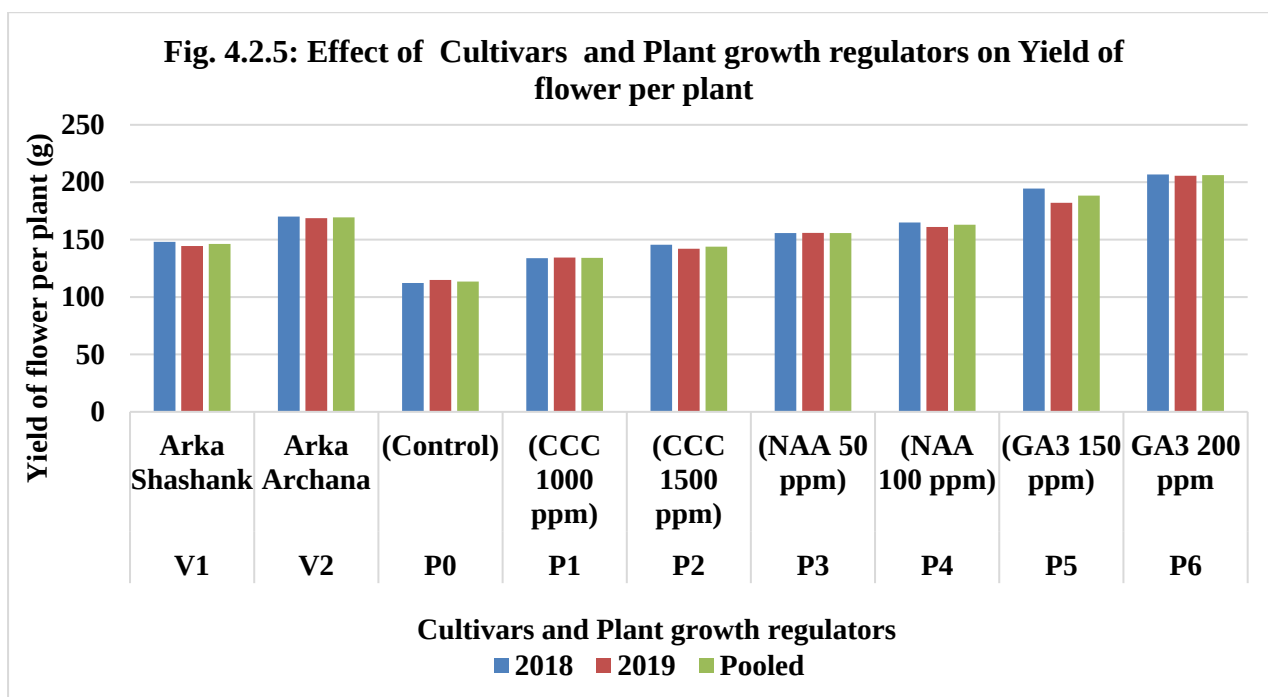
In case of cultivar, the highest yield of flower per plant were observed in cultivar (V₂) Arka Archana (170.09, 168.69 and 169.39 g) and lowest yield of flower per plant (148.03, 144.43 and 146.23 g) respectively were recorded in cultivar (V₂) Arka Shashank in both the years as well as on pooled mean analysis.

Table 4.2.5: Effect of Cultivars and Plant growth regulators on Yield of flower per plant

Treat.		Yield of flower per plant (g)		
	CULTIVAR	2018-19	2019-20	Pooled
V₁	Arka Shashank	148.03	144.43	146.23
V₂	Arka Archana	170.09	168.69	169.39
	SEm SEm±	2.44	2.16	1.63
	CD at 5%	5.01	4.44	3.27
PGR				
P₀	(Control)	112.26	114.81	113.53
P₁	(CCC 1000 ppm)	133.80	134.44	134.12
P₂	(CCC 1500 ppm)	145.53	142.11	143.82
P₃	(NAA 50 ppm)	155.68	155.86	155.77
P₄	(NAA 100 ppm)	164.93	161.01	162.97
P₅	(GA ₃ 150 ppm)	194.53	182.04	188.28
P₆	(GA ₃ 200 ppm)	206.70	205.64	206.17
	SEm SEm±	4.56	4.04	3.04
	CD at 5%	9.37	8.30	6.11

Table 4.2.5 a: Interaction effect of Cultivars and Plant growth regulators on Yield of flower per plant

Treat.			Yield of flower per plant (g)		
			2018-19	2019-20	Pooled
V ₁ P ₀	Arka Shashank	(Control)	111.20	111.50	111.35
V ₁ P ₁	Arka Shashank	(CCC 1000 ppm)	125.13	122.14	123.64
V ₁ P ₂	Arka Shashank	(CCC 1500 ppm)	132.23	129.92	131.08
V ₁ P ₃	Arka Shashank	(NAA 50 ppm)	140.55	137.07	138.81
V ₁ P ₄	Arka Shashank	(NAA 100 ppm)	148.50	146.12	147.31
V ₁ P ₅	Arka Shashank	(GA ₃ 150 ppm)	181.70	169.67	175.69
V ₁ P ₆	Arka Shashank	(GA ₃ 200 ppm)	196.90	194.59	195.74
V ₂ P ₀	Arka Archana	(Control)	113.31	118.12	115.72
V ₂ P ₁	Arka Archana	(CCC 1000 ppm)	142.46	146.75	144.60
V ₂ P ₂	Arka Archana	(CCC 1500 ppm)	158.82	154.30	156.56
V ₂ P ₃	Arka Archana	(NAA 50 ppm)	170.81	174.65	172.73
V ₂ P ₄	Arka Archana	(NAA 100 ppm)	181.36	175.89	178.63
V ₂ P ₅	Arka Archana	(GA ₃ 150 ppm)	207.35	194.41	200.88
V ₂ P ₆	Arka Archana	(GA ₃ 200 ppm)	216.50	216.69	216.60
SEm±			6.44	5.71	4.31
CD at 5%			NS	NS	NS



In respect to plant growth regulators, the highest yield of flowers per plant (206.70, 205.64 and 206.17 g) was observed under treatment P₆ (GA₃ 200 ppm) and it was found significantly superior over other plant growth regulators, during both the year as well as on pooled mean analysis and for rest of the other treatment it showed significant difference. Whereas, the minimum yield of flower per plant (112.26, 114.81 and 113.53 g) respectively was recorded under treatment P₀ (Control).

The interaction between cultivars and plant growth regulators was found non-significant during both the years as well as on pooled mean basis under this investigation.

The increase in yield and yield parameters with GA₃ spraying was due to better crop growth, thus increased the number of flowers per plant and ultimately increased the flower yield. This can be attributed to translocation of source to sink. Similar results were reported by Shivaprasad Shetty (1995) and Doddagoudar (2002) in China aster and Prabhat Kumar *et al.* (2003) in China aster.

Maximum flower yield per plant (g), were recorded with the GA₃ 200 ppm than other treatments (Table 4.1.20 and figs 4.1.20) this might be due to greater dry matter accumulation which is certainly suggestive to better photosynthetic activity, other metabolic activities and uptake of nutrients from soil. Therefore, the growth promoting substances might have positive influence on the yield of flowers. The present results are in conformity of Reddy and Sulladmath (1983) and Lal and Mishra (1986) in China aster.

4.2.6. Yield of flower per plot (kg)

It was clear from data presented in Table 4.2.6, 4.2.6 a and Fig. 4.2.6. that there was a significant difference in respect to Yield of flower per plot due to cultivars and plant growth regulators.

In case of cultivar, the maximum yield of flower per plot were observed in cultivar (V₂) Arka Archana (4.30, 4.20 and 4.20 kg) and minimum yield of flower per plot

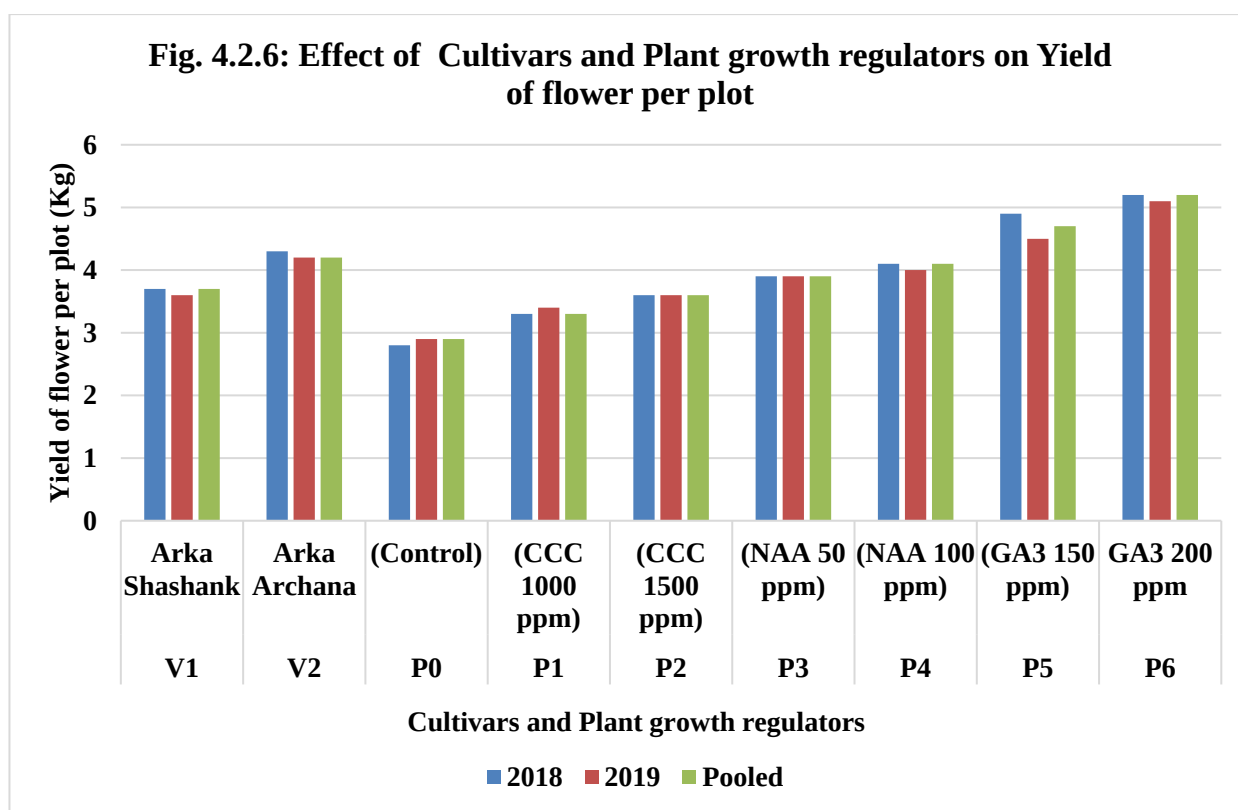
(3.70, 3.60 and 3.70 kg) respectively were recorded in cultivar (V₂) Arka Shashank in both the years as well as on pooled mean analysis.

Table 4.2.6: Effect of Cultivars and Plant growth regulators on Yield of flower per plot

Treat.		Yield of flower per plot (Kg)		
CULTIVAR		2018-19	2019-20	Pooled
V₁	Arka Shashank	3.70	3.60	3.70
V₂	Arka Archana	4.30	4.20	4.20
SEm SEm±		0.05	0.05	0.03
CD at 5%		0.11	0.11	0.07
PGR				
P₀	(Control)	2.80	2.90	2.90
P₁	(CCC 1000 ppm)	3.30	3.40	3.30
P₂	(CCC 1500 ppm)	3.60	3.60	3.60
P₃	(NAA 50 ppm)	3.90	3.90	3.90
P₄	(NAA 100 ppm)	4.10	4.00	4.10
P₅	(GA ₃ 150 ppm)	4.90	4.50	4.70
P₆	(GA ₃ 200 ppm)	5.20	5.10	5.20
SEm SEm±		0.10	0.10	0.07
CD at 5%		0.22	0.20	0.14

Table 4.2.6 a: Interaction effect of Cultivars and Plant growth regulators on Yield of flower per plot

Treat.			Yield of flower per plot (kg)		
			2018-19	2019-20	Pooled
V ₁ P ₀	Arka Shashank	(Control)	2.77	2.78	2.78
V ₁ P ₁	Arka Shashank	(CCC 1000 ppm)	3.12	3.05	3.08
V ₁ P ₂	Arka Shashank	CCC 1500 ppm)	3.30	3.25	3.27
V ₁ P ₃	Arka Shashank	(NAA 50 ppm)	3.51	3.42	3.46
V ₁ P ₄	Arka Shashank	(NAA 100 ppm)	3.71	3.65	3.67
V ₁ P ₅	Arka Shashank	(GA ₃ 150 ppm)	4.54	4.24	4.39
V ₁ P ₆	Arka Shashank	(GA ₃ 200 ppm)	4.94	4.86	4.90
V ₂ P ₀	Arka Archana	(Control)	2.91	2.95	2.93
V ₂ P ₁	Arka Archana	(CCC 1000 ppm)	3.56	3.67	3.61
V ₂ P ₂	Arka Archana	(CCC 1500 ppm)	3.97	3.85	3.91
V ₂ P ₃	Arka Archana	(NAA 50 ppm)	4.27	4.36	4.31
V ₂ P ₄	Arka Archana	(NAA 100 ppm)	4.53	4.39	4.46
V ₂ P ₅	Arka Archana	(GA ₃ 150 ppm)	5.18	4.86	5.01
V ₂ P ₆	Arka Archana	(GA ₃ 200 ppm)	5.41	5.42	5.41
SEm±			0.15	0.14	0.10
CD at 5%			NS	NS	NS



As far as plant growth regulators showed significant response on yield of flower per plot, the highest yield of flowers per plot (5.20, 5.10 and 5.20 kg) was observed under treatment P₆ (GA₃ 200 ppm) and it was found significantly superior over other plant growth regulators, during both the year as well as on pooled mean analysis and for rest of the other treatment it was showed significant difference. Whereas, the minimum yield of flowers per plot (2.80, 2.90 and 2.90 kg) respectively was recorded under treatment P₀ (Control).

The interaction between cultivars and plant growth regulators was found non-significant during both the years as well as on pooled mean basis under this investigation.

4.2.7. Yield of flower per hectare. (qt/ha)

It was evident from data presented in Table 4.2.7, 4.2.7 a and Fig. 4.2.7 that there was a significant difference in respect to Yield of flower per hectare due to cultivars and plant growth regulators.

In case of cultivar, the maximum yield of flower per hectare were observed in cultivar (V₂) Arka Archana (18.90, 18.70 and 18.80 qt/ha) respectively and minimum yield of flower per plant (16.40, 16.00 and 16.20 qt/ha) respectively were recorded in cultivar (V₂) Arka Shashank in both the years as well as on pooled mean analysis.

In respect to plant growth regulators, the highest yield of flowers per hectare (23.00, 22.80 and 22.90 qt/ha) was observed under treatment P₆ (GA₃ 200 ppm) and it was found significantly superior over other plant growth regulators, during both the year as well as on pooled mean analysis and for rest of the other treatment it was showed significant difference. Whereas, the minimum yield of flowers per hectare (12.6, 12.7 and 12.7 qt/ha) respectively was recorded under treatment P₀ (Control).

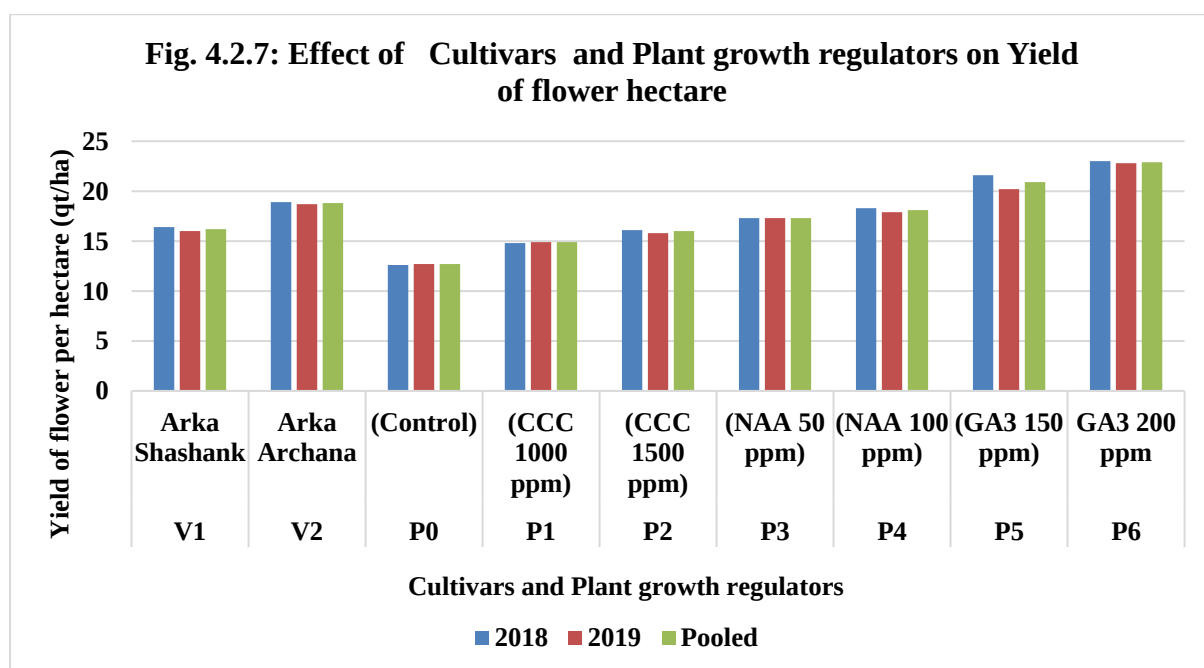
The interaction between cultivars and plant growth regulators was found non-significant during both the years as well as on pooled mean basis under this investigation.

Table 4.2.7: Effect of Cultivars and Plant growth regulators on Yield of flower hectare

Treat.		Yield of flower per hectare (qt/ha)		
	CULTIVAR	2018-19	2019-20	Pooled
V₁	Arka Shashank	16.4	16.0	16.2
V₂	Arka Archana	18.9	18.7	18.8
	SEm SEm±	0.25	0.23	0.17
	CD at 5%	0.52	0.49	0.35
PGR				
P₀	(Control)	12.6	12.7	12.7
P₁	(CCC 1000 ppm)	14.8	14.9	14.9
P₂	(CCC 1500 ppm)	16.1	15.8	16.0
P₃	(NAA 50 ppm)	17.3	17.3	17.3
P₄	(NAA 100 ppm)	18.3	17.9	18.1
P₅	(GA ₃ 150 ppm)	21.6	20.2	20.9
P₆	(GA ₃ 200 ppm)	23.0	22.8	22.9
	SEm SEm±	0.48	0.44	0.31
	CD at 5%	0.98	0.91	0.65

Table 4.2.7 a: Interaction effect of Cultivars and Plant growth regulators on Yield of flower per hectare

Treat.	Yield of flower per hectare (qt/ha)				
			2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	12.32	12.36	12.34
V₁P₁	Arka Shashank	(CCC 1000 ppm)	13.88	13.55	13.71
V₁P₂	Arka Shashank	(CCC 1500 ppm)	14.66	14.42	14.54
V₁P₃	Arka Shashank	(NAA 50 ppm)	15.59	15.21	15.40
V₁P₄	Arka Shashank	(NAA 100 ppm)	16.47	16.21	16.34
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	20.17	18.82	19.49
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	21.96	21.59	21.77
V₂P₀	Arka Archana	(Control)	12.94	13.10	13.02
V₂P₁	Arka Archana	(CCC 1000 ppm)	15.80	16.29	16.04
V₂P₂	Arka Archana	CCC 1500 ppm)	17.62	17.12	17.37
V₂P₃	Arka Archana	(NAA 50 ppm)	18.96	19.39	19.17
V₂P₄	Arka Archana	(NAA 100 ppm)	20.12	19.52	19.82
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	23.01	21.58	22.29
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	24.02	24.07	24.04
SEM±			0.67	0.63	0.45
CD at 5%			NS	NS	NS



4.3. Quality parameters

4.3.1. Stalk length (cm)

It is clear from the data presented in Table 4.3.1, 4.3.1 a and graphically presented in Fig- 4.3.1 that the stalk length was significantly influenced by cultivars and different levels of plant growth regulators.

Amongst the cultivars of China aster, it differs significantly on stalk length. The maximum stalk length were observed in cultivar (V₁) Arka Shashank (34.68, 34.23 and 34.46 cm) respectively. The minimum stalk length (25.50, 24.93, 25.21cm) respectively was obtained from cultivar (V₂) Arka Archana in both the years as well as on pooled mean basis.

The persual of data showed that the plant growth regulators showed significant response on stalk length, during both the years as well as on pooled mean basis. The maximum stalk length (39.28, 39.00 and 39.14 cm) respectively were recorded under treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) and it was noticed significant variance with rest of the other treatments. The minimum stalk length (18.17, 18.20 and 18.19 cm) respectively was noticed in treatment P₀ (Control) in both the years and on pooled mean basis.

The interaction between cultivar and plant growth regulators for stalk length were found non-significant variation during both the years as well as on pooled mean analysis.

The maximum stalk length were recorded under P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm). The differences in stalk length may be attributed to plant height and intermodal length which increases with increasing concentration of GA₃.

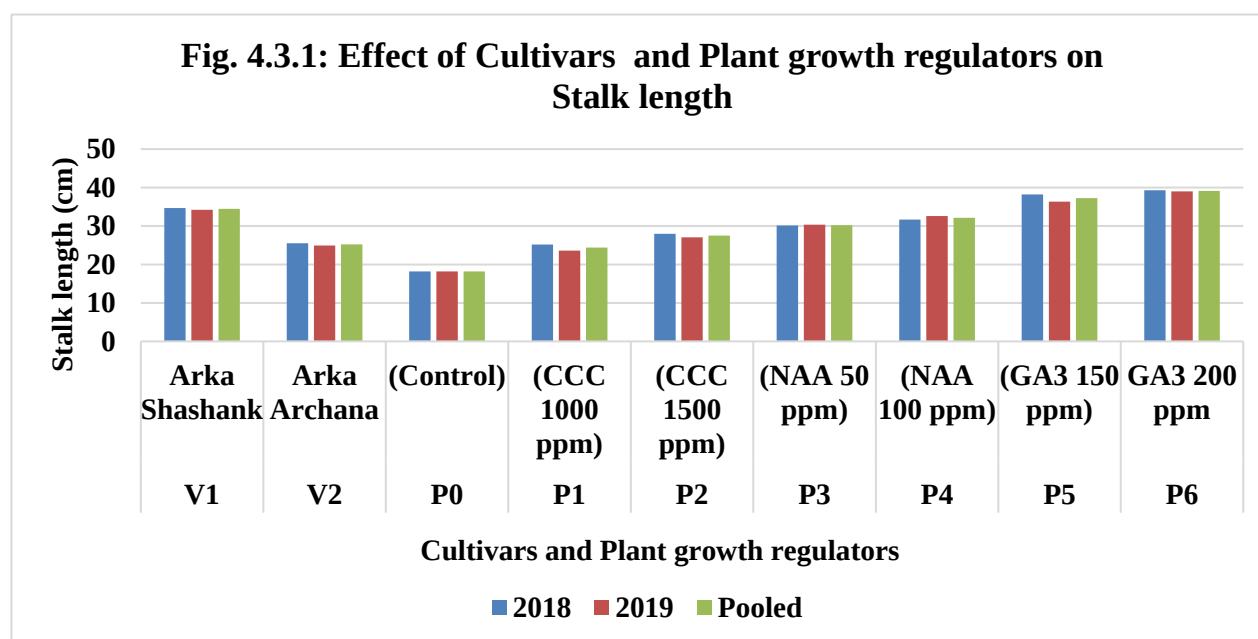
These findings were in close proximity with the findings of Chakradhar and Khirathkar (2003) in Rose, Vijai Kumar *et al.* (2008) in Carnation, Baghele *et al.* (2012) in Rose.

Table 4.3.1: Effect of Cultivars and Plant growth regulators on Stalk length

Treat.		Stalk length (cm)		
	CULTIVAR	2018-19	2019-20	Pooled
V₁	Arka Shashank	34.68	34.23	34.46
V₂	Arka Archana	25.50	24.93	25.21
	SEm SEm±	0.78	0.63	0.50
	CD at 5%	1.61	1.30	1.01
PGR				
P₀	(Control)	18.17	18.20	18.19
P₁	(CCC 1000 ppm)	25.19	23.60	24.40
P₂	(CCC 1500 ppm)	27.99	27.05	27.52
P₃	(NAA 50 ppm)	30.12	30.35	30.23
P₄	(NAA 100 ppm)	31.67	32.57	32.12
P₅	(GA ₃ 150 ppm)	38.20	36.32	37.26
P₆	(GA ₃ 200 ppm)	39.28	39.00	39.14
	SEm SEm±	1.46	1.18	0.94
	CD at 5%	3.01	2.43	1.89

Table 4.3.1 a: Interaction effect of Cultivars and Plant growth regulators on Stalk length

Treat.			Stalk length (cm)		
			2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	21.43	21.03	21.23
V₁P₁	Arka Shashank	(CCC 1000 ppm)	30.27	27.83	29.05
V₁P₂	Arka Shashank	CCC 1500 ppm)	32.80	32.00	32.40
V₁P₃	Arka Shashank	(NAA 50 ppm)	35.00	35.23	35.12
V₁P₄	Arka Shashank	(NAA 100 ppm)	37.30	38.00	37.65
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	42.60	41.47	42.03
V₁P₆	Arka Shashank	GA ₃ 200 ppm	43.37	44.07	43.72
V₂P₀	Arka Archana	(Control)	14.91	15.37	15.14
V₂P₁	Arka Archana	(CCC 1000 ppm)	20.12	19.37	19.74
V₂P₂	Arka Archana	CCC 1500 ppm)	23.17	22.10	22.64
V₂P₃	Arka Archana	(NAA 50 ppm)	25.23	25.47	25.35
V₂P₄	Arka Archana	(NAA 100 ppm)	26.03	27.13	26.58
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	33.80	31.17	32.48
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	35.20	33.93	34.57
SEm±			2.07	1.67	1.33
CD at 5%			NS	NS	NS



4.3.2. Fresh weight of 10 flowers (g)

It is clear from the data presented in Table 4.3.2, 4.3.2 a. and graphically presented in Fig -4.3.2 that the fresh weight of 10 flowers was significantly influenced by different levels of plant growth regulators and cultivars.

Cultivars differ significantly on fresh weight of 10 flowers. The highest fresh weight of 10 flowers (44.38, 44.88 and 44.63 g) respectively was observed in cultivar (V₂) Arka Archana. The minimum weight of fresh weight of flowers was obtained from cultivar (V₂) Arka Shashank (31.72, 32.23 and 31.98 g) respectively in both the years as well as on pooled mean basis.

The data in respect to plant growth regulators showed that there is significant response on fresh weight of 10 flowers during both the years as well as on pooled mean analysis. The maximum fresh weight of flowers (46.52, 46.60 and 46.56 g) respectively were recorded under treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) and it was observed significant difference with remaining all other treatments during both the tested years as well as on pooled mean basis. The minimum fresh weight of flowers (27.88, 28.29 and 28.09 g) respectively was recorded in treatment P₀ (Control) under this investigation.

The interaction between cultivar and plant growth regulator were found significant during first year and on pooled mean analysis except second year. The maximum fresh weight of flowers (51.65 and 52.13 g) respectively and were recorded in treatment combination (V₂P₆) which was found statistically similar with treatment combination (V₂P₅) and it was observed significant variant with remaining all other treatment combinations for first year and on pooled mean basis. The minimum fresh weight of flowers (23.51 and 23.25 g) respectively was obtained from treatment combination (V₁P₀) for first year and on pooled mean basis. The interaction effect was found non significant during second year of the investigation.

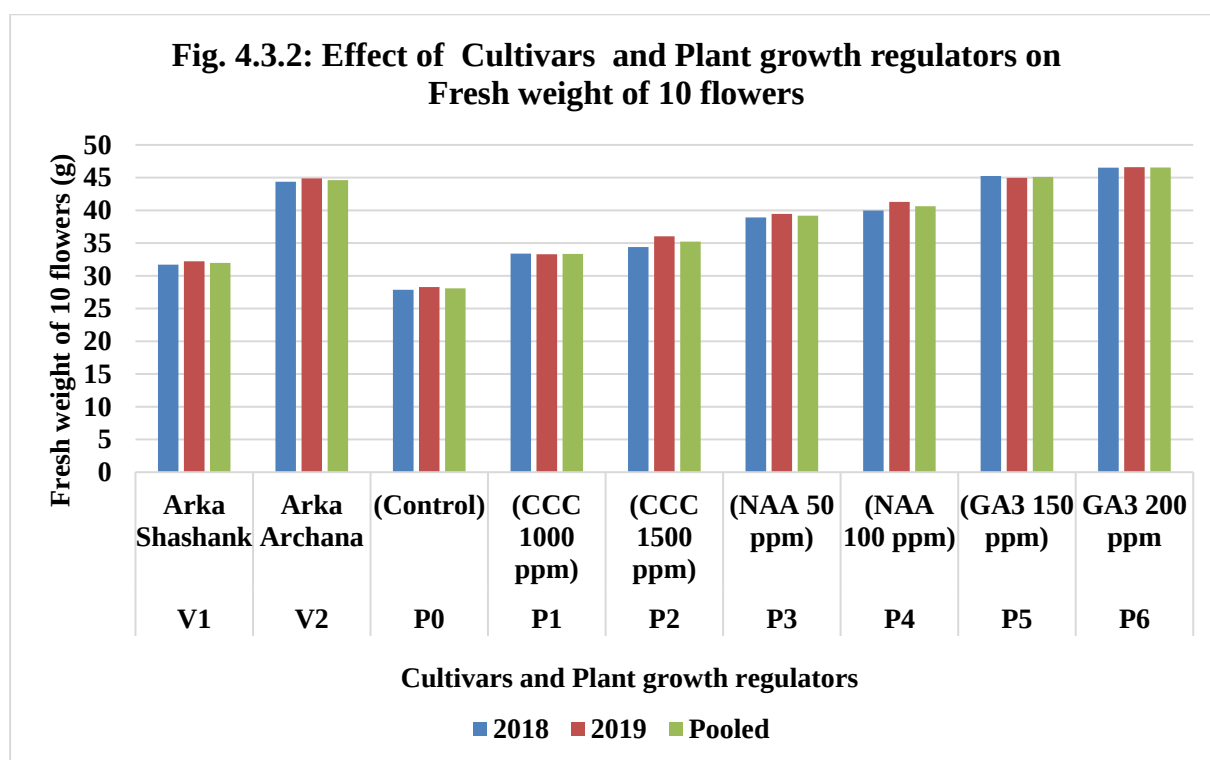
The highest 10 flower weight was observed in GA₃ at 200 ppm, which was followed by foliar spray with GA₃ at 150 ppm. The higher weight of ten flowers might be due to rapid mobilization and accumulation of metabolites by GA₃ which properly influences the floral morphogenesis rendered the higher weight of flowers. The results regarding weight of hundred flowers are in agreement with the results of Gupta and Dutta, (2000) in chrysanthemum, Shivangowda (2000) in China aster and Anil (2004) in French marigold.

Table 4.3.2: Effect of Cultivars and Plant growth regulators on Fresh weight of 10 flowers

Treat.		Fresh weight of 10 flowers (g)		
	CULTIVAR	2018-19	2019-20	Pooled
V ₁	Arka Shashank	31.72	32.23	31.98
V ₂	Arka Archana	44.38	44.88	44.63
	SEm SEm±	0.69	0.59	0.46
	CD at 5%	1.42	1.22	0.91
PGR				
P ₀	(Control)	27.88	28.29	28.09
P ₁	(CCC 1000 ppm)	33.39	33.29	33.34
P ₂	(CCC 1500 ppm)	34.41	36.03	35.22
P ₃	(NAA 50 ppm)	38.93	39.45	39.19
P ₄	(NAA 100 ppm)	39.98	41.29	40.63
P ₅	(GA ₃ 150 ppm)	45.25	44.96	45.10
P ₆	(GA ₃ 200 ppm)	46.52	46.60	46.56
	SEm SEm±	1.29	1.11	0.85
	CD at 5%	2.66	2.28	1.71

Table 4.3.2 a: Interaction effect of Cultivars and Plant growth regulators on Fresh weight of 10 flowers

Treat.	Fresh weight of 10 flowers (g)				
			2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	23.51	22.99	23.25
V₁P₁	Arka Shashank	(CCC 1000 ppm)	26.05	26.09	26.07
V₁P₂	Arka Shashank	(CCC 1500 ppm)	27.57	29.39	28.48
V₁P₃	Arka Shashank	(NAA 50 ppm)	31.25	33.25	32.25
V₁P₄	Arka Shashank	(NAA 100 ppm)	32.03	35.01	33.52
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	40.25	38.31	39.28
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	41.38	40.59	40.99
V₂P₀	Arka Archana	(Control)	32.25	33.60	32.92
V₂P₁	Arka Archana	(CCC 1000 ppm)	40.73	40.49	40.61
V₂P₂	Arka Archana	(CCC 1500 ppm)	41.25	42.68	41.97
V₂P₃	Arka Archana	(NAA 50 ppm)	46.61	45.65	46.13
V₂P₄	Arka Archana	(NAA 100 ppm)	47.33	47.57	47.75
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	50.25	51.61	50.93
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	51.65	52.60	52.13
SEm±			1.83	1.57	1.21
CD at 5%			3.76	NS	2.42



4.3.3. Total weight of fresh flowers per plant (g/plant)

It is clear from the data presented in Table 4.3.3, 4.3.3 a and graphically presented in Fig-4.3.3 that the total weight of fresh flowers per plant was significantly influenced by different levels of Cultivars and Plant growth regulators.

Cultivars differ significantly on total weight of fresh flowers. The highest total weight of fresh flowers (196.00, 195.42 and 195.71 g/plant) respectively was observed in cultivar (V₂) Arka Archana. The minimum total weight of fresh flowers per plant was obtained from cultivar (V₁) Arka Shashank (142.77, 142.68 and 142.73 g/plant) respectively in both the years as well as on pooled mean basis.

The Perusal of data showed that the plant growth regulators showed significant response on total weight of fresh flowers, during both the years as well as on pooled mean analysis. The maximum total weight of fresh flowers per plant (254.32, 252.80 and 259.56 g/plant) respectively were recorded under treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) in second year only. Whereas, it was showed significant difference with rest of the other treatments during first year, second year and on pooled mean basis. The minimum total weight of fresh flowers per plant (84.62, 86.19 and 85.40 g/plant) respectively was recorded in treatment P₀ (Control) under this investigation.

The interaction between cultivaras and plant growth regulator were found significant during both the years of investigation and on pooled mean analysis. The maximum total weight of fresh flowers per plant (312.68, 317.92 and 315.30 g/plant) were recorded in the treatment combination (V₂P₆) which was found statistically *at par* with treatment combination (V₂P₅) and it was noticed significant difference with remaining all other treatment combinations. The minimum total weight of fresh flowers per plant (73.71, 79.65 and 76.68 g/plant) respectively was obtained from treatment combination (V₁P₀).

Results revealed that GA₃ at 200 ppm increased the total weight of fresh flowers per plant. The reason for enhancement of flower size might be due to increase in length of petals and pedicles and it was caused by drawing photosynthetic to the

flower as a consequence of intensification of sink (Zieslin *et al.* 1974). The results are in conformity with the studies of Reddy and Sulladmath (1983) in China aster and Rajagopalan and Abdul khader (1994) in chrysanthemum. Girwani *et al.* (1990) reported that GA₃ induced maximum flower diameter in African marigold. Kore *et al.* (2003) reported that GA₃ at 300 ppm recorded maximum fresh weight and size of flowers in China aster.

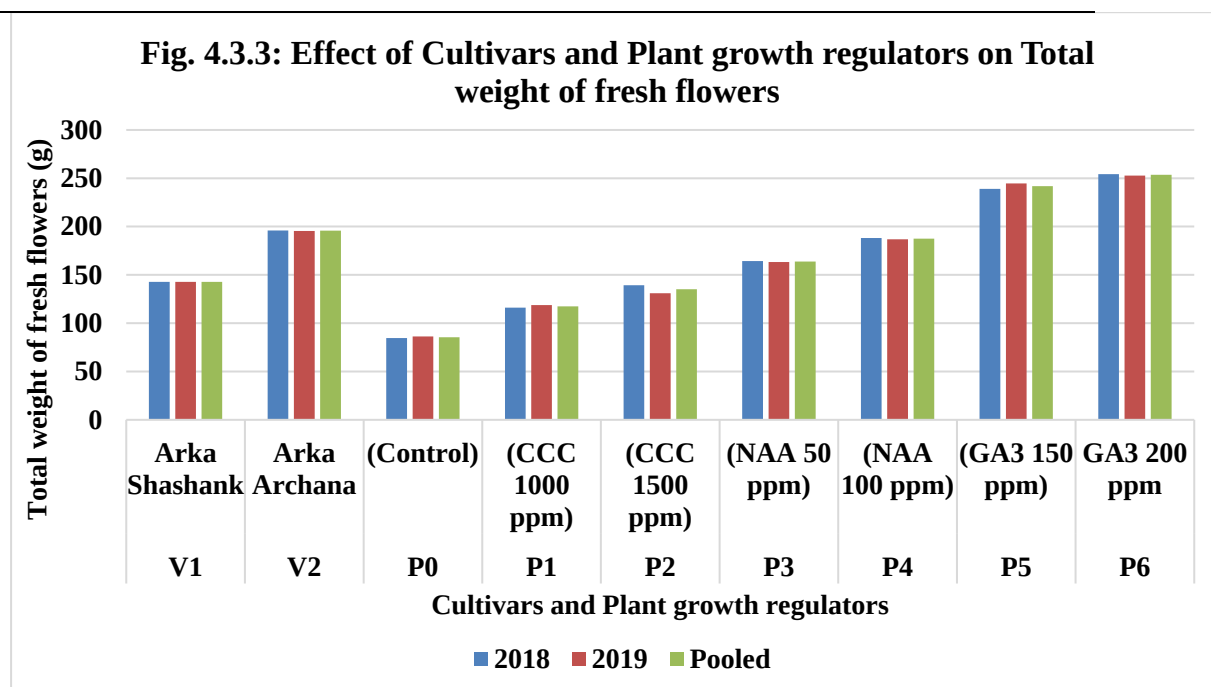
Further, increase in total weight of fresh flower per plant in treated plants may be attributed to the fact that GA₃ promoted the efficacy of plants in terms of photosynthetic activity, uptake of nutrients and their translocation, better partitioning of assimilates into reproductive parts. These results are in agreement with those reported by Rakesh *et al.* (2003) in chrysanthemum. Increase in cell size due to GA₃ might have increased the diameter of flower as stated by Madhumita and Paswan (1998).

Table 4.3.3: Effect of Cultivars and Plant growth regulators on Total weight of fresh flowers

Treat.		Total weight of fresh flowers (g)		
	CULTIVAR	2018-19	2019-20	Pooled
V₁	Arka Shashank	142.77	142.68	142.73
V₂	Arka Archana	196.00	195.42	195.71
	SEm SEm±	3.70	3.41	2.52
	CD at 5%	7.61	7.01	5.05
PGR				
P₀	(Control)	84.62	86.19	85.40
P₁	(CCC 1000 ppm)	116.06	118.69	117.38
P₂	(CCC 1500 ppm)	139.23	130.97	135.10
P₃	(NAA 50 ppm)	164.31	163.25	163.78
P₄	(NAA 100 ppm)	188.22	186.77	187.50
P₅	(GA ₃ 150 ppm)	238.93	244.70	241.81
P₆	(GA ₃ 200 ppm)	254.32	252.80	253.56
	SEm SEm±	6.93	6.38	4.71
	CD at 5%	14.24	13.12	9.45

Table 4.3.3 a: Interaction effect of Cultivars and Plant growth regulators on Total weight of fresh flowers

Treat.			Total weight of fresh flowers (g)		
			2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	73.71	79.65	76.68
V₁P₁	Arka Shashank	(CCC 1000 ppm)	110.65	110.97	110.81
V₁P₂	Arka Shashank	CCC 1500 ppm)	134.29	131.25	132.77
V₁P₃	Arka Shashank	(NAA 50 ppm)	153.70	151.55	152.63
V₁P₄	Arka Shashank	(NAA 100 ppm)	161.09	160.85	160.97
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	169.98	176.83	173.41
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	195.95	187.67	191.81
V₂P₀	Arka Archana	(Control)	95.53	92.72	94.12
V₂P₁	Arka Archana	(CCC 1000 ppm)	121.47	126.41	123.94
V₂P₂	Arka Archana	CCC 1500 ppm)	144.17	130.68	137.42
V₂P₃	Arka Archana	(NAA 50 ppm)	174.92	174.96	174.94
V₂P₄	Arka Archana	(NAA 100 ppm)	215.36	212.69	214.03
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	307.87	312.56	310.22
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	312.68	317.92	315.30
SEm±			9.80	9.03	6.66
CD at 5%			20.14	18.56	13.37



4.3.4. Dry weight of 10 flowers (g)

It was evident from data presented in Table 4.3.4, 4.3.4 a and Fig. 4.3.4, that there was a significant difference in respect to dry weight of flowers due to cultivars and plant growth regulators.

Cultivars differ significantly on dry weight of 10 flowers. The highest dry weight of 10 flowers (15.52, 15.70 and 15.61 g) respectively was observed in cultivar (V₂) Arka Archana. The minimum dry weight of 10 flowers was obtained from cultivar (V₁) Arka Shashank (13.07, 12.37 and 12.72 g) respectively in both the years as well as on pooled mean basis.

The vivid data showed that the plant growth regulators showed significant response on dry weight of flowers, during both the years as well as on pooled mean analysis. The maximum dry weight of flowers (20.48, 21.18 and 20.83 g) respectively were recorded under treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) during first year as well as on pooled mean basis except second year. Whereas, it was showed significant variation with rest of the other treatments during both the years and on pooled mean basis. The minimum dry weight of flowers (6.47, 4.64 and 5.56 g) respectively was recorded in P₀ (Control).

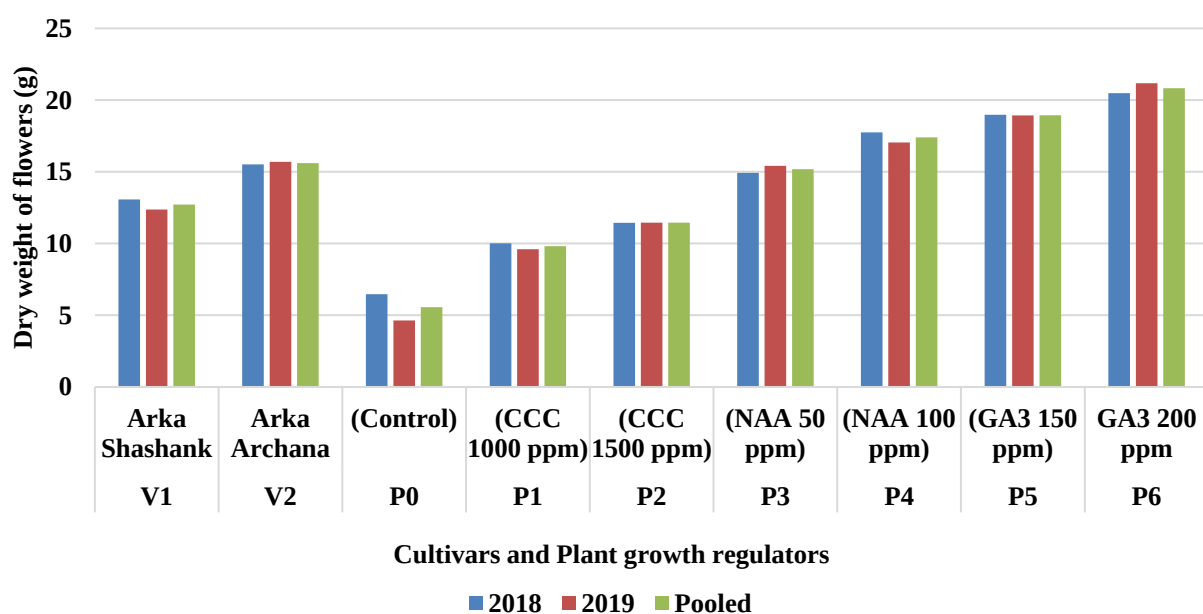
The interaction among cultivar and plant growth regulator were found significant during both the years and on pooled mean analysis. The maximum dry weight of flowers (23.19, 24.14 and 23.67 g) respectively and were recorded in treatment combinations (V₂P₆) which was found statistically *at par* with treatment combinations (V₂P₅) during first year only and it was observed significant difference with remaining other treatment combinations during first year, second year as well as on pooled mean analysis. The minimum dry weight of flowers (6.37, 4.56 and 5.46 g) respectively were obtained from treatment combinations (V₁P₀)

Table 4.3.4 : Effect of Cultivars and Plant growth regulators on Dry weight of 10 flowers

Treat.		Dry weight of flowers (g)		
	CULTIVAR	2018-19	2019-20	Pooled
V₁	Arka Shashank	13.07	12.37	12.72
V₂	Arka Archana	15.52	15.70	15.61
	SEm SEm±	0.48	0.36	0.30
	CD at 5%	0.99	0.73	0.60
PGR				
P₀	(Control)	6.47	4.64	5.56
P₁	(CCC 1000 ppm)	10.02	9.60	9.81
P₂	(CCC 1500 ppm)	11.45	11.46	11.46
P₃	(NAA 50 ppm)	14.93	15.42	15.18
P₄	(NAA 100 ppm)	17.75	17.05	17.40
P₅	(GA ₃ 150 ppm)	18.98	18.93	18.95
P₇	(GA ₃ 200 ppm)	20.48	21.18	20.83
	SEm SEm±	0.90	0.67	0.56
	CD at 5%	1.85	1.37	1.12

Table 4.3.4 a: Interaction effect of Cultivars and Plant growth regulators on Dry weight of 10 flowers

Treat.			Dry weight of flowers (g)		
			2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	6.37	4.56	5.46
V₁P₁	Arka Shashank	(CCC 1000 ppm)	9.83	8.67	9.25
V₁P₂	Arka Shashank	CCC 1500 ppm)	10.92	9.98	10.45
V₁P₃	Arka Shashank	(NAA 50 ppm)	13.59	13.14	13.37
V₁P₄	Arka Shashank	(NAA 100 ppm)	16.48	15.39	15.94
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	16.57	16.65	16.61
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	17.77	18.22	17.99
V₂P₀	Arka Archana	(Control)	6.58	4.72	5.65
V₂P₁	Arka Archana	(CCC 1000 ppm)	10.21	10.52	10.36
V₂P₂	Arka Archana	(CCC 1500 ppm)	11.99	12.94	12.46
V₂P₃	Arka Archana	(NAA 50 ppm)	16.27	17.70	16.99
V₂P₄	Arka Archana	(NAA 100 ppm)	19.02	18.70	18.86
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	21.38	21.21	21.30
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	23.19	24.14	23.67
SEM±			1.27	0.94	0.79
CD at 5%			2.62	1.94	1.59

Fig. 4.3.4: Effect of Cultivars and Plant growth regulators on Dry weight of 10 flowers

4.3.5. Total weight of dry flower per plant (g)

It is clear from the data presented in Table 4.3.5, 4.3.5 a and graphically presented in Fig 4.3.5 that the total weight of dry flower per plant was significantly influenced by cultivars and different levels of plant growth regulators.

Cultivars differ significantly on total weight of dry flower per plant. The highest total weight of dry flower per plant (61.80, 61.77 and 61.78 g) respectively was observed in cultivar (V₂) Arka Archana. The minimum total weight of dry flower per plant was obtained from cultivar (V₁) Arka Shashank (53.84, 54.41 and 54.13 g) respectively in both the years as well as on pooled mean basis.

The persual data showed that the plant growth regulators showed significant response on total weight of dry flower per plant, during both the years as well as on pooled mean analysis. The highest total weight of dry flower per plant (78.83, 78.92 and 78.87 g) respectively were recorded under treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) during first year only and it was observed significant difference with rest of the other treatments during both the year as well as on pooled mean analysis. The minimum total weight of dry flower per plant (34.90, 35.33 and 35.11 g) respectively was recorded in treatment P₀ (Control) under this investigation.

The interaction between cultivar and plant growth regulator were found non-significant during both the tested year as well as on pooled mean analysis.

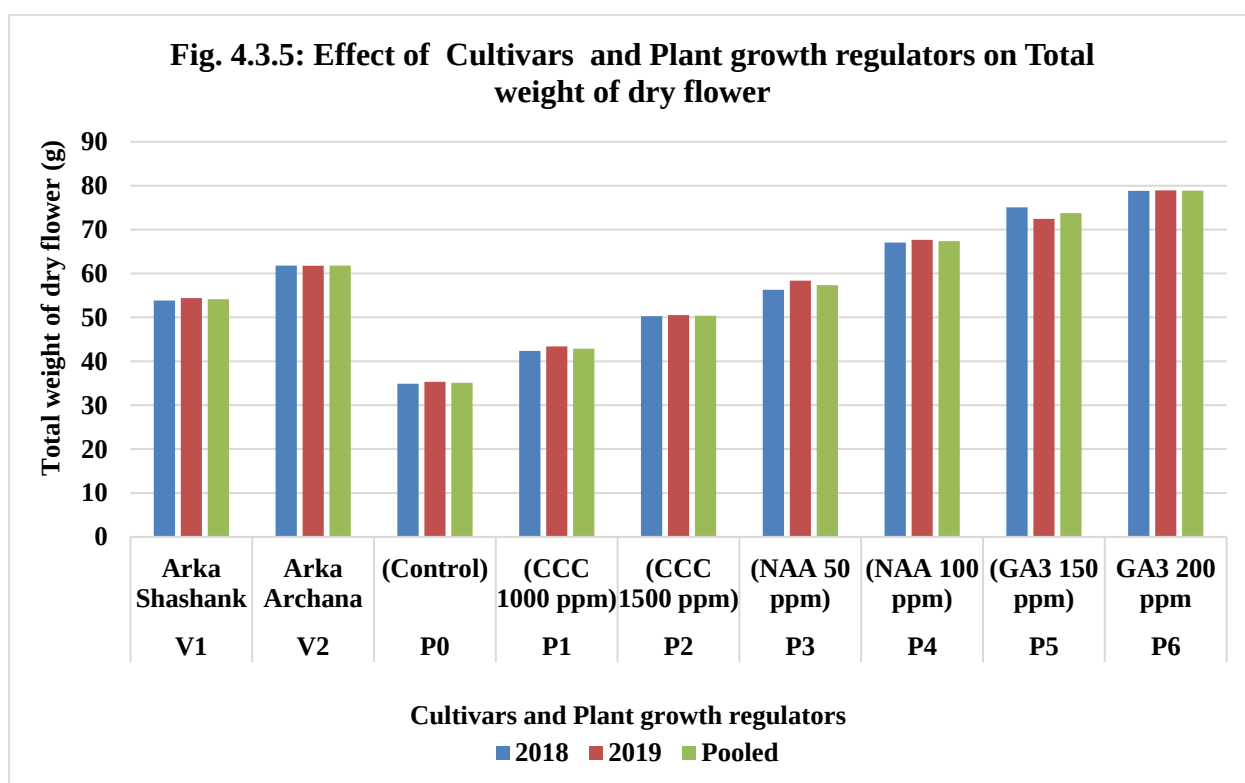
The total dry weight of flower per plant differed significantly due to application growth regulator. However, GA₃ 200 ppm recorded highest weight of dry flower. Improvement in flower dry weight as a result of GA₃ application might be due to better overall plant growth which resulted in net increase in photosynthates. This finding is in line with those of Prabhat Kumar *et al.* (2003) in China aster, Nagarjuna *et al.* (1988) in chrysanthemum and Kishan Swaroop *et al.* (2007) in African marigold.

Table 4.3.5: Effect of Cultivars and Plant growth regulators on Total weight of dry flower

Treat.		Total weight of dry flower (g)		
	CULTIVAR	2018-19	2019-20	Pooled
V₁	Arka Shashank	53.84	54.41	54.13
V₂	Arka Archana	61.80	61.77	61.78
	SEm SEm±	1.13	1.08	0.78
	CD at 5%	2.33	2.22	1.57
PGR				
P₀	(Control)	34.90	35.33	35.11
P₁	(CCC 1000 ppm)	42.36	43.37	42.87
P₂	(CCC 1500 ppm)	50.27	50.53	50.40
P₃	(NAA 50 ppm)	56.28	58.38	57.33
P₄	(NAA 100 ppm)	67.06	67.66	67.36
P₅	(GA ₃ 150 ppm)	75.06	72.44	73.75
P₆	(GA ₃ 200 ppm)	78.83	78.92	78.87
	SEm SEm±	2.12	2.02	1.47
	CD at 5%	4.36	4.16	2.94

Table 4.3.5 a: Interaction effect of Cultivars and Plant growth regulators on Total weight of dry flower

Treat.			Total weight of dry flower (g)		
			2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	30.29	30.58	30.44
V₁P₁	Arka Shashank	(CCC 1000 ppm)	40.68	41.46	41.07
V₁P₂	Arka Shashank	(CCC 1500 ppm)	44.99	45.95	45.47
V₁P₃	Arka Shashank	(NAA 50 ppm)	52.79	53.61	53.20
V₁P₄	Arka Shashank	(NAA 100 ppm)	61.67	64.52	63.09
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	71.61	68.22	69.92
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	74.86	76.55	75.70
V₂P₀	Arka Archana	(Control)	39.50	40.08	39.79
V₂P₁	Arka Archana	(CCC 1000 ppm)	44.05	45.28	44.67
V₂P₂	Arka Archana	CCC 1500 ppm)	55.55	55.11	55.33
V₂P₃	Arka Archana	(NAA 50 ppm)	59.77	63.16	61.46
V₂P₄	Arka Archana	(NAA 100 ppm)	72.45	70.79	71.62
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	78.50	76.67	77.58
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	82.80	81.28	82.04
SEm±			3.00	2.86	2.07
CD at 5%			NS	NS	NS



4.3.6. Weight of flower with stalk (g)

It is clear from the data presented in Table 4.3.6, 4.3.6 a. and graphically presented in Fig 4.3.6 that the weight of flower with stalk per plant was significantly influenced by cultivars and different levels of Plant growth regulators.

Cultivars of China aster, differs significantly on weight of flower with stalk. The highest weight of flower with stalk were observed in cultivar (V₂) Arka Archana (14.70, 14.10 and 14.40 g) respectively. The lowest weight of flower with stalk per plant was obtained from cultivar (V₂) Arka Shashank (11.50, 11.70 and 11.60 g) respectively in both the years as well as on pooled mean basis.

The data showed that the plant growth regulators showed significant response on weight of flower with stalk, during both the years as well as on pooled mean analysis. The maximum weight of flower with stalk (19.20, 19.30 and 19.00 g) respectively were recorded under treatment P₆ (GA₃ 200 ppm) respectively and it was noticed significant response with rest of the other treatments. The minimum weight of flower with stalk (5.30, 5.00 and 5.20 g) respectively was recorded in P₀ (Control) under both the years and on pooled mean basis.

The interaction between cultivars and plant growth regulators were found non-significant during both the years as well as on pooled mean analysis.

The highest weight of a flower with stalk in the treatment of GA₃ 200 ppm may be attributed to the fact that gibberellic acid promoted the efficacy of plants in terms of photosynthetic activity, uptake of nutrients and their translocation as well as better partitioning of assimilates into reproductive parts. The results obtained during this investigation are closely in agreement with the findings of Sharma and Joshi (2015) in China aster, Palei *et al.* (2016) in African marigold, Maurya *et al.* (2017), Vijayakumar *et al.* (2017^a) and Sindhuja *et al.* (2018-19) in China aster.

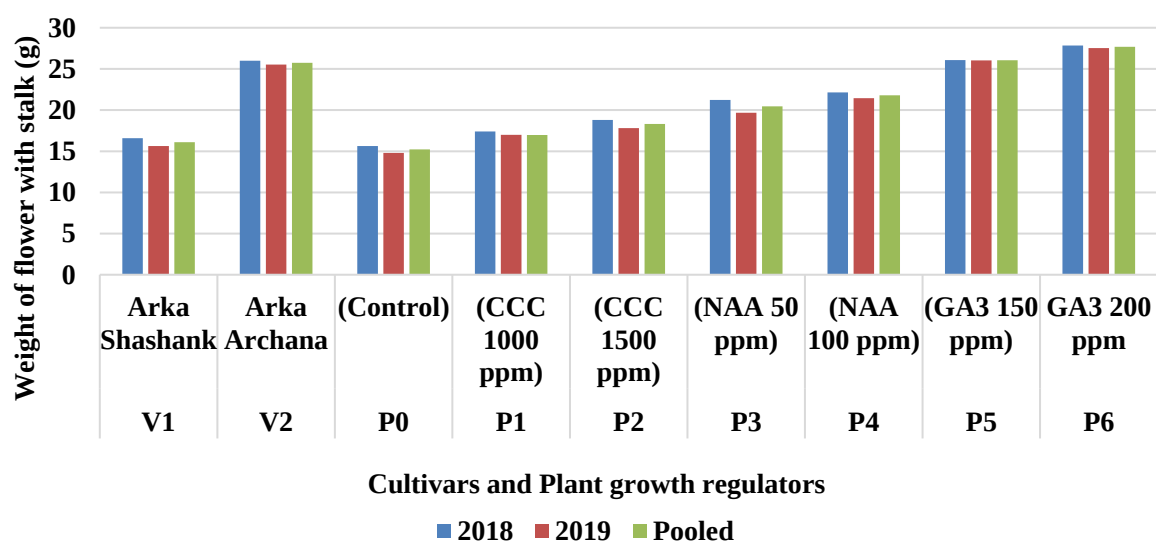
Table 4.3.6: Effect of Cultivar and Plant growth regulators on Weight of flower with stalk

Treat.		Weight of flower with stalk (g)		
CULTIVAR		2018-19	2019-20	Pooled
V₁	Arka Shashank	11.50	11.70	11.60
V₂	Arka Archana	14.70	14.10	14.40
SEm SEm±		0.32	0.31	0.25
CD at 5%		0.66	0.63	0.52
PGR				
P₀	(Control)	5.30	5.00	5.20
P₁	(CCC 1000 ppm)	8.80	8.90	8.80
P₂	(CCC 1500 ppm)	10.40	9.80	10.10
P₃	(NAA 50 ppm)	14.50	14.30	14.40
P₄	(NAA 100 ppm)	15.40	15.10	15.20
P₅	(GA ₃ 150 ppm)	17.90	17.70	17.80
P₆	(GA ₃ 200 ppm)	19.20	19.30	19.00
SEm SEm±		0.60	0.58	0.47
CD at 5%		1.25	1.19	0.98

Table 4.3.6 a: Interaction effect of Cultivar and Plant growth regulators on Weight of flower with stalk

Treat.			Weight of flower with stalk (g)		
			2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	4.31	4.06	4.18
V₁P₁	Arka Shashank	(CCC 1000 ppm)	6.77	7.02	6.89
V₁P₂	Arka Shashank	(CCC 1500 ppm)	8.02	8.64	8.33
V₁P₃	Arka Shashank	(NAA 50 ppm)	13.02	13.58	13.30
V₁P₄	Arka Shashank	(NAA 100 ppm)	14.47	14.47	14.47
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	16.44	16.36	16.40
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	17.19	17.80	17.50
V₂P₀	Arka Archana	(Control)	6.31	6.02	6.16
V₂P₁	Arka Archana	(CCC 1000 ppm)	10.81	10.77	10.79
V₂P₂	Arka Archana	CCC 1500 ppm)	12.69	11.02	11.86
V₂P₃	Arka Archana	(NAA 50 ppm)	16.04	15.04	15.54
V₂P₄	Arka Archana	(NAA 100 ppm)	16.35	15.70	16.03
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	19.34	19.14	19.24
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	21.26	20.80	21.03
SEm±			1.17	0.86	0.82
CD at 5%			NS	NS	NS

Fig 4.3.6: Effect of Cultivar and Plant growth regulators on Weight of flower with stalk



4.3.7. Diameter of flowers (cm)

The diameter of flowers was measured and its data are presented in Table 4.3.7, 4.3.7 a and Fig -4.3.7

It is vivid from the data presented in the table 4.3.7 that the diameter of flowers was significantly influenced by cultivars, maximum diameter of flower (7.01, 7.14 and 7.07 cm) were observed in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank (5.04, 5.35 and 5.19 cm) during both the tested years and on pooled mean data respectively.

In respect to plant growth regulator during both the year and on pooled mean basis., The maximum diameter of flowers (8.31, 8.79 and 8.55 cm) respectively was observed under treatment P₆ (GA₃ 200 ppm) and it was noticed significant difference with rest of the other treatments. Whereas, minimum diameter of flowers (3.88, 4.12 and 4.00 cm) respectively was recorded under treatment P₀ (Control) during both the year of investigation as well as on pooled mean basis.

The interaction between cultivars and plant growth regulators was found non significant, during both the years as well as on pooled mean basis under this investigation.

The two years result indicated that there was significant difference in flower size within the Cultivars and maximum flower diameter was obtained from cultivar Arka Archana. It could be stated that variation within the varieties for diameter of fully opened flower might be due to genotypic and environmental interaction. Similar results were reported by Nursude *al.* (2010), Beniwal and Dahiya (2012), Singh and Mishra (2009) in African marigold and Singh and Singh (2010) and Raghuvanshi and Sharma (2011) in French marigold.

During the research findings of two years experimentation marked differences were noticed among growth regulator applications on flower diameter (Table 4.3.7 & Fig. 4.3.7). The maximum flower diameter was recorded with the application of GA₃ at 200 ppm. This may be due to active cell elongation in the flower caused increase in length of petals and pedicels or may be owing to division of

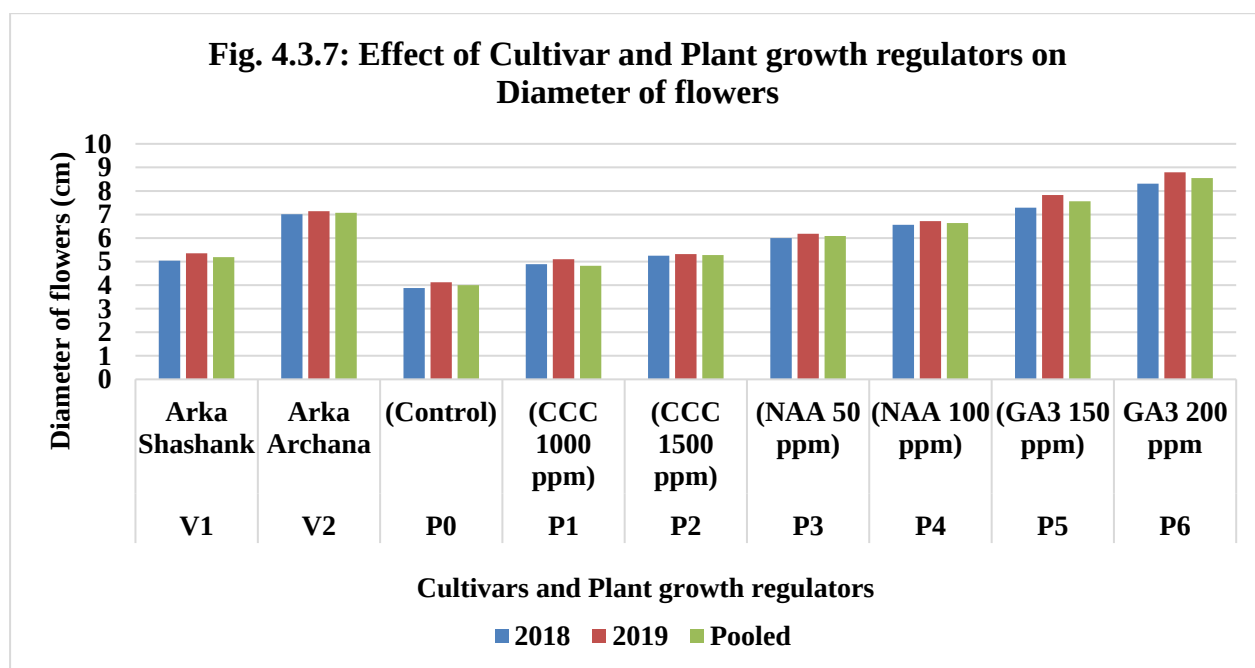
photosynthates towards flower as a consequence of which there is intensification of sink in China aster. The findings are in line with the results obtained by Gupta *et al.* (2015) and Sharma and Joshi (2015) in China aster, Palei *et al.* (2016) in African marigold, Maurya *et al.* (2017), Vijayakumar *et al.* (2017^a) and Sindhuja *et al.* (2018-19) in China aster.

Table 4.3.7: Effect of Cultivar and Plant growth regulators on Diameter of flowers

Treat.		Diameter of flowers (cm)		
	CULTIVAR	2018-19	2019-20	Pooled
V ₁	Arka Shashank	5.04	5.35	5.19
V ₂	Arka Archana	7.01	7.14	7.07
	SEm SEm±	0.18	0.25	0.15
	CD at 5%	0.38	0.51	0.31
PGR				
P ₀	(Control)	3.88	4.12	4.00
P ₁	(CCC 1000 ppm)	4.89	4.74	4.82
P ₂	(CCC 1500 ppm)	5.25	5.32	5.28
P ₃	(NAA 50 ppm)	6.00	6.18	6.09
P ₄	(NAA 100 ppm)	6.56	6.72	6.64
P ₅	(GA ₃ 150 ppm)	7.29	7.83	7.56
P ₆	GA ₃ 200 ppm	8.31	8.79	8.55
	SEm SEm±	0.34	0.46	0.29
	CD at 5%	0.71	0.95	0.58

Table 4.3.7 a: Interaction effect of Cultivar and Plant growth regulators on Diameter of flowers

Treat.			Diameter of flowers (cm)		
			2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	3.28	3.38	3.33
V₁P₁	Arka Shashank	(CCC 1000 ppm)	4.14	4.15	4.14
V₁P₂	Arka Shashank	(CCC 1500 ppm)	4.33	4.63	4.48
V₁P₃	Arka Shashank	(NAA 50 ppm)	5.04	5.20	5.12
V₁P₄	Arka Shashank	(NAA 100 ppm)	5.26	5.43	5.35
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	5.79	6.65	6.22
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	7.45	7.98	7.72
V₂P₀	Arka Archana	(Control)	4.49	4.85	4.67
V₂P₁	Arka Archana	(CCC 1000 ppm)	5.64	5.34	5.49
V₂P₂	Arka Archana	(CCC 1500 ppm)	6.17	6.00	6.09
V₂P₃	Arka Archana	(NAA 50 ppm)	6.96	7.15	7.06
V₂P₄	Arka Archana	(NAA 100 ppm)	7.85	8.02	7.93
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	8.78	9.00	8.89
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	9.17	9.60	9.39
SEm±			0.49	0.66	0.41
CD at 5%			NS	NS	NS



4.3.8. Chlorophyll content before flowering (mg/g)

It is clear from the data presented in Table 4.3.8, 4.3.8 a and graphically presented in Fig 4.3.8 that the chlorophyll content before flowering was significantly influenced by cultivars and different levels of plant growth regulators.

Amongst the cultivars, they show significant influence on chlorophyll content before flowering. The highest chlorophyll content before flowering was observed in cultivar (V₂) Arka Archana (50.08, 50.24 and 50.16 mg/g). The lowest chlorophyll content before flowering were obtained from cultivar (V₁) Arka Shashank (48.38, 48.67 and 48.53 mg/g) respectively in both the years as well as on pooled mean basis.

Plant growth regulators showed significant impact on chlorophyll content before flowering during both the years as well as on pooled mean analysis. The highest chlorophyll content before flowering (53.46, 54.78 and 54.12 mg/g) respectively were recorded under P₆ (GA₃ 200 ppm) which was found statistically *at par* with P₅ (GA₃ 150 ppm) in second year and on pooled mean basis. While, during first year both the treatments P₄ (NAA 100 ppm) and P₆ (GA₃ 200 ppm) was found statistically similar and it was observed significant difference with respite of all other treatments during both the years and on pooled mean basis. The lowest Chlorophyll content before flowering (42.52, 41.22 and 41.87 mg/g) respectively was recorded in P₀ (Control).

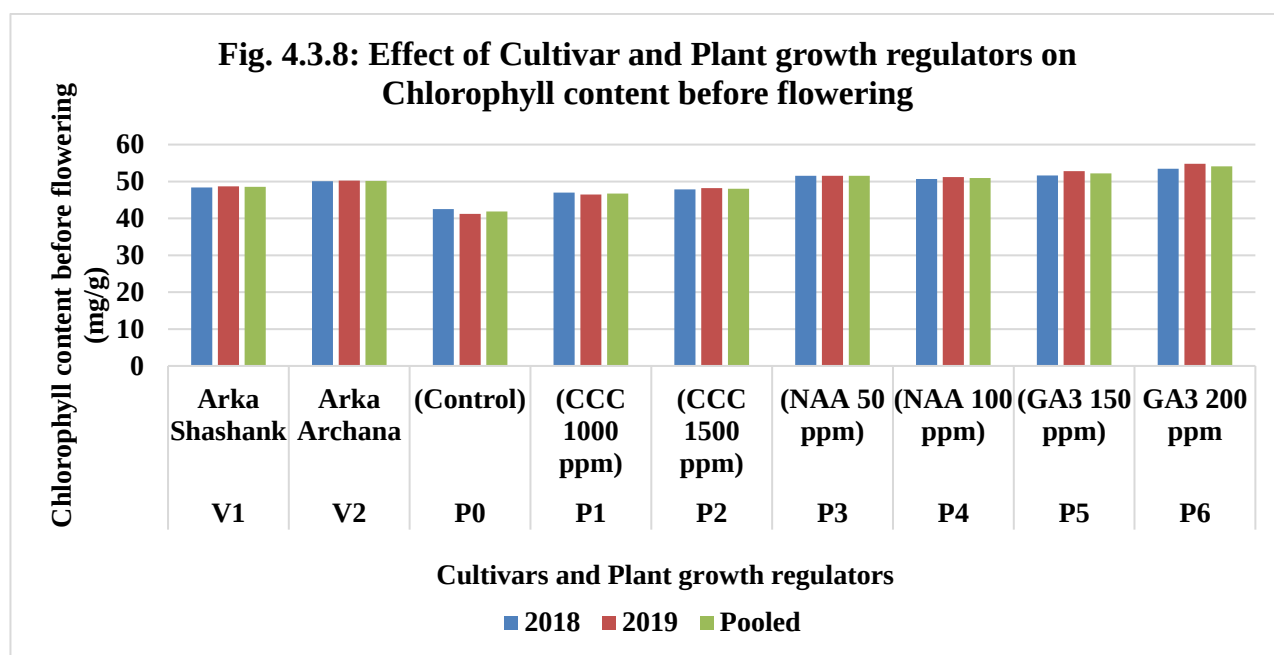
The interaction between cultivar and plant growth regulators were found non significant during both the years as well as on pooled mean analysis under this investigation.

Table 4.3.8: Effect of Cultivar and Plant growth regulators on Chlorophyll content before flowering

Treat.		Chlorophyll content before flowering (mg/g)		
	CULTIVAR	2018-19	2019-20	Pooled
V₁	Arka Shashank	48.38	48.67	48.53
V₂	Arka Archana	50.08	50.24	50.16
	SEm SEm±	0.79	0.71	0.53
	CD at 5%	1.63	1.46	1.07
PGR				
P₀	(Control)	42.52	41.22	41.87
P₁	(CCC 1000 ppm)	46.99	46.45	46.72
P₂	(CCC 1500 ppm)	47.84	48.20	48.02
P₃	(NAA 50 ppm)	51.54	51.55	51.54
P₄	(NAA 100 ppm)	50.67	51.21	50.94
P₅	(GA ₃ 150 ppm)	51.61	52.80	52.20
P₆	(GA ₃ 200 ppm)	53.46	54.78	54.12
	SEm SEm±	1.48	1.33	0.99
	CD at 5%	3.05	2.72	2.00

Table 4.3.8 a: Interaction effect of Cultivar and Plant growth regulators on Chlorophyll content before flowering

Treat.			Chlorophyll content before flowering (mg/g)		
			2018-19	2019-20	Pooled
V ₁ P ₀	Arka Shashank	(Control)	42.51	40.02	41.27
V ₁ P ₁	Arka Shashank	(CCC 1000 ppm)	45.85	44.64	45.25
V ₁ P ₂	Arka Shashank	(CCC 1500 ppm)	45.79	46.43	46.11
V ₁ P ₃	Arka Shashank	(NAA 50 ppm)	50.98	51.17	51.08
V ₁ P ₄	Arka Shashank	(NAA 100 ppm)	50.54	50.62	50.58
V ₁ P ₅	Arka Shashank	(GA ₃ 150 ppm)	50.61	53.42	52.02
V ₁ P ₆	Arka Shashank	GA ₃ 200 ppm	52.40	54.40	53.40
V ₂ P ₀	Arka Archana	(Control)	42.53	42.41	42.47
V ₂ P ₁	Arka Archana	(CCC 1000 ppm)	48.12	48.25	48.19
V ₂ P ₂	Arka Archana	(CCC 1500 ppm)	49.90	49.97	49.94
V ₂ P ₃	Arka Archana	(NAA 50 ppm)	52.09	51.92	52.00
V ₂ P ₄	Arka Archana	(NAA 100 ppm)	50.79	51.80	51.30
V ₂ P ₅	Arka Archana	(GA ₃ 150 ppm)	52.60	52.17	52.38
V ₂ P ₆	Arka Archana	(GA ₃ 200 ppm)	54.51	55.15	54.83
SEm±			2.10	1.87	1.41
CD at 5%			NS	NS	NS



4.3.9. Chlorophyll content after flowering (mg/g)

The data on chlorophyll content after flowering are presented in table 4.3.9, 4.3.9 a revealed that the cultivar and plant growth regulator and their interaction exhibited significant impact on chlorophyll content after flowering.

In case of cultivars, they show significant influence on chlorophyll content after flowering. The highest chlorophyll content after flowering (46.39, 47.00 and 46.70 mg/g) respectively were observed in cultivar (V₂) Arka Archana. The lowest chlorophyll content after flowering (41.76, 42.05 and 41.90 mg/g) respectively were obtained from cultivar (V₁) Arka Shashank in both the years as well as on pooled mean basis.

As far as, Plant growth regulators showed significant impact on chlorophyll content after flowering during both the years as well as on pooled mean analysis. The highest chlorophyll content after flowering (48.88, 50.92 and 49.90 mg/g) respectively were recorded under treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm) in second year. Whereas, during first year and on pooled mean basis both the treatments P₄ (NAA 100 ppm) and P₆ (GA₃ 200 ppm) was found statistically *at par* and it was noticed significant difference with rest of the other treatments during both the tested year as well as on pooled mean analysis. The lowest chlorophyll content after flowering (37.90, 38.07 and 37.98 mg/g) respectively was recorded under P₀ (Control).

The interaction between cultivar and plant growth regulators were found non significant during both the years as well as on pooled mean analysis under this investigation.

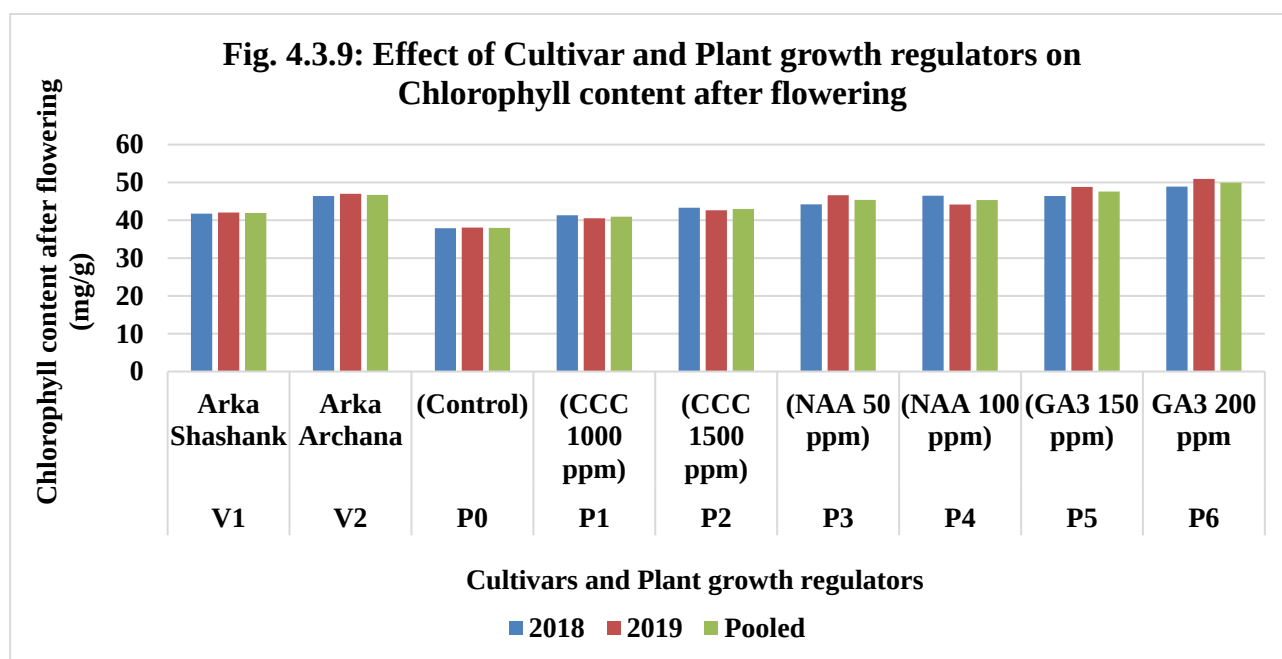
The highest chlorophyll content after flowering was recorded under GA₃ 200 ppm. GA₃ moves readily in all directions and in all tissues in China aster. Especially in young leaves, it regulates the mitotic process; there by it increases the cell division, cell elongation and cell wall permeability which favour the synthesis and more accumulation of chlorophyll in the plant system. In Chrysanthemum, in tuberose, in rose, and in gerbera

Table 4.3.9: Effect of Cultivar and Plant growth regulators on Chlorophyll content after flowering

Treat.		Chlorophyll content after flowering (mg/g)		
CULTIVAR		2018-19	2019-20	Pooled
V₁	Arka Shashank	41.76	42.05	41.90
V₂	Arka Archana	46.39	47.00	46.70
SEm SEm±		1.08	1.61	0.97
CD at 5%		2.22	3.31	1.94
PGR				
P₀	(Control)	37.90	38.07	37.98
P₁	(CCC 1000 ppm)	41.33	40.52	40.93
P₂	(CCC 1500 ppm)	43.32	42.62	42.97
P₃	(NAA 50 ppm)	44.18	46.62	45.40
P₄	(NAA 100 ppm)	46.50	44.15	45.33
P₅	(GA ₃ 150 ppm)	46.38	48.82	47.60
P₆	(GA ₃ 200 ppm)	48.88	50.92	49.90
SEm SEm±		2.02	3.01	1.81
CD at 5%		4.15	6.18	3.64

Table 4.3.9 a: Interaction effect of Cultivar and Plant growth regulators on Chlorophyll content after flowering

Treat.			Chlorophyll content after flowering (mg/g)		
			2018-19	2019-20	Pooled
V ₁ P ₀	Arka Shashank	(Control)	35.93	35.13	35.53
V ₁ P ₁	Arka Shashank	(CCC 1000 ppm)	39.37	37.67	38.52
V ₁ P ₂	Arka Shashank	(CCC 1500 ppm)	40.70	41.50	41.10
V ₁ P ₃	Arka Shashank	(NAA 50 ppm)	41.70	43.93	42.82
V ₁ P ₄	Arka Shashank	(NAA 100 ppm)	43.53	37.53	40.53
V ₁ P ₅	Arka Shashank	(GA ₃ 150 ppm)	44.23	48.63	46.43
V ₁ P ₆	Arka Shashank	(GA ₃ 200 ppm)	46.83	49.97	48.40
V ₂ P ₀	Arka Archana	(Control)	39.87	41.00	40.43
V ₂ P ₁	Arka Archana	(CCC 1000 ppm)	43.30	43.37	43.33
V ₂ P ₂	Arka Archana	CCC 1500 ppm)	45.93	43.73	44.83
V ₂ P ₃	Arka Archana	(NAA 50 ppm)	46.67	49.30	47.98
V ₂ P ₄	Arka Archana	(NAA 100 ppm)	49.47	50.77	50.12
V ₂ P ₅	Arka Archana	(GA ₃ 150 ppm)	48.53	49.00	48.77
V ₂ P ₆	Arka Archana	(GA ₃ 200 ppm)	50.93	51.87	51.40
SEm±			2.86	4.26	2.56
CD at 5%			NS	NS	NS



4.3.10 Vase life of flowers (days)

The data presented in the Table 4.3.10, 4.3.10 a and Fig. 4.3.10 exhibited that the vase life of flowers was significantly influenced due to cultivars and plant growth regulators.

The evident data showed that the maximum vase life of flowers in days (8.31 and 8.15 days) respectively was recorded under cultivar (V₂) Arka Archana and the minimum vase life in days (7.90 and 7.82 days) respectively was recorded under cultivar (V₁) Arka shashank during second year as well as on pooled mean analysis. During first year the interaction was found non significant.

As far as, plant growth regulators showed significant response on vase life of flowers, during both the years as well as on pooled mean analysis. The longer vase life of flowers (9.90, 9.99 and 9.95 days) respectively were recorded under treatment P₆ (GA₃ 200 ppm) which was found statistically similar with treatment P₅ (GA₃ 150 ppm) during both the tested years except on pooled mean basis and it was showed significant difference among the rest of the other treatments during both the years as well as on pooled mean basis. The minimum vase life of flowers (5.23, 5.52 and 5.38 days) respectively was recorded in treatment P₀ (Control) under this investigation.

The interaction among cultivar and plant growth regulators for vase life of flowers were found non- significant during both the years as well as on pooled mean analysis.

The results of two years research work indicated that vase life of flowers was maximum in Arka Archana which may be due to the diffuseness of flowers which was observed in Arka Archana. It might be also due to the congenial environment to express the dominant genes in the genotypes and different genetic makeup of the variety. The present research work confirms the findings of Bhanu Pratap *et al.* (1999), Nand- Kishore and Mohanti (2002), Sreekala *et al.* (2002), and Nursude *et al.* (2010) in African marigold.

One of the greatest problems in post harvest flower physiology is the blockage of the vascular system. This blockage might be due to air or bacterial growth. Another cause of vascular blockage is the plants reactions to the actual cut. Even in the flower stem that is removed from the mother plant, certain enzymes are mobilized to the wounded area where chemicals are released in order to try to seal the wound (Loub and Van Doorn 2004).

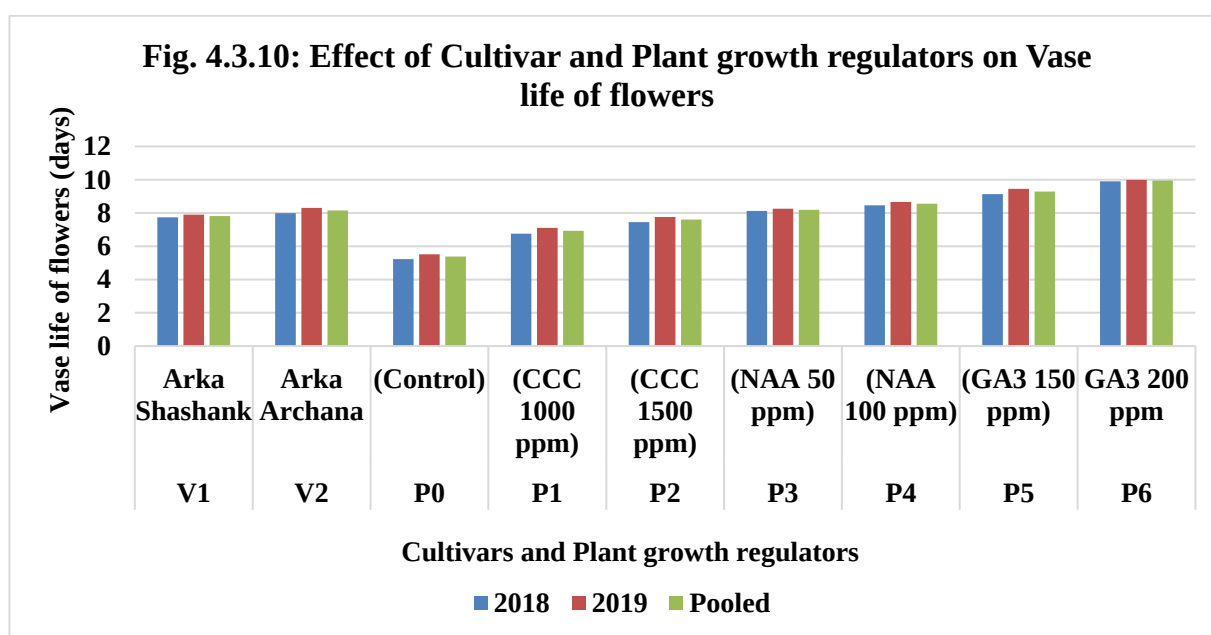
The maximum longevity of flowers was with GA₃ 200 ppm than all other treatments (Table 15 and fig 12). Improvement in vase life of flowers owing to the application of GA may be attributed to the maintenance of higher levels of RNA in leaves thus delaying senescence. Growth retardants like cycocel also improved the longevity compared to control by maintaining the levels of chlorophyll, protein, RNA content of leaves at a higher level for a longer duration suppressing the senescence deferral effect of this chemical (Kar *et al.*, 1989). Similar results were also reported by Mukhopadhyay and Bankar (1981) in tuberose and Aswath *et al.* (1995) in China aster.

Table 4.3.10: Effect of Cultivar and Plant growth regulators on Vase life of flowers

Treat.		Vase life of flowers (days)		
	CULTIVAR	2018-19	2019-20	Pooled
V ₁	Arka Shashank	7.74	7.90	7.82
V ₂	Arka Archana	7.99	8.31	8.15
	SEm SEm±	0.20	0.17	0.13
	CD at 5%	NS	0.36	0.27
PGR				
P ₀	(Control)	5.23	5.52	5.38
P ₁	(CCC 1000 ppm)	6.76	7.10	6.93
P ₂	(CCC 1500 ppm)	7.45	7.76	7.60
P ₃	(NAA 50 ppm)	8.12	8.26	8.19
P ₄	(NAA 100 ppm)	8.46	8.66	8.56
P ₅	(GA ₃ 150 ppm)	9.13	9.45	9.29
P ₆	(GA ₃ 200 ppm)	9.90	9.99	9.95
	SEm SEm±	0.38	0.32	0.25
	CD at 5%	0.79	0.67	0.50

Table 4.3.10 a: Interaction effect of Cultivar and Plant growth regulators on Vase life of flowers

Treat.	Vase life of flowers				
			2018-19	2019-20	Pooled
V₁P₀	Arka Shashank	(Control)	5.05	4.94	4.99
V₁P₁	Arka Shashank	(CCC 1000 ppm)	6.83	6.54	6.69
V₁P₂	Arka Shashank	(CCC 1500 ppm)	7.40	7.79	7.59
V₁P₃	Arka Shashank	(NAA 50 ppm)	8.09	8.08	8.09
V₁P₄	Arka Shashank	(NAA 100 ppm)	8.43	8.71	8.57
V₁P₅	Arka Shashank	(GA ₃ 150 ppm)	8.81	9.47	9.14
V₁P₆	Arka Shashank	(GA ₃ 200 ppm)	9.60	9.78	9.69
V₂P₀	Arka Archana	(Control)	5.41	6.10	5.76
V₂P₁	Arka Archana	(CCC 1000 ppm)	6.69	7.67	7.18
V₂P₂	Arka Archana	(CCC 1500 ppm)	7.50	7.72	7.61
V₂P₃	Arka Archana	(NAA 50 ppm)	8.15	8.43	8.29
V₂P₄	Arka Archana	(NAA 100 ppm)	8.49	8.61	8.55
V₂P₅	Arka Archana	(GA ₃ 150 ppm)	9.45	9.43	9.44
V₂P₆	Arka Archana	(GA ₃ 200 ppm)	10.21	10.19	10.20
SEm±			0.54	0.46	0.35
CD at 5%			NS	NS	NS



Experiment II: Effect on different levels on nitrogen and phosphorus on growth, flowering, yield and quality of China aster (*Callistephus chinensis* (L.) Nees).

4.4 Growth parameters

4.4.1 Plant height (cm)

The revealed data on plant height at 45, 75 and 105 DAT influenced by varieties of China aster and different levels of nitrogen and phosphorus are presented in Table 4.4.1, 4.4.1 a and Fig.4.4.1a and 4.4.1 b

The perusal of the data reveals that the cultivars show significant difference on plant height at 45 DAT, during both the years as well as on pooled mean. The maximum plant height (16.23, 16.84 and 16.53 cm) respectively was observed in cultivar (V₁) Arka Shashank. Whereas, the minimum plant height (14.98, 15.39 and 15.18 cm) respectively was found in cultivar (V₂) Arka Archana.

Application of different levels of nitrogen and phosphorus showed significant difference on plant height during both the year and on pooled mean basis. The maximum plant height (20.17, 19.98 and 20.08 cm) respectively was recorded under the treatment F₁₂ (N₁₈₀: P₁₄₀) which was found statistically *at par* with treatment F₁₁ (N₁₈₀: P₁₂₀) during both the tested years and on pooled mean basis. However, it was found significant difference with rest of the other treatments during first year and second year. Whereas, rest of other treatments shows significant difference under pooled mean basis. The minimum plant height (12.40, 12.90 and 12.65 cm) respectively was noticed in F₁ (N₁₂₀: P₁₀₀) under this investigation.

The interactions between cultivar and different levels of nitrogen and phosphorus were found significant during first year and on pooled mean basis. The maximum plant height (22.30, 21.73 cm) respectively was found in treatment combination (V₁F₁₂) which was found statistically similar with (V₁F₁₁) and it was showed

significant variance with rest of the other treatments during first year and on pooled mean basis..The minimum plant height (12.20, 12.53 cm) was observed in treatment combination (V₁F₁). However, in second year interaction effect was showed non-significant.

Table 4.4.1: Effect of Cultivars, Nitrogen and Phosphorus on Plant height

Treat.		Plant height(cm)								
		45 days			75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	16.23	16.84	16.53	51.68	53.07	52.38	56.21	56.41	56.30
V ₂	Arka Archana	14.98	15.39	15.18	44.53	44.9	44.71	47.1	47.44	47.30
SEm SEm±		0.32	0.4	0.25	0.97	1.11	0.74	0.83	0.73	0.75
CD at 5%		0.64	0.8	0.5	1.95	2.23	1.46	1.67	1.48	1.52
NITROGEN AND PHOSPHORUS										
F₁	N ₁₂₀ : P ₁₀₀	12.40	12.90	12.65	40.72	39.77	40.24	46.90	47.00	46.91
F₂	N ₁₂₀ : P ₁₂₀	13.15	13.35	13.25	42.25	41.33	41.79	47.70	47.70	47.70
F₃	N ₁₂₀ : P ₁₄₀	13.88	15.68	14.78	45.27	46.62	45.94	48.20	48.50	48.30
F₄	N ₁₄₀ : P ₁₀₀	13.53	14.75	14.14	47.13	48.55	47.84	48.50	49.70	49.10
F₅	N ₁₄₀ : P ₁₂₀	14.11	14.87	14.49	47.87	49.85	48.86	49.30	49.50	49.40
F₆	N ₁₄₀ : P ₁₄₀	14.50	15.13	14.82	48.40	48.98	48.69	50.50	50.70	50.60
F₇	N ₁₆₀ : P ₁₀₀	15.55	16.15	15.85	49.03	50.27	49.65	51.29	51.00	51.12
F₈	N ₁₆₀ : P ₁₂₀	16.13	16.38	16.26	49.15	51.20	50.18	51.80	52.60	52.20
F₉	N ₁₆₀ : P ₁₄₀	16.58	17.22	16.90	50.40	52.02	51.21	53.90	54.40	54.10
F₁₀	N ₁₈₀ : P ₁₀₀	17.75	17.92	17.83	51.55	51.83	51.69	55.90	55.00	55.60
F₁₁	N ₁₈₀ : P ₁₂₀	19.45	19.08	19.27	52.20	53.37	52.78	57.50	56.50	57.50
F₁₂	N ₁₈₀ : P ₁₄₀	20.17	19.98	20.08	53.30	54.02	53.66	59.20	58.70	59.00
SEm SEm±		0.77	0.97	0.62	2.37	2.71	1.80	2.03	1.80	1.85
CD at 5%		1.56	1.95	1.23	4.77	5.46	3.58	4.10	3.62	3.74

In case of cultivars, it showed significant differences in plant height at 75 DAT. The maximum plant height (51.68, 53.07 and 52.38 cm) respectively was observed in Cultivar (V₁) Arka Shashank during both the tested years as well as on pooled mean basis which was superior over as compared to Cultivar (V₂) Arka Archana (44.53, 44.90 and 44.71 cm) respectively.

At 75 DAT, there was significant difference in plant height due to application of different levels of nitrogen and phosphorus during both the year and on pooled mean basis. It clearly showed that the maximum plant height (53.30, 54.02 and 53.66 cm) respectively was recorded under the treatment F₁₂ (N₁₈₀: P₁₄₀), which was found statistically *at par* with treatments F₈(N₁₆₀: P₁₂₀), F₉(N₁₆₀: P₁₄₀), F₁₀(N₁₈₀: P₁₀₀), F₁₁(N₁₈₀: P₁₂₀) during first year and on pooled mean basis, whereas during second year F₅(N₁₄₀: P₁₂₀), F₆(N₁₄₀: P₁₄₀), F₇(N₁₆₀: P₁₀₀), F₈(N₁₆₀: P₁₂₀), F₉(N₁₆₀: P₁₂₀), F₁₀(N₁₈₀: P₁₀₀) and F₁₁(N₁₈₀: P₁₂₀) was found statistically *at par*. However, it was found significant difference with remaining other treatments during both the tested years as well as on pooled mean analysis. The minimum plant height (40.72, 39.77 and 40.24 cm) was noticed in treatment F₁ (N₁₂₀: P₁₀₀) under this investigation.

The interaction between cultivars and different levels of nitrogen and phosphorus at 75 DAT was found non-significant, during both the years as well as on pooled mean basis.

In respect to cultivars, it showed significant differences in plant height at 105 DAT. The maximum plant height (56.21, 56.41 and 56.30 cm) respectively was observed in Cultivar (V₁) Arka Shashank during both the tested years as well as on pooled mean basis which was superior over as compared to Cultivar (V₂) Arka Archana (47.10, 47.44 and 47.30 cm) respectively.

The data at 105 DAT shows significant difference in plant height due to different levels of nitrogen and phosphorus. It clearly showed that the maximum plant height (59.20, 58.70 and 59.00 cm) respectively was recorded under the treatment F₁₂

(N₁₈₀: P₁₄₀), which was found statistically *at par* with treatments F₁₀(N₁₈₀: P₁₀₀) and F₁₁(N₁₈₀: P₁₂₀) during both the years and on pooled mean basis. However, it was found significant difference with remaining of the other treatments F₇(N₁₆₀: P₁₀₀), F₈(N₁₆₀: P₁₂₀) and F₉(N₁₆₀: P₁₄₀). The minimum plant height (46.90, 47.00 and 46.91 cm) was noticed in treatment F₁ (N₁₂₀: P₁₀₀) under this investigation.

The interaction between cultivars and different levels of nitrogen and phosphorus at 75 and 105 DAT was found non-significant, during both the years as well as on pooled mean basis.

Maximum plant height was noticed in Arka Archana as compare to Arka Shashank. The variation in plant height between China aster varieties might be due to congenial environment to plant that express the dominant genes in the genotypes and different genetic makeup of the varieties. The observations are in conformity with the findings of Bhanu Pratap *et al.* (1999), Sreekala *et al.* (2002), Rao *et al.* (2005), Nursude *et al.* (2010) in African marigold and Namita *et al.* (2008)) in French marigold.

Maximum plant height was recorded under the treatment F₁₂ (N₁₈₀: P₁₄₀). The plant height was found to be significantly affected by the levels of fertilizer applications. This might be due to the increase in transport of metabolites and rate of photosynthesis in the plant, which enables the plant to have quick and better upward vegetative growth. The results are in close conformity with the findings which revealed that the increase in application of nitrogen and phosphorus significantly influenced by plant height (Yasheen *et al.*, 2014). Similar observations were also reported by Jain and Gupta, (2004) and (Maheta *et al.*, 2016). They further concluded that the higher dose of NP proved to be the best for attaining the maximum plant height in China aster.

Table 4.4.1 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on plant height

Treat.	Plant height (cm)								
	45 Days			75 Days			105 Days		
	NP	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20
V ₁ F ₁	12.20	12.87	12.53	42.70	43.83	43.27	50.90	52.56	51.73
V ₁ F ₂	12.93	13.43	13.18	44.50	44.23	44.37	51.56	52.90	52.23
V ₁ F ₃	13.17	15.97	14.57	47.33	49.37	48.35	52.03	53.36	52.70
V ₁ F ₄	13.07	14.87	13.97	49.53	51.47	50.50	53.10	54.43	53.76
V ₁ F ₅	14.60	15.93	15.27	51.33	52.93	52.13	53.53	53.86	53.70
V ₁ F ₆	15.30	16.07	15.68	51.63	52.03	51.83	54.66	54.66	54.66
V ₁ F ₇	16.37	17.40	16.88	52.57	53.20	52.88	55.33	55.00	55.16
V ₁ F ₈	17.27	17.67	17.47	52.47	55.63	54.05	56.36	56.70	56.53
V ₁ F ₉	17.70	18.17	17.93	54.83	57.00	55.92	57.90	58.56	58.23
V ₁ F ₁₀	18.60	18.43	18.52	56.97	57.50	57.23	60.56	59.56	60.06
V ₁ F ₁₁	21.20	20.17	20.68	57.57	59.70	58.63	63.96	61.96	62.96
V ₁ F ₁₂	22.30	21.17	21.73	58.77	59.93	59.35	65.50	62.83	64.16
V ₂ F ₁	12.60	12.93	12.77	38.73	35.70	37.22	42.80	41.46	42.13
V ₂ F ₂	13.37	13.27	13.32	40.00	38.43	39.22	43.83	42.50	43.16
V ₂ F ₃	14.60	15.40	15.00	43.20	43.87	43.53	44.26	43.60	43.93
V ₂ F ₄	14.00	14.63	14.32	44.73	45.63	45.18	43.96	44.96	44.46
V ₂ F ₅	13.62	13.80	13.71	44.40	46.77	45.58	45.03	45.03	45.03
V ₂ F ₆	13.70	14.20	13.95	45.17	45.93	45.55	46.40	46.73	46.56
V ₂ F ₇	14.73	14.90	14.82	45.50	47.33	46.42	47.13	47.46	47.30
V ₂ F ₈	15.00	15.10	15.05	45.83	46.77	46.30	47.16	48.50	47.83
V ₂ F ₉	15.47	16.27	15.87	45.97	47.03	46.50	49.83	50.16	50.00
V ₂ F ₁₀	16.90	17.40	17.15	46.13	46.17	46.15	51.20	51.20	51.20
V ₂ F ₁₁	17.70	18.00	17.85	46.83	47.03	46.93	50.93	52.93	51.93
V ₂ F ₁₂	18.03	18.80	18.42	47.83	48.10	47.97	52.96	54.63	53.80
SEm	1.09	1.37	0.88	3.35	3.84	2.55	4.41	3.40	2.78
CD at 5%	2.20	NS	1.74	NS	NS	NS	NS	NS	NS

Fig 4.4.1 a: Effect of Cultivars, Nitrogen and Phosphorus on Plant height at 45 Days

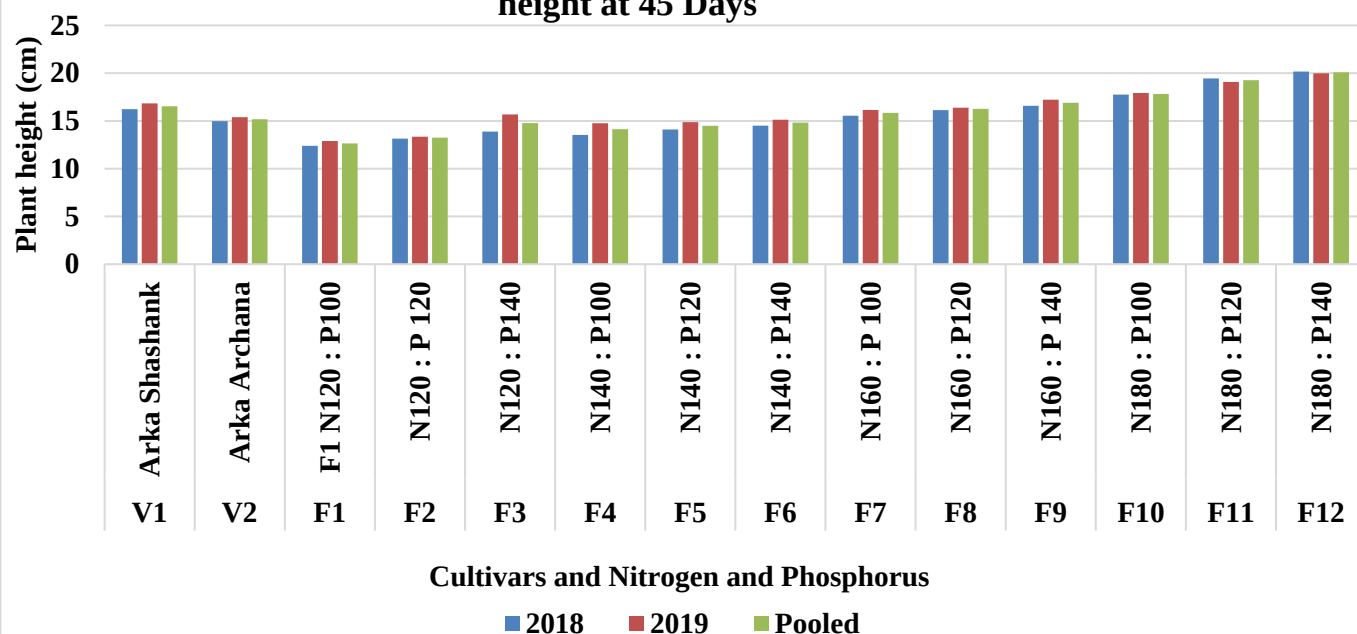
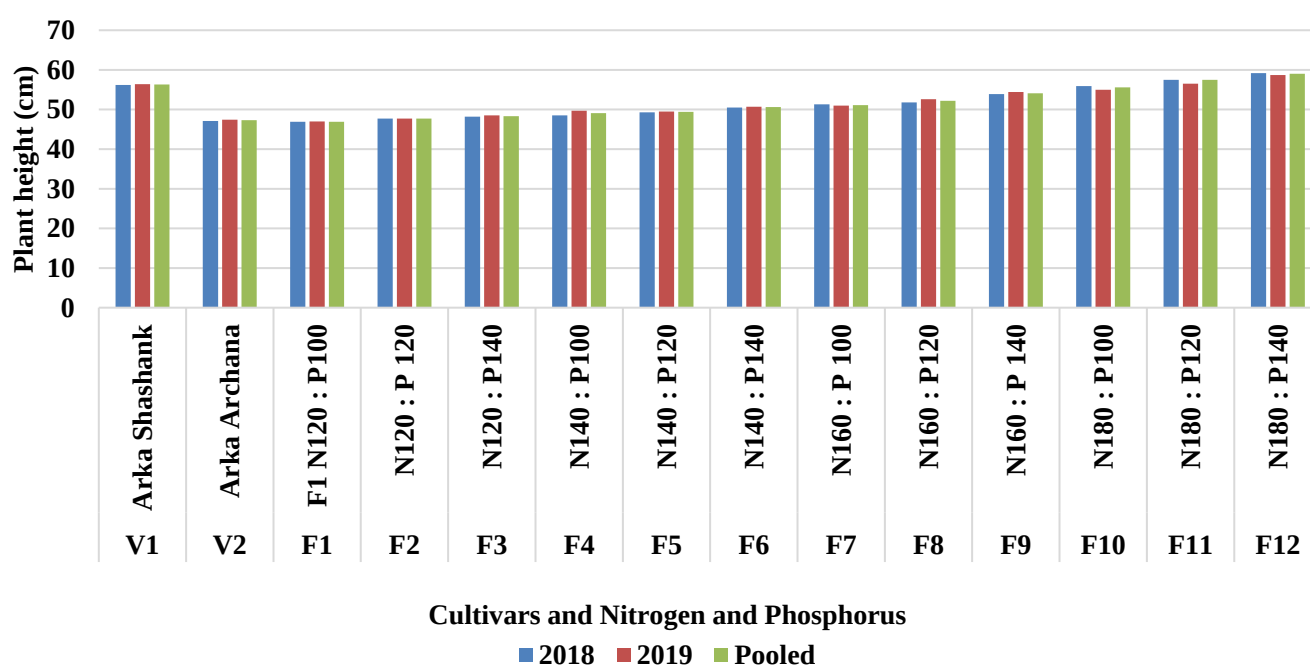


Fig 4.4.1 b: Effect of Cultivars, Nitrogen and Phosphorus on Plant height at 105 Days



4.4.2 Plant spread (cm)

The result on plant spread as influence by cultivars and different levels of nitrogen and phosphorus are presented in Table 4.4.2, 4.4.2 a and Fig.4.4.1a and 4.4.1 b

At 45 DAT cultivar showed significant influence on plant spread during both the years as well as on pooled mean basis. The plant spread (25.12, 25.58 and 25.35 cm) respectively were found maximum in cultivar (V₂) Arka Archana in both the years and on pooled mean basis and minimum plant spread (20.43, 20.32 and 20.38 cm) respectively was found in cultivar (V₁) Arka Shashank..

In case of nutrient application, the results on plant spread at 45 DAT showed significant differences between treatments. Maximum plant spread (26.77, 26.60, 26.68 cm) respectively was observed in treatment F₁₂ (N₁₈₀: P₁₄₀) which was found statistically *at par* with the treatments F₉ (N₁₆₀: P₁₄₀), F₁₀(N₁₈₀: P₁₀₀) , F₁₁(N₁₈₀: P₁₂₀) during first year and second year whereas, during on pooled mean basis treatment F₁₁(N₁₈₀: P₁₂₀) was found statistically similar and it was showed significant variance with rest of the other treatments during both the tested year and on pooled mean basis. The minimum plant spread (18.62, 18.95 and 18.78 cm) was found under treatment F₁(N₁₂₀: P₁₀₀) during both the tested years as well as on pooled mean analysis during this investigation.

At 75 DAT, data clearly showed that the maximum plant spread (31.89, 33.34 and 32.61 cm) respectively was recorded under cultivar (V₂) Arka Archana in both the years and on pooled mean basis and the minimum plant spread (23.76, 25.32 and 24.54 cm) respectively was found in cultivar (V₁) Arka Shashank under this investigation.

The data revealed that the plant spread at 75 DAT was significantly influenced by different levels of nitrogen and phosphorus during this investigation. The maximum plant spread (32.35, 34.32 and 33.33 cm) respectively was recorded under treatment F₁₂ (N₁₈₀: P₁₄₀) which were found statistically *at par* with treatment F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) in first year and on pooled mean

basis. Whereas, in second year, it was found statistically *at par* with the treatment F₉ (N₁₆₀: P₁₄₀), F₁₀ (N₁₈₀: P₁₀₀) and F₁₁(N₁₈₀: P₁₄₀) and it was showed significant difference with rest of the other treatments. However, minimum plant spread (22.42, 23.43 and 22.93 cm) was recorded under F₁ (N₁₂₀: P₁₀₀).

The interactions between cultivars with different levels of nitrogen and phosphorus were found non-significant at 45 DAT and 75 DAT for plant spread.

The data in respect to cultivars at 105 DAT, the plant spread (36.79, 39.42 and 38.10 cm) respectively were found highest in cultivar (V₂) Arka Archana in first and second year as well as on pooled mean analysis as compared to plant spread (28.15, 30.55 and 29.35 cm) respectively obtained from cultivar (V₁) Arka Shashank.

The results of plant spread at 105 DAT showed significant differences between treatments at both the year as well as on pooled mean data with application of different levels of fertilizers. The plant spread (37.72, 39.20 and 38.46 cm) respectively was recorded maximum in treatment F₁₂ (N₁₈₀: P₁₄₀), however it was found statistically *at par* with treatments F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₄₀) and it was showed significant difference with rest of the other treatments. Whereas minimum plant spread (26.48, 28.77 and 27.69 cm) respectively were recorded under F₁ (N₁₂₀: P₁₀₀).

The interaction between different levels of nitrogen and phosphorus and cultivars at 105 days was found significant during second years as well as on pooled mean basis. The maximum plant spread (44.53 cm) was found in treatment combination (V₂F₁₂) which was found statistically *at par* with treatment combination (V₂F₉), (V₂F₁₀) and (V₂F₁₁) and it was showed significant impact with rest of the other treatment. The minimum plant spread (26.17 cm) was observed in (V₁F₁) under this investigation.

Variety Arka Archana having more plant spread than Arka Shashank. The difference in plant spread per plant is a varietal trait as it is governed by the genetical makeup of the plant. Similar variations in plant spread among varieties were also observed in China aster reported by Rao and Negi (1990) and Ravikumar (2002).

Increase in N uptake noticed with the application of higher levels of phosphorus that resulted in vigorous growth (Balyan and Singh, 1984). Beneficial effects of nitrogen and phosphorus on the growth were probably being the resultant of the increased synthesis of metabolites in the presence of directly applied phosphorus to these plants. Since phosphorus is found in nucleic acids and is involved through ATP in the activation of amino acids for the synthesis of proteins, thus importance of this element is well documented. These results obtained are in agreement with Monish *et al.* (2008) in China aster.

Table 4.4.2 : Effect Cultivars, Nitrogen and Phosphorus on Plant Spread

Treat.		Plant Spread(cm)								
		45 days			75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	20.43	20.32	20.38	23.76	25.32	24.54	28.15	30.55	29.35
V ₂	Arka Archana	25.12	25.58	25.35	31.89	33.34	32.61	36.79	39.42	38.10
SEm SEm±		0.48	0.45	0.33	0.52	0.75	0.46	0.75	0.64	0.49
CD at 5%		0.96	0.91	0.65	1.06	1.51	0.91	1.51	1.28	0.98
NITROGEN AND PHOSPHORUS										
F₁	N ₁₂₀ : P ₁₀₀	18.62	18.95	18.78	22.42	23.43	22.93	26.48	28.77	27.69
F₂	N ₁₂₀ : P ₁₂₀	19.50	20.22	19.86	23.70	24.03	23.87	26.62	29.38	27.93
F₃	N ₁₂₀ : P ₁₄₀	20.57	20.42	20.49	25.40	24.95	25.18	28.97	32.62	30.79
F₄	N ₁₄₀ : P ₁₀₀	21.33	21.20	20.77	25.73	26.62	26.18	30.77	33.98	32.38
F₅	N ₁₄₀ : P ₁₂₀	21.88	22.35	22.12	28.47	29.22	28.84	33.55	36.57	35.06
F₆	N ₁₄₀ : P ₁₄₀	22.83	22.93	22.88	27.68	29.57	28.63	31.92	35.75	33.83
F₇	N ₁₆₀ : P ₁₀₀	23.03	23.47	23.25	29.33	31.18	30.26	33.68	37.83	35.76
F₈	N ₁₆₀ : P ₁₂₀	23.73	24.22	24.13	28.42	30.33	29.38	33.85	36.08	34.97
F₉	N ₁₆₀ : P ₁₄₀	24.62	25.15	24.88	29.32	32.25	30.78	34.12	34.23	34.18
F₁₀	N ₁₈₀ : P ₁₀₀	25.10	24.87	24.98	30.07	32.45	31.26	35.15	36.98	36.09
F₁₁	N ₁₈₀ : P ₁₂₀	25.35	25.77	25.56	31.03	33.58	32.31	36.78	38.42	37.60
F₁₂	N ₁₈₀ : P ₁₄₀	26.77	26.60	26.68	32.35	34.32	33.33	37.72	39.20	38.46
SEm SEm±		1.16	1.10	0.80	1.28	1.84	1.12	1.84	1.56	1.21
CD at 5%		2.34	2.22	1.59	2.59	3.70	2.23	3.71	3.13	2.39

Table 4.4.2 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on plant Spread

Treat.	Plant Spread (cm)								
	45 Days			75 Days			105 Days		
	NP	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20
V ₁ F ₁	15.57	15.87	15.72	20.83	21.77	21.30	25.40	27.13	26.17
V ₁ F ₂	16.53	16.80	16.67	21.10	22.67	21.88	24.50	27.83	26.27
V ₁ F ₃	17.90	16.93	17.42	22.17	23.30	22.73	26.90	28.93	27.92
V ₁ F ₄	19.03	18.00	18.52	22.03	24.60	23.32	27.37	29.50	28.43
V ₁ F ₅	19.50	19.30	19.40	23.97	24.60	24.28	27.27	30.33	28.80
V ₁ F ₆	20.97	20.93	20.95	22.83	24.87	23.85	27.20	32.07	29.73
V ₁ F ₇	21.33	21.23	21.28	25.10	25.70	25.40	28.73	32.80	30.77
V ₁ F ₈	21.40	22.40	21.90	24.53	26.00	25.27	29.60	32.13	30.87
V ₁ F ₉	22.23	22.63	22.43	24.43	27.63	26.03	28.60	28.03	28.32
V ₁ F ₁₀	22.90	22.37	22.63	24.90	27.47	26.18	28.90	30.87	29.62
V ₁ F ₁₁	23.23	23.27	23.25	25.83	27.47	26.65	31.13	33.07	32.10
V ₁ F ₁₂	24.60	24.13	24.37	27.40	27.77	27.58	32.17	33.87	33.02
V ₂ F ₁	21.67	22.03	21.85	24.00	25.10	24.55	27.83	30.40	29.12
V ₂ F ₂	22.47	23.63	23.05	26.30	25.40	25.85	28.47	30.93	29.70
V ₂ F ₃	23.23	23.90	23.57	28.63	26.60	27.62	31.03	36.30	33.67
V ₂ F ₄	23.63	22.40	23.02	29.43	28.63	29.03	34.17	38.47	36.32
V ₂ F ₅	24.27	25.40	24.83	32.97	33.83	33.40	39.83	42.80	41.32
V ₂ F ₆	24.70	24.93	24.82	32.53	34.27	33.40	36.63	39.43	38.03
V ₂ F ₇	24.73	25.70	25.22	33.57	36.67	35.12	38.63	42.87	40.75
V ₂ F ₈	26.07	26.63	26.35	32.30	34.67	33.48	38.10	40.03	39.07
V ₂ F ₉	27.00	27.67	27.33	34.20	36.87	35.53	39.63	40.43	40.03
V ₂ F ₁₀	27.30	27.37	27.33	35.23	37.43	36.33	41.40	43.10	42.25
V ₂ F ₁₁	27.47	28.27	27.87	36.23	39.70	37.97	42.43	43.77	43.10
V ₂ F ₁₂	28.93	29.07	29.00	37.30	40.87	39.08	43.27	44.53	43.90
SEm	1.65	1.56	1.13	1.82	2.60	1.59	2.60	2.20	1.70
CD at 5%	NS	NS	NS	NS	NS	NS	NS	4.43	3.39

Fig. 4.4.2 a: Effect of Cultivars, Nitrogen and phosphorus on Plant Spread at 45 Days

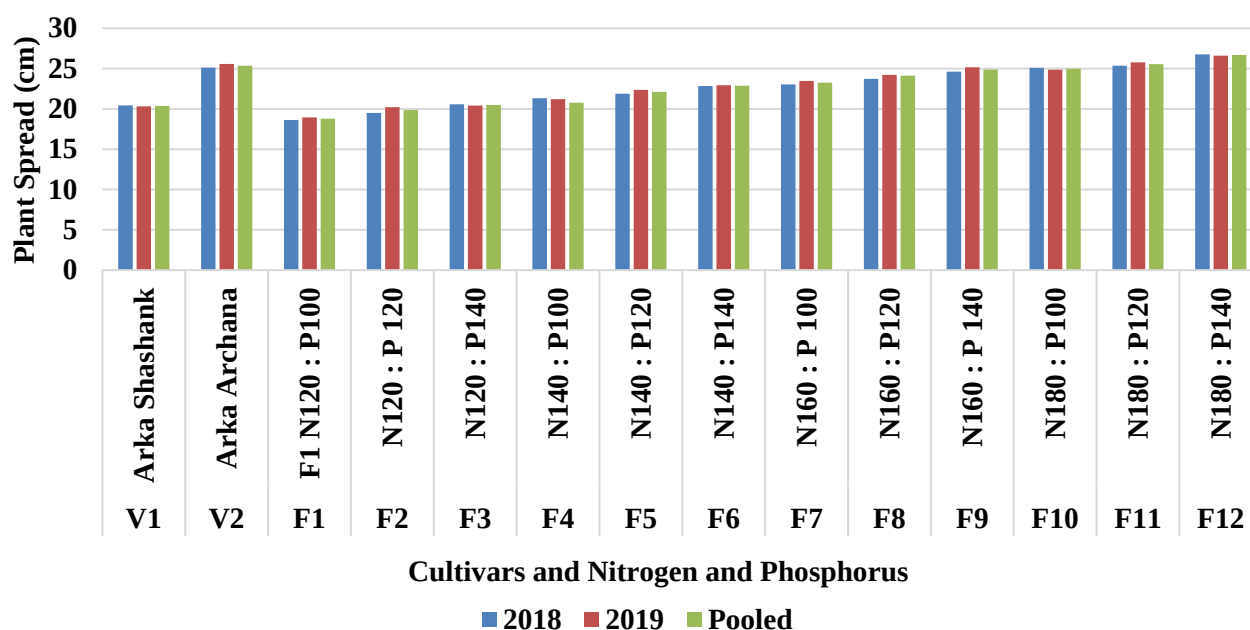
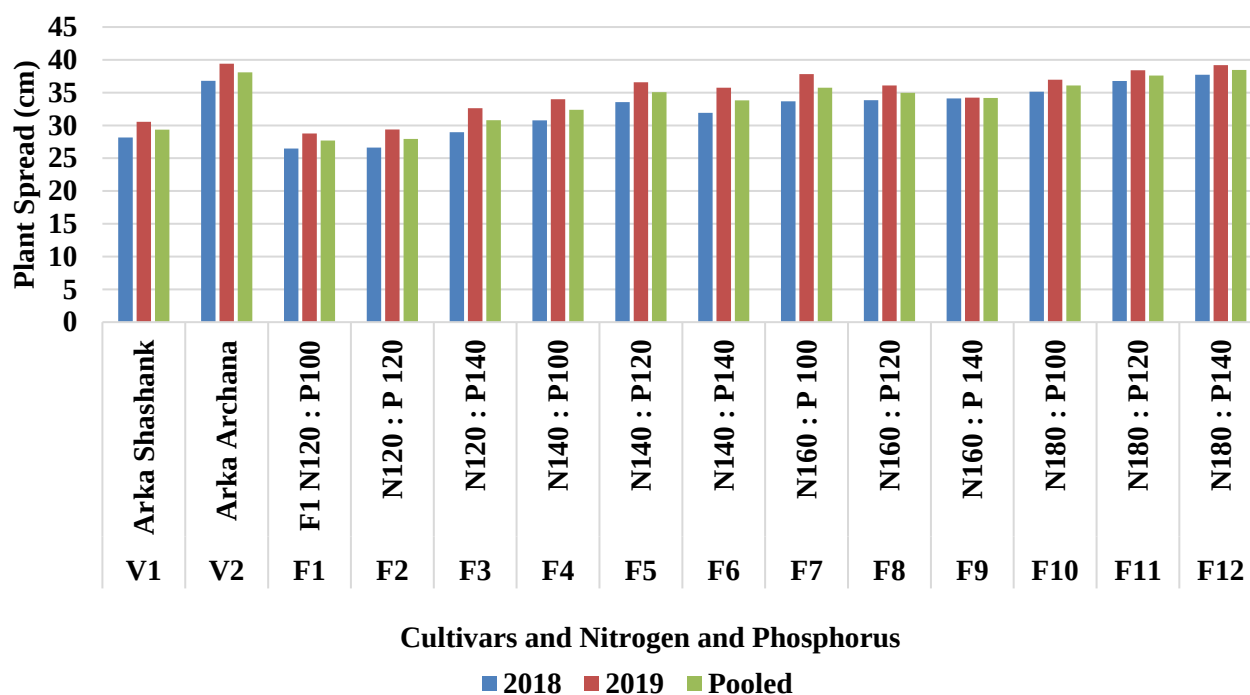


Fig. 4.4.2 b: Effect of Cultivars, Nitrogen and Phosphorus on Plant Spread at 105 Days



4.4.3. Number of primary branches per plant

The results on number of primary branches per plant were significantly influenced by Cultivar and application of different levels of nitrogen and phosphorus are presented in Table 4.4.3, 4.4.3 a and Fig 4.4.3 a and 4.4.3 b

The perusal of data on the influence of Cultivar on number of primary branches plant per plant revealed that at 75 DAT, during both the year as well as pooled mean basis of investigation showed significant effect. The maximum number of primary branches per plant were recorded under cultivar (V₂) Arka Archana (18.94, 19.94 and 19.44) respectively as compared to cultivar (V₁) Arka Shashank (14.54, 15.18 and 14.86) respectively.

In respect to application of different levels of nitrogen and phosphorus showed significant impact on number of primary branches per plant at 75 DAT. The highest number of primary branches per plant (21.77, 21.90 and 21.84) respectively was observed in treatment F₁₂ (N₁₈₀: P₁₄₀), which was showed statistically similar with treatments F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀), during both the tested year as well as on pooled mean basis. However, it was showed significant difference during rest of the other treatments. The lowest number of primary branches per plant (12.18, 12.20 and 12.90) respectively was recorded under treatment F₁ (N₁₂₀: P₁₀₀).

The interaction between the Cultivar and different levels of nitrogen and phosphorus shows significant impact on number of primary branches per plant at 75 DAT during second year as well as on pooled mean analysis. The maximum number of primary branches per plant (24.90 and 24.21) respectively were obtained from treatment combination (V₁F₁₂) which was found significantly *at par* with treatment combinations (V₂F₉), (V₂F₁₀) and (V₂F₁₁) and it showed significant difference with rest of the other treatment combinations. However, interaction effect was found non-significant during first year.

At 105 DAT, the number of primary branches per plant indicated significant impact, highest number of primary branches per plant (23.52, 25.44 and 24.48) were observed in cultivar (V₂) Arka Archana and the minimum number of primary branches per plant (20.00, 21.03 and 20.52) respectively was recorded in cultivar (V₁) Arka Shashank during both the tested years and on pooled mean data respectively.

In case of application of different levels of nitrogen and phosphorus showed significant response on number of primary branches per plant at 105 DAT. The highest number of primary branches per plant (27.17, 27.97 and 27.57) respectively was observed in treatment F₁₂ (N₁₈₀: P₁₄₀), which was showed statistically similar with treatments F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀), during first year as well as on pooled mean basis whereas, it was found statistically *at par* with F₈ (N₁₆₀: P₁₂₀), F₉ (N₁₆₀: P₁₄₀), F₁₀ (N₁₈₀: P₁₀₀), and F₁₁ (N₁₈₀: P₁₂₀) during second year. However it was showed significant difference during rest of the other treatments during both the year and pooled mean basis. The lowest number of primary branches per plant (16.42, 17.78 and 17.10) respectively was recorded under treatment F₁ (N₁₂₀: P₁₀₀) during the investigation.

Table 4.4.3 : Effect of Cultivars, Nitrogen and Phosphorus on Number. of Primary Branches

Treat.		Number of Primary Branches					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	14.54	15.18	14.86	20.00	21.03	20.52
V ₂	Arka Archana	18.94	19.94	19.44	23.52	25.44	24.48
SEm SEm±		0.34	0.30	0.23	0.58	0.66	0.44
CD at 5%		0.68	0.61	0.45	1.17	1.33	0.87
NITROGEN AND PHOSPHORUS							
F₁	N ₁₂₀ : P ₁₀₀	12.18	12.20	12.90	16.42	17.78	17.10
F₂	N ₁₂₀ : P ₁₂₀	13.03	12.93	12.98	17.10	19.20	18.15
F₃	N ₁₂₀ : P ₁₄₀	13.60	13.62	13.00	17.73	19.02	18.38
F₄	N ₁₄₀ : P ₁₀₀	13.93	15.47	14.40	19.00	20.77	19.88
F₅	N ₁₄₀ : P ₁₂₀	16.35	17.42	16.88	20.52	22.32	21.42
F₆	N ₁₄₀ : P ₁₄₀	16.67	18.27	17.47	21.37	22.43	21.90
F₇	N ₁₆₀ : P ₁₀₀	17.50	18.50	18.00	22.35	24.48	23.42
F₈	N ₁₆₀ : P ₁₂₀	17.53	18.07	17.80	23.65	25.28	24.47
F₉	N ₁₆₀ : P ₁₄₀	19.38	21.12	20.25	24.30	26.35	25.36
F₁₀	N ₁₈₀ : P ₁₀₀	18.47	20.02	19.24	25.40	26.28	25.84
F₁₁	N ₁₈₀ : P ₁₂₀	21.03	21.02	21.03	26.05	26.95	26.50
F₁₂	N ₁₈₀ : P ₁₄₀	21.77	21.90	21.84	27.17	27.97	27.57
SEm SEm±		0.82	0.74	0.55	1.42	1.61	1.08
CD at 5%		1.66	1.49	1.10	2.87	3.25	2.14

Table 4.4.3 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Number of Primary Branches

Treat.	Number of Primary Branches						
	75 Days			105 Days			
	NP	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V₁F₁		8.80	10.03	9.42	10.03	15.00	14.42
V₁F₂		9.50	11.10	10.30	11.10	16.63	15.83
V₁F₃		11.27	12.63	11.95	12.63	17.07	16.57
V₁F₄		12.30	13.40	12.85	13.40	19.27	18.23
V₁F₅		14.03	15.00	14.52	15.00	20.97	20.20
V₁F₆		15.23	16.33	15.78	16.33	20.33	20.37
V₁F₇		15.90	17.00	16.45	17.00	21.77	21.25
V₁F₈		15.03	15.00	15.02	15.00	22.63	22.17
V₁F₉		17.60	18.63	18.12	18.63	24.37	23.55
V₁F₁₀		15.20	16.27	15.73	16.27	24.10	23.85
V₁F₁₁		19.57	17.80	18.68	17.80	24.53	24.27
V₁F₁₂		20.03	18.90	19.47	18.90	25.73	25.48
V₂F₁		18.40	14.37	16.38	14.37	20.57	19.78
V₂F₂		16.57	14.77	15.67	14.77	21.77	20.47
V₂F₃		13.10	15.00	14.05	15.00	20.97	20.18
V₂F₄		14.37	17.53	15.95	17.53	22.27	21.53
V₂F₅		18.67	19.83	19.25	19.83	23.67	22.63
V₂F₆		18.10	20.20	19.15	20.20	24.53	23.43
V₂F₇		19.10	20.00	19.55	20.00	27.20	25.58
V₂F₈		20.03	21.13	20.58	21.13	27.93	26.77
V₂F₉		21.17	23.60	22.38	23.60	28.33	27.17
V₂F₁₀		21.73	23.77	22.75	23.77	28.47	27.83
V₂F₁₁		22.50	24.23	23.37	24.23	29.37	28.73
V₂F₁₂		23.51	24.90	24.21	24.90	30.20	29.65
SEm		1.17	1.04	0.78	1.04	2.28	1.52
CD at 5%		NS	2.10	1.55	NS	NS	NS

Fig. 4.4.3 a: Effect of Cultivars , Nitrogen and Phosphorus on Number of Primary Branches at 75 days

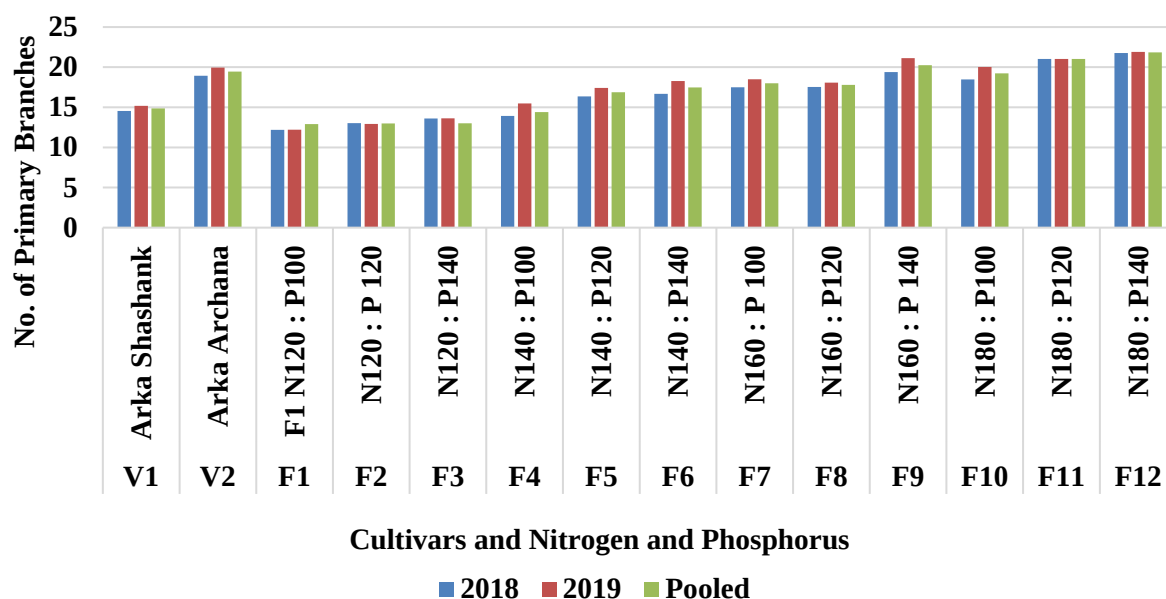
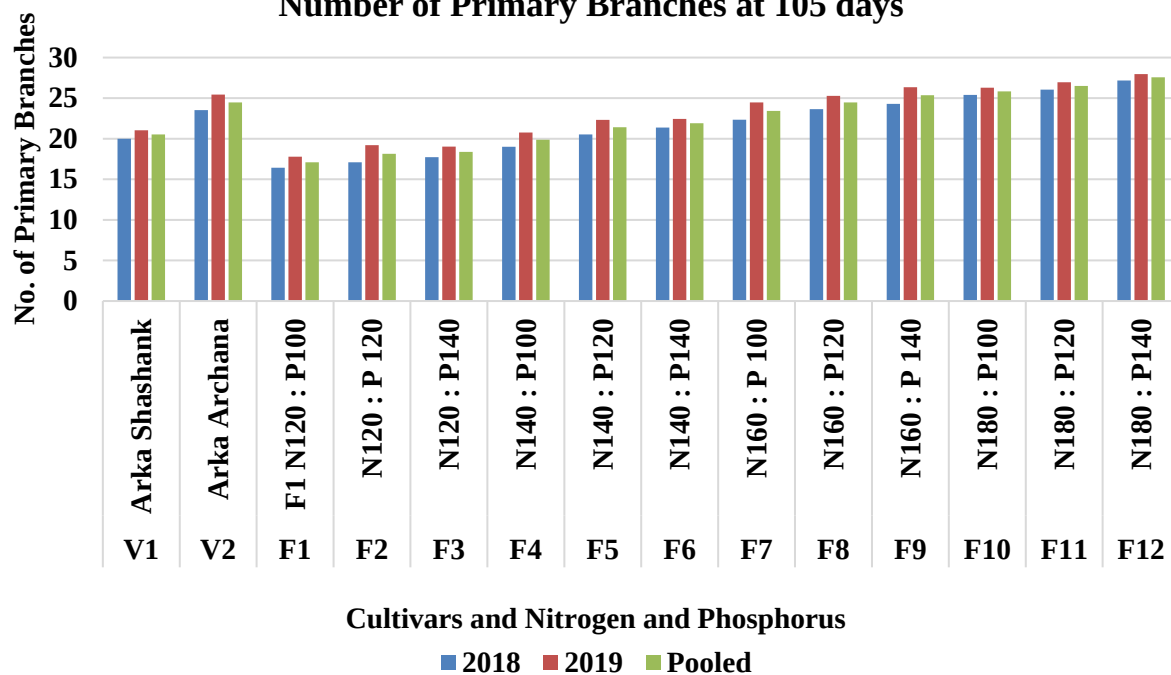


Fig. 4.4.3 b: Effect of Cultivars , Nitrogen and Phosphorus on Number of Primary Branches at 105 days



The interaction between cultivars and different levels of nitrogen and phosphorus at 105 DAT was found non-significant during both the tested year as well as on pooled mean analysis.

From the above findings, significantly maximum number of primary branches was observed in Arka Archana at all the growth stages, as well as on pooled mean data and the increasing in primary branches might be due to the pleasant environment to express the dominant genes in the genotypes and different genetic makeup of the variety. The present research work confirms with the findings of Bhanu Pratap *et al.* (1999), Nand- Kishore and Mohanti (2002), Sreekala *et al.* (2002), Rao *et al.* (2005) and Nursude *et al.* (2010) in African marigold.

Highest number of primary branches per plant was observed in treatment F₁₂ (N₁₈₀: P₁₄₀). The increase in levels of applications of N and P were found to affect the number of primary branches significantly. A balanced supply of nutrients promotes the translocation of plant growth hormones to shoot and increased the metabolite transport for growth which may lead to significant increase in number of branches. Similarly Monish *et al.* (2008) stated that application of different levels of nitrogen and phosphorus at their higher levels resulted in the maximum number of primary branches. The results are in line with those reported by Marshner (1983).

4.4.4. Number of secondary branches per plant

The data pertaining to the number of secondary branches per plant were significantly influenced by Cultivars and application of different levels of nitrogen and phosphorus are presented in Table 4.4.4, 4.4.4 a and Fig 4.4.4a and 4.4.4 b

It is evident from the data that the influence of Cultivars on number of secondary branches at 75 DAT, during both the year as well as pooled mean basis of investigation showed significant effect. The maximum number of secondary branches per plant were recorded under cultivar (V₂) Arka Archana (27.22, 27.60

and 27.41) respectively as compared to cultivar (V₁) Arka Shashank (19.54, 20.49 and 20.02) respectively under this investigation.

The number of secondary branches per plant at 75 DAT varied significantly due to different nitrogen and phosphorus levels. The highest number of secondary branches per plant (28.88, 28.70 and 28.79) respectively was observed in treatment F₁₂ (N₁₈₀: P₁₄₀), which was showed statistically similar with treatments F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀), and it was observed significant difference with rest of the other treatments. The lowest number of secondary branches per plant (19.92, 20.02 and 19.97) respectively was recorded in treatment F₁ (N₁₂₀: P₁₀₀) in both the years and on pooled mean basis.

Among the cultivars at 105 DAT showed significant response. The highest number of secondary branches per plant (33.94, 36.34 and 35.14) respectively was observed in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank (25.31, 27.35 and 26.33) during both the tested years and on pooled mean data respectively.

As far as, the different levels of nitrogen and phosphorus exhibited significantly influence on number of secondary branches per plant. The maximum number of secondary branches per plant (33.58, 36.87 and 35.23) respectively was observed under treatment F₁₂ (N₁₈₀: P₁₄₀) which was found statistically at par with treatment F₉ (N₁₆₀: P₁₄₀), F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) during both the year as well as on pooled mean analysis and it was found significant differ with rest of the other treatments during both the year as well as on pooled mean analysis, whereas minimum number of secondary branches per plant (26.17, 27.03 and 26.60) respectively was found under treatment F₁ (N₁₂₀: P₁₀₀) during this investigation.

Table 4.4.4: Effect of Cultivars, Nitrogen and Phosphorus on Number of Secondary Branches

Treat.		Number of Secondary Branches					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	19.54	20.49	20.02	25.31	27.35	26.33
V ₂	Arka Archana	27.22	27.60	27.41	33.94	36.34	35.14
SEm SEm±		0.59	0.46	0.37	0.67	0.55	0.43
CD at 5%		1.18	0.92	0.74	1.34	1.10	0.86
NITROGEN AND PHOSPHORUS							
F₁	N ₁₂₀ : P ₁₀₀	19.92	20.02	19.97	26.17	27.03	26.60
F₂	N ₁₂₀ : P ₁₂₀	20.20	19.85	20.03	26.32	28.38	27.35
F₃	N ₁₂₀ : P ₁₄₀	21.40	20.90	21.15	27.52	29.30	28.41
F₄	N ₁₄₀ : P ₁₀₀	21.65	22.02	21.83	27.88	29.55	28.72
F₅	N ₁₄₀ : P ₁₂₀	22.85	22.82	22.78	27.35	30.47	28.91
F₆	N ₁₄₀ : P ₁₄₀	22.88	23.90	23.09	28.12	31.80	29.96
F₇	N ₁₆₀ : P ₁₀₀	22.93	24.65	23.49	30.10	33.98	32.04
F₈	N ₁₆₀ : P ₁₂₀	23.43	24.72	24.08	30.12	33.33	32.43
F₉	N ₁₆₀ : P ₁₄₀	23.72	25.98	24.85	32.07	34.38	33.23
F₁₀	N ₁₈₀ : P ₁₀₀	26.58	27.83	27.21	32.03	33.72	32.88
F₁₁	N ₁₈₀ : P ₁₂₀	27.38	27.15	27.27	32.85	33.32	33.88
F₁₂	N ₁₈₀ : P ₁₄₀	28.88	28.70	28.79	33.58	36.87	35.23
SEm SEm±		1.43	1.12	0.91	1.63	1.34	1.06
CD at 5%		2.89	2.26	1.81	3.29	2.70	2.10

The interaction between the Cultivars with different levels of nitrogen and phosphorus shows non-significant effect on number of secondary branches per plant at 75 and 105 DAT in both the tested year as well as on pooled mean basis.

Arka Archana recorded maximum secondary branches as compared to Arka Shashank. The difference in branches among the Cultivars could be due to the influence of genetical framework of the Cultivars. Similar variations for number of branches were also observed in china aster (Rao and Negi, 1990 and Ravikumar, 2002) and in chrysanthemum (Chezhian *et al.*, 1985a and Kanamadi and Patil, 1993).

The numbers of secondary branches per plant were increased with the increase in dose of fertilizer levels at all the growth stages in both the years of experimentation. The F₁₂ (N₁₈₀: P₁₄₀) produced significantly higher number of branches. The higher primary branches at higher doses might be due to higher supplementation of nutrition to the plants and faster multiplication and vigorous growth at higher doses of fertilizers. The similar results were obtained by Rajanna, (2001) in China aster.

Table 4.4.4 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Number of Secondary Branches

Treat.	Number of Secondary Branches					
	75 Days			105 Days		
	NP	2018-19	2019-20	Pooled	2018-19	2019-20
V ₁ F ₁	14.93	15.70	15.32	20.03	22.00	21.02
V ₁ F ₂	15.20	16.63	15.92	22.07	23.30	22.68
V ₁ F ₃	16.40	16.97	16.68	23.03	24.10	23.57
V ₁ F ₄	17.27	18.40	17.83	23.63	25.73	24.68
V ₁ F ₅	18.03	19.77	18.90	23.90	26.10	25.00
V ₁ F ₆	19.37	20.77	20.07	25.57	28.37	26.97
V ₁ F ₇	20.17	21.47	20.82	26.20	30.30	28.25
V ₁ F ₈	21.50	21.33	21.42	26.57	28.00	27.28
V ₁ F ₉	21.33	22.77	22.05	27.73	29.73	28.73
V ₁ F ₁₀	22.13	23.80	22.97	27.77	29.03	28.40
V ₁ F ₁₁	23.23	23.23	23.23	28.07	29.90	28.98
V ₁ F ₁₂	24.90	25.07	24.98	29.10	31.67	30.38
V ₂ F ₁	24.90	24.33	24.62	32.30	32.07	32.18
V ₂ F ₂	25.20	23.07	24.13	30.57	33.47	32.02
V ₂ F ₃	26.40	24.83	25.62	32.00	34.50	33.25
V ₂ F ₄	26.03	25.63	25.83	32.13	33.37	32.75
V ₂ F ₅	27.47	25.87	26.67	30.80	34.83	32.82
V ₂ F ₆	25.20	27.03	26.12	30.67	35.23	32.95
V ₂ F ₇	24.50	27.83	26.17	34.00	37.67	35.83
V ₂ F ₈	25.37	28.10	26.73	36.47	38.67	37.57
V ₂ F ₉	26.10	29.20	27.65	36.40	39.03	37.72
V ₂ F ₁₀	31.03	31.87	31.45	36.30	38.40	37.35
V ₂ F ₁₁	31.53	31.07	31.30	37.63	36.73	37.18
V ₂ F ₁₂	32.87	32.33	32.60	38.07	42.07	40.07
SEm	2.03	1.59	1.29	2.31	1.89	1.49
CD at 5%	NS	NS	NS	NS	NS	NS

Fig4.4.4 a. : Effect of Cultivars, Nitrogen and Phosphorus on Number of Secondary Branches at 75 Days

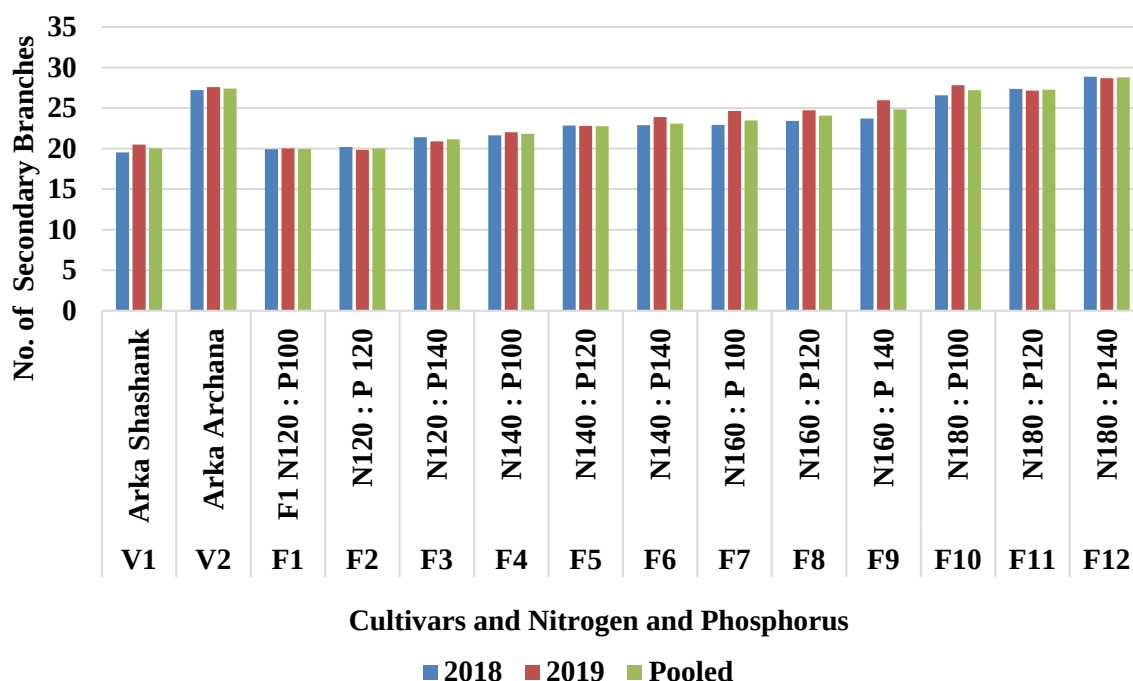
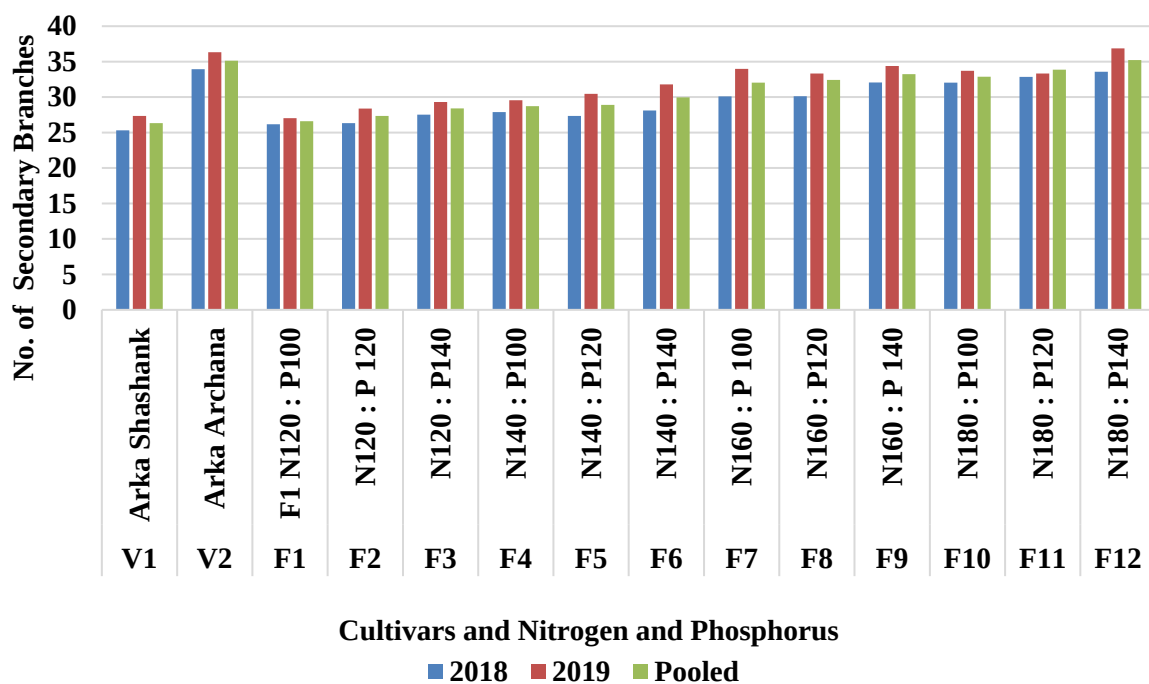


Fig4.4.4 b. : Effect of Cultivars, Nitrogen and Phosphorus on Number. of Secondary Branches at 105 Days



4.4.5 Number of leaves per plant

The data on number of leaves per plant at different growth stages are presented in Table in 4.4.5, 4.4.5 a and Fig 4.4.5 a and 4.4.5 b

The perusal of the data revealed that at 45 DAT there was significant difference in number of leaves due to cultivars during both the years and on pooled mean basis. The maximum number of leaves was observed in cultivar (V₂) Arka Archana (23.15, 22.87 and 23.01) respectively as compared to cultivar (V₁) Arka Shashank (18.80, 19.23 and 19.01) respectively during this investigation.

At 45 DAT there was significant variation in number of leaves per plant due to different levels of nitrogen and phosphorus application. The maximum number of leaves per plant (24.68, 24.80, 24.74) respectively was recorded in treatment F₁₂ (N₁₈₀: P₁₄₀) which was found statistically *at par* with treatment F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) during both the year, however it was found similar trend with F₁₁ (N₁₈₀: P₁₂₀) only during pooled mean basis. Whereas, it was found significant difference with rest of the treatments during both the tested year as well as pooled mean basis. The minimum number of leaves (18.32, 18.25 and 18.28) was found under treatment F₁ (N₁₂₀:P₁₀₀).

At 75 DAT cultivars exhibited significant differences on number of leaves per plant during both the years as well as on pooled mean analysis. The highest number of leaves per plant (99.13, 99.66 and 99.40) respectively was noticed in cultivar (V₂) Arka Archana which was superior over as compared to cultivar (V₁) Arka Shashank (71.93, 69.97 and 70.95) respectively.

The data on number of leaves per plant at 75 DAT showed significant difference with application of different levels of nitrogen and phosphorus during both the year and on pooled mean basis. It clearly showed that the maximum number of leaves per plant (102.63, 98.48 and 100.56) respectively was recorded under the treatment

F₁₂ (N₁₈₀: P₁₄₀) which was found statistically *at par* with treatment F₁₁ (N₁₈₀: P₁₂₀) during first year and on pooled mean basis. Further, it was found statistically similar with treatment F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) in second year and it was observed significant difference with rest of the treatments. While, minimum number of leaves per plant (68.30, 69.65, and 68.98) respectively was noticed under treatment F₁ (N₁₂₀:P₁₀₀) during this investigation.

The number of leaves per plant at 105 DAT exerts significant impact for cultivars. The maximum number of leaves (234.47, 240.91 and 237.69) was observed in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank (172.29, 172.04 and 172.16) during both the tested years and on pooled mean data respectively.

The data pertaining on number of leaves at 105 DAT revealed that there was significant impact on number of leaves due to different levels of nitrogen and phosphorus. The highest number of leaves per plant (238.57, 242.47 and 240.52) respectively was observed under treatment F₁₂ (N₁₈₀: P₁₄₀) which was found statistically similar with treatment F₁₁ (N₁₈₀: P₁₂₀) and it was found significant difference with rest of the other treatments. Further, minimum number of leaves per plant (175.70, 175.65 and 175.68) respectively was recorded under treatment F₁ (N₁₂₀:P₁₀₀) during both the year and on pooled mean basis of investigation respectively.

The interaction between cultivars and different levels of nitrogen and phosphorus at 45, 75 and 105 DAT were found non-significant during both the years as well as on pooled mean basis.

Table 4.4.5: Effect of Cultivars, Nitrogen and Phosphorus on No. of Leaves per plant

Treat.		No. of Leaves per plant								
		45 days			75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	18.80	19.23	19.01	71.93	69.97	70.95	172.29	172.04	172.16
V ₂	Arka Archana	23.15	22.87	23.01	99.13	99.66	99.40	234.47	240.91	237.69
SEm SEm±		0.47	0.59	0.38	1.23	1.42	0.94	3.17	2.52	2.03
CD at 5%		0.94	1.19	0.75	2.48	2.87	1.87	6.38	5.08	4.03
NITROGEN AND PHOSPHORUS										
F₁	N ₁₂₀ : P ₁₀₀	18.32	18.25	18.28	68.30	69.65	68.98	175.70	175.65	175.68
F₂	N ₁₂₀ : P ₁₂₀	18.90	19.38	19.14	69.83	72.20	71.02	179.38	179.67	179.53
F₃	N ₁₂₀ : P ₁₄₀	19.43	20.45	19.94	75.47	78.48	76.98	184.90	186.00	185.45
F₄	N ₁₄₀ : P ₁₀₀	20.30	21.37	20.83	77.02	79.40	78.21	191.47	191.47	190.47
F₅	N ₁₄₀ : P ₁₂₀	20.00	19.50	19.75	81.25	79.28	80.27	192.72	196.85	194.78
F₆	N ₁₄₀ : P ₁₄₀	20.62	20.10	20.36	84.70	83.47	84.08	199.08	205.43	202.26
F₇	N ₁₆₀ : P ₁₀₀	20.12	20.83	20.48	87.07	88.02	87.54	209.63	214.73	212.18
F₈	N ₁₆₀ : P ₁₂₀	21.48	21.15	21.32	90.50	89.57	90.03	214.13	220.75	217.44
F₉	N ₁₆₀ : P ₁₄₀	21.77	21.62	21.69	94.07	90.47	92.27	207.60	209.25	208.43
F₁₀	N ₁₈₀ : P ₁₀₀	22.60	21.52	22.06	96.42	92.70	94.56	214.15	222.15	218.15
F₁₁	N ₁₈₀ : P ₁₂₀	23.45	23.63	23.54	99.10	96.05	97.58	235.22	233.25	234.23
F₁₂	N ₁₈₀ : P ₁₄₀	24.68	24.80	24.74	102.63	98.48	100.56	238.57	242.47	240.52
SEm SEm±		1.14	1.45	0.92	3.02	3.49	2.31	7.77	6.18	2.31
CD at 5%		2.30	2.91	1.83	6.08	7.02	4.58	15.64	12.45	9.86

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Fig. 4.4.5 a: Effect of Cultivars , Nitrogen and Phosphorus and No. of Leaves per plant at 45 Days

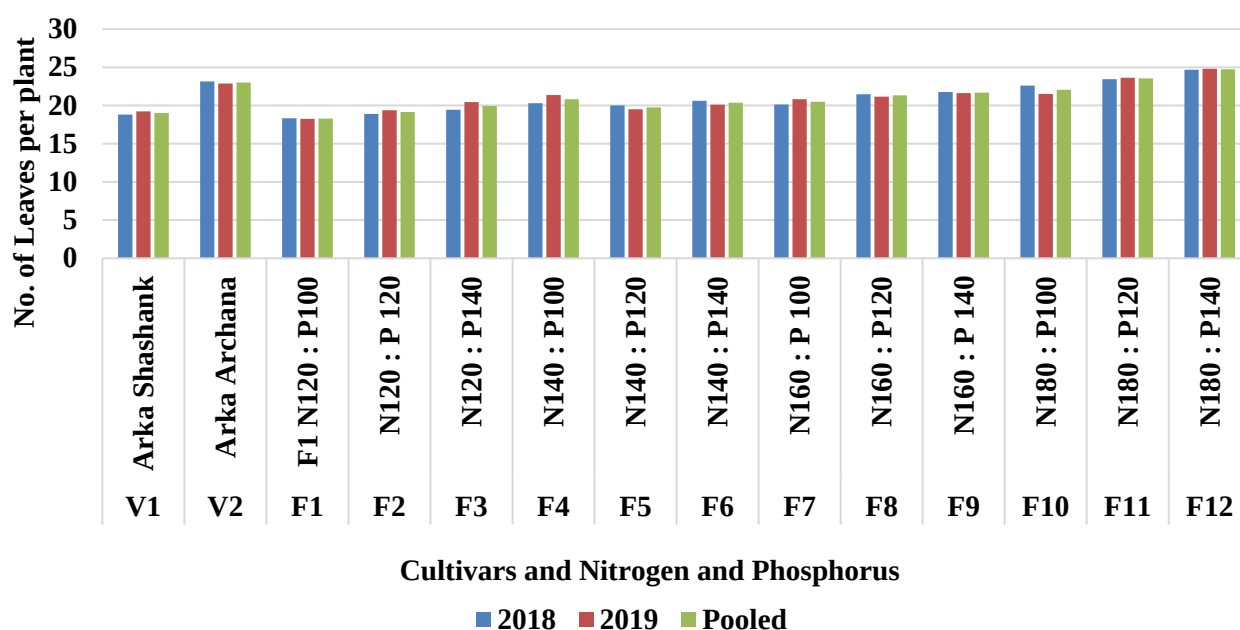
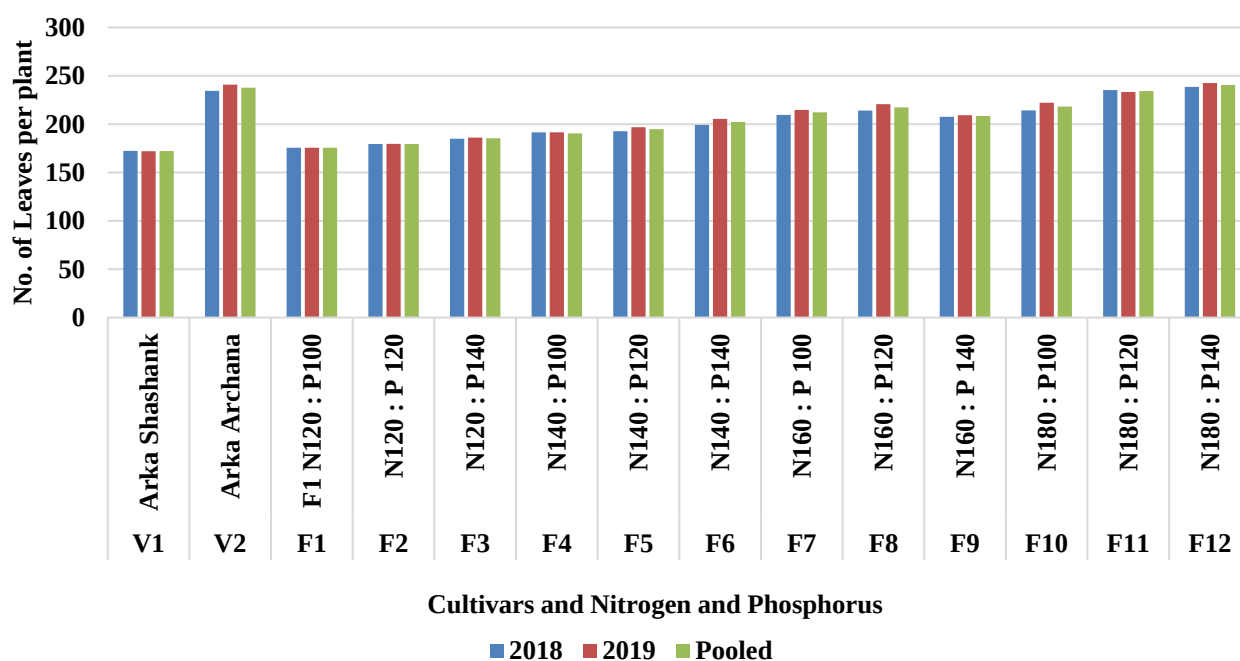


Fig4.4.5 b: Effect of Cultivars , Nitrogen and Phosphorus and No. of Leaves at 105 Days



4.4.6 Leaf area per plant (cm²)

It is clear from the data presented in Table 4.4.6, 4.4.6 a and graphically presented in Fig 4.4.6 a and 4.4.6 b that the leaf area per plant was significantly influenced by cultivars and different levels of nitrogen and phosphorus

The perusal of the data revealed that at 75 DAT there was significant difference in leaf area per plant due to cultivars during both the year and on pooled mean basis. The maximum leaf area per plant (15.21, 14.27 and 14.74 cm²) respectively was observed in cultivar (V₂) Arka Archana and the minimum leaf area (13.40, 13.87 and 13.64 cm²) respectively was noticed in cultivar (V₁) Arka Shashank (13.40, 13.87 and 13.64 cm²) respectively during this investigation.

At 75 DAT there was significant difference in leaf area per plant due to application of different levels of nitrogen and phosphorus. The maximum leaf area per plant (16.78, 14.66, 15.72 cm²) was recorded in treatment F₁₂ (N₁₈₀: P₁₄₀) which was found statistically *at par* with treatment F₇ (N₁₆₀: P₁₀₀), F₈ (N₁₆₀: P₁₂₀), F₉ (N₁₆₀: P₁₄₀), F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) during first year as well as on pooled mean analysis, whereas, in second year it was showed similarity with treatment F₄ (N₁₄₀: P₁₀₀) and F₅ (N₁₄₀: P₁₂₀) and it was noticed significant difference with rest of the other during first year as well as on pooled mean basis. The minimum leaf area per plant (11.11, 13.37 and 12.24 cm²) respectively was found under treatment F₁ (N₁₂₀: P₁₀₀)

The data pertaining on cultivars exhibited significant differences on leaf area per plant at 105 DAT. The highest leaf area per plant (19.97, 20.77 and 20.37 cm²) respectively during this investigation was observed in cultivar (V₂) Arka Archana which was superior over as compared to cultivar (V₁) Arka Shashank (19.14, 19.47 and 19.30 cm²) respectively.

In case of application of various doses of nitrogen and phosphorus on leaf area per plant at 105 DAT showed significant difference. It clearly showed that the maximum leaf area per plant (22.52, 22.87 and 22.69 cm²) respectively was recorded under the treatment F₁₂ (N₁₈₀: P₁₄₀), which was found statistically *at par* with treatment F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) during first year and second year. However, it was found statistically similar with the treatment F₁₁ (N₁₈₀: P₁₂₀) during on pooled mean data only. Whereas, it was observed significant difference with rest of the other treatments during both the year and on pooled mean basis. While, minimum Leaf area per plant (16.57, 17.52, and 17.04 cm²) respectively was noticed in F₁ (N₁₂₀: P₁₀₀) during this investigation.

Table 4.4.6: Effect of Cultivars, Nitrogen and Phosphorus on Leaf Area per plant

Treat.		Leaf Area per plant (cm ²)					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	13.40	13.87	13.64	19.14	19.47	19.3
V ₂	Arka Archana	15.21	14.27	14.74	19.97	20.77	20.37
SEm SEm±		0.44	0.19	0.24	0.39	0.40	0.28
CD at 5%		0.88	0.38	0.47	0.79	0.80	0.55
NITROGEN AND PHOSPHORUS							
F ₁	N ₁₂₀ : P ₁₀₀	11.11	13.37	12.24	16.57	17.52	17.04
F ₂	N ₁₂₀ : P ₁₂₀	12.05	14.29	13.17	17.27	18.33	17.80
F ₃	N ₁₂₀ : P ₁₄₀	12.70	13.39	13.04	18.02	19.00	18.51
F ₄	N ₁₄₀ : P ₁₀₀	13.97	13.81	13.89	19.07	19.92	19.49
F ₅	N ₁₄₀ : P ₁₂₀	13.35	14.17	13.76	19.20	19.90	19.55
F ₆	N ₁₄₀ : P ₁₄₀	14.03	12.92	13.47	19.02	19.85	19.43
F ₇	N ₁₆₀ : P ₁₀₀	14.67	14.05	14.71	20.08	20.42	20.25
F ₈	N ₁₆₀ : P ₁₂₀	15.31	14.39	14.85	19.97	19.78	19.88
F ₉	N ₁₆₀ : P ₁₄₀	15.30	13.81	14.65	20.32	20.68	20.50
F ₁₀	N ₁₈₀ : P ₁₀₀	15.68	14.73	15.20	20.82	21.08	20.95
F ₁₁	N ₁₈₀ : P ₁₂₀	16.75	14.81	15.78	21.82	22.10	21.96
F ₁₂	N ₁₈₀ : P ₁₄₀	16.78	14.66	15.72	22.52	22.87	22.69
SEm SEm±		1.07	0.47	0.58	0.96	0.97	0.68
CD at 5%		2.15	0.94	1.16	1.93	1.96	1.36

The interaction between cultivars and application of different levels of nitrogen and phosphorus at 75 and 105 DAT was found non-significant during both the year and on pooled mean basis.

Table 4.4.6 a: Interaction effect of Cultivars, Nitrogen and Phosphorus and on Leaf Area per plant

Treat.	Leaf Area per plant (cm ²)					
	75 Days			105 Days		
	NP	2018-19	2019-20	Pooled	2018-19	2019-20
V ₁ F ₁	10.10	11.51	10.81	16.03	16.87	16.45
V ₁ F ₂	10.73	11.53	11.13	16.30	17.33	16.82
V ₁ F ₃	11.06	13.38	12.22	17.73	18.17	17.95
V ₁ F ₄	13.28	13.78	13.53	18.47	19.83	19.15
V ₁ F ₅	12.50	13.93	13.21	18.63	18.87	18.75
V ₁ F ₆	13.11	14.39	13.75	19.00	19.57	19.28
V ₁ F ₇	14.22	14.80	14.51	19.40	20.20	19.80
V ₁ F ₈	14.97	14.69	14.83	19.97	19.37	19.67
V ₁ F ₉	14.62	14.60	14.61	20.40	20.07	20.23
V ₁ F ₁₀	14.87	15.14	15.00	20.53	20.57	20.55
V ₁ F ₁₁	15.83	15.12	15.48	21.40	21.10	21.25
V ₁ F ₁₂	15.55	13.62	14.58	21.77	21.73	21.75
V ₂ F ₁	12.12	15.22	13.67	17.1	18.17	17.63
V ₂ F ₂	13.37	17.05	15.21	18.23	19.33	18.78
V ₂ F ₃	14.34	13.37	13.85	18.3	19.83	19.07
V ₂ F ₄	14.67	13.83	14.25	19.67	20	19.83
V ₂ F ₅	14.21	14.41	14.31	19.77	20.93	20.35
V ₂ F ₆	14.94	11.45	13.2	19.03	20.13	19.58
V ₂ F ₇	15.12	14.69	14.91	20.77	20.63	20.7
V ₂ F ₈	15.65	14.1	14.88	19.97	20.2	20.08
V ₂ F ₉	15.97	12.62	14.3	20.23	21.3	20.77
V ₂ F ₁₀	16.49	14.31	15.4	21.1	21.6	21.35
V ₂ F ₁₁	17.67	14.5	16.09	22.23	23.1	22.67
V ₂ F ₁₂	18	15.71	16.86	23.27	24	23.63
SEm	1.51	0.66	0.82	1.36	1.38	0.97
CD at 5%	NS	NS	NS	NS	NS	NS

Fig. 4.4.6 a: Effect of Cultivars , Nitrogen and Phosphorus on Leaf Area per plant at 75 days

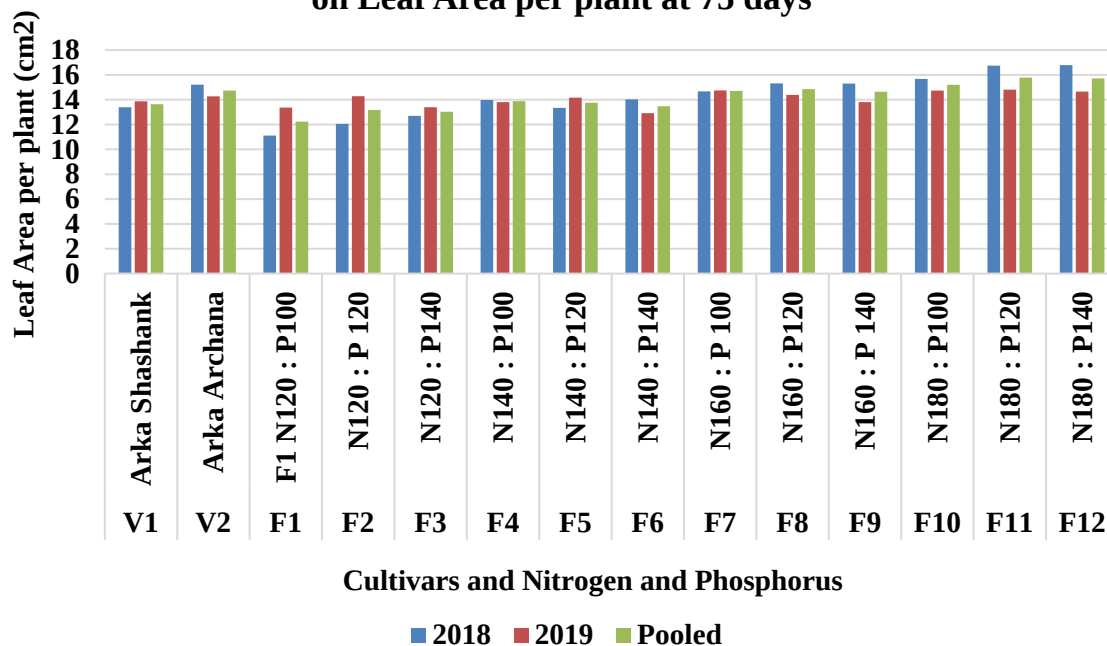
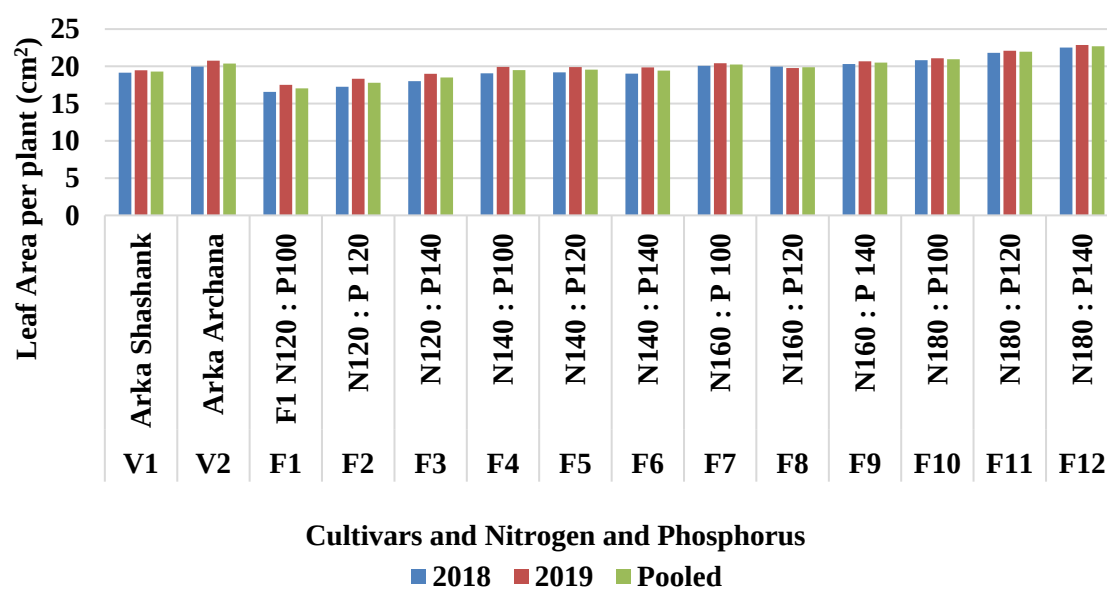


Fig. 4.4.6 b: Effect of Cultivars, Nitrogen and Phosphorus on Leaf Area per plant at 105 days



4.4.7 Leaf area index

It is clear from the data presented in Table 4.4.7, 4.4.7 a and graphically presented in Fig 4.4.7a and 4.4.7 b that the leaf area index was significantly influenced by cultivars and different levels of nitrogen and phosphorus

The perusal of the data revealed that at 75 DAT there was significant difference in leaf area due to cultivars during both the year and on pooled mean basis. The maximum leaf area index (0.014, 0.014 and 0.015) respectively was observed in cultivar (V₂) Arka Archana and the minimum leaf area index (0.014, 0.014 and 0.014 cm²) respectively was noticed in cultivar (V₁) Arka Shashank.

At 75 DAT there was significant difference in leaf area index due to application of different levels of nitrogen and phosphorus. The maximum leaf area index (0.020, 0.016, and 0.018) was recorded in treatment F₁₂ (N₁₈₀: P₁₄₀). The minimum leaf area index (0.010, 0.017, and 0.013) respectively was found under treatment F₁ (N₁₂₀: P₁₀₀).

Interaction between cultivars and application of different levels of nitrogen and phosphorus was found significant during 75 DAT. The maximum leaf area index (0.020, 0.015 and 0.017) was obtained in the treatment combination (V₂F₁₂) and the minimum leaf area index (0.010, 0.016 and 0.013) was observed in the treatment combination (V₁F₁) during both the tested years as well as on pooled mean basis.

The data pertaining on cultivars exhibited significant differences on leaf area index at 105 DAT. The highest leaf area (0.021, 0.024 and 0.022) respectively during this investigation was observed in cultivar (V₂) Arka Archana which is superior over as compared to cultivar (V₁) Arka Shashank (0.021, 0.024 and 0.022) respectively.

In case of application of various doses of nitrogen and phosphorus on leaf area at 105 DAT showed significant difference. It clearly showed that the maximum leaf area index (0.025, 0.026 and 0.025) respectively was recorded under the treatment

F₁₂ (N₁₈₀: P₁₄₀). While, minimum Leaf area index (0.020, 0.022, and 0.021) respectively was noticed in F₁ (N₁₂₀: P₁₀₀) during this investigation.

The interaction between cultivars and different levels of nitrogen and phosphorus at 105 DAT was found significant response during both the year and on pooled mean basis. The maximum leaf area index (0.026, 0.027 and 0.027) respectively was recorded under the treatment combination (V₂F₁₂). While, minimum Leaf area index (0.020, 0.021, and 0.020) respectively was noticed in treatment combination (V₁F₁) during this investigation.

Maximum leaf area per plant and leaf area index was recorded in Arka Archana and was followed by Arka Shashank. Higher leaf area in these varieties was due to the increased size of leaf. Lesser leaf size resulted in minimum leaf area since the varieties varied for their number of leaves. Variations in leaf production could be expected among the varieties due to genetic character. The similar finding was also reported by Ravikumar (2002), marigold (Nalawadi, 1982) in china aster and also reported by Nalawadi (1982) in marigold.

The increased leaf area per plant and leaf area index recorded in F₁₂ (N₁₈₀: P₁₄₀), may be due to an increase in the number of branches, number of leaves and dry matter production in leaf. Watson (1952) reported that the leaf area per plant was greatly dependent on dry matter production in leaves. The increased leaf area and leaf area index in F₁₂ (N₁₈₀: P₁₄₀) might have increased the photosynthetic efficiency leading to the increased production of flowers and flower yield. The similar findings were also quoted by Nalawadi (1982) in marigold, Vijayakumar *et al.* (1989) in china aster and Sharanabasappa (1990) in helichrysum.

Table 4.4.7: Effect of Cultivars, Nitrogen and Phosphorus on Leaf Area Index

Treat.		Leaf Area Index					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	0.014	0.015	0.015	0.021	0.022	0.022
V ₂	Arka Archana	0.014	0.014	0.014	0.021	0.024	0.022
SEm SEm±		0.00	0.00	0.00	0.00	0.00	0.00
CD at 5%		0.001	0.001	0.001	0.002	0.002	0.002
NITROGEN AND PHOSPHORUS							
F₁	N ₁₂₀ : P ₁₀₀	0.010	0.017	0.013	0.020	0.022	0.021
F₂	N ₁₂₀ : P ₁₂₀	0.010	0.015	0.012	0.021	0.022	0.022
F₃	N ₁₂₀ : P ₁₄₀	0.013	0.013	0.013	0.021	0.023	0.022
F₄	N ₁₄₀ : P ₁₀₀	0.016	0.015	0.015	0.021	0.024	0.023
F₅	N ₁₄₀ : P ₁₂₀	0.015	0.015	0.015	0.021	0.023	0.022
F₆	N ₁₄₀ : P ₁₄₀	0.015	0.016	0.015	0.021	0.022	0.021
F₇	N ₁₆₀ : P ₁₀₀	0.013	0.016	0.014	0.023	0.022	0.023
F₈	N ₁₆₀ : P ₁₂₀	0.011	0.014	0.013	0.020	0.024	0.022
F₉	N ₁₆₀ : P ₁₄₀	0.013	0.012	0.013	0.020	0.022	0.021
F₁₀	N ₁₈₀ : P ₁₀₀	0.015	0.015	0.015	0.020	0.023	0.021
F₁₁	N ₁₈₀ : P ₁₂₀	0.018	0.015	0.016	0.021	0.025	0.023
F₁₂	N ₁₈₀ : P ₁₄₀	0.020	0.016	0.018	0.025	0.026	0.025
SEm SEm±		0.002	0.001	0.001	0.002	0.001	0.001
CD at 5%		0.004	0.002	0.002	0.004	0.002	0.002

Table 4.4.7 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Leaf Area Index

NP	Phosphorus on Leaf Area Index					
	Leaf Area Index					
	75 Days			105 Days		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁ F ₁	0.010	0.016	0.013	0.020	0.021	0.020
V ₁ F ₂	0.010	0.018	0.014	0.023	0.019	0.021
V ₁ F ₃	0.016	0.014	0.015	0.020	0.024	0.022
V ₁ F ₄	0.020	0.015	0.017	0.023	0.024	0.024
V ₁ F ₅	0.016	0.016	0.016	0.023	0.024	0.023
V ₁ F ₆	0.010	0.014	0.012	0.023	0.019	0.021
V ₁ F ₇	0.013	0.016	0.014	0.023	0.021	0.022
V ₁ F ₈	0.013	0.015	0.014	0.020	0.023	0.021
V ₁ F ₉	0.010	0.013	0.011	0.020	0.020	0.020
V ₁ F ₁₀	0.016	0.015	0.016	0.020	0.023	0.021
V ₁ F ₁₁	0.016	0.015	0.015	0.023	0.025	0.024
V ₁ F ₁₂	0.020	0.017	0.018	0.023	0.026	0.024
V ₂ F ₁	0.010	0.018	0.014	0.020	0.023	0.021
V ₂ F ₂	0.010	0.012	0.011	0.020	0.021	0.020
V ₂ F ₃	0.010	0.012	0.011	0.023	0.022	0.022
V ₂ F ₄	0.013	0.014	0.014	0.020	0.024	0.022
V ₂ F ₅	0.013	0.015	0.014	0.020	0.021	0.020
V ₂ F ₆	0.020	0.018	0.019	0.020	0.024	0.022
V ₂ F ₇	0.013	0.016	0.014	0.023	0.023	0.023
V ₂ F ₈	0.010	0.013	0.011	0.020	0.024	0.022
V ₂ F ₉	0.016	0.011	0.014	0.020	0.024	0.020
V ₂ F ₁₀	0.013	0.014	0.013	0.020	0.023	0.021
V ₂ F ₁₁	0.020	0.015	0.017	0.020	0.025	0.022
V ₂ F ₁₂	0.020	0.015	0.017	0.026	0.027	0.027
SEm	0.003	0.001	0.001	0.002	0.001	0.001
CD at 5%	0.006	0.003	0.003	0.005	0.003	0.003

Fig. 4.4.7 a.: Effect of Cultivars , Nitrogen and Phosphorus on Leaf Area Index at 75 Days

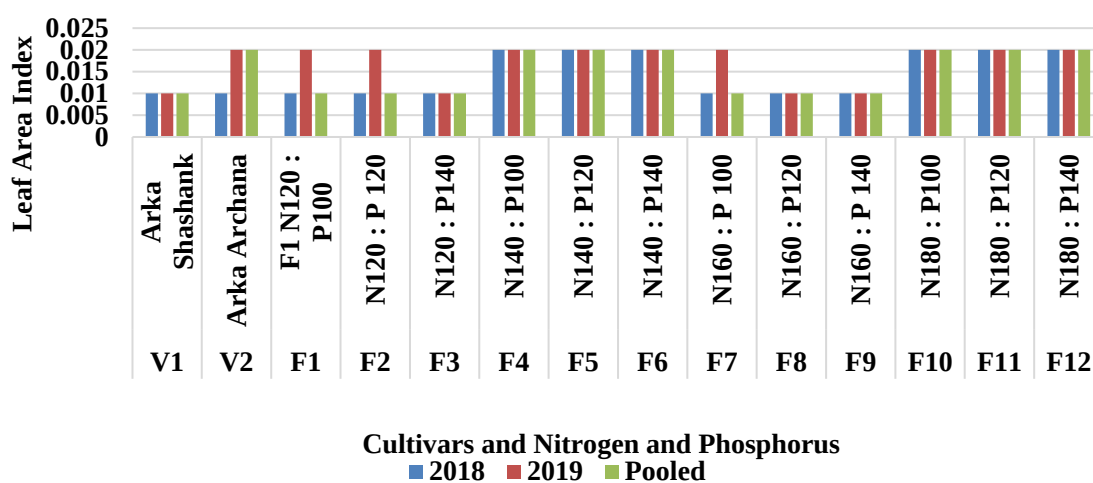
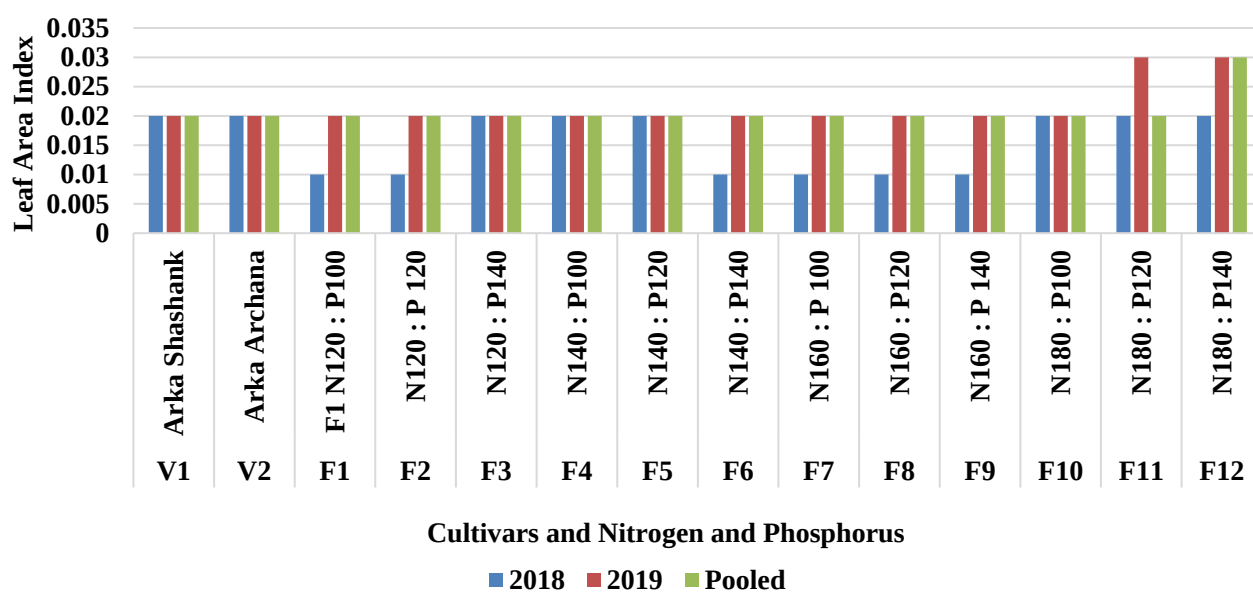


Fig. 4.4.7 b.: Effect of Cultivars , Nitrogen and Phosphorus on Leaf Area Index at 105 Days



4.4.8 Dry Matter Production of Leaves (g/plant)

The result on dry matter production of leaves was influence by cultivars and different levels of nitrogen and phosphorus are presented in Table 4.4.8, 4.4.8 a and Fig 4.4.8a and 4.4.8 b

In case of cultivars at 75 DAT, cultivar showed significant influence on dry matter production of leaves during both the years as well as on pooled mean basis. Dry matter production of leaves (8.35, 9.35, 8.85 g/plant) respectively were found maximum in cultivar (V₂) Arka Archana during the investigation and minimum dry matter production of leaves was found in cultivar (V₁) Arka Shashank (6.91, 7.22 and 7.07 g/plant) respectively.

In respect to different levels of nitrogen and phosphorus, the results revealed that the dry matter production of leaves at 75 DAT was significantly influenced during both the year as well as on pooled mean basis. The maximum dry matter production of leaves (11.30, 10.81 and 11.05g/plant) respectively was recorded under treatment F₁₂ (N₁₈₀: P₁₄₀), which was found statistically *at par* with treatment F₁₁ (N₁₈₀: P₁₂₀) during first year and pooled mean basis. However, it was showed statistically similar with treatment F₇ (N₁₆₀: P₁₀₀), F₈ (N₁₆₀: P₁₂₀), F₉ (N₁₈₀: P₁₄₀), F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) during second year. whereas, it was found significantly different with rest of the other treatments during both the year and on pooled mean basis. The minimum dry matter production of leaves (4.87, 5.44 and 5.15 g/plant) was recorded under treatment F₁ (N₁₂₀: P₁₀₀)

Among the cultivars at 105 DAT, the highest dry matter production of leaves (15.47, 16.84 and 16.15 g/plant) were found in cultivar (V₂) Arka Archana in both the years as well as on pooled mean analysis as compared to dry matter production of leaves (13.20, 14.28 and 13.74 g/plant) respectively obtained from cultivar (V₁) Arka Shashank

As far as at 105 days, the results on dry matter production of leaves show significant response between treatments for different levels of nitrogen and phosphorus. The maximum dry matter production of leaves (18.60, 19.70 and 19.15 g/plant) respectively was recorded in treatment F₁₂ (N₁₈₀: P₁₄₀) which was found statistically *at par* with treatment F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) during both the years whereas, it was showed at par with treatment F₁₁ (N₁₈₀: P₁₂₀) only in pooled mean basis. However, it was found significantly different with rest of the other treatments during both the year and on pooled mean basis. The minimum dry matter production of leaves (10.57, 11.57 and 11.07 g/plant) respectively were recorded under treatment F₁ (N₁₂₀: P₁₀₀) during this investigation.

The interaction between different levels of nitrogen and phosphorus with cultivars at 75 and 105 DAT was found non-significant, during both the years as well as on pooled mean basis.

Table 4.4.8: Effect of Cultivars, Nitrogen and Phosphorus on Dry matter production of Leaves

Treat.		Dry matter production of Leaves (g/plant)					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	6.91	7.22	7.07	13.20	14.28	13.74
V ₂	Arka Archana	8.35	9.35	8.85	15.47	16.84	16.15
SEm SEm±		0.36	0.45	0.29	0.37	0.41	0.27
CD at 5%		0.72	0.90	0.57	0.74	0.82	0.55
NITROGEN AND PHOSPHORUS							
F₁	N ₁₂₀ : P ₁₀₀	4.87	5.44	5.15	10.57	11.57	11.07
F₂	N ₁₂₀ : P ₁₂₀	5.67	6.00	5.83	11.51	12.78	12.14
F₃	N ₁₂₀ : P ₁₄₀	5.87	6.50	6.18	11.89	12.69	12.29
F₄	N ₁₄₀ : P ₁₀₀	6.84	7.66	7.03	12.87	14.15	13.51
F₅	N ₁₄₀ : P ₁₂₀	6.81	7.67	7.24	13.45	14.55	14.00
F₆	N ₁₄₀ : P ₁₄₀	7.20	7.84	7.52	14.03	15.82	14.92
F₇	N ₁₆₀ : P ₁₀₀	7.63	9.75	8.34	14.31	15.88	15.09
F₈	N ₁₆₀ : P ₁₂₀	7.85	9.77	8.56	14.24	15.28	14.76
F₉	N ₁₆₀ : P ₁₄₀	8.50	9.79	8.89	15.92	17.39	16.65
F₁₀	N ₁₈₀ : P ₁₀₀	9.19	9.81	9.50	16.96	17.99	17.48
F₁₁	N ₁₈₀ : P ₁₂₀	9.81	10.55	10.18	17.67	18.96	18.32
F₁₂	N ₁₈₀ : P ₁₄₀	11.30	10.81	11.05	18.60	19.70	19.15
SEm SEm±		0.87	1.10	0.70	0.90	1.00	0.67
CD at 5%		1.76	2.21	1.39	1.81	2.02	1.34

Table 4.4.8 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Dry matter production of Leaves

Treat.	Dry matter production of Leaves (g/plant)					
	75 Days			105 Days		
	NP	2018-19	2019-20	Pooled	2018-19	2019-20
V ₁ F ₁	4.60	4.73	4.66	9.71	10.42	10.06
V ₁ F ₂	4.89	4.98	4.94	10.70	11.86	11.28
V ₁ F ₃	5.53	5.24	5.38	11.91	12.35	12.13
V ₁ F ₄	5.99	5.50	5.75	11.59	13.09	12.34
V ₁ F ₅	5.94	6.03	5.99	11.50	12.23	11.87
V ₁ F ₆	6.42	6.76	6.59	12.88	14.66	13.77
V ₁ F ₇	6.53	7.64	7.08	13.66	15.04	14.35
V ₁ F ₈	6.56	7.87	7.21	13.38	14.69	14.04
V ₁ F ₉	7.76	8.05	7.90	14.11	15.51	14.81
V ₁ F ₁₀	8.72	9.23	8.97	15.69	16.61	16.15
V ₁ F ₁₁	9.64	10.10	9.87	16.33	17.39	16.86
V ₁ F ₁₂	10.35	10.54	10.44	16.94	17.57	17.25
V ₂ F ₁	5.14	6.15	5.65	11.43	12.72	12.07
V ₂ F ₂	6.44	7.01	6.73	12.31	13.69	13.00
V ₂ F ₃	6.21	7.76	6.99	11.86	13.02	12.44
V ₂ F ₄	7.69	8.94	8.32	14.14	15.22	14.68
V ₂ F ₅	7.68	9.30	8.49	15.39	16.88	16.14
V ₂ F ₆	7.97	8.91	8.44	15.17	16.98	16.08
V ₂ F ₇	8.74	10.46	9.60	14.95	16.73	15.84
V ₂ F ₈	9.13	10.66	9.90	15.10	15.87	15.49
V ₂ F ₉	9.25	10.53	9.89	17.72	19.26	18.49
V ₂ F ₁₀	9.67	10.40	10.03	18.24	19.38	18.81
V ₂ F ₁₁	9.98	11.00	10.49	19.02	20.53	19.78
V ₂ F ₁₂	12.24	11.09	11.67	20.26	21.83	21.05
SEm	1.24	1.55	0.99	1.27	1.42	0.95
CD at 5%	NS	NS	NS	NS	NS	NS

Fig. 4.4.8 a: Effect of Cultivars, Nitrogen and Phosphorus on Dry matter production of Leaves at 75 days

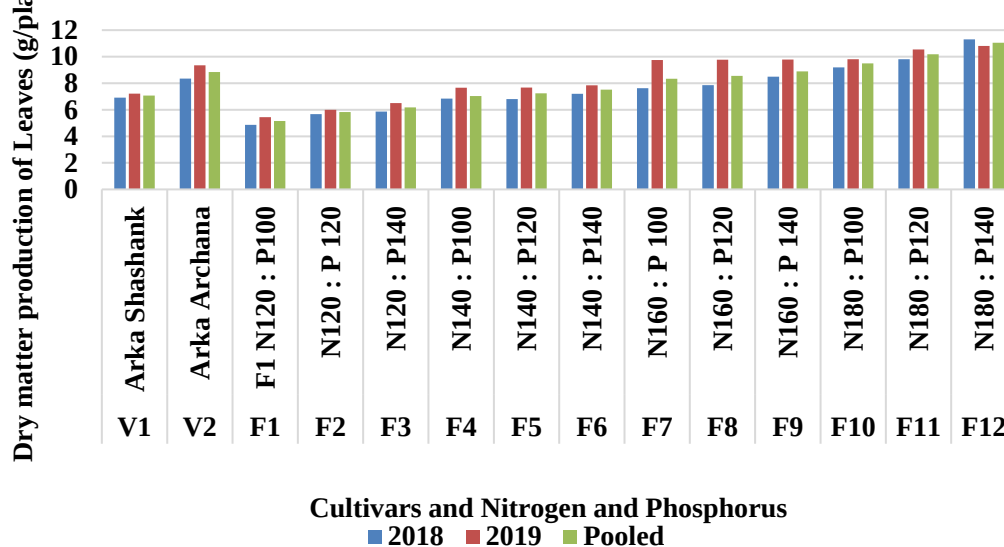
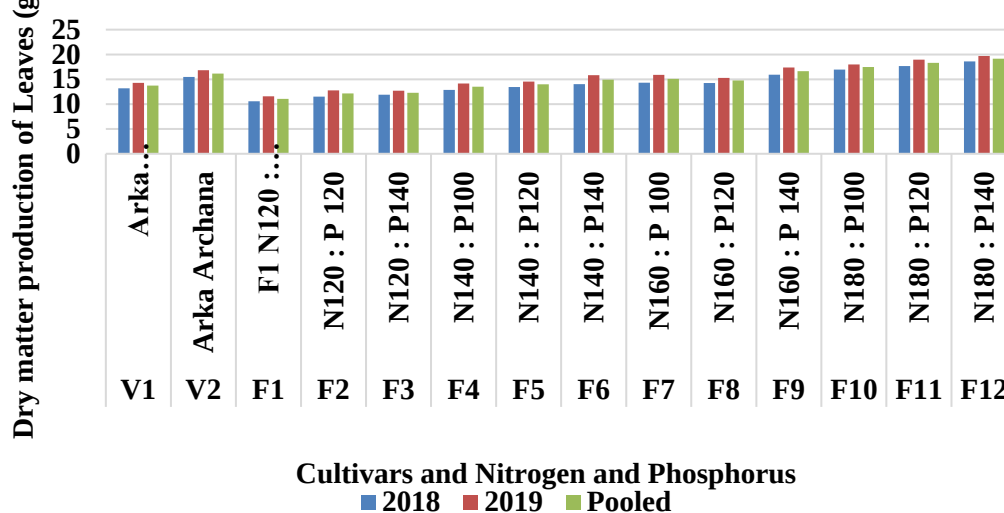


Fig. 4.4.8 b: Effect of Cultivars, Nitrogen and Phosphorus on Dry matter production of Leaves at 105 days



4.4.9 Dry Matter Production of Stems (g/plant)

The data on dry matter production of stems was influence by cultivars and different levels of nitrogen and phosphorus are presented in Table 4.4.9, 4.4.9 a and Fig 4.4.9a and 4.4.9 b

The evident data showed that at 75 DAT, cultivar showed significant influence on dry matter production of stems. Maximum dry matter production of stems (34.12, 37.10 and 35.61 g/plant) respectively were found in cultivar (V₂) Arka Archana during this investigation and minimum dry matter production of stems (13.35, 15.01 and 14.18 g/plant) respectively was found in cultivar (V₁) Arka Shashank during both the tested year as well as on pooled mean data.

The application of different levels of nitrogen and phosphorus on dry matter production of stems at 75 DAT was significantly influenced during both the year as well as on pooled mean basis. The maximum dry matter production of stems (28.37, 30.57, 29.47 g/plant) respectively was recorded under treatment F₁₂ (N₁₈₀: P₁₄₀), which was found statistically *at par* with treatment F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) and it was observed significant effect with rest of the other treatments. However minimum dry matter production of stems (18.05, 20.65 and 19.50 g/plant) was recorded under treatment F₁ (N₁₂₀: P₁₀₀)

The data in respect to cultivars at 105 DAT, the dry matter production of stems (40.28, 42.47, and 41.37 g/plant) respectively were found highest in cultivar (V₂) Arka Archana in first and second year as well as on pooled mean analysis with respect to dry matter production of stems (20.97, 21.40 and 21.18 g/plant) respectively obtained from cultivar (V₁) Arka Shashank. .

The results at 105 DAT showed significant differences between treatments for different levels of nitrogen and phosphorus during first year and second year as well as on pooled mean data on dry matter production of stems. The maximum dry

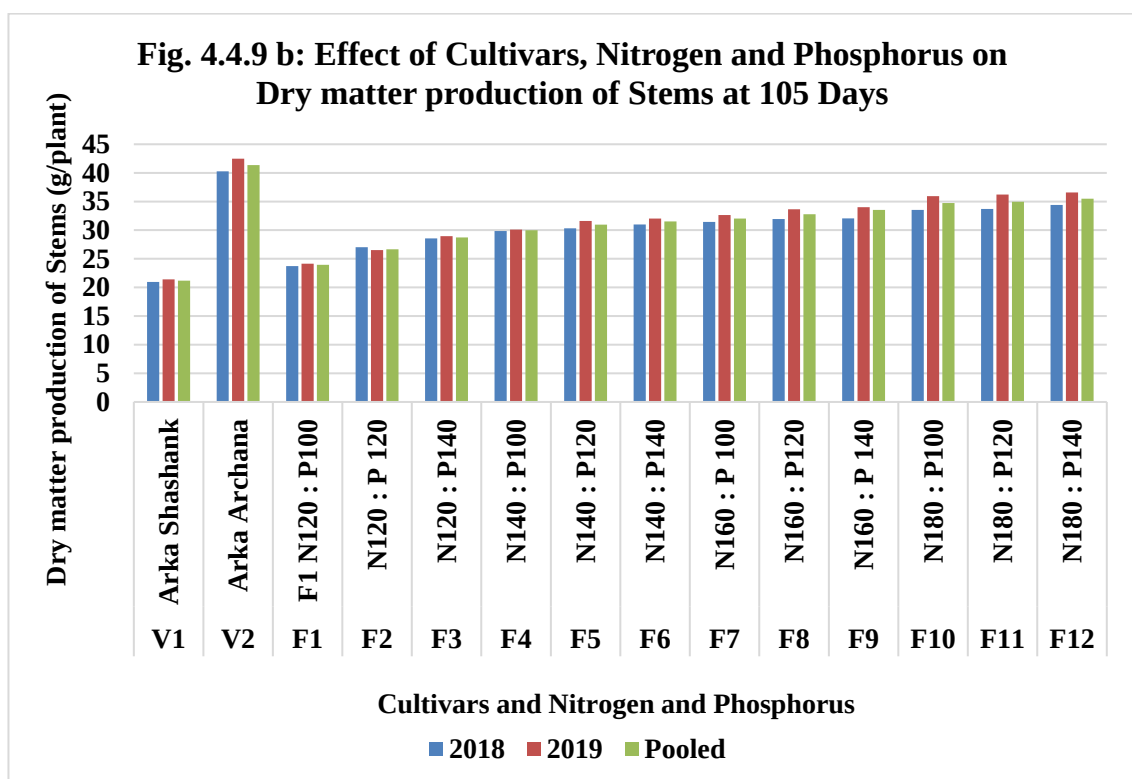
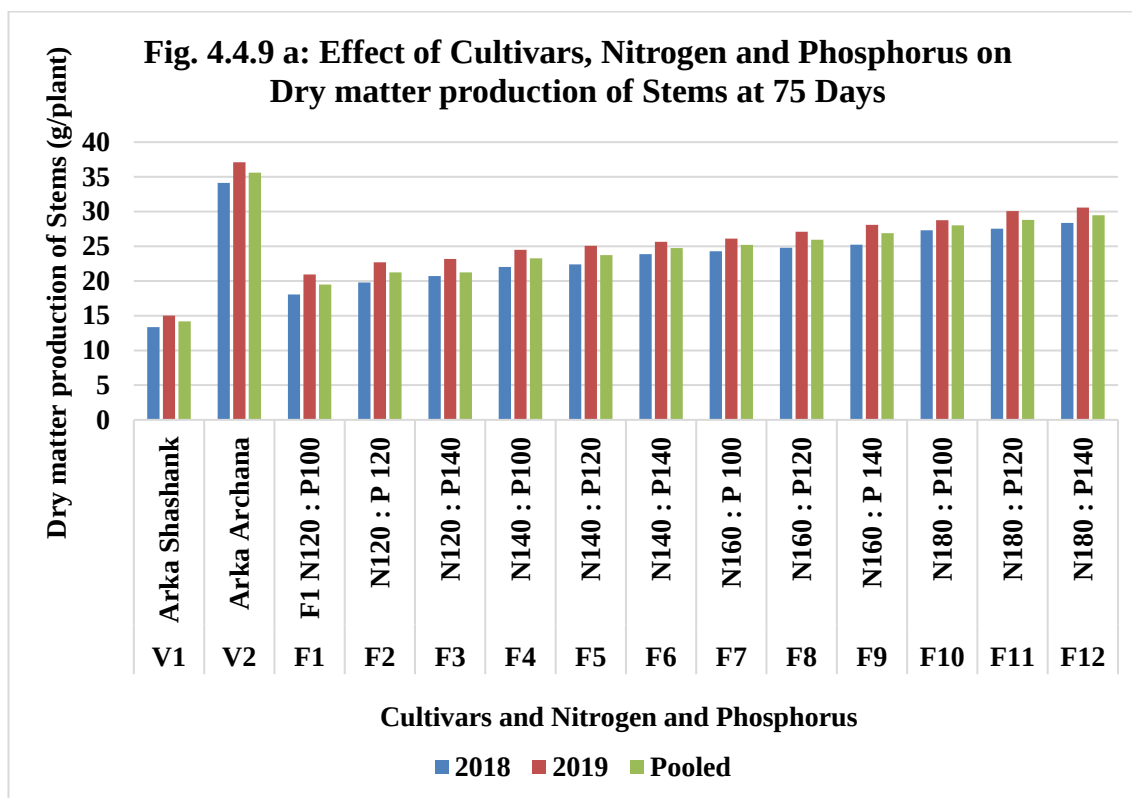
matter production of stems (34.41, 36.58, and 35.49 g/plant) respectively was recorded in treatment F₁₂ (N₁₈₀: P₁₄₀) and it was found statistically similar with the treatment F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) and it was observed significant difference with rest of the other treatments. Whereas, minimum dry matter production of stems (23.73, 24.15 and 23.95 g/plant) respectively were recorded under treatment F₁ (N₁₂₀: P₁₀₀) during both years as well as on pooled mean analysis. The interaction between different doses of nitrogen and phosphorus and cultivars at 75 and 105 DAT was found non-significant during both the years as well as on pooled mean basis.

Table 4.4.9: Effect of Cultivars, Nitrogen and Phosphorus on Dry matter production of Stems

Treat.		Dry matter production of Stems (g/plant)					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	13.35	15.01	14.18	20.97	21.40	21.18
V ₂	Arka Archana	34.12	37.10	35.61	40.28	42.47	41.37
SEm SEm±		0.62	0.43	0.38	0.46	0.47	0.33
CD at 5%		1.25	0.87	0.75	0.93	0.95	0.66
NITROGEN AND PHOSPHORUS							
F ₁	N ₁₂₀ : P ₁₀₀	18.05	20.95	19.50	23.73	24.15	23.95
F ₂	N ₁₂₀ : P ₁₂₀	19.79	22.70	21.24	27.01	26.53	26.67
F ₃	N ₁₂₀ : P ₁₄₀	20.70	23.18	21.24	28.55	28.94	28.74
F ₄	N ₁₄₀ : P ₁₀₀	22.03	24.49	23.26	29.84	30.11	29.98
F ₅	N ₁₄₀ : P ₁₂₀	22.40	25.07	23.74	30.31	31.60	30.96
F ₆	N ₁₄₀ : P ₁₄₀	23.86	25.64	24.75	31.00	32.02	31.51
F ₇	N ₁₆₀ : P ₁₀₀	24.28	26.11	25.20	31.43	32.63	32.03
F ₈	N ₁₆₀ : P ₁₂₀	24.78	27.10	25.94	31.93	33.65	32.79
F ₉	N ₁₆₀ : P ₁₄₀	25.23	28.08	26.90	32.04	34.02	33.53
F ₁₀	N ₁₈₀ : P ₁₀₀	27.31	28.76	28.03	33.53	35.94	34.74
F ₁₁	N ₁₈₀ : P ₁₂₀	27.54	30.06	28.80	33.69	36.23	34.96
F ₁₂	N ₁₈₀ : P ₁₄₀	28.37	30.57	29.47	34.41	36.58	35.49
SEm SEm±		1.52	1.06	0.93	1.13	1.15	0.81
CD at 5%		3.06	2.13	1.84	2.28	2.32	1.60

Table 4.4.9 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Dry matter production of Stems

Treat.	Dry matter production of Stems (g/plant)						
	75 Days			105 Days			
	NP	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁ F ₁		9.16	10.46	9.81	16.89	14.81	15.85
V ₁ F ₂		10.64	11.10	10.87	18.39	17.30	17.85
V ₁ F ₃		11.35	12.39	11.87	18.17	18.75	18.46
V ₁ F ₄		12.10	13.89	12.99	18.69	18.52	18.60
V ₁ F ₅		12.15	14.04	13.10	18.97	19.97	19.47
V ₁ F ₆		13.81	15.08	14.45	20.23	21.10	20.67
V ₁ F ₇		12.75	15.20	13.98	20.14	21.71	20.92
V ₁ F ₈		13.95	16.10	15.03	21.89	22.13	22.01
V ₁ F ₉		15.03	16.90	15.97	22.70	23.44	23.07
V ₁ F ₁₀		16.02	17.72	16.87	24.41	25.64	25.02
V ₁ F ₁₁		16.15	18.48	17.32	25.51	26.42	25.96
V ₁ F ₁₂		17.11	18.81	17.96	25.64	26.98	26.31
V ₂ F ₁		26.95	31.44	29.20	30.57	33.48	32.03
V ₂ F ₂		28.94	34.30	31.62	35.62	35.36	35.49
V ₂ F ₃		30.05	33.96	32.00	38.92	39.13	39.03
V ₂ F ₄		31.97	35.09	33.53	40.99	41.71	41.35
V ₂ F ₅		32.66	36.10	34.38	41.66	43.22	42.44
V ₂ F ₆		33.90	36.21	35.05	41.77	42.93	42.35
V ₂ F ₇		35.80	37.03	36.42	42.72	43.56	43.14
V ₂ F ₈		35.60	38.09	36.85	41.97	45.18	43.57
V ₂ F ₉		36.43	39.26	37.84	41.39	46.60	44.00
V ₂ F ₁₀		38.59	39.80	39.20	42.66	46.24	44.45
V ₂ F ₁₁		38.93	41.65	40.29	41.87	46.03	43.95
V ₂ F ₁₂		39.62	42.33	40.97	43.18	46.17	44.68
SEm		2.15	1.50	1.31	1.60	1.63	1.14
CD at 5%		NS	NS	NS	NS	NS	NS



4.4.10. Dry Matter Production of Roots (g/plant)

It is clear from the data presented in Table 4.4.10, 4.4.10 a and graphically presented in Fig 4.4.10a and 4.4.10 b that the dry matter production of roots was significantly influenced by different levels of cultivars and different levels of nitrogen and phosphorus.

It is vivid from the data presented in Table 4.1.10 that the cultivar showed significant influence on dry matter production of roots during both the years as well as on pooled mean basis. At 75 DAT, the maximum dry matter production of roots (26.84, 28.30, and 27.57 g/plant) respectively were found in cultivar (V₂) Arka Archana under this investigation and minimum dry Matter Production of roots (13.15, 14.70 and 13.92 g/plant) respectively was found in cultivar (V₁) Arka Shashank.

In respect to different levels of nitrogen and phosphorus, the dry matter production of roots at 75 DAT was significantly influenced by different levels of nitrogen and phosphorus. The maximum dry matter production of roots (24.40, 26.16 and 25.28 g/plant) respectively was recorded under treatment F₁₂ (N₁₈₀: P₁₄₀) during both the years and pooled mean basis and it was observed statistically similar with F₁₁ (N₁₈₀: P₁₂₀) and it was observed significant difference with rest of the other treatments. However, minimum dry matter production of roots (16.41, 16.63 and 16.52 g/plant) respectively were recorded under treatment F₁ (N₁₂₀: P₁₀₀) during both years and on pooled mean basis respectively.

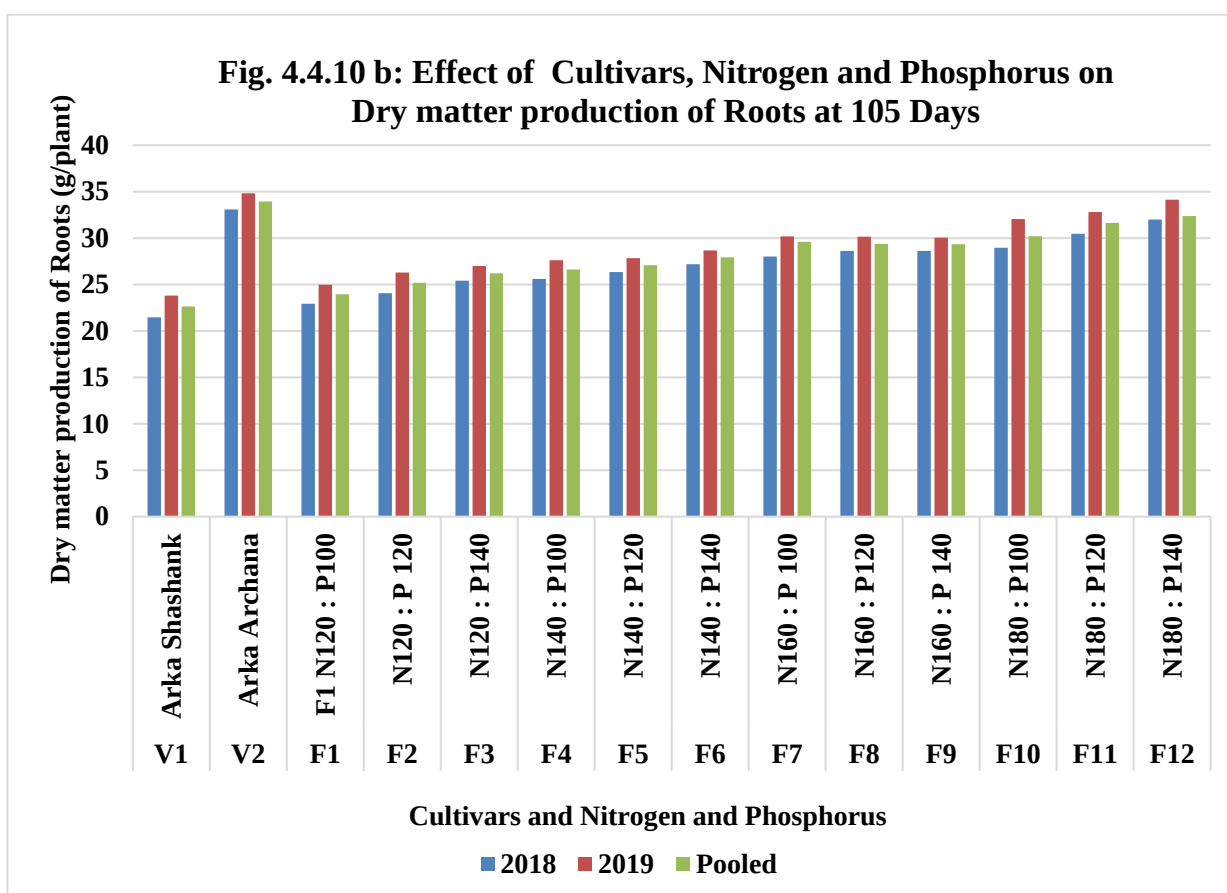
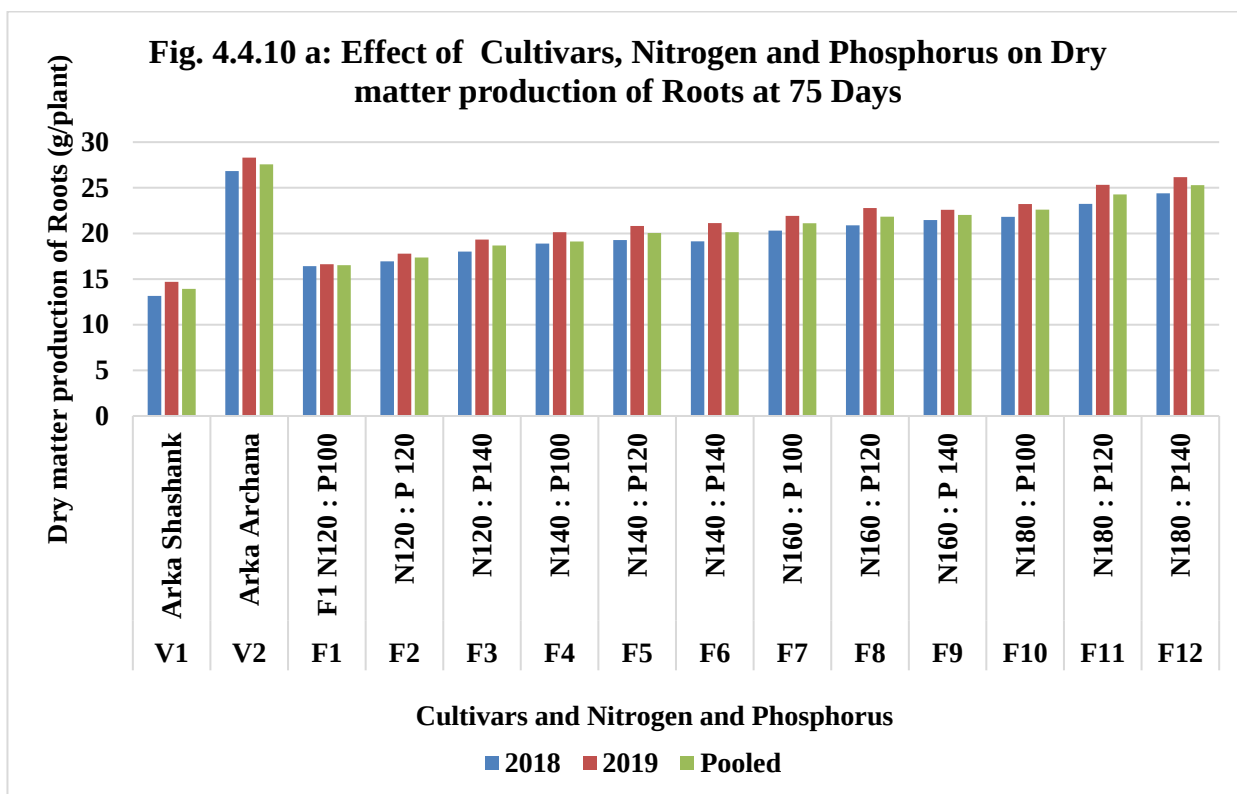
The data in respect to cultivars at 105 DAT, the dry matter production of roots (33.08, 34.83 and 33.95 g/plant) respectively were found highest in cultivar (V₂) Arka Archana in first and second year as well as on pooled mean analysis as compared to dry matter production of roots (21.46, 23.80 and 22.63 g/plant) respectively obtained from cultivar (V₁) Arka Shashank.

Table 4.4.10: Effect of Cultivars, Nitrogen and Phosphorus on Dry matter production of Roots

Treat.		Dry matter production of Roots (g/plant)					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	13.15	14.70	13.92	21.46	23.80	22.63
V ₂	Arka Archana	26.84	28.30	27.57	33.08	34.83	33.95
SEm SEm±		0.48	0.58	0.38	0.62	0.65	0.45
CD at 5%		0.97	1.17	0.75	1.25	1.31	0.89
NITROGEN AND PHOSPHORUS							
F₁	N ₁₂₀ : P ₁₀₀	16.41	16.63	16.52	22.93	24.98	23.95
F₂	N ₁₂₀ : P ₁₂₀	16.94	17.78	17.36	24.07	26.29	25.18
F₃	N ₁₂₀ : P ₁₄₀	18.02	19.33	18.68	25.41	26.99	26.20
F₄	N ₁₄₀ : P ₁₀₀	18.88	20.13	19.11	25.60	27.62	26.61
F₅	N ₁₄₀ : P ₁₂₀	19.27	20.82	20.05	26.34	27.84	27.09
F₆	N ₁₄₀ : P ₁₄₀	19.13	21.13	20.13	27.19	28.67	27.93
F₇	N ₁₆₀ : P ₁₀₀	20.31	21.93	21.12	28.02	30.19	29.60
F₈	N ₁₆₀ : P ₁₂₀	20.88	22.78	21.83	28.62	30.15	29.38
F₉	N ₁₆₀ : P ₁₄₀	21.47	22.59	22.03	28.62	30.05	29.34
F₁₀	N ₁₈₀ : P ₁₀₀	21.81	23.22	22.61	28.96	32.05	30.21
F₁₁	N ₁₈₀ : P ₁₂₀	23.24	25.32	24.28	30.46	32.80	31.63
F₁₂	N ₁₈₀ : P ₁₄₀	24.40	26.16	25.28	32.00	34.14	32.38
SEm SEm±		1.18	1.42	0.92	1.52	1.60	1.10
CD at 5%		2.38	2.86	1.83	3.06	3.22	2.19

Table 4.4.10 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Dry matter production of Roots

Treat.	Dry matter production of Roots (g/plant)					
	75 Days			105 Days		
	NP	2018-19	2019-20	Pooled	2018-19	2019-20
V ₁ F ₁	9.32	10.24	9.78	16.69	19.86	18.27
V ₁ F ₂	10.66	11.68	11.17	16.77	20.58	18.68
V ₁ F ₃	11.31	12.52	11.92	19.54	21.38	20.46
V ₁ F ₄	10.92	12.94	11.93	19.95	22.38	21.17
V ₁ F ₅	12.74	14.10	13.42	20.13	21.64	20.88
V ₁ F ₆	12.18	13.65	12.92	21.65	22.93	22.29
V ₁ F ₇	14.01	15.47	14.74	23.03	23.56	23.30
V ₁ F ₈	14.19	15.53	14.86	23.29	24.25	23.77
V ₁ F ₉	15.04	16.99	16.02	23.66	25.14	24.40
V ₁ F ₁₀	15.30	17.88	16.59	23.01	26.16	24.59
V ₁ F ₁₁	15.47	17.06	16.27	25.23	28.03	26.63
V ₁ F ₁₂	16.62	18.35	17.49	24.63	29.70	27.16
V ₂ F ₁	23.50	23.01	23.26	29.17	30.10	29.63
V ₂ F ₂	23.22	23.88	23.55	31.38	31.99	31.68
V ₂ F ₃	24.74	26.14	25.44	31.28	32.60	31.94
V ₂ F ₄	25.24	27.32	26.28	31.25	32.86	32.06
V ₂ F ₅	25.81	27.55	26.68	32.55	34.05	33.30
V ₂ F ₆	26.07	28.61	27.34	32.72	34.41	33.57
V ₂ F ₇	26.61	28.38	27.49	35.01	36.81	35.91
V ₂ F ₈	27.57	30.03	28.80	33.94	36.04	34.99
V ₂ F ₉	27.91	28.19	28.05	33.58	34.96	34.27
V ₂ F ₁₀	28.31	28.95	28.63	33.71	37.94	35.82
V ₂ F ₁₁	31.00	33.58	32.29	35.69	37.57	36.63
V ₂ F ₁₂	32.17	33.96	33.07	36.63	38.57	37.60
SEm	1.67	2.01	1.31	2.15	2.26	1.56
CD at 5%	NS	NS	NS	NS	NS	NS



In case of fertilizers applications, the results of dry matter production of roots at 105 DAT showed significant differences between treatments during first year and second year as well as on pooled mean data. The dry matter production of roots (32.00, 34.14 and 32.38 g/plant) respectively was recorded maximum in treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with F₁₀(N₁₈₀: P₁₀₀) and F₁₁(N₁₈₀: P₁₂₀) and it was showed significant difference with rest of the other treatments.. Whereas, minimum dry matter production of roots (17.71, 16.94 and 17.33 g/plant) respectively was recorded under treatment F₁ (N₁₂₀: P₁₀₀).

The interaction between different levels of nitrogen and phosphorus and cultivars at 75 and 105 days was found non-significant during both the years as well as on pooled mean basis.

4.4.11. Total Dry Matter Production (g/plant)

The results on total dry matter production were significantly influenced by Cultivars and application of different levels of nitrogen and phosphorus are presented in Table 4.4.11, 4.4.11 a and Fig 4.4.11a and 4.4.11 b

The resulted data on total dry matter production at 75 DAT indicated that significantly maximum total dry matter production (69.48, 70.20, 69.80 g/plant) respectively were observed in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank (33.43, 34.10 and 33.80 g/plant) during both the tested years and on pooled mean data respectively.

In respect to different levels of nitrogen and phosphorus, the total dry matter production at 75 DAT was significantly influenced by application of various doses of nitrogen and phosphorus during both the year and on pooled mean basis. The maximum total dry matter production (62.56, 63.64 and 63.50 g/plant) respectively was observed under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with treatment F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) and it was observed

significant difference with remaining of the other treatments. However, minimum total dry matter production (39.67, 40.41 and 40.00 g/plant) respectively was found under treatment F₁ (N₁₂₀: P₁₀₀) during the investigation.

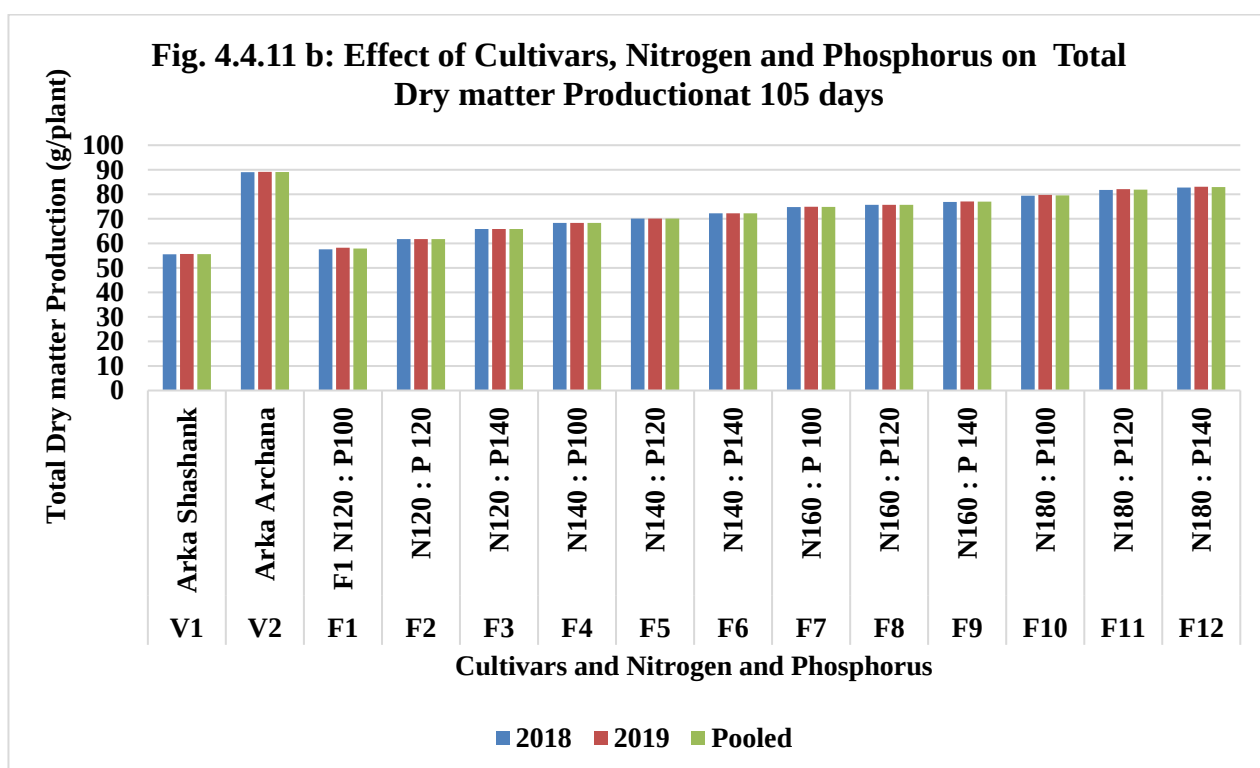
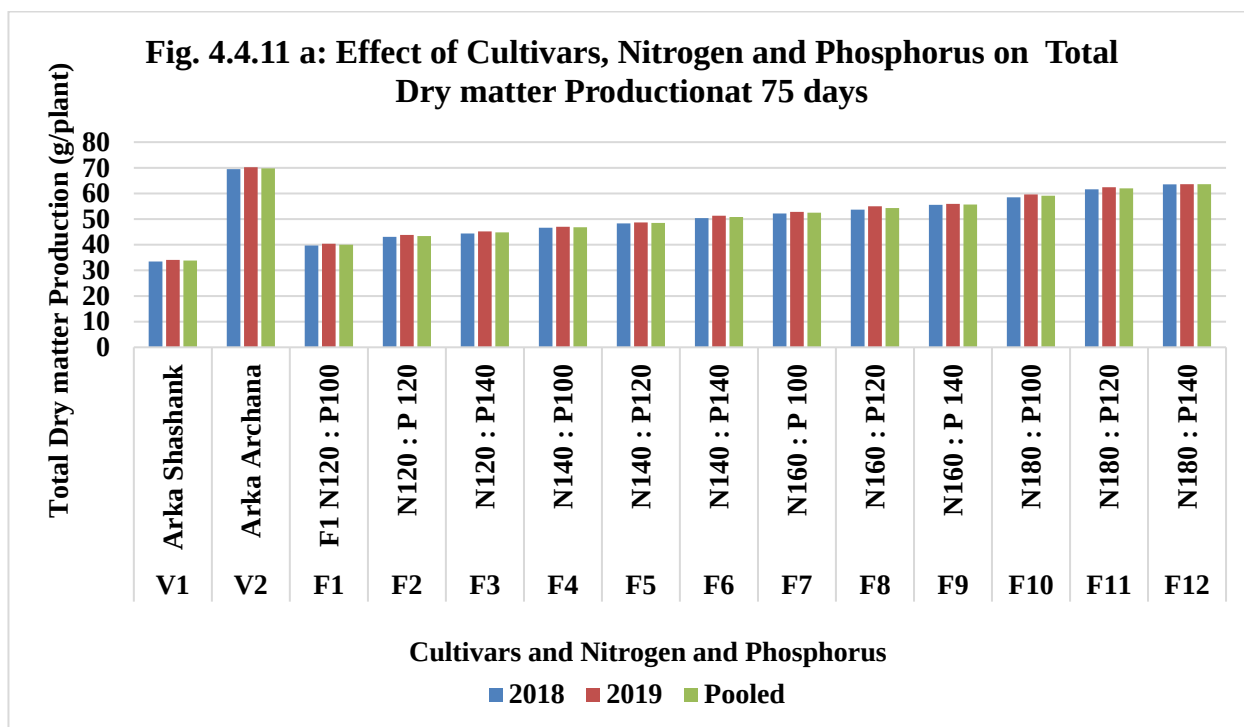
The observation on total dry matter production at 105 DAT indicated that significantly maximum total dry matter production (89.01, 89.15, 89.08 g/plant) respectively were observed in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank (55.50, 55.69, 55.59 g/plant) during both the tested years and on pooled mean data respectively.

Table 4.4.11: Effect of Cultivars, Nitrogen and Phosphorus on Total Dry matter Production

Treat.		Total Dry matter Production (g/plant)					
		75 days			105 days		
CULTIVAR		2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁	Arka Shashank	33.43	34.10	33.80	55.50	55.69	55.59
V ₂	Arka Archana	69.48	70.20	69.80	89.01	89.15	89.08
SEm SEm±		1.20	1.23	1.20	1.17	1.28	0.87
CD at 5%		2.42	2.47	2.41	2.35	2.58	1.72
NITROGEN AND PHOSPHORUS							
F ₁	N ₁₂₀ : P ₁₀₀	39.67	40.41	40.00	57.56	58.22	57.89
F ₂	N ₁₂₀ : P ₁₂₀	43.09	43.83	43.42	61.75	61.75	61.75
F ₃	N ₁₂₀ : P ₁₄₀	44.40	45.21	44.81	65.86	65.85	65.85
F ₄	N ₁₄₀ : P ₁₀₀	46.62	47.02	46.81	68.31	68.31	68.31
F ₅	N ₁₄₀ : P ₁₂₀	48.32	48.73	48.52	70.10	70.10	70.10
F ₆	N ₁₄₀ : P ₁₄₀	50.35	51.31	50.81	72.21	72.21	72.21
F ₇	N ₁₆₀ : P ₁₀₀	52.17	52.81	52.56	74.75	74.92	74.84
F ₈	N ₁₆₀ : P ₁₂₀	53.67	55.00	54.34	75.72	75.72	75.72
F ₉	N ₁₆₀ : P ₁₄₀	55.54	55.91	55.74	76.89	77.06	76.97
F ₁₀	N ₁₈₀ : P ₁₀₀	58.47	59.61	59.11	79.41	79.74	79.57
F ₁₁	N ₁₈₀ : P ₁₂₀	61.59	62.42	62.01	81.75	82.08	81.91
F ₁₂	N ₁₈₀ : P ₁₄₀	62.56	63.64	63.50	82.76	83.10	82.93
SEm SEm±		2.94	3.01	2.93	2.86	3.14	2.12

Table 4.4.11 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Total Dry matter Production

Treat.	Total Dry matter Production (g/plant)						
	75 Days			105 Days			
	NP	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
V ₁ F ₁	23.75	24.54	24.14	40.95	42.28	41.61	
V ₁ F ₂	27.57	28.24	27.90	45.85	45.85	45.85	
V ₁ F ₃	27.81	28.47	28.14	49.66	49.63	49.64	
V ₁ F ₄	28.01	28.00	28.00	50.23	50.23	50.23	
V ₁ F ₅	29.83	30.49	30.16	50.60	50.60	50.60	
V ₁ F ₆	32.42	33.08	32.75	54.77	54.77	54.77	
V ₁ F ₇	33.19	33.52	33.35	56.83	57.16	56.99	
V ₁ F ₈	35.03	36.03	35.53	58.56	58.56	58.56	
V ₁ F ₉	37.50	38.16	37.83	60.47	60.47	60.47	
V ₁ F ₁₀	39.71	40.38	40.04	63.11	63.11	63.11	
V ₁ F ₁₁	42.60	43.60	43.10	67.06	67.06	67.06	
V ₁ F ₁₂	43.75	44.42	44.08	67.87	68.54	68.20	
V ₂ F ₁	55.59	56.26	55.92	74.16	74.16	74.16	
V ₂ F ₂	58.60	59.26	58.93	77.65	77.65	77.65	
V ₂ F ₃	61.00	61.99	61.49	82.06	82.06	82.06	
V ₂ F ₄	65.23	65.9	65.56	86.38	86.38	86.38	
V ₂ F ₅	66.81	66.81	66.81	89.60	89.60	89.60	
V ₂ F ₆	68.27	69.60	68.94	89.66	89.66	89.66	
V ₂ F ₇	71.15	72.14	71.64	92.68	92.68	92.68	
V ₂ F ₈	72.30	73.96	73.13	92.89	92.89	92.89	
V ₂ F ₉	73.58	73.58	73.58	93.31	93.64	93.47	
V ₂ F ₁₀	77.23	78.9	78.06	95.71	96.37	96.04	
V ₂ F ₁₁	80.58	81.24	80.91	96.43	97.09	96.76	
V ₂ F ₁₂	83.37	82.7	83.03	97.66	97.66	97.66	
SEm	4.16	4.26	4.15	4.04	4.44	3.00	
CD at 5%	NS	NS	NS	NS	NS	NS	
CD at 5%		5.93	6.06	5.91	5.75	6.32	4.22



The perusal data showed that the total dry matter production at 105 DAT was significantly influenced by application of various doses of different levels of nitrogen and phosphorus during both the year and on pooled mean basis. The maximum total dry matter production (82.76, 83.10, 82.93 g/plant) respectively was observed under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) and it was observed significant difference with remaining of the other treatments. However, minimum total dry matter production (57.56, 58.22 and 57.89 g/plant) respectively was found under treatment F₁ (N₁₂₀: P₁₀₀) during the investigation.

The interaction between different doses of nitrogen and phosphorus and cultivars at 75 and 105 DAT was found non-significant during both the years as well as on pooled mean basis.

The China aster Cultivars varied significantly for dry matter accumulation in leaves, stem, root and total dry matter. Arka Archana recorded maximum total dry matter accumulation as compare to Arka Shashank. The increased dry matter accumulation might be due to vigorous growth, more number of leaves, higher leaf area and production of fairly more number of primary and secondary branches in these Cultivars. Particularly, the variety Arka Archana, produced thicker and straight stems compared to other variety. The efficient photosynthetic ability of crop might facilitate the accumulation of more carbohydrates in stems, which in turn increased the dry matter accumulation. Similar results were also observed in china aster (Ravikumar, 2002) and marigold (Nalawadi, 1982 and Vijayalaxmi, 1998).

The increase in levels of N, P were found to affect dry matter yield (leaves, stem and root) in China aster. The total dry matter increased with the increasing levels of NP inputs. A comparison of nutrient application contributing to the overall flower, leaves, stem and root biomass revealed that in this case, N is playing a major role. P application also increased the biomass but the increase was more due to their interactive effect with N rather than their individual effects. N is known to

play an important role in accelerating the plant growth, which, ultimately helps in increasing the photosynthetic activity, which leads to the accumulation of higher amount of biomass. Similarly, increased dry matter production by the soil fertility management treatments have also been reported by Rupa, 2010 and Chandana and Dorajeerao, 2014.

4.5. Flowering and yield attributes

4.5.1. Days to Bud initiation

The data on Days to bud initiation were recorded and are presented in Table 4.5.1, 4.5.1 a and Fig. 4.5.1

Amongst the cultivars, there were found significant difference between Cultivars in both the years as well as on pooled mean analysis. Maximum days required for bud initiation (68.61, 69.3 and 68.97) respectively were observed in cultivar (V₁) Arka Shashank. Minimum days required for bud initiation was observed in cultivar (V₂) Arka Archana (64.67, 67.52 and 66.09) during both the tested years and on pooled mean data respectively.

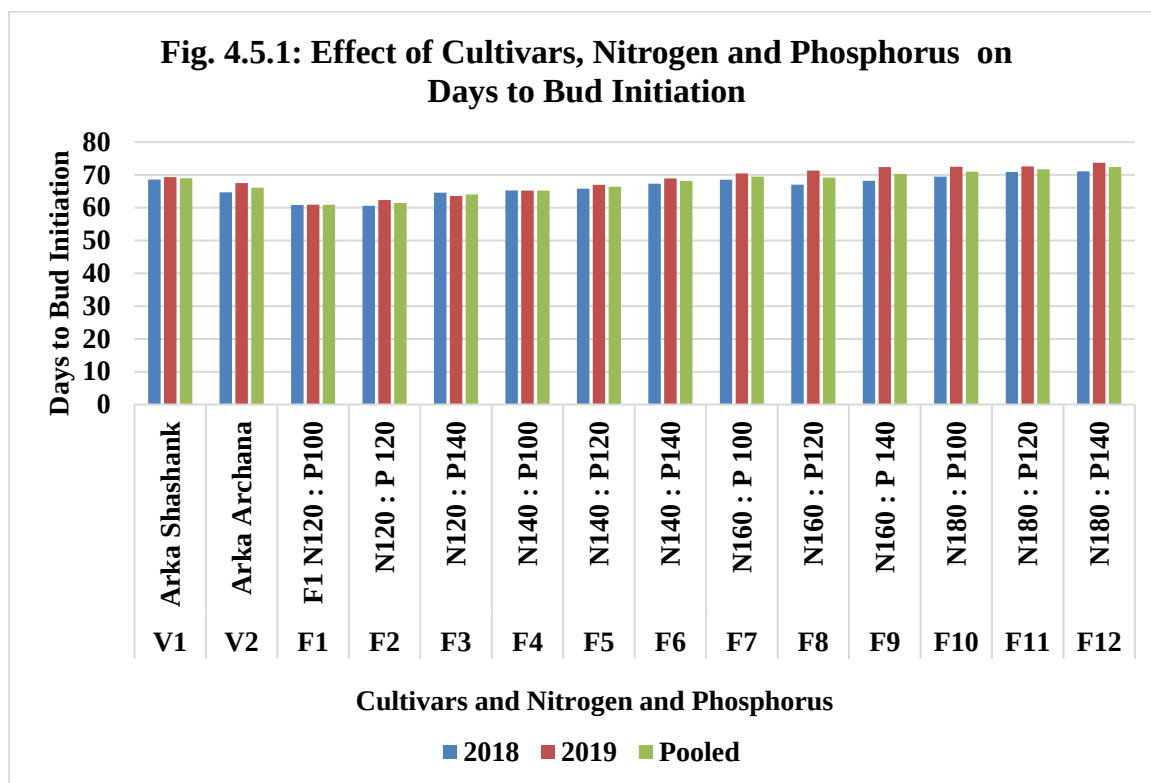
Nitrogen and phosphorus showed significant influence on days to bud initiation during both the years and on pooled mean basis. The earlier bud initiation (60.57, 60.95 and 60.90) was observed in F₂ (N₁₂₀: P₁₂₀) in first year, while it was noticed in the treatment F₁ (N₁₂₀: P₁₀₀) during second as well as on pooled mean analysis respectively. Further, it was found statistically *at par* with treatments F₉ (N₁₆₀: P₁₄₀), F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀:P₁₂₀) during first year and on pooled mean basis and while during second year, treatments F₇ (N₁₆₀: P₁₄₀), F₈ (N₁₆₀: P₁₄₀), F₉ (N₁₆₀: P₁₄₀), F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀:P₁₂₀) was found statistically similar. It was showed significant difference with rest of the other treatments. The maximum days (71.1, 73.73, and 72.42) required for bud initiation were observed in treatment F₁₂ (N₁₂₀: P₁₂₀)

Table 4.5.1: Effect of Cultivars, Nitrogen and Phosphorus on Days to Bud Initiation

Treat.		Days to Bud Initiation		
		2018-19	2019-20	Pooled
CULTIVAR				
V ₁	Arka Shashank	68.61	69.32	68.97
V ₂	Arka Archana	64.67	67.52	66.09
SEm SEm±		0.92	0.77	0.60
CD at 5%		1.86	1.55	1.19
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	60.85	60.95	60.9
F₂	N ₁₂₀ : P ₁₂₀	60.57	62.33	61.45
F₃	N ₁₂₀ : P ₁₄₀	64.60	63.57	64.08
F₄	N ₁₄₀ : P ₁₀₀	65.27	65.22	65.24
F₅	N ₁₄₀ : P ₁₂₀	65.82	67	66.41
F₆	N ₁₄₀ : P ₁₄₀	67.35	68.95	68.15
F₇	N ₁₆₀ : P ₁₀₀	68.53	70.43	69.48
F₈	N ₁₆₀ : P ₁₂₀	67.05	71.35	69.2
F₉	N ₁₆₀ : P ₁₄₀	68.2	72.42	70.31
F₁₀	N ₁₈₀ : P ₁₀₀	69.45	72.48	70.97
F₁₁	N ₁₈₀ : P ₁₂₀	70.88	72.6	71.74
F₁₂	N ₁₈₀ : P ₁₄₀	71.1	73.73	72.42
SEm SEm±		2.26	1.88	1.47
CD at 5%		4.55	3.79	2.92

Table 4.5.1 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Days to Bud Initiation

Treat.	Days to Bud Initiation			
	NP	2018-19	2019-20	Pooled
V ₁ F ₁		59.2	60.33	59.77
V ₁ F ₂		59.9	62.23	61.07
V ₁ F ₃		67	63.37	65.18
V ₁ F ₄		66.43	66.3	66.37
V ₁ F ₅		68.43	68.33	68.38
V ₁ F ₆		70.13	71.3	70.72
V ₁ F ₇		71.73	71.8	71.77
V ₁ F ₈		69.07	72.4	70.73
V ₁ F ₉		71.73	73.9	72.82
V ₁ F ₁₀		72	73.67	72.83
V ₁ F ₁₁		73.37	73.57	73.47
V ₁ F ₁₂		74.33	74.63	74.48
V ₂ F ₁		62.5	61.57	62.03
V ₂ F ₂		61.23	62.43	61.83
V ₂ F ₃		62.2	63.77	62.98
V ₂ F ₄		64.1	64.13	64.12
V ₂ F ₅		63.2	65.67	64.43
V ₂ F ₆		64.57	66.6	65.58
V ₂ F ₇		65.33	69.07	67.2
V ₂ F ₈		65.03	70.3	67.67
V ₂ F ₉		64.67	70.93	67.8
V ₂ F ₁₀		66.9	71.3	69.1
V ₂ F ₁₁		68.4	71.63	70.02
V ₂ F ₁₂		67.87	72.83	70.35
SEm		3.19	2.67	2.08
CD at 5%		NS	NS	NS



Interaction between both the cultivars and different levels of nitrogen and phosphorus showed non-significant variation on days to bud initiation in both the years as well as on pooled mean analysis.

The earlier bud initiation was observed in F₂ (N₁₂₀: P₁₂₀) in first year, while it was noticed in the treatment F₁ (N₁₂₀: P₁₀₀) during second as well as on pooled mean analysis respectively. It is quite obvious that an increase in different levels of nitrogen supply resulted in vigorous growth of the plants which delayed the bud formation and opening of the flowers as well. Similar findings were observed by (Mengel and Kirkby, 1987) and Gaikwad *et al.* (2004)

4.5.2. Days to 1st Flowering (days)

It is clear from the data presented in Table 4.5.2, 4.5.2 a and graphically presented in Fig 4.5.2 that the Days to 1st flowering was significantly influenced by different levels of nitrogen and phosphorus and cultivars.

In case of cultivars, there were found significant difference between Cultivars in both the years as well as on pooled mean analysis. Maximum days required for 1st flowering (79.05, 79.15, 79.10 days) respectively were observed in cultivar (V₁) Arka Shashank. Minimum days required for 1st flowering was observed in cultivar (V₂) Arka Archana (77.54, 78.29, 77.92 days) during both the tested years and on pooled mean data respectively.

In respect to different levels of nitrogen and phosphorus showed significant influence on days to 1st flowering during both the years and on pooled mean basis. The days to 1st flowering (71.37, 71.58 and 71.48 days) was earlier in treatment F₁ (N₁₂₀: P₁₂₀) which was found statistically *at par* with treatments F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀:P₁₂₀) during both the year and on pooled mean basis treatments. It was showed significant difference with rest of the other treatments. The maximum days (84.32, 84.6 and 84.46 days) required for 1st flowering were observed in treatment F₁₂ (N₁₈₀: P₁₄₀).

Interaction between both the cultivars and different levels of nitrogen and phosphorus were showed non-significant variation on days to bud 1st flowering in both the years as well as on pooled mean analysis.

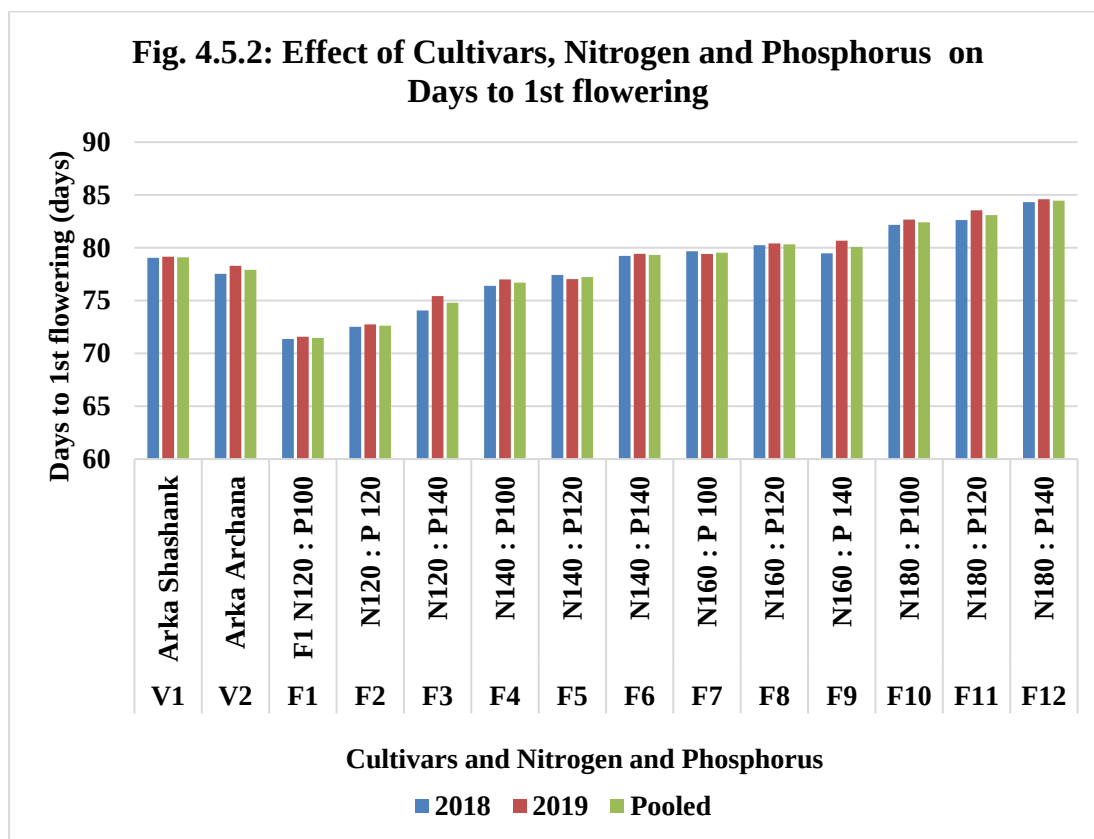
Earlier flowering was observed in F₁ (N₁₂₀: P₁₂₀). The increasing levels of N, P showed significant effect on days taken for first flower opening. Reduction in days taken for flowering due to low level of nitrogen and phosphorus was reported by Singatkar *et al.* (1995) in gaillardia. Early emergence of flower buds might be due to increased availability of nitrogen, easy uptake of nutrients and simultaneous transport of growth-promoting substances like cytokinin's to axillary buds, resulting in breakage of apical dominance and facilitated better sink for faster mobilization of photosynthates and early transformation of plant parts from vegetative to reproductive phase.

Table 4.5.2: Effect of Cultivars, Nitrogen and Phosphorus on Days to 1st flowering

Treat.		Days to 1st flowering (days)		
		2018-19	2019-20	Pooled
CULTIVAR				
V ₁	Arka Shashank	79.05	79.15	79.10
V ₂	Arka Archana	77.54	78.29	77.92
SEm SEm±		0.73	0.79	0.54
CD at 5%		1.47	1.58	1.06
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	71.37	71.58	71.48
F₂	N ₁₂₀ : P ₁₂₀	72.52	72.75	72.63
F₃	N ₁₂₀ : P ₁₄₀	74.07	75.43	74.8
F₄	N ₁₄₀ : P ₁₀₀	76.4	77	76.7
F₅	N ₁₄₀ : P ₁₂₀	77.43	77.03	77.23
F₆	N ₁₄₀ : P ₁₄₀	79.23	79.43	79.33
F₇	N ₁₆₀ : P ₁₀₀	79.67	79.42	79.54
F₈	N ₁₆₀ : P ₁₂₀	80.25	80.42	80.33
F₉	N ₁₆₀ : P ₁₄₀	79.48	80.67	80.08
F₁₀	N ₁₈₀ : P ₁₀₀	82.17	82.67	82.42
F₁₁	N ₁₈₀ : P ₁₂₀	82.63	83.55	83.09
F₁₂	N ₁₈₀ : P ₁₄₀	84.32	84.6	84.46
SEm SEm±		1.78	1.93	1.31
CD at 5%		3.59	3.88	2.61

Table 4.5.2 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Days to 1st flowering

Treat.	Days to 1 st flowering (days)		
	2018-19	2019-20	Pooled
NP			
V₁F₁	72.07	73.10	72.58
V₁F₂	74.00	73.80	73.9
V₁F₃	75.17	75.17	75.17
V₁F₄	76.87	77.77	77.32
V₁F₅	77.43	77.00	77.22
V₁F₆	79.97	80.47	80.22
V₁F₇	82.23	81.90	82.07
V₁F₈	82.43	81.17	81.8
V₁F₉	80.23	81.60	80.92
V₁F₁₀	82.4	81.67	82.03
V₁F₁₁	82.03	82.43	82.23
V₁F₁₂	83.77	83.73	83.75
V₂F₁	70.67	70.07	70.37
V₂F₂	71.03	71.70	71.37
V₂F₃	72.97	75.90	74.43
V₂F₄	75.93	76.23	76.08
V₂F₅	77.43	77.07	77.25
V₂F₆	78.5	78.40	78.45
V₂F₇	77.1	76.93	77.02
V₂F₈	78.07	79.67	78.87
V₂F₉	78.73	79.73	79.23
V₂F₁₀	81.93	83.67	82.80
V₂F₁₁	83.23	84.67	83.95
V₂F₁₂	84.87	85.47	85.17
SEm	2.52	2.72	1.86
CD at 5%	NS	NS	NS



4.5.3. Flowering Duration (Days)

The data on Flowering Duration were recorded and are presented in Table 4.5.3, 4.5.3 a and Fig. 4.5.3

Significantly, maximum flowering duration (31.01, 31.76, and 31.38 days) respectively were recorded in cultivar (V₁) Arka Shashank as compared to cultivar (V₂) Arka Archana (27.35, 27.56 and 27.45 days) respectively during both the tested years and on pooled mean data respectively.

It is vivid from the data that the flowering duration was significantly influenced by different levels of nitrogen and phosphorus during both the year and on pooled mean basis. The maximum flowering duration (32.82, 33.48 and 33.15 days) respectively was observed under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatment F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀).

Whereas, it was showed significant different with rest of the other treatments. The minimum flowering duration (26.06, 26.70 and 26.38 days) respectively was recorded in treatment F₁ (N₁₂₀: P₁₀₀).

The interaction between cultivar and different levels of nitrogen and phosphorus were found significant for first year as well as on pooled mean analysis. The maximum flowering duration (35.57 and 35.76 days) respectively were recorded under treatment combination (V₁F₁₁) during first year and on pooled mean basis. The minimum flowering duration (25.44 and 25.56 days) respectively was recorded in (V₂F₁) under first year and on pooled mean basis. Interaction effect was found non-significant for second year.

The duration of bloom of individual variety might be due to different genetic makeup of Cultivars and prevailing favourable environment. Similar findings were also noticed by Pattnaik and Mohanti (2002), Singh *et al.* (2003), Khanvilkar *et al.* (2003), Raet *al.* (2005) in African marigold, and Raghuvanshi and Sharma (2011) in French marigold.

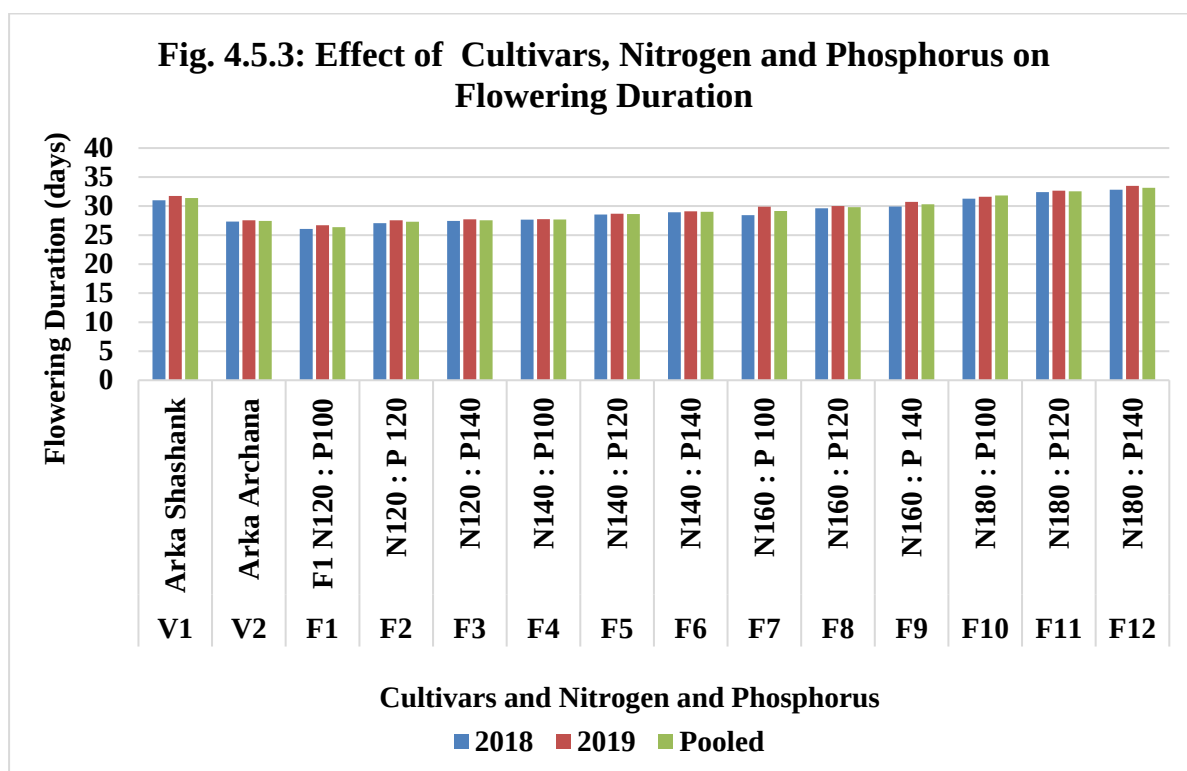
The maximum flowering duration was observed under treatment F₁₂(N₁₈₀: P₁₄₀). The prolonged duration of flowering significantly affected by the levels of fertilizer application. This may be due to the easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinins to axillary buds. The findings are in line with Narasimha and Haripriya, 2001 in crossandra, Ghormade, 2014 in China aster and Kishan *et al.* 2007 in marigold

Table 4.5.3: Effect of Cultivars, Nitrogen and Phosphorus on Flowering Duration

Treat.		Flowering Duration (days)		
	CULTIVAR	2018-19	2019-20	Pooled
V ₁	Arka Shashank	31.01	31.76	31.38
V ₂	Arka Archana	27.35	27.56	27.45
SEm SEm±		0.37	0.44	0.29
CD at 5%		0.75	0.88	0.57
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	26.06	26.70	26.38
F₂	N ₁₂₀ : P ₁₂₀	27.07	27.56	27.31
F₃	N ₁₂₀ : P ₁₄₀	27.44	27.71	27.57
F₄	N ₁₄₀ : P ₁₀₀	27.66	27.75	27.70
F₅	N ₁₄₀ : P ₁₂₀	28.54	28.69	28.62
F₆	N ₁₄₀ : P ₁₄₀	28.93	29.11	29.02
F₇	N ₁₆₀ : P ₁₀₀	28.43	29.89	29.16
F₈	N ₁₆₀ : P ₁₂₀	29.63	30.00	29.82
F₉	N ₁₆₀ : P ₁₄₀	29.92	30.72	30.32
F₁₀	N ₁₈₀ : P ₁₀₀	31.28	31.60	31.84
F₁₁	N ₁₈₀ : P ₁₂₀	32.41	32.66	32.54
F₁₂	N ₁₈₀ : P ₁₄₀	32.82	33.48	33.15
SEm SEm±		0.91	1.07	0.70
CD at 5%		1.84	2.15	1.39

Table 4.5.3 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Flowering Duration

Treat.	Phosphorus on Flowering Duration		
	Flowering Duration (days)		
NP	2018-19	2019-20	Pooled
V ₁ F ₁	26.67	27.72	27.20
V ₁ F ₂	28.10	29.08	28.59
V ₁ F ₃	28.65	29.01	28.83
V ₁ F ₄	28.37	29.17	28.77
V ₁ F ₅	29.40	30.47	29.94
V ₁ F ₆	30.56	31.03	30.79
V ₁ F ₇	31.18	32.47	31.83
V ₁ F ₈	31.23	32.31	31.77
V ₁ F ₉	32.93	33.25	33.09
V ₁ F ₁₀	34.31	34.35	34.33
V ₁ F ₁₁	35.57	35.94	35.76
V ₁ F ₁₂	35.11	36.28	35.69
V ₂ F ₁	25.44	25.67	25.56
V ₂ F ₂	26.03	26.04	26.04
V ₂ F ₃	26.22	26.41	26.31
V ₂ F ₄	26.94	26.34	26.64
V ₂ F ₅	27.67	26.92	27.29
V ₂ F ₆	27.29	27.19	27.24
V ₂ F ₇	25.67	27.30	26.49
V ₂ F ₈	28.02	27.69	27.86
V ₂ F ₉	26.92	28.19	27.55
V ₂ F ₁₀	28.26	28.86	28.56
V ₂ F ₁₁	29.25	29.38	29.32
V ₂ F ₁₂	30.53	30.69	30.61
SEm	1.29	1.51	0.99
CD at 5%	2.60	NS	1.97



4.5.4. No. of flowers per plant

The data on number of flowers per plant are presented in table 4.5.4, 4.5.4 a revealed that the cultivar and different levels of nitrogen and phosphorus and their interaction exhibited significant impact on number of flower per plant.

In, case of cultivars, they show significant influence on number of flowers per plant. The highest number of flowers (59.64, 61.92 and 60.78) respectively was observed in cultivar (V₂) Arka Archana. The lowest number of flowers per plant (52.90, 53.06 and 52.98) respectively was obtained from cultivar (V₁) Arka Shashank during both the years as well as on pooled mean basis.

As far as, application of different levels of nitrogen and phosphorus showed significant response on number of flowers per plant, during both the years as well as on pooled mean analysis. The maximum number of flowers (67.92, 67.88 and 67.90) respectively were recorded under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with F₁₁ (N₁₈₀: P₁₂₀) and it was observed significant difference with rest of the other treatments. The minimum number of flowers

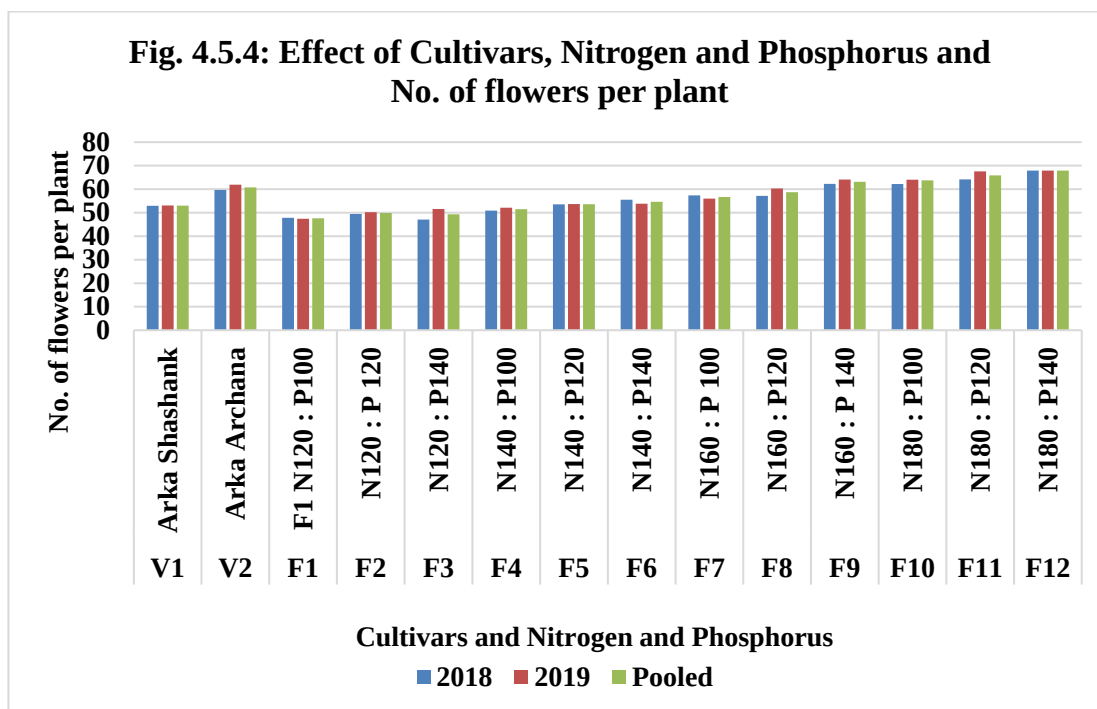
(47.84, 47.39 and 47.61) respectively was recorded under treatment F₁ (N₁₂₀: P₁₀₀) during this investigation.

Table 4.5.4: Effect of Cultivars, Nitrogen and Phosphorus on No. of flowers per plant

Treat.		No. of flowers per plant		
		2018-19	2019-20	Pooled
CULTIVAR				
V ₁	Arka Shashank	52.90	53.06	52.98
V ₂	Arka Archana	59.64	61.92	60.78
SEm SEm±		0.89	0.73	0.58
CD at 5%		1.80	1.47	1.14
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	47.84	47.39	47.61
F₂	N ₁₂₀ : P ₁₂₀	49.48	50.23	49.85
F₃	N ₁₂₀ : P ₁₄₀	47.06	51.57	49.31
F₄	N ₁₄₀ : P ₁₀₀	50.91	52.10	51.51
F₅	N ₁₄₀ : P ₁₂₀	53.55	53.70	53.62
F₆	N ₁₄₀ : P ₁₄₀	55.48	53.81	54.64
F₇	N ₁₆₀ : P ₁₀₀	57.36	55.98	56.67
F₈	N ₁₆₀ : P ₁₂₀	57.12	60.29	58.71
F₉	N ₁₆₀ : P ₁₄₀	62.22	64.07	63.14
F₁₀	N ₁₈₀ : P ₁₀₀	62.21	64.00	63.73
F₁₁	N ₁₈₀ : P ₁₂₀	64.13	67.59	65.86
F₁₂	N ₁₈₀ : P ₁₄₀	67.92	67.88	67.90
SEm SEm±		2.19	1.78	1.41
CD at 5%		4.40	3.59	2.80

Table 4.5.4 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on No. of flowers per plant

Treat.	No. of flowers per plant		
	NP	2018-19	2019-20
			Pooled
V₁F₁		42.99	43.73
V₁F₂		44.52	45.82
V₁F₃		45.40	46.53
V₁F₄		47.01	46.88
V₁F₅		50.88	47.38
V₁F₆		53.89	48.89
V₁F₇		55.07	51.56
V₁F₈		53.82	57.04
V₁F₉		54.64	59.99
V₁F₁₀		61.37	61.36
V₁F₁₁		62.15	63.17
V₁F₁₂		63.03	64.33
V₂F₁		52.68	51.04
V₂F₂		54.43	54.63
V₂F₃		48.72	56.60
V₂F₄		54.81	57.32
V₂F₅		56.21	60.02
V₂F₆		57.07	58.73
V₂F₇		59.64	60.41
V₂F₈		60.42	63.54
V₂F₉		69.80	68.14
V₂F₁₀		63.05	69.14
V₂F₁₁		66.11	72.00
V₂F₁₂		72.80	71.44
SEm		3.09	2.52
CD at 5%		NS	NS



The interaction between cultivar and application of different levels of nitrogen and phosphorus were found non-significant during both the years as well as on pooled mean analysis.

The two years results indicated that there was highly significant difference in number of flowers per plant within the Cultivars. The maximum number of flowers was obtained from Arka Archana. It could be stated that variation within the varieties for number of flowers per plant might be due to genotypic and environmental differences. Similar results were reported by Choudhary *et al.* (2013) Nursude *et al.* (2010), Beniwal and Dahiya (2012), Singh *et al.* (2004) and Singh and Misra (2009) in marigold.

The maximum number of flowers were recorded under treatment F₁₂ (N₁₈₀: P₁₄₀). More photosynthesis enhanced food accumulation which might have resulted in better growth and subsequently higher number of flowers per plant and hence, more number of flower yield per hectare. The results of the present study are in the conformity with those of Chandrikapure *et al.* 1999 and Vasudev *et al.*, 2010 in marigold.

4.5.5. Yield of flower per plant (g)

It was evident from data presented in Table 4.5.5, 4.5.5 a and Fig. 4.5.5, that there was a significant difference in respect to yield of flower per plant due to cultivars and different levels of nitrogen and phosphorus.

In case of cultivar, the maximum yield of flower per plant were observed in cultivar (V₂) Arka Archana (170.63, 174.01 and 172.32 g) and minimum yield of flower per plant (143.59, 148.75 and 146.17 g) respectively were recorded in cultivar (V₂) Arka Shashank in both the years as well as on pooled mean analysis.

In respect to different levels of nitrogen and phosphorus, the highest yield of flowers per plant (190.63, 195.24 and 192.93 g) was observed under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatment F₁₁(N₁₈₀: P₁₂₀) during both the years as well as on pooled mean analysis and it showed significant difference with rest of the other treatments. Whereas, the minimum yield of flowers per plant (128.07, 127.06 and 127.57 g) respectively was recorded under treatment F₁ (N₁₂₀: P₁₀₀)

The interaction between cultivars and application of different levels of nitrogen and phosphorus was found significant during both the years as well as on pooled mean basis under this investigation.

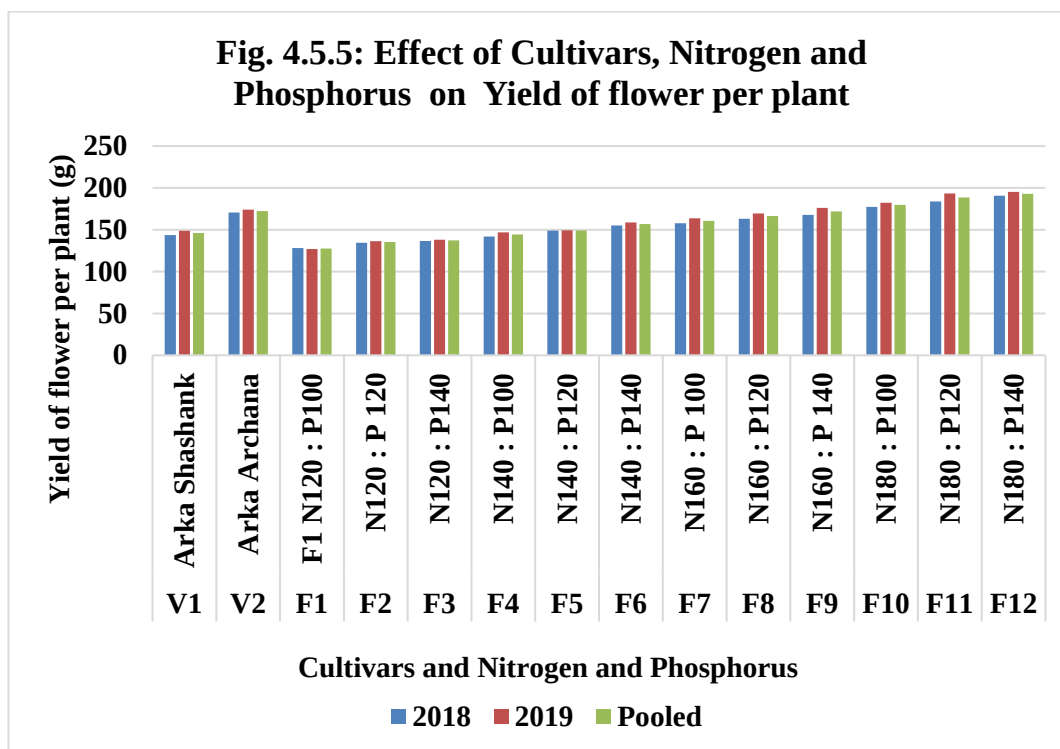
The highest yield of flowers per plant was observed under treatment F₁₂ (N₁₈₀: P₁₄₀). The increase in levels of N and P exerted the significant effect on flower yield. The increase in flower yield might be attributed to the greater leaf area and more number of leaves per plant as well as plant spread would have resulted in production and accumulation of maximum photosynthates, resulting the production of more number of flowers. Similar finding have been reported by Deshmukh *et al.* 2008 in *gaillardia*, Meshram *et al.* 2008 in *chrysanthemum*, Ravindra *et al.* 2013 and Maheta *et al.* 2016 in *China aster*.

Table 4.5.5: Effect of Cultivars, Nitrogen and Phosphorus on Yield of flower per plant

Treat.		Yield of flower per plant (g)		
		2018-19	2019-20	Pooled
CULTIVAR				
V ₁	Arka Shashank	143.59	148.75	146.17
V ₂	Arka Archana	170.63	174.01	172.32
SEm SEm±		1.66	1.46	1.11
CD at 5%		3.35	2.94	2.20
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	128.07	127.06	127.57
F₂	N ₁₂₀ : P ₁₂₀	134.39	136.31	135.35
F₃	N ₁₂₀ : P ₁₄₀	136.46	138.10	137.28
F₄	N ₁₄₀ : P ₁₀₀	141.92	146.92	144.42
F₅	N ₁₄₀ : P ₁₂₀	148.99	149.35	149.17
F₆	N ₁₄₀ : P ₁₄₀	155.03	158.79	156.91
F₇	N ₁₆₀ : P ₁₀₀	157.87	163.62	160.74
F₈	N ₁₆₀ : P ₁₂₀	163.18	169.49	166.33
F₉	N ₁₆₀ : P ₁₄₀	167.73	176.21	171.97
F₁₀	N ₁₈₀ : P ₁₀₀	177.25	182.18	179.71
F₁₁	N ₁₈₀ : P ₁₂₀	183.86	193.31	188.58
F₁₂	N ₁₈₀ : P ₁₄₀	190.63	195.24	192.93
SEm SEm±		4.08	3.58	2.71
CD at 5%		8.20	7.21	5.39

Table 4.5.5 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Yield of flower per plant

Treat.	Yield of flower per plant (g)		
	NP	2018-19	2019-20
			Pooled
V ₁ F ₁		112.53	110.92
V ₁ F ₂		119.94	118.85
V ₁ F ₃		122.99	124.58
V ₁ F ₄		129.92	133.53
V ₁ F ₅		133.13	133.00
V ₁ F ₆		138.51	144.63
V ₁ F ₇		140.42	150.66
V ₁ F ₈		146.19	157.69
V ₁ F ₉		151.03	168.88
V ₁ F ₁₀		165.36	175.76
V ₁ F ₁₁		177.42	181.98
V ₁ F ₁₂		185.65	184.54
V ₂ F ₁		143.62	143.20
V ₂ F ₂		148.83	153.77
V ₂ F ₃		149.92	151.63
V ₂ F ₄		153.91	160.30
V ₂ F ₅		164.84	165.71
V ₂ F ₆		171.55	172.96
V ₂ F ₇		175.31	176.57
V ₂ F ₈		180.16	181.30
V ₂ F ₉		184.43	183.54
V ₂ F ₁₀		189.14	188.59
V ₂ F ₁₁		190.29	204.63
V ₂ F ₁₂		195.60	205.94
SEm		5.76	5.06
CD at 5%		NS	NS



4.5.6. Yield of flower per plot (kg)

It was evident from data presented in Table 4.5.6, 4.5.6 a and Fig. 4.5.6, that there was a significant difference in respect to yield of flower per plot due to cultivars and different levels of nitrogen and phosphorus.

In case of cultivar, the maximum yield of flower per plot were observed in cultivar (V₂) Arka Archana (4.30, 4.44 and 4.34 kg) and minimum yield of flower per plant (3.61, 3.70 and 3.60 kg) respectively were recorded in cultivar (V₂) Arka Shashank in both the years as well as on pooled mean analysis.

In respect to different levels of nitrogen and phosphorus, the highest yield of flowers per plot (4.87, 5.00 and 4.90 kg) was observed under treatment F₁₂(N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatment F₁₁(N₁₈₀: P₁₂₀) during both the years as well as on pooled mean analysis and it showed significant effect with rest of the other treatments . Whereas, the minimum yield of flowers

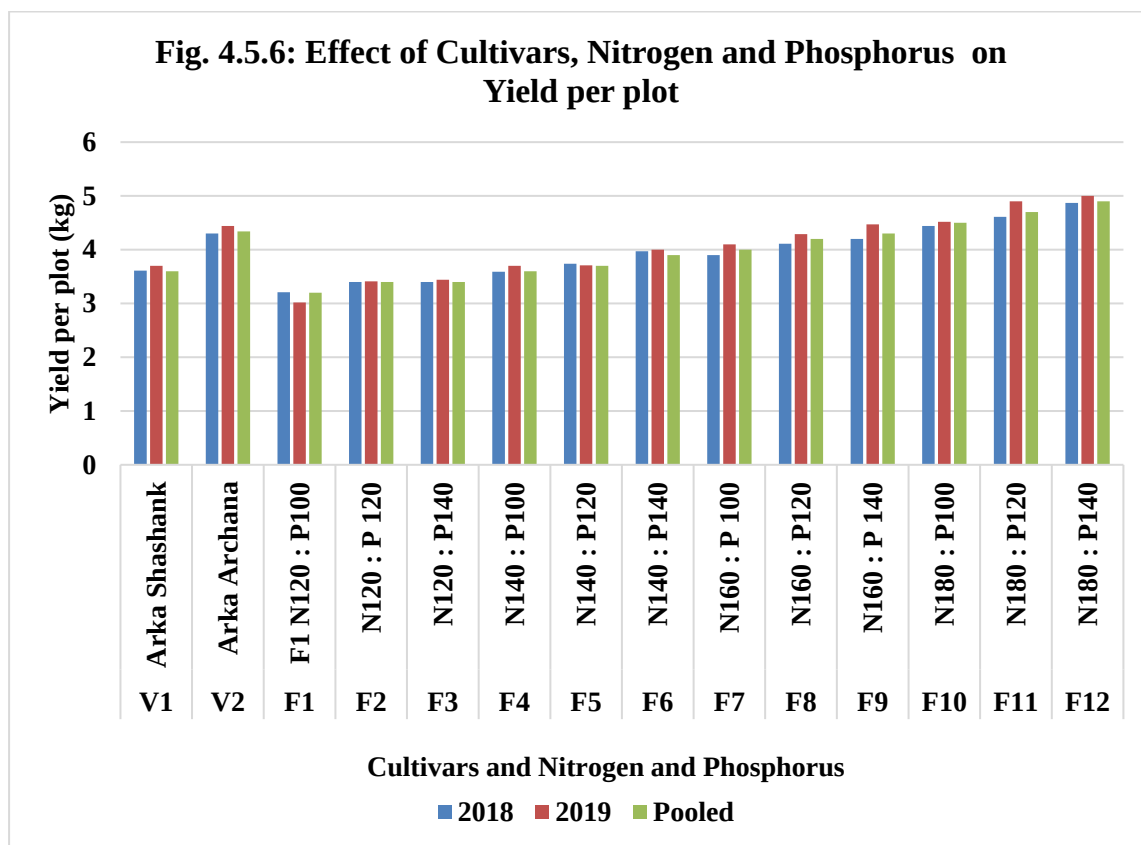
per plot (3.21, 3.02 and 3.20 kg) respectively was recorded under treatment F₁ (N₁₂₀: P₁₀₀).

Table 4.5.6: Effect of Cultivars, Nitrogen and Phosphorus on Yield per plot

Treat.		Yield per plot (kg)		
	CULTIVAR	2018-19	2019-20	Pooled
V ₁	Arka Shashank	3.61	3.70	3.6
V ₂	Arka Archana	4.30	4.44	4.34
SEm SEm±		0.04	0.03	0.02
CD at 5%		0.08	0.07	0.05
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	3.21	3.02	3.2
F₂	N ₁₂₀ : P ₁₂₀	3.40	3.41	3.4
F₃	N ₁₂₀ : P ₁₄₀	3.40	3.44	3.4
F₄	N ₁₄₀ : P ₁₀₀	3.59	3.70	3.6
F₅	N ₁₄₀ : P ₁₂₀	3.74	3.71	3.7
F₆	N ₁₄₀ : P ₁₄₀	3.97	4.00	3.9
F₇	N ₁₆₀ : P ₁₀₀	3.90	4.10	4.0
F₈	N ₁₆₀ : P ₁₂₀	4.11	4.29	4.2
F₉	N ₁₆₀ : P ₁₄₀	4.20	4.47	4.3
F₁₀	N ₁₈₀ : P ₁₀₀	4.44	4.52	4.5
F₁₁	N ₁₈₀ : P ₁₂₀	4.61	4.90	4.7
F₁₂	N ₁₈₀ : P ₁₄₀	4.87	5.00	4.9
SEm SEm±		0.10	0.09	0.06
CD at 5%		0.20	0.19	0.14

Table 4.5.6 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Yield per plot

Treat.	Yield per plot (kg)		
	2018-19	2019-20	Pooled
NP			
V₁F₁	2.80	2.76	2.786667
V₁F₂	2.99	2.96	2.98
V₁F₃	3.07	3.11	3.09
V₁F₄	3.24	3.33	3.28
V₁F₅	3.32	3.32	3.32
V₁F₆	3.45	3.61	3.53
V₁F₇	3.50	3.76	3.63
V₁F₈	3.65	3.93	3.79
V₁F₉	3.77	4.22	3.99
V₁F₁₀	4.13	4.38	4.25
V₁F₁₁	4.43	4.54	4.48
V₁F₁₂	4.63	4.61	4.62
V₂F₁	3.58	3.57	3.58
V₂F₂	3.71	3.83	3.77
V₂F₃	3.74	3.78	3.76
V₂F₄	3.84	4.00	3.92
V₂F₅	4.11	4.13	4.12
V₂F₆	4.28	4.31	4.30
V₂F₇	4.37	4.41	4.39
V₂F₈	4.5	4.52	4.51
V₂F₉	4.60	4.58	4.59
V₂F₁₀	4.72	4.70	4.71
V₂F₁₁	4.75	5.19	4.97
V₂F₁₂	4.88	5.31	5.09
SEm	0.14	0.13	0.09
CD at 5%	NS	NS	NS



The interaction between cultivars and application of n different levels of nitrogen and phosphorus was found significant during both the years as well as on pooled mean basis under this investigation.

4.5.7. Yield of flower per hectare (qt/ha)

It was evident from data presented in Table 4.5.7, 4.5.7 a and Fig. 4.5.7, that there was a significant difference in respect to yield of flower per hectare due to cultivars and different levels of nitrogen and phosphorus.

In case of cultivar, the maximum yield of flower per hectare were observed in cultivar (V₂) Arka Archana (18.90, 19.40 and 19.20 qt/ha) and minimum yield of flower hectare (15.90, 16.50 and 16.20 qt/ha) respectively were recorded in cultivar (V₁) Arka Shashank in both the years as well as on pooled mean analysis.

In respect to different levels of nitrogen and phosphorus, the highest yield of flowers per hectare (21.20, 22.10 and 21.60 qt/ha) was observed under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatment F₁₁ (N₁₈₀:

P₁₂₀) during both the years as well as on pooled mean analysis and it was showed significant difference with rest of the other treatments. Whereas, the minimum yield of flowers per hectare (14.20, 14.10 and 14.20 qt/ha) respectively was recorded under treatment F₁ (N₁₂₀: P₁₀₀).

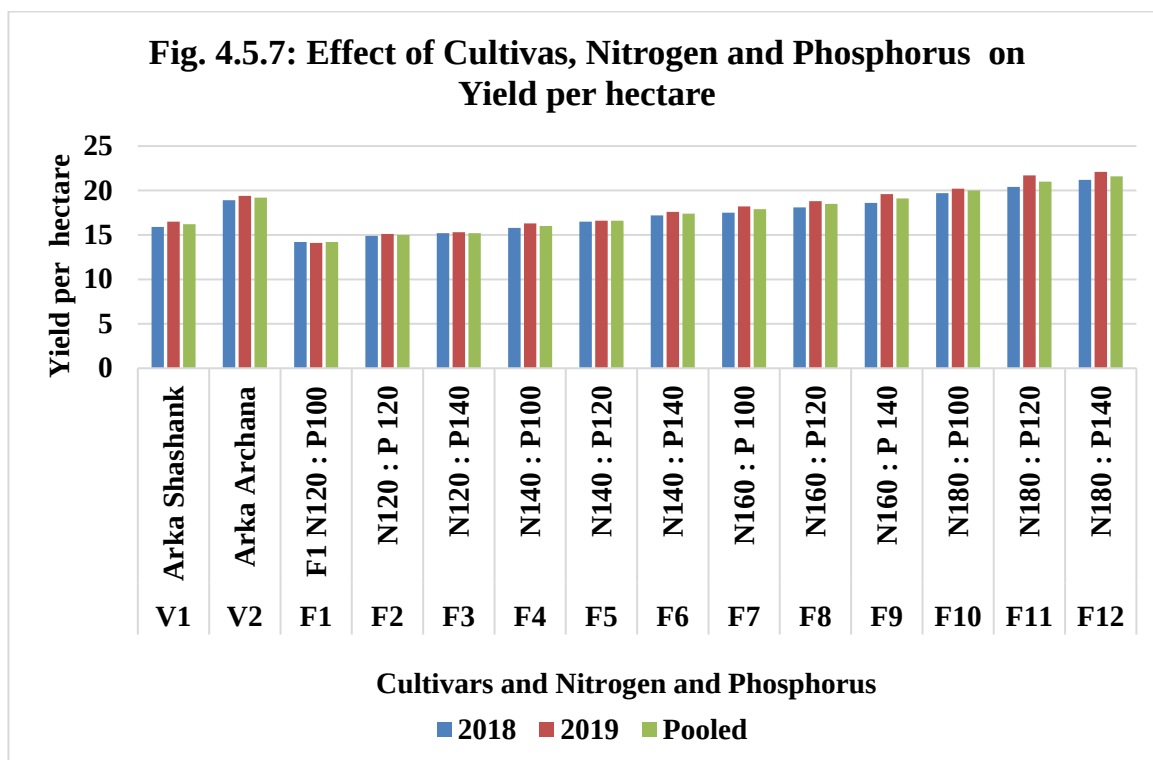
The interaction between cultivars and application of different levels of nitrogen and phosphorus was found significant during both the years as well as on pooled mean basis under this investigation.

Table 4.5.7: Effect of Cultivars, Nitrogen and Phosphorus on Yield per hectare

Treat.		Yield per hectare (qt/ha)		
	CULTIVAR	2018-19	2019-20	Pooled
V ₁	Arka Shashank	15.90	16.50	16.20
V ₂	Arka Archana	18.90	19.40	19.20
SEm SEm±		0.45	0.42	0.30
CD at 5%		0.91	0.84	0.62
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	14.20	14.10	14.20
F₂	N ₁₂₀ : P ₁₂₀	14.90	15.10	15.00
F₃	N ₁₂₀ : P ₁₄₀	15.20	15.30	15.20
F₄	N ₁₄₀ : P ₁₀₀	15.80	16.30	16.00
F₅	N ₁₄₀ : P ₁₂₀	16.50	16.60	16.60
F₆	N ₁₄₀ : P ₁₄₀	17.20	17.60	17.40
F₇	N ₁₆₀ : P ₁₀₀	17.50	18.20	17.90
F₈	N ₁₆₀ : P ₁₂₀	18.10	18.80	18.50
F₉	N ₁₆₀ : P ₁₄₀	18.60	19.60	19.10
F₁₀	N ₁₈₀ : P ₁₀₀	19.70	20.20	20.00
F₁₁	N ₁₈₀ : P ₁₂₀	20.40	21.70	21.00
F₁₂	N ₁₈₀ : P ₁₄₀	21.20	22.10	21.60
SEm SEm±		0.18	0.17	0.12
CD at 5%		0.37	0.34	0.25

Table 4.5.7: Interaction effect of Cultivars, Nitrogen and Phosphorus on Yield per hectare

Treat.	Phosphorus on Yield per hectare		
	Yield per hectare (qt/ha)		
NP	2018-19	2019-20	Pooled
V ₁ F ₁	12.49	12.31	12.40
V ₁ F ₂	13.32	13.2	13.26
V ₁ F ₃	13.66	13.83	13.74
V ₁ F ₄	14.43	14.83	14.63
V ₁ F ₅	14.78	14.77	14.77
V ₁ F ₆	15.38	16.06	15.72
V ₁ F ₇	15.59	16.73	16.16
V ₁ F ₈	16.23	17.51	16.87
V ₁ F ₉	16.77	18.76	17.76
V ₁ F ₁₀	18.36	19.52	18.94
V ₁ F ₁₁	19.70	20.21	19.96
V ₁ F ₁₂	20.62	20.49	20.55
V ₂ F ₁	15.95	15.90	15.92
V ₂ F ₂	16.53	17.08	16.80
V ₂ F ₃	16.65	16.84	16.74
V ₂ F ₄	17.09	17.8	17.44
V ₂ F ₅	18.31	18.40	18.35
V ₂ F ₆	19.05	19.21	19.13
V ₂ F ₇	19.47	19.61	19.54
V ₂ F ₈	20.00	20.14	20.07
V ₂ F ₉	20.46	20.39	20.42
V ₂ F ₁₀	21.00	20.95	20.97
V ₂ F ₁₁	21.13	23.10	22.12
V ₂ F ₁₂	21.72	23.61	22.67
SEm	0.64	0.59	0.43
CD at 5%	NS	NS	NS



4.6. Quality characters

4.6.1. Stalk length (cm)

It is clear from the data presented in Table 4.6.1, 4.6.1 a and graphically presented in Fig-4.6.1 that the Stalk length was significantly influenced by cultivars and different levels of nitrogen and phosphorus.

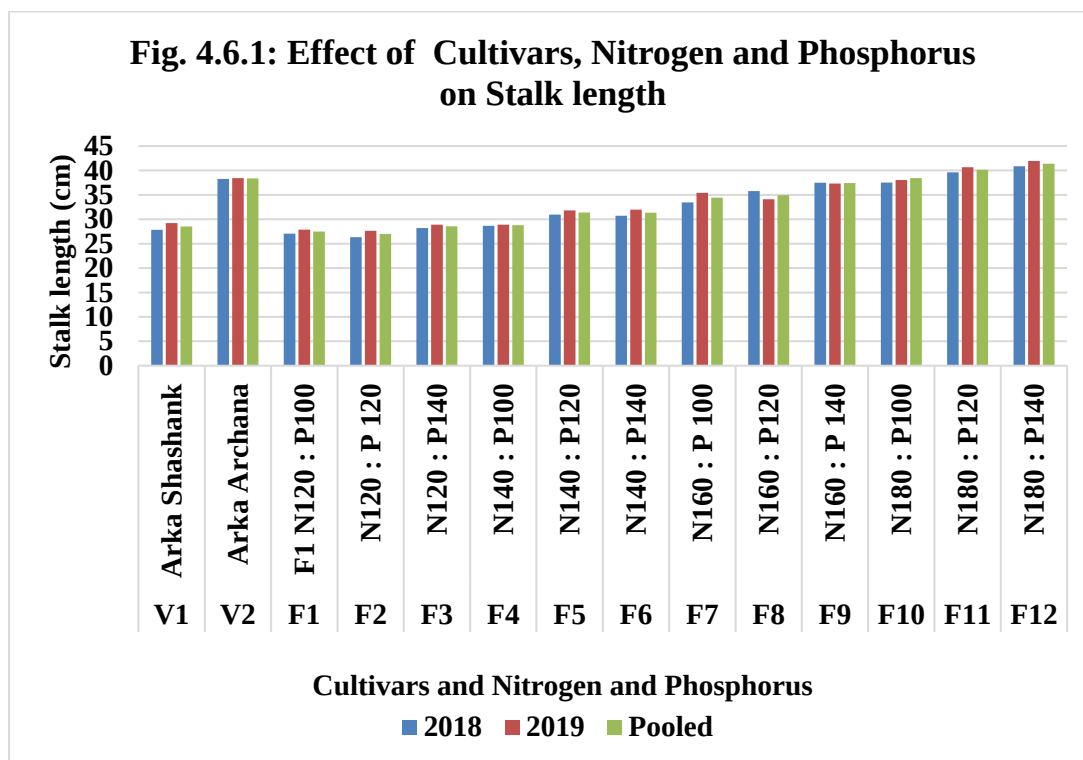
Amongst the cultivars of China aster, differs significantly on stalk length. The highest stalk length were observed in cultivar (V₁) Arka Shashank (38.28, 38.44 and 38.36 cm) respectively. The lowest stalk length (27.83, 29.21, 28.52cm) respectively was obtained from cultivar (V₂) Arka Archana in both the years as well as on pooled mean basis.

Table 4.6.1: Effect of Cultivars, Nitrogen and Phosphorus on Stalk length

Treat.		Stalk length (cm)		
		2018-19	2019-20	Pooled
CULTIVAR				
V ₁	Arka Shashank	27.83	29.21	28.52
V ₂	Arka Archana	38.28	38.44	38.36
SEm SEm±		0.60	0.77	0.49
CD at 5%		1.21	1.55	0.97
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	27.07	27.89	27.48
F₂	N ₁₂₀ : P ₁₂₀	26.32	27.65	26.98
F₃	N ₁₂₀ : P ₁₄₀	28.20	28.90	28.55
F₄	N ₁₄₀ : P ₁₀₀	28.65	28.90	28.78
F₅	N ₁₄₀ : P ₁₂₀	30.95	31.80	31.38
F₆	N ₁₄₀ : P ₁₄₀	30.73	31.97	31.35
F₇	N ₁₆₀ : P ₁₀₀	33.45	35.43	34.44
F₈	N ₁₆₀ : P ₁₂₀	35.78	34.10	34.94
F₉	N ₁₆₀ : P ₁₄₀	37.48	37.33	37.41
F₁₀	N ₁₈₀ : P ₁₀₀	37.52	38.05	38.43
F₁₁	N ₁₈₀ : P ₁₂₀	39.60	40.67	40.13
F₁₂	N ₁₈₀ : P ₁₄₀	40.85	41.95	41.40
SEm SEm±		1.47	1.89	1.20
CD at 5%		2.96	3.81	2.38

Table 4.6.1 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Stalk length

Treat .	Stalk length (cm)		
	NP	2018-19	2019-20
			Pooled
V ₁ F ₁		21.93	22.77
V ₁ F ₂		22.57	23.53
V ₁ F ₃		23.23	24.34
V ₁ F ₄		23.07	25.44
V ₁ F ₅		26.77	27.74
V ₁ F ₆		23.27	26.13
V ₁ F ₇		30.73	32.97
V ₁ F ₈		28.53	27.77
V ₁ F ₉		31.13	32.59
V ₁ F ₁₀		33.03	34.93
V ₁ F ₁₁		34.57	35.67
V ₁ F ₁₂		35.07	36.67
V ₂ F ₁		32.20	33.00
V ₂ F ₂		30.07	31.77
V ₂ F ₃		33.17	33.47
V ₂ F ₄		34.23	32.37
V ₂ F ₅		35.13	35.87
V ₂ F ₆		38.20	37.80
V ₂ F ₇		36.17	37.90
V ₂ F ₈		43.03	40.43
V ₂ F ₉		43.83	42.07
V ₂ F ₁₀		42.00	43.77
V ₂ F ₁₁		44.63	45.67
V ₂ F ₁₂		46.63	47.23
SEm		2.08	2.67
CD at 5%		NS	NS



The persual data showed that the different levels of nitrogen and phosphorus showed significant response on stalk length, during both the years as well as on pooled mean analysis. The maximum stalk length (40.85, 41.95 and 41.40 cm) respectively were recorded under treatment F₁₂(N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatment F₁₁(N₁₈₀: P₁₂₀). Whereas, it was showed significant different with rest of the other treatments. The minimum stalk length (27.07, 27.89 and 27.48 cm) respectively was noticed in treatment F₁ (N₁₂₀: P₁₀₀) in both the years and on pooled mean basis.

The interaction between cultivar and different levels of nitrogen and phosphorus were found non-significant during both the years as well as on pooled mean analysis.

With respect to cut flower stalk length, the F₁₂ (N₁₈₀: P₁₄₀) were found superior over other fertilizer levels. The higher stalk length of flowers was observed in F₁₂ (N₁₈₀: P₁₄₀) might be due to the utilization of higher amount of nutrients which increases the stalk length. Similar results were obtained by

Rachayanavar (1983) in chrysanthemum, where increased fertilizer levels resulted in better size of flowers Komosa (1978) and Hosoya *et al.* (1978) in china aster.

4.6.2. Fresh weight of 10 flowers (g)

It is clear from the data presented in Table 4.6.2, 4.6.2 a and graphically presented in Fig-4.6.2 that the fresh weight of flowers was significantly influenced by cultivars and different levels of nitrogen and phosphorus

Cultivars differ significantly on fresh weight of ten flowers. The highest fresh weight of flowers (40.15, 41.08 and 40.61 g) respectively was observed in cultivar (V₂) Arka Archana. The minimum fresh weight of ten flowers was obtained from cultivar (V₂) Arka Shashank (30.61, 33.10 and 31.85 g) respectively in both the years as well as on pooled mean basis.

The data in respect to different levels of nitrogen and phosphorus showed that there is significant response on fresh weight of 10 flowers during both the years as well as on pooled mean analysis. The maximum fresh weight of 10 flowers (40.61, 41.86 and 41.23 g) respectively were recorded under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatments F₉ (N₁₆₀: P₁₄₀), F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) and it was observed significant difference with remaining all other treatments during both the tested year as well as on pooled mean basis. The minimum fresh weight of ten flowers (28.69, 29.66 and 29.17 g) respectively was recorded in treatment F₁ (N₁₂₀: P₁₀₀).

The interaction between cultivars and different levels of nitrogen and phosphorus was found non-significant during both the years of the investigation.

The enhancement in the weight of individual flower head might be due to proper utilization of nutrients in protein synthesis and carbohydrate assimilation. Monish

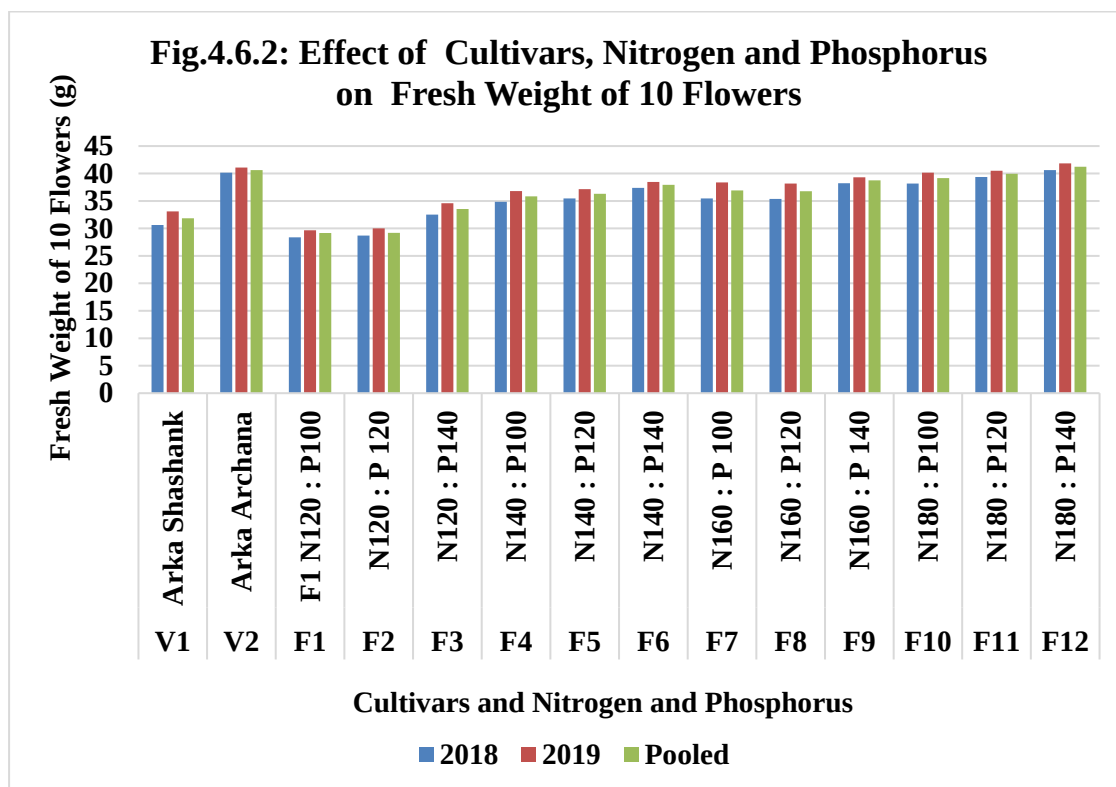
et al. (2008) also stated that application of different levels of nitrogen at their higher levels resulted in large sized flower. Abundant supply of nitrogen at higher level might have accelerated the photosynthetic activities of plants and more assimilates may have translocated into flowers to develop, resulting in increased fresh weight of flowers.

Table 4.6.2: Effect of Cultivars, Nitrogen and Phosphorus on Fresh Weight of 10 Flowers

Treat.		Fresh Weight of 10 Flowers (g)		
		2018-19	2019-20	Pooled
CULTIVAR				
V ₁	Arka Shashank	30.61	33.10	31.85
V ₂	Arka Archana	40.15	41.08	40.61
SEm SEm±		0.69	0.67	0.48
CD at 5%		1.39	1.35	0.96
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	28.37	29.66	29.17
F₂	N ₁₂₀ : P ₁₂₀	28.69	30.00	29.19
F₃	N ₁₂₀ : P ₁₄₀	32.51	34.60	33.55
F₄	N ₁₄₀ : P ₁₀₀	34.86	36.81	35.84
F₅	N ₁₄₀ : P ₁₂₀	35.45	37.15	36.30
F₆	N ₁₄₀ : P ₁₄₀	37.40	38.48	37.94
F₇	N ₁₆₀ : P ₁₀₀	35.47	38.39	36.93
F₈	N ₁₆₀ : P ₁₂₀	35.39	38.17	36.78
F₉	N ₁₆₀ : P ₁₄₀	38.24	39.30	38.77
F₁₀	N ₁₈₀ : P ₁₀₀	38.16	40.17	39.16
F₁₁	N ₁₈₀ : P ₁₂₀	39.37	40.51	39.94
F₁₂	N ₁₈₀ : P ₁₄₀	40.61	41.86	41.23
SEm SEm±		1.70	1.64	1.18
CD at 5%		3.41	3.31	2.34

Table 4.6.2 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Fresh Weight of 10 Flowers

Treat.	Fresh Weight of 10 Flowers (g)			
	NP	2018-19	2019-20	Pooled
V ₁ F ₁		25.09	25.39	25.24
V ₁ F ₂		26.96	28.32	27.64
V ₁ F ₃		29.69	31.46	30.57
V ₁ F ₄		30.46	32.72	31.59
V ₁ F ₅		30.63	33.02	31.83
V ₁ F ₆		31.80	34.06	32.93
V ₁ F ₇		30.02	34.80	32.41
V ₁ F ₈		31.63	35.40	33.52
V ₁ F ₉		31.65	35.33	33.49
V ₁ F ₁₀		32.22	35.47	33.85
V ₁ F ₁₁		33.40	35.07	34.24
V ₁ F ₁₂		33.72	36.18	34.95
V ₂ F ₁		32.28	33.93	33.11
V ₂ F ₂		29.79	31.68	30.73
V ₂ F ₃		35.34	37.73	36.54
V ₂ F ₄		39.26	40.90	40.08
V ₂ F ₅		40.26	41.29	40.78
V ₂ F ₆		43.00	42.89	42.94
V ₂ F ₇		40.92	41.98	41.45
V ₂ F ₈		39.14	40.94	40.04
V ₂ F ₉		44.83	43.27	44.05
V ₂ F ₁₀		44.10	44.86	44.48
V ₂ F ₁₁		45.33	45.94	45.64
V ₂ F ₁₂		47.50	47.53	47.52
SEm		2.40	2.32	1.67
CD at 5%		NS	NS	NS



4.6.3. Total weight of fresh flowers per plant (g/plant)

It is clear from the data presented in Table 4.6.3, 4.6.3 a and graphically presented in Fig 4.6.3 that the total weight of fresh flowers per plant was significantly influenced by different levels of nitrogen and phosphorus and cultivars.

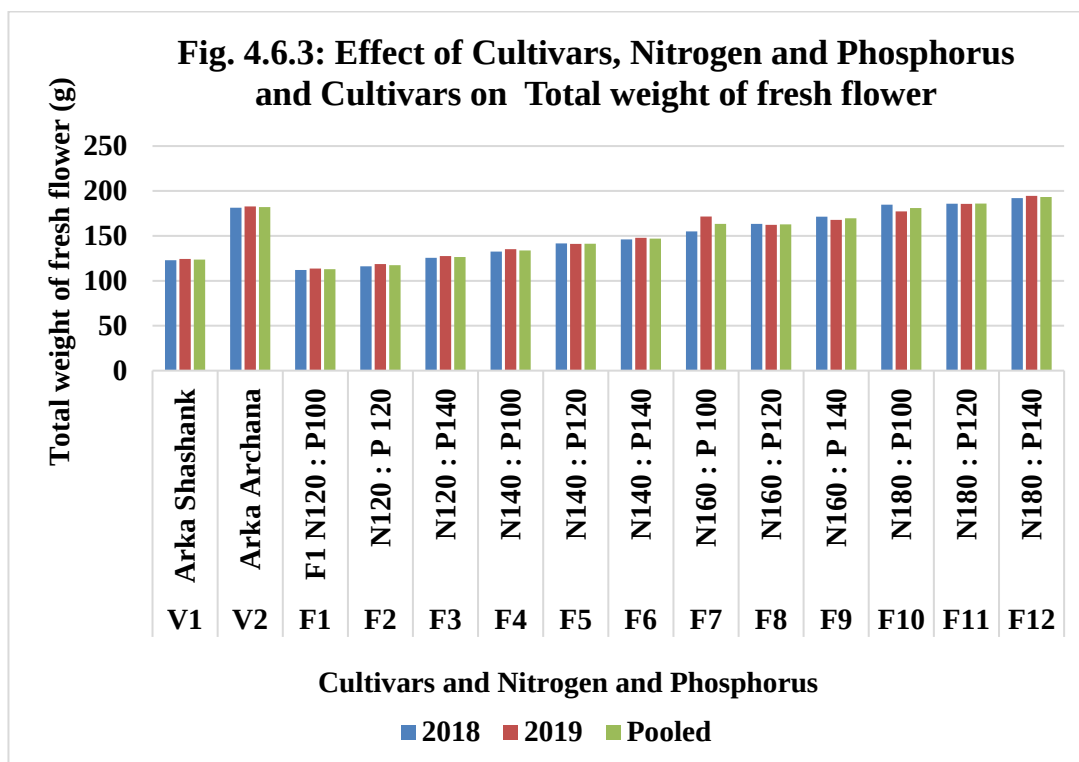
Cultivars differ significantly on total weight of fresh flowers. The highest total weight of fresh flowers per plant (181.39, 182.81 and 182.10 g/plant) respectively was observed in cultivar (V₂) Arka Archana. The minimum total weight of fresh flowers per plant was obtained from cultivar (V₂) Arka Shashank (122.93, 124.39 and 123.66 g/plant) respectively in both the years as well as on pooled mean basis.

Table 4.6.3: Effect of Cultivars, Nitrogen and Phosphorus on Total weight of fresh flower

Treat.		Total weight of fresh flower (g)		
CULTIVAR		2018-19	2019-20	Pooled
V ₁	Arka Shashank	122.93	124.39	123.66
V ₂	Arka Archana	181.39	182.81	182.10
SEm SEm±		1.95	2.26	1.49
CD at 5%		3.92	4.56	2.97
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	111.97	113.73	112.85
F₂	N ₁₂₀ : P ₁₂₀	116.17	118.72	117.45
F₃	N ₁₂₀ : P ₁₄₀	125.50	127.57	126.54
F₄	N ₁₄₀ : P ₁₀₀	132.50	135.20	133.85
F₅	N ₁₄₀ : P ₁₂₀	141.57	141.09	141.33
F₆	N ₁₄₀ : P ₁₄₀	146.03	147.88	146.95
F₇	N ₁₆₀ : P ₁₀₀	154.99	171.63	163.31
F₈	N ₁₆₀ : P ₁₂₀	163.32	162.30	162.81
F₉	N ₁₆₀ : P ₁₄₀	171.34	167.76	169.55
F₁₀	N ₁₈₀ : P ₁₀₀	184.75	177.25	181.00
F₁₁	N ₁₈₀ : P ₁₂₀	185.79	185.59	185.99
F₁₂	N ₁₈₀ : P ₁₄₀	191.97	194.47	193.22
SEm SEm±		4.77	5.55	3.66
CD at 5%		9.60	11.17	7.26

Table 4.6.3 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Total weight of fresh flower

Treat.	Total weight of fresh flower (g)		
NP	2018-19	2019-20	Pooled
V ₁ F ₁	82.30	81.81	82.06
V ₁ F ₂	86.92	89.40	88.16
V ₁ F ₃	99.32	101.46	100.39
V ₁ F ₄	107.00	110.47	108.73
V ₁ F ₅	120.51	117.54	119.03
V ₁ F ₆	120.74	123.73	122.23
V ₁ F ₇	131.27	132.81	132.04
V ₁ F ₈	136.57	137.58	137.08
V ₁ F ₉	140.78	143.66	142.22
V ₁ F ₁₀	147.72	146.38	147.05
V ₁ F ₁₁	147.32	150.91	149.12
V ₁ F ₁₂	154.68	156.92	155.80
V ₂ F ₁	141.64	145.65	143.65
V ₂ F ₂	145.42	148.04	146.73
V ₂ F ₃	151.68	153.68	152.68
V ₂ F ₄	157.99	159.92	158.96
V ₂ F ₅	162.63	164.64	163.63
V ₂ F ₆	171.31	172.03	171.67
V ₂ F ₇	178.72	210.44	194.58
V ₂ F ₈	190.07	187.03	188.55
V ₂ F ₉	201.90	191.86	196.88
V ₂ F ₁₀	221.79	208.11	214.95
V ₂ F ₁₁	224.25	220.27	222.26
V ₂ F ₁₂	229.25	232.01	230.63
SEm	6.74	7.84	5.17
CD at 5%	13.57	NS	10.27



The Perusal of data showed that the different levels of nitrogen and phosphorus showed significant response on total weight of fresh flowers per plant, during both the years as well as on pooled mean analysis. The maximum total weight of fresh flowers per plant (191.97, 194.47 and 193.22 g/plant) respectively were recorded under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatments F₁₀ (N₁₈₀: P₁₀₀) and F₁₁(N₁₈₀: P₁₂₀) during first year. However, during second year and pooled mean basis, it was observed similar with treatment F₁₁(N₁₈₀: P₁₂₀) only. Whereas, it was showed significant different with rest of the other treatments during first year, second year and on pooled mean basis. The minimum total weight of fresh flowers per plant (111.97, 113.73 and 112.85 g/plant) respectively was recorded in treatment F₁ (N₁₂₀: P₁₀₀).

The interaction between cultivar and different levels of nitrogen and phosphorus were found significant impact on total weight of fresh flowers. The maximum total weight of fresh flowers per plant (229.25 and 230.63 g/plant) respectively were recorded under treatment combination (V₂F₁₂) and it was observed statistically similar with treatment combination (V₂F₁₀) and (V₂F₁₁) during first year and

treatment combination (V₂F₁₁) in pooled mean basis and it was noticed significant difference with rest of the other treatments combination during first year and on pooled mean basis. The minimum total weight of fresh flowers per plant (82.30 and 82.06 g/plant) respectively was recorded in (V₂F₁) under first year and on pooled mean basis. Interaction effect was found non-significant for second year.

4.6.4. Dry weight of 10 flowers (g)

It was evident from data presented in Table 4.6.4, 4.6.4 a and Fig. 4.6.4 that there was a significant difference in respect to dry weight of flowers due to cultivars and different levels of nitrogen and phosphorus.

Cultivars differ significantly on dry weight of flowers. The highest dry weight of 10 flowers (16.81, 16.42 and 16.61 g) respectively was observed in cultivar (V₂) Arka Archana. The minimum dry weight of 10 flowers was obtained from cultivar (V₁) Arka Shashank (12.17, 12.30 and 12.23 g) respectively in both the years as well as on pooled mean basis.

The vivid data showed that the different levels of nitrogen and phosphorus showed significant response on dry weight of 10 flowers, during both the years as well as on pooled mean analysis. The maximum dry weight of flowers (20.52, 20.26 and 20.38 g) respectively were recorded under treatment F₁₂ (N₁₈₀: P₁₄₀) which was found statistically *at par* with treatment F₁₁(N₁₈₀: P₁₂₀) and it was observed significant difference with remaining all other treatments during both the years and on pooled mean basis. The minimum dry weight of 10 flowers (9.18, 8.97 and 9.07 g) respectively was recorded in treatment F₁ (N₁₂₀: P₁₀₀).

The interaction between cultivar and different levels of nitrogen and phosphorus were found significant during both the year as well as on pooled mean analysis. The maximum dry weight of 10 flowers (23.89, 22.26 and 23.58 g) respectively were recorded under treatment combination (V₂F₁₂) which was found statistically

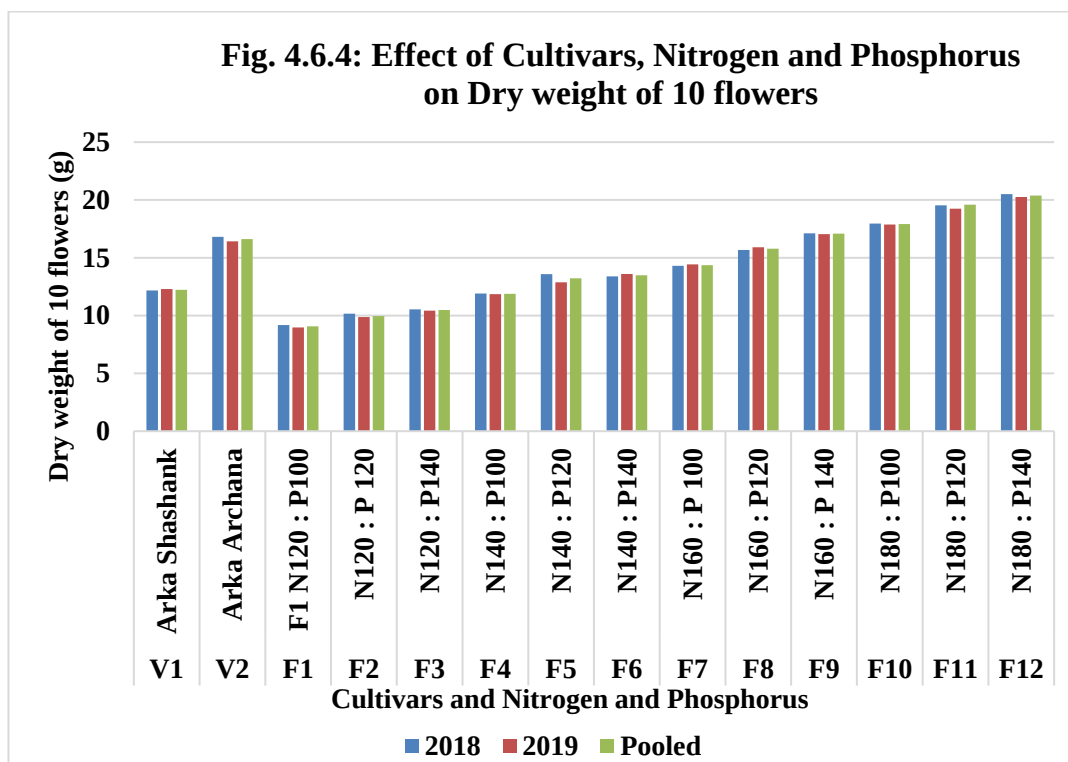
equal with the treatment combination(V₂F₁₁) and it was found significantly different with rest of the other treatment combinations. The minimum dry weight of 10 flowers (7.52, 7.48 and 7.50 g) respectively was recorded in (V₁F₁) under both the year and on pooled mean basis.

Table 4.6.4: Effect of Cultivars, Nitrogen and Phosphorus on Dry weight of 10 flowers

Treat.		Dry weight of 10 flowers (g)		
	CULTIVAR	2018-19	2019-20	Pooled
V ₁	Arka Shashank	12.17	12.30	12.23
V ₂	Arka Archana	16.81	16.42	16.61
SEm SEm±		0.23	0.28	0.18
CD at 5%		0.47	0.56	0.36
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	9.18	8.97	9.07
F₂	N ₁₂₀ : P ₁₂₀	10.17	9.87	9.95
F₃	N ₁₂₀ : P ₁₄₀	10.54	10.42	10.48
F₄	N ₁₄₀ : P ₁₀₀	11.91	11.85	11.88
F₅	N ₁₄₀ : P ₁₂₀	13.58	12.88	13.23
F₆	N ₁₄₀ : P ₁₄₀	13.39	13.59	13.49
F₇	N ₁₆₀ : P ₁₀₀	14.30	14.43	14.36
F₈	N ₁₆₀ : P ₁₂₀	15.67	15.91	15.79
F₉	N ₁₆₀ : P ₁₄₀	17.11	17.05	17.08
F₁₀	N ₁₈₀ : P ₁₀₀	17.96	17.88	17.92
F₁₁	N ₁₈₀ : P ₁₂₀	19.54	19.25	19.59
F₁₂	N ₁₈₀ : P ₁₄₀	20.50	20.26	20.38
SEm SEm±		0.57	0.69	0.45
CD at 5%		1.15	1.38	0.89

Table 4.6.4 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Dry weight of 10 flowers

Treat.	Dry weight of 10 flowers (g)		
	NP	2018-19	2019-20
			Pooled
V ₁ F ₁		7.52	7.48
V ₁ F ₂		8.36	8.52
V ₁ F ₃		9.34	9.45
V ₁ F ₄		10.89	10.47
V ₁ F ₅		10.93	11.08
V ₁ F ₆		11.50	11.72
V ₁ F ₇		11.65	12.30
V ₁ F ₈		12.65	13.09
V ₁ F ₉		15.08	14.21
V ₁ F ₁₀		14.61	15.48
V ₁ F ₁₁		16.35	16.52
V ₁ F ₁₂		17.10	17.26
V ₂ F ₁		10.83	10.45
V ₂ F ₂		11.98	11.22
V ₂ F ₃		11.73	11.38
V ₂ F ₄		12.92	13.22
V ₂ F ₅		16.23	14.68
V ₂ F ₆		15.29	15.45
V ₂ F ₇		16.95	16.55
V ₂ F ₈		18.69	18.73
V ₂ F ₉		19.13	19.89
V ₂ F ₁₀		21.31	20.27
V ₂ F ₁₁		22.72	21.97
V ₂ F ₁₂		23.89	23.26
SEm		0.80	0.97
CD at 5%		1.62	1.95



4.6.5. Total weight of dry flower per plant (g)

It is clear from the data presented in Table 4.6.5, 4.6.5 a and graphically presented in Fig 4.6.5 that the total weight of dry flower per plant was significantly influenced by different levels of nitrogen and phosphorus and cultivars.

Cultivars differ significantly on total weight of dry flower per plant. The highest total weight of dry flower (68.03, 68.20 and 68.11 g) respectively was observed in cultivar (V₂) Arka Archana. The minimum total weight of dry flower per plant was obtained from cultivar (V₁) Arka Shashank (56.76, 54.39 and 55.58 g) respectively in both the years as well as on pooled mean basis.

The persual data showed that the different levels of nitrogen and phosphorus showed significant response on total weight of dry flower per plant. The maximum total weight of dry flower per plant (76.59, 76.23 and 76.41 g) respectively were recorded under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed similar impact with

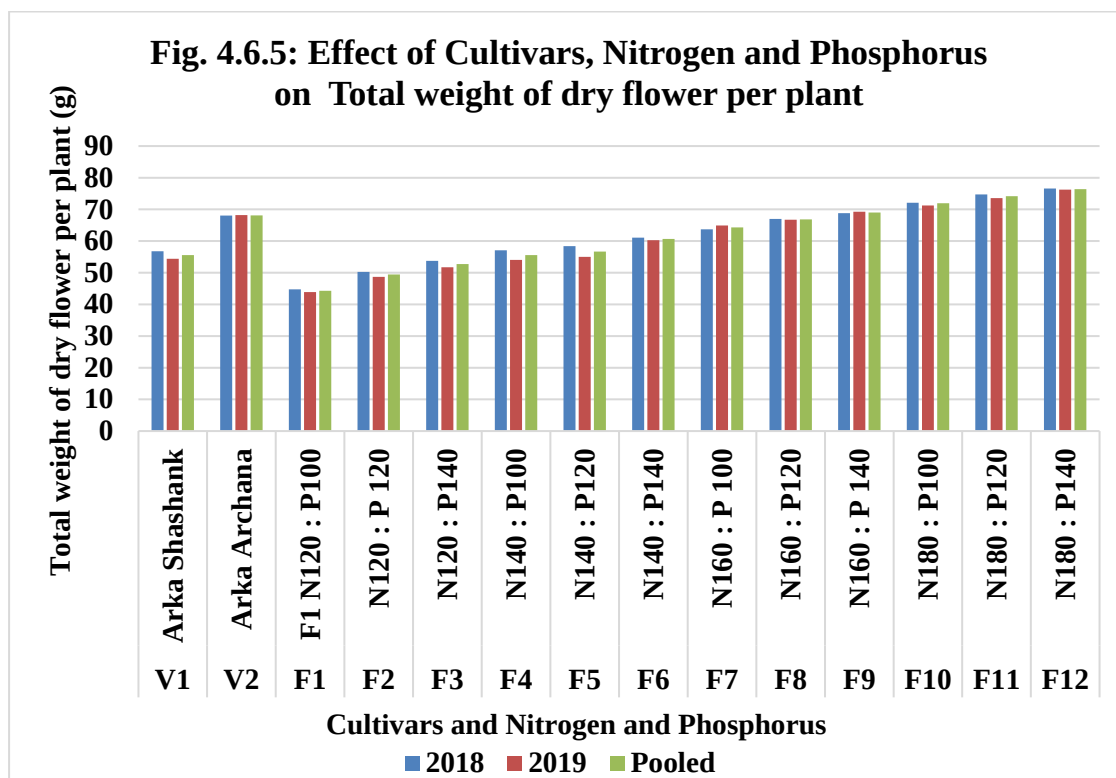
treatment F₁₁ (N₁₈₀: P₁₂₀). However, it was showed significant difference with remaining all other treatments during both the year and on pooled mean basis.

Table 4.6.5: Effect of Cultivars, Nitrogen and Phosphorus on Total weight of dry flower per plant

Treat.		Total weight of dry flower per plant (g)		
	CULTIVAR	2018-19	2019-20	Pooled
V ₁	Arka Shashank	56.76	54.39	55.58
V ₂	Arka Archana	68.03	68.20	68.11
SEm SEm±		0.91	0.82	0.61
CD at 5%		1.83	1.66	1.22
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	44.73	43.88	44.30
F₂	N ₁₂₀ : P ₁₂₀	50.24	48.69	49.47
F₃	N ₁₂₀ : P ₁₄₀	53.75	51.73	52.74
F₄	N ₁₄₀ : P ₁₀₀	57.07	54.04	55.55
F₅	N ₁₄₀ : P ₁₂₀	58.40	55.00	56.70
F₆	N ₁₄₀ : P ₁₄₀	61.07	60.28	60.68
F₇	N ₁₆₀ : P ₁₀₀	63.71	64.92	64.31
F₈	N ₁₆₀ : P ₁₂₀	66.97	66.75	66.86
F₉	N ₁₆₀ : P ₁₄₀	68.80	69.25	69.03
F₁₀	N ₁₈₀ : P ₁₀₀	72.10	71.22	71.93
F₁₁	N ₁₈₀ : P ₁₂₀	74.75	73.54	74.15
F₁₂	N ₁₈₀ : P ₁₄₀	76.59	76.23	76.41
SEm SEm±		2.22	2.02	1.50
CD at 5%		4.47	4.06	2.98

**Table 4.6.5 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on
Total weight of dry flower per plant**

Treat.	Total weight of dry flower per plant (g)			
	NP	2018-19	2019-20	Pooled
V ₁ F ₁		34.01	33.91	33.96
V ₁ F ₂		43.48	39.86	41.67
V ₁ F ₃		46.11	41.43	43.77
V ₁ F ₄		49.93	43.85	46.89
V ₁ F ₅		52.39	44.00	48.20
V ₁ F ₆		55.59	52.01	53.80
V ₁ F ₇		58.64	59.67	59.16
V ₁ F ₈		62.12	60.87	61.50
V ₁ F ₉		64.23	64.66	64.45
V ₁ F ₁₀		69.22	67.77	68.50
V ₁ F ₁₁		71.87	70.79	71.33
V ₁ F ₁₂		73.53	73.87	73.70
V ₂ F ₁		55.44	53.85	54.65
V ₂ F ₂		57.00	57.52	57.26
V ₂ F ₃		61.39	62.02	61.71
V ₂ F ₄		64.21	64.22	64.22
V ₂ F ₅		64.41	66.00	65.21
V ₂ F ₆		66.55	68.56	67.56
V ₂ F ₇		68.77	70.16	69.47
V ₂ F ₈		71.82	72.62	72.22
V ₂ F ₉		73.37	73.84	73.61
V ₂ F ₁₀		76.06	74.66	75.36
V ₂ F ₁₁		77.64	76.29	76.97
V ₂ F ₁₂		79.64	78.59	79.12
SEm		3.14	2.85	2.12
CD at 5%		6.33	5.74	4.21



The minimum total weight of dry flower per plant (44.73, 43.88 and 44.30 gm) respectively was recorded in treatment F₁ (N₁₂₀: P₁₀₀) under this investigation.

The interaction between cultivar and different levels of nitrogen and phosphorus were found significant during both the year as well as on pooled mean analysis. The maximum total weight of dry flower per plant (79.64, 78.59 and 79.12 g) respectively were recorded under treatment combination (V₂F₁₂) which was found statistically equal with the treatment combination (V₂F₉), (V₂F₁₀) and (V₂F₁₁) and it was found significantly different with rest of the other treatment combinations. The minimum The total weight of dry flower per plant (34.10, 33.91 and 33.96 g) respectively was recorded in (V₁F₁) under both the year and on pooled mean basis.

The maximum total weight of dry flower per plant were found with treatment F₁₂ (N₁₈₀: P₁₄₀). Monish *et al.* (2008) reported an increase in dry weight of flower with different levels of nitrogen and phosphorus. Jamkhande *et al.* (2004) also reported

more weight of dry flowers with higher doses of nitrogen and phosphorus in China aster cv. 'Local'. dry weight of flowers per plant, dry weight of flowers per plot increased with higher nitrogen application @ 250 kg/ha (25 g N/m²) in China aster cv. 'Phule Ganesh White' (Gaikwad *et al.*, 2004).

4.6.6. Weight of flower with stalk (g)

It is clear from the data presented in Table 4.6.6, 4.6.6 a and graphically presented in Fig 4.6.6 that the weight of flower with stalk was significantly influenced by different levels of cultivars and application of different levels of nitrogen and phosphorus.

Cultivars of China aster, differs significantly on weight of flower with stalk. The highest weight of flower with stalk were observed in cultivar (V₂) Arka Archana (15.50, 15.41 and 15.57 g) respectively. The lowest weight of flower with stalk per plant were obtained from cultivar (V₂) Arka Shashank (11.30, 11.62, 11.41 g) respectively in both the years as well as on pooled mean basis.

The data showed that the different levels of nitrogen and phosphorus showed significant response on weight of flower with stalk, during both the years as well as on pooled mean analysis. The maximum weight of flower with stalk (18.69, 18.83 and 18.71 g) respectively were recorded under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed significant difference with rest of the other treatments during both the year and pooled mean basis. The minimum weight of flower with stalk (8.71, 8.20 and 8.57 g) respectively was recorded in F₁ (N₁₂₀: P₁₀₀) under both the years and on pooled mean basis.

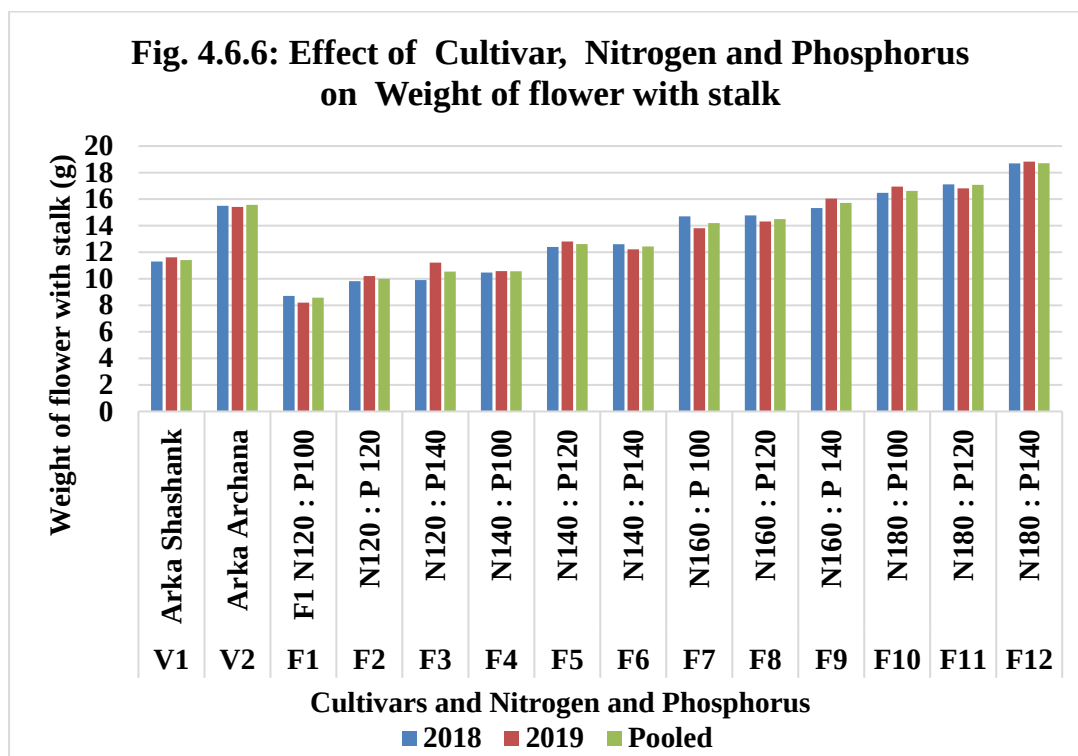
The interaction between cultivar and different levels of nitrogen and phosphorus were found non-significant during both the years as well as on pooled mean analysis.

Table 4.6.6: Effect of Cultivars, Nitrogen and Phosphorus on Weight of flower with stalk

Treat.		Weight of flower with stalk (g)		
		2018-19	2019-20	Pooled
CULTIVAR				
V ₁	Arka Shashank	11.30	11.62	11.41
V ₂	Arka Archana	15.50	15.41	15.57
SEm SEm±		0.33	0.28	0.26
CD at 5%		0.67	0.58	0.54
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	8.71	8.20	8.57
F₂	N ₁₂₀ : P ₁₂₀	9.82	10.2	10.0
F₃	N ₁₂₀ : P ₁₄₀	9.90	11.22	10.54
F₄	N ₁₄₀ : P ₁₀₀	10.47	10.58	10.57
F₅	N ₁₄₀ : P ₁₂₀	12.40	12.81	12.61
F₆	N ₁₄₀ : P ₁₄₀	12.60	12.22	12.44
F₇	N ₁₆₀ : P ₁₀₀	14.70	13.81	14.20
F₈	N ₁₆₀ : P ₁₂₀	14.77	14.32	14.50
F₉	N ₁₆₀ : P ₁₄₀	15.33	16.04	15.71
F₁₀	N ₁₈₀ : P ₁₀₀	16.47	16.94	16.62
F₁₁	N ₁₈₀ : P ₁₂₀	17.12	16.81	17.08
F₁₂	N ₁₈₀ : P ₁₄₀	18.69	18.83	18.71
SEm SEm±		0.82	0.70	0.66
CD at 5%		1.65	1.42	1.32

Table 4.6.6 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Weight of flower with stalk

Treat.	Weight of flower with stalk (g)		
NP	2018-19	2019-20	Pooled
V ₁ F ₁	6.64	7.02	6.83
V ₁ F ₂	6.91	8.64	7.775
V ₁ F ₃	6.76	8.97	7.87
V ₁ F ₄	8.02	8.11	8.065
V ₁ F ₅	9.97	10.76	10.37
V ₁ F ₆	11.91	11.02	11.47
V ₁ F ₇	12.61	11.95	12.28
V ₁ F ₈	13.13	13.47	13.30
V ₁ F ₉	13.02	13.58	13.30
V ₁ F ₁₀	14.46	14.46	14.46
V ₁ F ₁₁	15.10	14.32	14.71
V ₁ F ₁₂	16.44	16.35	16.4
V ₂ F ₁	10.80	9.47	10.14
V ₂ F ₂	12.68	11.68	12.18
V ₂ F ₃	13.03	13.37	13.20
V ₂ F ₄	12.84	12.84	12.84
V ₂ F ₅	14.88	14.88	14.88
V ₂ F ₆	13.37	13.37	13.37
V ₂ F ₇	16.70	15.70	16.20
V ₂ F ₈	16.35	15.13	15.74
V ₂ F ₉	17.61	18.44	18.02
V ₂ F ₁₀	18.25	19.25	18.75
V ₂ F ₁₁	19.14	19.33	19.23
V ₂ F ₁₂	20.80	21.25	21.03
SEm	1.16	0.99	0.93
CD at 5%	NS	NS	NS



Monish *et al.* (2008) reported an increase in weight of flower with stalk by application of different levels of nitrogen and phosphorus in treatment F₁₂(N₁₈₀: P₁₄₀). Jamkhande *et al.* (2004) also reported more weight of cut flowers with higher doses of nitrogen in China aster cv. 'Local'. Weight of flowers with stalk per plant. Beneficial effects of nitrogen for flower weight with stalk have been reported by other workers namely Belgaonkar *et al.* (1997) and Rao *et al.* (1992) in chrysanthemum.

4.6.7 Diameter of flowers (cm)

The diameter of flowers was measured and its data are presented in Table 4.6.7, 4.6.7 a and Fig-4.6.7

It is vivid from the data presented in the table 4.6.7 that the diameter of flowers was significantly influenced by cultivars, maximum flower diameter (7.85, 7.89 and 7.87 cm) were observed in cultivar (V₂) Arka Archana as compared to cultivar

(V₁) Arka Shashank (5.86, 6.20 and 6.03 cm) during both the tested years and on pooled mean data respectively.

In respect to different levels of nitrogen and phosphorus during both the year and on pooled mean basis. The maximum diameter of flowers (8.88, 9.25 and 9.06 cm) respectively was observed under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed significant difference with rest of the other treatments. Whereas, minimum diameter of flowers (4.82, 5.12, 4.97cm) respectively was recorded under treatment F₁ (N₁₂₀: P₁₀₀) during both the year of investigation as well as on pooled mean basis.

The interaction between cultivar and different levels of nitrogen and phosphorus were found significant during first year as well as on pooled mean analysis. The maximum diameter of flowers (10.04 and 10.17 cm) respectively were recorded under treatment combination (V₂F₁₂) and it was observed statistically similar with treatment combination (V₂F₁₁) and it was noticed significant difference with rest of the other treatments combination during first year and on pooled mean basis. The minimum weight of flower with stalk per plant (3.81 and 4.00 cm) respectively was recorded in (V₂F₁) under first year and on pooled mean basis. Interaction effect was found non-significant for second year.

The two years result indicated that there was significant difference in flower size within the Cultivars and maximum flower diameter was obtained from variety Arka Archana. It could be stated that variation within the Cultivars for diameter of fully opened flower might be due to genotypic and environmental interaction. Similar results were reported by Nursudeet *al.* (2010), Beniwal and Dahiya (2012), Singh and Misra (2009) in African marigold and Singh and Singh (2010) and Raghuvanshi and Sharma (2011) in French marigold.

With respect to diameter of flower, the F₁₂ (N₁₈₀: P₁₄₀) were found superior over other fertilizer levels. The greater diameter of flow might be due to the utilization of higher amount of nutrients which increases the diameter of the

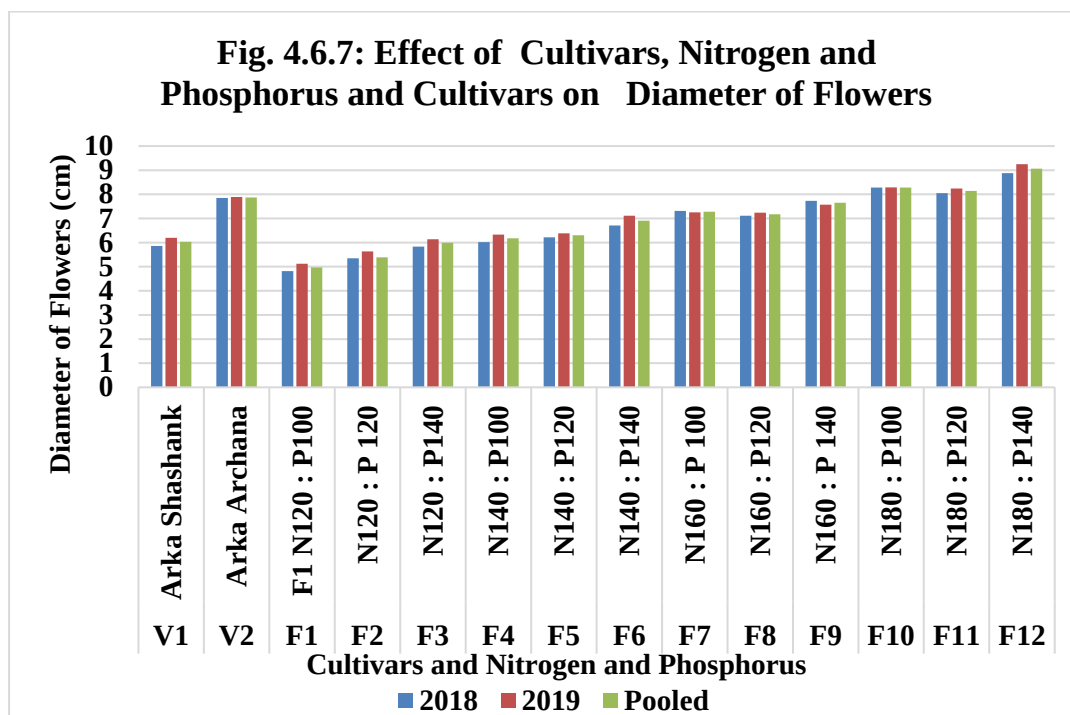
flower. Similar results were obtained by Rachayanavar (1983) in chrysanthemum, where increased fertilizer levels resulted in better size of flowers Komosa (1978) and Hosoya *et al.* (1978) in china aster. Beneficial effects of different levels of nitrogen application on the flower sizes have been reported by other workers viz. Belgaonkar *et al.* (1997) in chrysanthemum and Agarwal *et al.* (2002) in marigold.

Table 4.6.7: Effect of Cultivars, Nitrogen and Phosphorus on Diameter of Flowers

Treat.		Diameter of Flowers (cm)		
	CULTIVAR	2018-19	2019-20	Pooled
V ₁	Arka Shashank	5.86	6.20	6.03
V ₂	Arka Archana	7.85	7.89	7.87
SEm SEm±		0.12	0.13	0.09
CD at 5%		0.25	0.26	0.18
NITROGEN AND PHOSPHORUS				
F ₁	N ₁₂₀ : P ₁₀₀	4.82	5.12	4.97
F ₂	N ₁₂₀ : P ₁₂₀	5.35	5.63	5.39
F ₃	N ₁₂₀ : P ₁₄₀	5.83	6.14	5.99
F ₄	N ₁₄₀ : P ₁₀₀	6.02	6.33	6.18
F ₅	N ₁₄₀ : P ₁₂₀	6.22	6.38	6.30
F ₆	N ₁₄₀ : P ₁₄₀	6.71	7.11	6.91
F ₇	N ₁₆₀ : P ₁₀₀	7.31	7.25	7.28
F ₈	N ₁₆₀ : P ₁₂₀	7.11	7.24	7.17
F ₉	N ₁₆₀ : P ₁₄₀	7.73	7.57	7.65
F ₁₀	N ₁₈₀ : P ₁₀₀	8.28	8.29	8.28
F ₁₁	N ₁₈₀ : P ₁₂₀	8.05	8.24	8.14
F ₁₂	N ₁₈₀ : P ₁₄₀	8.88	9.25	9.06
SEm SEm±		0.30	0.32	0.22
CD at 5%		0.60	0.63	0.43

Table 4.6.7 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Diameter of Flowers

Treat.	Diameter of Flowers (cm)		
	NP	2018-19	2019-20
			Pooled
V₁F₁		3.81	4.20
V₁F₂		4.70	5.07
V₁F₃		4.99	5.03
V₁F₄		4.72	5.14
V₁F₅		5.26	5.69
V₁F₆		5.53	6.25
V₁F₇		6.85	6.73
V₁F₈		5.95	6.43
V₁F₉		6.55	6.62
V₁F₁₀		7.73	7.80
V₁F₁₁		6.58	7.22
V₁F₁₂		7.71	8.21
V₂F₁		5.82	6.04
V₂F₂		6.00	6.20
V₂F₃		6.67	7.25
V₂F₄		7.31	7.53
V₂F₅		7.17	7.07
V₂F₆		7.89	7.97
V₂F₇		7.76	7.77
V₂F₈		8.26	8.04
V₂F₉		8.91	8.52
V₂F₁₀		8.84	8.77
V₂F₁₁		9.51	9.26
V₂F₁₂		10.04	10.29
SEm		0.42	0.45
CD at 5%		0.85	NS



4.6.8. Chlorophyll content before flowering (mg/g)

It is clear from the data presented in Table 4.6.8, 4.6.8 a and graphically presented in Fig 4.6.8 that the chlorophyll content before flowering was significantly influenced by different levels of nitrogen and phosphorus and cultivars.

Amongst the cultivars, they showed significant influence on chlorophyll content before flowering. The highest chlorophyll content before flowering was observed in cultivar (V₂) Arka Archana (55.83, 57.36 and 56.59 mg/g). The lowest chlorophyll content before flowering were obtained from cultivar (V₁) Arka Shashank (53.81, 55.41 and 54.61 mg/g) respectively in both the years as well as on pooled mean basis.

In respect to different levels of nitrogen and phosphorus, it showed significant impact on chlorophyll content before flowering during both the years as well as on pooled mean analysis. The highest chlorophyll content before flowering (59.23, 61.82 and 60.53 mg/g) respectively were recorded under treatment F₁₂(N₁₈₀: P₁₄₀)

and it was observed statistically similar with the treatment $F_8(N_{160}: P_{120})$, $F_9(N_{160}: P_{140})$, $F_{10}(N_{180}: P_{100})$ and $F_{11}(N_{180}: P_{120})$ during both the years whereas, it was observed statistically similar with the treatment $F_{10}(N_{180}: P_{100})$ and $F_{11}(N_{180}: P_{120})$ on pooled mean analysis. The lowest chlorophyll content before flowering (51.47, 52.50 and 51.98 mg/g) respectively was recorded under $F_1(N_{120}: P_{100})$

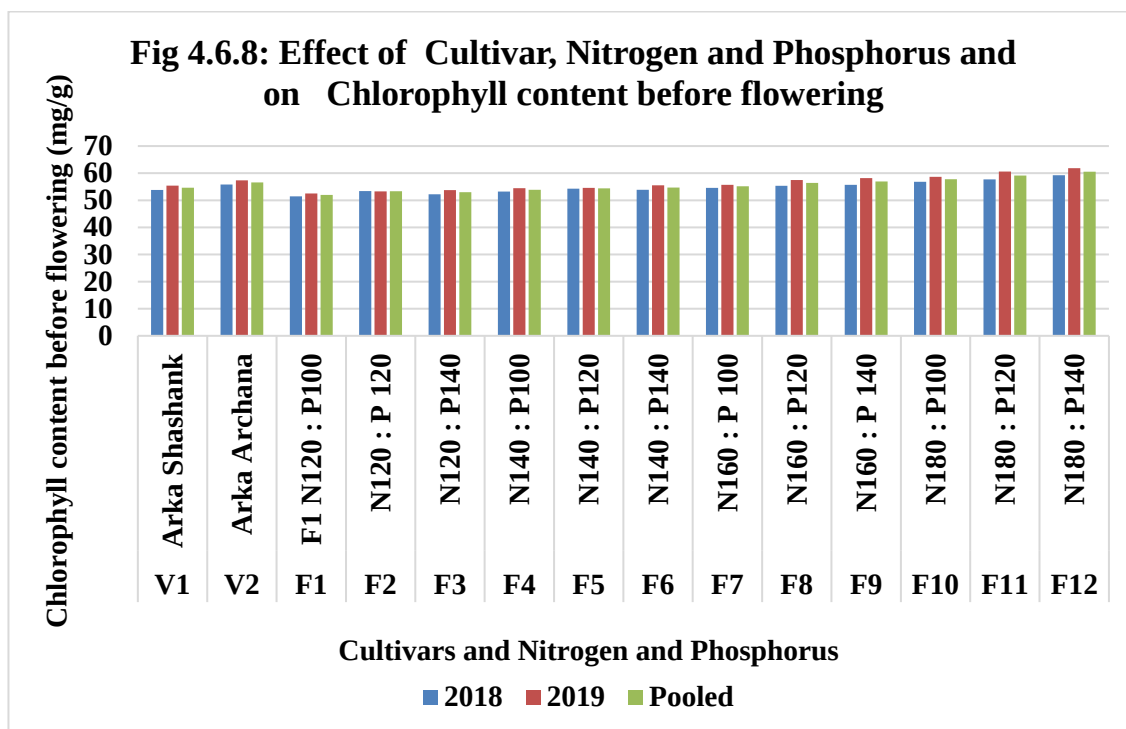
The interaction between cultivar and application of different levels of nitrogen and phosphorus were found non-significant during both the years as well as on pooled mean analysis under this investigation.

Table 4.6.8: Effect of Cultivars, Nitrogen and Phosphorus on Chlorophyll content before flowering

Treat.		Chlorophyll content before flowering (mg/g)		
CULTIVARS		2018-19	2019-20	Pooled
V ₁	Arka Shashank	53.81	55.41	54.61
V ₂	Arka Archana	55.83	57.36	56.59
SEm SEm±		0.86	0.95	0.64
CD at 5%		1.74	1.90	1.27
NITROGEN AND PHOSPHORUS				
F₁	$N_{120}: P_{100}$	51.47	52.50	51.98
F₂	$N_{120}: P_{120}$	53.42	53.30	53.36
F₃	$N_{120}: P_{140}$	52.22	53.78	53.00
F₄	$N_{140}: P_{100}$	53.23	54.47	53.85
F₅	$N_{140}: P_{120}$	54.27	54.58	54.43
F₆	$N_{140}: P_{140}$	53.88	55.52	54.70
F₇	$N_{160}: P_{100}$	54.60	55.72	55.16
F₈	$N_{160}: P_{120}$	55.33	57.47	56.40
F₉	$N_{160}: P_{140}$	55.68	58.20	56.94
F₁₀	$N_{180}: P_{100}$	56.80	58.68	57.74
F₁₁	$N_{180}: P_{120}$	57.70	60.60	59.15
F₁₂	$N_{180}: P_{140}$	59.23	61.82	60.53
SEm SEm±		2.11	2.32	1.57
CD at 5%		4.25	4.66	3.11

Table 4.6.8 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Chlorophyll content before flowering

Treat.	Chlorophyll content before flowering (mg/g)			
	NP	2018-19	2019-20	Pooled
V ₁ F ₁		49.63	50.73	50.18
V ₁ F ₂		50.60	52.30	51.45
V ₁ F ₃		50.17	52.57	51.37
V ₁ F ₄		51.80	53.23	52.52
V ₁ F ₅		52.87	53.50	53.18
V ₁ F ₆		53.17	54.70	53.93
V ₁ F ₇		54.80	54.27	54.53
V ₁ F ₈		55.57	56.77	56.17
V ₁ F ₉		54.80	57.80	56.30
V ₁ F ₁₀		56.13	58.93	57.53
V ₁ F ₁₁		57.27	59.27	58.27
V ₁ F ₁₂		58.97	60.87	59.92
V ₂ F ₁		53.30	54.27	53.78
V ₂ F ₂		56.23	54.30	55.27
V ₂ F ₃		54.27	55.00	54.63
V ₂ F ₄		54.67	55.70	55.18
V ₂ F ₅		55.67	55.67	55.67
V ₂ F ₆		54.60	56.33	55.47
V ₂ F ₇		54.40	57.17	55.78
V ₂ F ₈		55.10	58.17	56.63
V ₂ F ₉		56.57	58.60	57.58
V ₂ F ₁₀		57.47	58.43	57.95
V ₂ F ₁₁		58.13	61.93	60.03
V ₂ F ₁₂		59.50	62.77	61.13
SEm		2.99	3.28	2.22
CD at 5%		NS	NS	NS



4.6.9. Chlorophyll content after flowering (mg/g)

The data on chlorophyll content after flowering are presented in table 4.6.9, 4.6.9 a and fig. 4.6.9 revealed that the cultivar and application of different levels of nitrogen and phosphorus and their interaction exhibited significant impact on chlorophyll content after flowering.

In case of cultivars, they show significant influence on chlorophyll content after flowering. The highest chlorophyll content after flowering (48.07, 48.50, 48.29 mg/g) respectively was observed in cultivar (V₂) Arka Archana. The lowest chlorophyll content after flowering (46.51, 46.94 and 46.72 mg/g) respectively were obtained from cultivar (V₁) Arka Shashank in both the years as well as on pooled mean basis.

As far as, different levels of nitrogen and phosphorus showed significant impact on chlorophyll content after flowering during both the years as well as on pooled mean analysis. The highest chlorophyll content after flowering (51.64, 52.27 and

51.95 mg/g) respectively were recorded under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatment F₉ (N₁₆₀: P₁₄₀), F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀). The lowest chlorophyll content after flowering (41.61, 45.13 and 43.37 mg/g) respectively was recorded under F₁ (N₁₂₀: P₁₀₀)

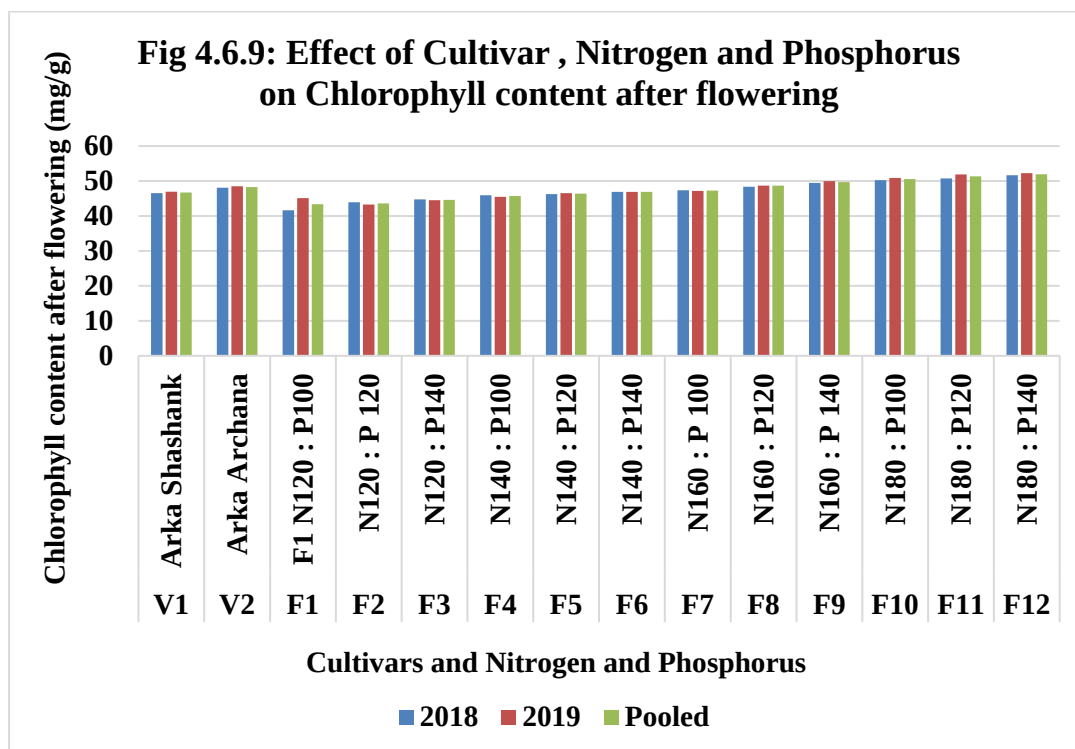
The interaction between cultivar and application of different levels of nitrogen and phosphorus were found non-significant during both the years as well as on pooled mean analysis under this investigation.

Table 4.6.9: Effect of Cultivars, Nitrogen and Phosphorus on Chlorophyll content after flowering

Treat.		Chlorophyll content after flowering (mg/g)		
		2018-19	2019-20	Pooled
CULTIVAR				
V ₁	Arka Shashank	46.51	46.94	46.72
V ₂	Arka Archana	48.07	48.50	48.29
SEm SEm±		0.65	0.63	0.45
CD at 5%		1.31	1.26	0.90
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	41.61	45.13	43.37
F₂	N ₁₂₀ : P ₁₂₀	43.93	43.26	43.60
F₃	N ₁₂₀ : P ₁₄₀	44.76	44.51	44.63
F₄	N ₁₄₀ : P ₁₀₀	45.93	45.47	45.70
F₅	N ₁₄₀ : P ₁₂₀	46.27	46.51	46.39
F₆	N ₁₄₀ : P ₁₄₀	46.89	46.90	46.89
F₇	N ₁₆₀ : P ₁₀₀	47.34	47.15	47.25
F₈	N ₁₆₀ : P ₁₂₀	48.38	48.69	48.69
F₉	N ₁₆₀ : P ₁₄₀	49.44	49.97	49.70
F₁₀	N ₁₈₀ : P ₁₀₀	50.25	50.90	50.57
F₁₁	N ₁₈₀ : P ₁₂₀	50.74	51.90	51.32
F₁₂	N ₁₈₀ : P ₁₄₀	51.64	52.27	51.95
SEm SEm±		1.59	1.53	1.11
CD at 5%		3.21	3.09	2.20

Table 4.6.9 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Chlorophyll content after flowering

NP	Chlorophyll content after flowering (mg/g)		
	2018-19	2019-20	Pooled
V ₁ F ₁	41.15	41.55	41.35
V ₁ F ₂	43.35	42.69	43.02
V ₁ F ₃	44.35	44.84	44.60
V ₁ F ₄	44.56	44.77	44.66
V ₁ F ₅	45.13	45.21	45.17
V ₁ F ₆	46.73	46.67	46.70
V ₁ F ₇	46.11	46.28	46.19
V ₁ F ₈	47.96	47.22	47.59
V ₁ F ₉	48.38	49.51	48.95
V ₁ F ₁₀	49.56	50.47	50.01
V ₁ F ₁₁	50.12	51.85	50.99
V ₁ F ₁₂	50.68	52.21	51.45
V ₂ F ₁	42.08	48.70	45.39
V ₂ F ₂	44.51	43.84	44.18
V ₂ F ₃	45.17	44.18	44.67
V ₂ F ₄	47.29	46.18	46.74
V ₂ F ₅	47.41	47.81	47.61
V ₂ F ₆	47.05	47.13	47.09
V ₂ F ₇	48.56	48.03	48.30
V ₂ F ₈	49.40	50.16	49.78
V ₂ F ₉	50.49	50.42	50.46
V ₂ F ₁₀	50.95	51.32	51.14
V ₂ F ₁₁	51.35	51.96	51.65
V ₂ F ₁₂	52.60	52.32	52.46
	2.26	2.17	1.56
SEm CD at 5%	NS	NS	NS



4.6.10 Vase life of flowers (days)

The data presented in the Table 4.6.10, 4.6.10 a and Fig. 4.6.10 exhibited that the vase life of flowers was significantly influenced due to cultivars and different levels of nitrogen and phosphorus.

The evident data showed that the maximum vase life of flowers in days (8.21, 8.07 and 8.14 days) respectively was recorded under cultivar (V₁) Arka shashank and the minimum vase life in days (7.44 and 7.42 and 7.43 days) respectively was recorded under cultivar (V₂) Arka Archana during both the tested year as well as on pooled mean analysis.

As far as, different levels of nitrogen and phosphorus showed significant response on vase life of flowers, the longer vase life of flowers (9.60, 9.50 and 9.55 days) respectively were recorded under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatment. Whereas, it was showed significant different with rest of the other treatments) during both the years and on pooled

mean basis. The minimum vase life of flowers (5.99 and 6.08 and 6.04 days) respectively was recorded in treatment F₁ (N₁₂₀: P₁₀₀) under this investigation.

The interaction among cultivar and different levels of nitrogen and phosphorus application were found non-significant during both the years as well as on pooled mean analysis.

The results of two years research work indicated that vase life of cut flowers was maximum in Arka Archana that may be due to the diffuseness of flowers which was observed in Arka Archana. It might be also due to the congenial environment to express the dominant genes in the genotypes and different genetic makeup of the variety. The present research work confirms the findings of Bhanu Pratap *et al.* (1999), Nand- Kishore and Mohanti (2002), Sreekala *et al.* (2002), and Nursude *et al.* (2010) in African marigold.

The vase life of flowers was influenced by fertilizer levels. Higher vase life of China aster flowers was noticed in the F₁₂ (N₁₈₀: P₁₄₀). Higher levels of fertilizer significantly increase the vase life of flowers (particularly nitrogen). This may be due to the fact that the lower doses of nitrogen and phosphorus lead to succulence and softness in stem, leaves and petals. Similar findings were recorded by Gilly (1974) where the reduction in vase life was noticed due to increased nitrogen levels. Similarly Anuradha *et al.* (1990) noticed the decrease in keeping quality of marigold flowers at increased levels of nitrogen. While increased levels of phosphorus had no significant effect on keeping quality of flowers.

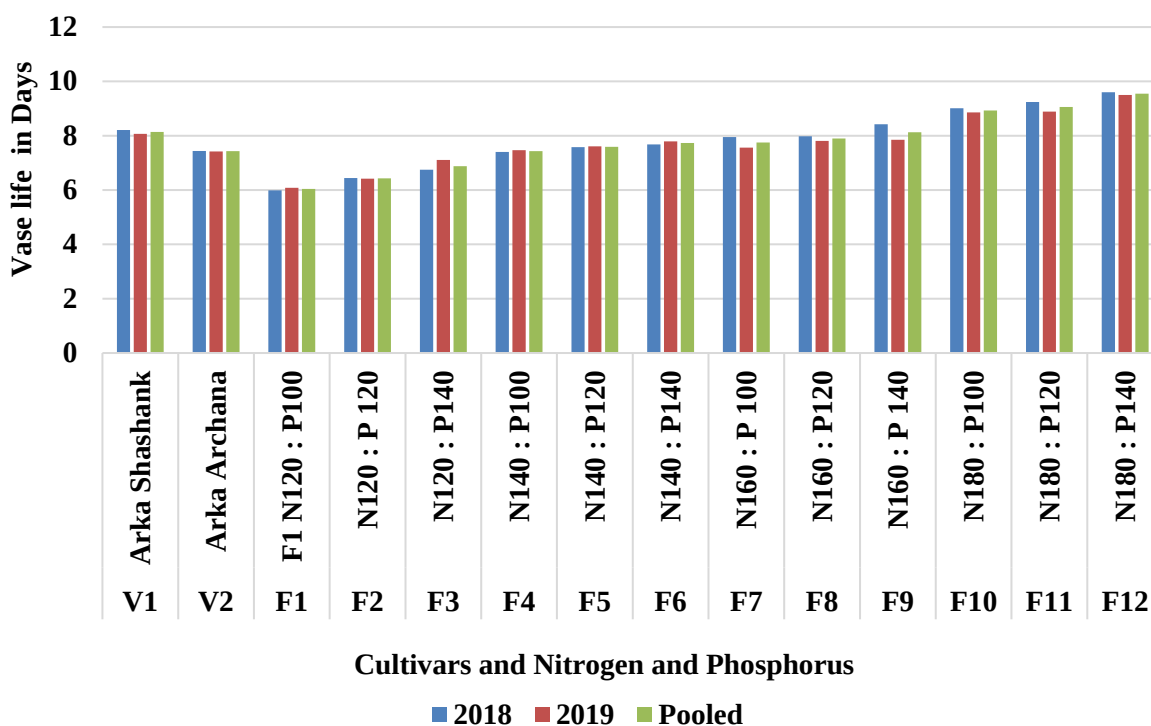
Table 4.6.10: Effect of Cultivars, Nitrogen and Phosphorus on Vase life of flowers

Treat.		Vase life of flowers (Days)		
	CULTIVAR	2018-19	2019-20	Pooled
V ₁	Arka Shashank	8.21	8.07	8.14
V ₂	Arka Archana	7.44	7.42	7.43
SEm SEm±		0.15	0.16	0.11
CD at 5%		0.31	0.32	0.22
NITROGEN AND PHOSPHORUS				
F₁	N ₁₂₀ : P ₁₀₀	5.99	6.08	6.04
F₂	N ₁₂₀ : P ₁₂₀	6.44	6.42	6.43
F₃	N ₁₂₀ : P ₁₄₀	6.75	7.11	6.88
F₄	N ₁₄₀ : P ₁₀₀	7.40	7.47	7.43
F₅	N ₁₄₀ : P ₁₂₀	7.58	7.61	7.59
F₆	N ₁₄₀ : P ₁₄₀	7.68	7.79	7.73
F₇	N ₁₆₀ : P ₁₀₀	7.95	7.56	7.75
F₈	N ₁₆₀ : P ₁₂₀	7.98	7.81	7.90
F₉	N ₁₆₀ : P ₁₄₀	8.42	7.85	8.13
F₁₀	N ₁₈₀ : P ₁₀₀	9.01	8.86	8.93
F₁₁	N ₁₈₀ : P ₁₂₀	9.24	8.89	9.06
F₁₂	N ₁₈₀ : P ₁₄₀	9.60	9.50	9.55
SEm SEm±		0.37	0.38	0.27
CD at 5%		0.75	0.77	0.53

Table 4.6.10 a: Interaction effect of Cultivars, Nitrogen and Phosphorus on Vase life of flowers

Treat.	Vase life of flowers (Days)		
	NP	2018-19	2019-20
			Pooled
V₁F₁		6.36	6.16
V₁F₂		6.85	6.78
V₁F₃		6.87	7.26
V₁F₄		7.88	7.98
V₁F₅		8.12	7.71
V₁F₆		8.00	8.07
V₁F₇		8.12	7.70
V₁F₈		8.16	8.21
V₁F₉		8.79	8.03
V₁F₁₀		9.85	9.90
V₁F₁₁		9.31	9.04
V₁F₁₂		10.22	10.00
V₂F₁		5.62	6.00
V₂F₂		6.04	6.06
V₂F₃		6.42	6.95
V₂F₄		6.92	6.96
V₂F₅		7.03	7.51
V₂F₆		7.36	7.51
V₂F₇		7.77	7.41
V₂F₈		7.80	7.42
V₂F₉		8.05	7.66
V₂F₁₀		8.16	7.82
V₂F₁₁		9.16	8.73
V₂F₁₂		8.99	9.01
SEm		0.53	0.54
CD at 5%		NS	NS

Fig 4.6.10: Effect of Cultivars, Nitrogen and Phosphorus and on Vase life of flowers



4.7 Economics

The data pertaining to economics of China aster cultivation in term of level of investment and return per hectare under different treatment combinations between cultivars and growth regulators and varieties and are presented in Table 4.7.1 and cultivars and application of different levels of nitrogen and phosphorus are presented in Table 4.7.2.

In this study, investment refers to the cash expenses paid for raising China aster crop and flower production whereas return denote the value of the product calculated with the help of its whole sale market value.

In Experiment No. 1, the data revealed that the total cost ranged from Rs. 85706.48 to Rs. 95706.48. The highest gross return of Rs. 240433.33 was found in the treatment combination (V₂P₆) followed by (V₂P₅) of Rs. 222933.33 whereas the lowest (Rs. 123400.00) was observed in control. The highest benefit-cost ratio (1.77) was calculated in (V₂P₆) followed by (V₂P₅) (1.57). Thus, the treatment combination V₂P₆ (Arka Archana + GA₃ 200 ppm) proved to be the most beneficial. As per the economic point of view the V₂P₆ (Arka Archana + GA₃ 200 ppm) gained more benefit-cost ratio, thus this combination was more better for high return from the cultivation of China aster.

This might be due to the fact that the foliar application of growth regulators and varietal response might have improved the yield and quality of China aster flowers. Similar findings are noticed by Naik *et al.* (2005) in African marigold.

In Experiment No. 2, the data revealed that the highest gross return of Rs. 226666.67 was found in the treatment combination (V₂F₁₂) followed by (V₂F₁₁) of Rs. 226666.67 whereas the lowest (Rs. 124000.00) was observed in control. The highest benefit-cost ratio (1.64) was calculated in (V₂F₁₂) followed by (V₂F₁₁) (1.58). Thus, the treatment combination V₂F₁₂ (Arka Archana + N₁₈₀: P₁₄₀) proved to be the most beneficial. As per the

economic point of view the combination V₂F₁₂ (Arka Archana + N₁₈₀: P₁₄₀) gained more benefit-cost ratio, thus this combination was better for high return from the cultivation of China aster.

This might be due to the fact that the foliar application of nitrogen and phosphorus and varietal response might have improved the yield and quality of China aster flowers. Similar findings are noticed by Naik *et al.* (2005) in African marigold.

Table no. 4.7.1: Total cost of China aster under different treatments

Experiment -I

SL. No	Variable cost	Quantity/Time/ Amount (ha.)		Rate (Rs)		Total Cost (Rs/ha.)	
		2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
1	Different doses of Growth Regulators						
	i. Control 0 ppm	0	0	0	0	0	0
	ii. CCC 1000 ppm	75ml	75ml	100	100	7500	7500
	iii. CCC 1500 ppm	100ml	100ml	100	100	10000	10000
	iv. NAA @ 50ppm	1gm	1gm	160	160	160	160
	v. NAA @ 100ppm	1.5gm	1.5gm	160	160	240	240
	vi. GA ₃ 150 ppm	2.0gm	2.0gm	440	440	880	880
	vii. GA ₃ 200 ppm	2.5gm	2.5gm	440	440	1100	1100
2.	Seeds of Cultivars	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
	i. Arka Shashank	0.75	0.75	1000	1000	750	750
	ii. Arka Archana	0.75	0.75	1000	1000	750	750

Experiment -I

Sl. No	Variable cost	Quantity/Time/ Amount (ha.)				Rate (Rs)				Total Cost (Rs/ha.)	
		2018-19		2019-20		2018-19		2019-20		2018-19	2019-20
1	Different doses of Growth Regulators	N	P	N	P	N	P	N	P		
	i. N ₁₂₀ : P ₁₀₀	31.58	42.5	31.58	42.5	10	15	10	15	0.95	0.95
	ii. N ₁₂₀ : P ₁₂₀	31.58	51.0	31.58	51.0	10	15	10	15	1.08	1.08
	iii. N ₁₂₀ : P ₁₄₀	31.58	59.54	31.58	59.54	10	15	10	15	1.21	1.21
	iv. N ₁₄₀ : P ₁₀₀	35.25	42.5	35.25	42.5	10	15	10	15	0.99	0.99
	v. N ₁₄₀ : P ₁₂₀	35.25	51.0	35.25	51.0	10	15	10	15	1.12	1.12
	vi. N ₁₄₀ : P ₁₄₀	35.25	59.54	35.25	59.54	10	15	10	15	1.25	1.25
	vii. N ₁₆₀ : P ₁₀₀	38.92	42.5	38.92	42.5	10	15	10	15	1.03	1.03
	viii. N ₁₆₀ : P ₁₂₀	38.92	51.0	38.92	51.0	10	15	10	15	1.15	1.15
	ix. N ₁₆₀ : P ₁₄₀	38.92	59.54	38.92	59.54	10	15	10	15	1.28	1.28
	x. N ₁₈₀ : P ₁₀₀	42.59	42.5	42.59	42.5	10	15	10	15	1.06	1.06
	xi. N ₁₈₀ : P ₁₂₀	42.59	51.0	42.59	51.0	10	15	10	15	1.19	1.19
	xii. N ₁₈₀ : P ₁₄₀	42.59	59.54	42.59	59.54	10	15	10	15	1.32	1.32

2.	Seeds of Cultivars		2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
	i.	Arka Shashank	0.75	0.75	1000	1000	750	750
	ii.	Arka Archana	0.75	0.75	1000	1000	750	750

Experiment No. I

Treatment combinations		V	P	Cost	Total Cost
V₁P₀	Arka Shashank (Control)	750	0	84956.48	85706.48
V₁P₁	Arka Shashank (CCC 1000 ppm)	750	7500	84956.48	93206.48
V₁P₂	Arka Shashank (CCC 1500 ppm)	750	10000	84956.48	95706.48
V₁P₃	Arka Shashank (NAA 50 ppm)	750	160	84956.48	85866.48
V₁P₄	Arka Shashank (NAA 100 ppm)	750	240	84956.48	85946.48
V₁P₅	Arka Shashank (GA ₃ 150 ppm)	750	880	84956.48	86586.48
V₁P₆	Arka Shashank (GA ₃ 200 ppm)	750	1100	84956.48	86806.48
V₂P₀	Arka Archana (Control)	750	0	84956.48	85706.48
V₂P₁	Arka Archana (CCC 1000 ppm)	750	7500	84956.48	93206.48
V₂P₂	Arka Archana (CCC 1500 ppm)	750	10000	84956.48	95706.48
V₂P₃	Arka Archana (NAA 50 ppm)	750	160	84956.48	85866.48
V₂P₄	Arka Archana (NAA 100 ppm)	750	240	84956.48	85946.48
V₂P₅	Arka Archana (GA ₃ 150 ppm)	750	880	84956.48	86586.48
V₂P₆	Arka Archana (GA ₃ 200 ppm)	750	1100	84956.48	86806.48

Experiment No. II

Treatment combinations		V	P	Cost	Total Cost
V ₁ F ₁	Arka Shashank	N ₁₂₀ : P ₁₀₀	750	0.95	84956.48
V ₁ F ₂	Arka Shashank	N ₁₂₀ : P ₁₂₀	750	1.08	84956.48
V ₁ F ₃	Arka Shashank	N ₁₂₀ : P ₁₄₀	750	1.21	84956.48
V ₁ F ₄	Arka Shashank	N ₁₄₀ : P ₁₀₀	750	0.99	84956.48
V ₁ F ₅	Arka Shashank	N ₁₄₀ : P ₁₂₀	750	1.12	84956.48
V ₁ F ₆	Arka Shashank	N ₁₄₀ : P ₁₄₀	750	1.25	84956.48
V ₁ F ₇	Arka Shashank	N ₁₆₀ : P ₁₀₀	750	1.03	84956.48
V ₁ F ₈	Arka Shashank	N ₁₆₀ : P ₁₂₀	750	1.15	84956.48
V ₁ F ₉	Arka Shashank	N ₁₆₀ : P ₁₄₀	750	1.28	84956.48
V ₁ F ₁₀	Arka Shashank	N ₁₈₀ : P ₁₀₀	750	1.06	84956.48
V ₁ F ₁₁	Arka Shashank	N ₁₈₀ : P ₁₂₀	750	1.19	84956.48
V ₁ F ₁₂	Arka Shashank	N ₁₈₀ : P ₁₄₀	750	1.32	84956.48
V ₂ F ₁	Arka Archana	N ₁₂₀ : P ₁₀₀	750	0.95	84956.48
V ₂ F ₂	Arka Archana	N ₁₂₀ : P ₁₂₀	750	1.08	84956.48
V ₂ F ₃	Arka Archana	N ₁₂₀ : P ₁₄₀	750	1.21	84956.48

V₂F₄	Arka Archana	N ₁₄₀ : P ₁₀₀	750	0.99	84956.48	85707.47
V₂F₅	Arka Archana	N ₁₄₀ : P ₁₂₀	750	1.12	84956.48	85707.6
V₂F₆	Arka Archana	N ₁₄₀ : P ₁₄₀	750	1.25	84956.48	85707.73
V₂F₇	Arka Archana	N ₁₆₀ : P ₁₀₀	750	1.03	84956.48	85707.51
V₂F₈	Arka Archana	N ₁₆₀ : P ₁₂₀	750	1.15	84956.48	85707.63
V₂F₉	Arka Archana	N ₁₆₀ : P ₁₄₀	750	1.28	84956.48	85707.76
V₂F₁₀	Arka Archana	N ₁₈₀ : P ₁₀₀	750	1.06	84956.48	85707.54
V₂F₁₁	Arka Archana	N ₁₈₀ : P ₁₂₀	750	1.19	84956.48	85707.67
V₂F₁₂	Arka Archana	N ₁₈₀ : P ₁₄₀	750	1.32	84956.48	85707.8

Table 4.7.2-: Economics of China aster production under different treatment

Experiment No. I

Treatment combinations		Cost of cultivation	Flower yield (lakh ha-1)	Gross return (lakh ha-1)		Net return (lakh ha-1)	B:C Ratio
T ₁	V ₁ P ₀	85706.48	12.34	12.34	123400.00	37693.52	0.44
T ₂	V ₁ P ₁	93206.48	13.71	13.71	137133.33	43926.85	0.47
T ₃	V ₁ P ₂	95706.48	14.54	14.54	145400.00	49693.52	0.52
T ₄	V ₁ P ₃	85866.48	15.40	15.40	154000.00	68133.52	0.79
T ₅	V ₁ P ₄	85946.48	16.34	16.34	163400.00	77453.52	0.90
T ₆	V ₁ P ₅	86586.48	19.49	19.49	194933.33	108346.85	1.25
T ₇	V ₁ P ₆	86806.48	21.77	21.77	217733.33	130926.85	1.51
T ₈	V ₂ P ₀	85706.48	13.02	13.02	130200.00	44493.52	0.52
T ₉	V ₂ P ₁	93206.48	16.04	16.04	160433.33	67226.85	0.72
T ₁₀	V ₂ P ₂	95706.48	17.37	17.37	173700.00	77993.52	0.81
T ₁₁	V ₂ P ₃	85866.48	19.17	19.17	191733.33	105866.85	1.23
T ₁₂	V ₂ P ₄	85946.48	19.82	19.82	198200.00	112253.52	1.31
T ₁₃	V ₂ P ₅	86586.48	22.29	22.29	222933.33	136346.85	1.57
T ₁₄	V ₂ P ₆	86806.48	24.04	24.04	240433.33	153626.85	1.77

Experiment No.II

Treatment combinations		Cost of cultivation	Flower yield (lakh ha-1)	Gross return (lakh ha-1)		Net return (lakh ha-1)	B:C Ratio
T ₁	V ₁ F ₁	85707.43	12.40	12.40	124000.00	38292.57	0.45
T ₂	V ₁ F ₂	85707.56	13.26	13.26	132600.00	46892.44	0.55
T ₃	V ₁ F ₃	85707.69	13.74	13.74	137433.33	51725.64	0.60
T ₄	V ₁ F ₄	85707.47	14.63	14.63	146300.00	60592.53	0.71
T ₅	V ₁ F ₅	85707.6	14.77	14.77	147733.33	62025.73	0.72
T ₆	V ₁ F ₆	85707.73	15.72	15.72	157200.00	71492.27	0.83
T ₇	V ₁ F ₇	85707.51	16.16	16.16	161600.00	75892.49	0.89
T ₈	V ₁ F ₈	85707.63	16.87	16.87	168700.00	82992.37	0.97
T ₉	V ₁ F ₉	85707.76	17.76	17.76	177633.33	91925.57	1.07
T ₁₀	V ₁ F ₁₀	85707.54	18.94	18.94	189400.00	103692.46	1.21
T ₁₁	V ₁ F ₁₁	85707.67	19.96	19.96	199566.67	113859.00	1.33
T ₁₂	V ₁ F ₁₂	85707.8	20.55	20.55	205533.33	119825.53	1.40
T ₁₃	V ₂ F ₁	85707.43	15.92	15.92	159233.33	73525.90	0.86
T ₁₄	V ₂ F ₂	85707.56	16.80	16.80	168033.33	82325.77	0.96
T ₁₅	V ₂ F ₃	85707.69	16.74	16.74	167433.33	81725.64	0.95
T ₁₆	V ₂ F ₄	85707.47	17.44	17.44	174433.33	88725.86	1.04
T ₁₇	V ₂ F ₅	85707.6	18.35	18.35	183533.33	97825.73	1.14
T ₁₈	V ₂ F ₆	85707.73	19.13	19.13	191300.00	105592.27	1.23
T ₁₉	V ₂ F ₇	85707.51	19.54	19.54	195400.00	109692.49	1.28
T ₂₀	V ₂ F ₈	85707.63	20.07	20.07	200700.00	114992.37	1.34

T ₂₁	V₂F₉	85707.76	20.42333	20.42333333	204233.33	118525.57	1.38
T ₂₂	V₂F₁₀	85707.54	20.97333	20.97333333	209733.33	124025.79	1.45
T ₂₃	V₂F₁₁	85707.67	22.11667	22.11666667	221166.67	135459.00	1.58
T ₂₄	V₂F₁₂	85707.80	22.66667	22.66666667	226666.67	140958.87	1.64

SUMMARY AND CONCLUSIONS

The present investigation entitled **“Standardization of Different Concentrations of Plant Growth Regulators and Levels of Nitrogen, Phosphorus on Growth, Flowering, Yield and Quality of China Aster (*Callistephus chinensis* (L.) Nees) under Chhattisgarh conditions”** was conducted at the College of Agriculture, IGKV, Raipur (C.G.). The Experiment-I entitled **“Effect on different concentrations of plant growth regulators on growth, flowering, yield and quality of China Aster”** was conducted during winter season of 2018-19, whereas, Experiment-II entitled **“Effect on different levels of nitrogen and phosphorus on growth, flowering, yield and quality of China Aster”** was conducted during winter season of 2019-20. The main objective of this investigation is to find out the effect of PGR and Nitrogen and phosphorus on vegetative growth, flowering, yield, quality & vase life of China aster. To study the best combination of PGR & NP for Arka Archana and Arka Shashank varieties of china aster and to work out the economics of PGR & NP in china aster.

5.1. Experiment I: “Effect on different concentrations of plant growth regulators on growth, flowering, yield and quality of China Aster (*Callistephus chinensis* (L.) Nees).”

The experimental field was laid out in FRBD with 3 replications. There were 14 treatment combinations of 2 varieties viz. Arka Shashank and Arka Archana as factor A and three plant growth regulators with two doses each *i.e.*, Cycocel @ 1500, 1000 ppm, NAA @ 50, 100 ppm and GA₃ @ 150, 200 along with water spray (control) as factor B. The details of the treatments are given below.

The findings of the present investigation are summarized below:

5.1.1. Vegetative characters

- ❖ At 45, 75, 105 the maximum plant height was observed under cultivar (V₁) Arka Shashank. Whereas, the minimum plant height was found in cultivar (V₂) Arka Archana. The plant height was significantly influenced due to different treatments of plant growth regulators. The significantly maximum plant height was recorded under the treatment P₆ (GA₃ 200 ppm). Whereas, minimum plant height was recorded under treatment P₂ (CCC 1500 ppm) during both the year and pooled mean analysis at 45, 75 and 105 DAT.
- ❖ At 45, 75 and 105 DAT cultivars showed significant influence on plant spread during both the years as well as pooled mean basis. The plant spread were found maximum in cultivar (V₂) Arka Archana and minimum plant was found in cultivar (V₁) Arka Shashank during both the years and pooled mean basis. Maximum plant spread was observed in treatment P₆ (GA₃ 200 ppm) which was found statistically similar with P₅ (GA₃ 150 ppm) and P₂ (CCC 1500 ppm) and the minimum plant spread were recorded under P₀ (control) during this investigation.
- ❖ Greater number of branches per plant were observed in cultivars (V₂) Arka Archana and the minimum number of branches per plant was observed under cultivars (V₁) Arka Shashank at 75 and 105 DAT during both the tested years and pooled mean data respectively. At 45, 75 and 105 DAT, highest number of branches per plant was observed in treatment P₆ (GA₃ 200 ppm) and which was found statistically at par with P₅ (GA₃ 150 ppm). The least number of primary and secondary branches per plant was recorded under treatment P₀ (Control) during the investigation.
- ❖ The highest number of leaves was observed in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank at 45, 75 and 105 DAT. During 45 and 105 DAT, the highest number of leaves per plant was recorded in treatment P₆ (GA₃ 200 ppm) and the lowest number of leaves was noticed in treatment P₀ (Control) during this investigation.
- ❖ At 75 and 105 DAT, the maximum leaf area and leaf area index was observed in (V₂) Arka Archana and the minimum leaf area and leaf area

index was noticed in (V₁) Arka Shashank. Plant growth regulators was found significantly. The maximum leaf area and leaf area index was recorded in treatment P₆ (GA₃ 200 ppm). The minimum leaf area and leaf area index was found under treatment P₀ (Control) during both the years and pooled mean analysis.

- ❖ At 75 and 105 DAT, the maximum dry matter production of (stems, roots and leaves) as compare to cultivar (V₂) Arka Archana and the minimum dry matter production were noticed in cultivar (V₁) Arka Shashank. Significantly higher dry matter production of (stems, roots and leaves) was observed with the application of P₆ (GA₃ 200 ppm). The minimum dry matter production of (stems, roots and leaves) was found under treatment P₀ (Control) at 75 and 105 DAT during both the year as well as pooled mean data.

5.1.2 Floral and yield characters

- ❖ Amongst the cultivars, there were found non significant difference between varieties in both the years as well as pooled mean analysis. The early flowering was noticed in plants applied with (GA₃ 200 ppm) which took first bud initiation and days to 1st flowering and it was found statistically at par with treatments P₅ (GA₃ 150 ppm) during both the years and pooled mean basis. The maximum days required for bud initiation and days to first flowering were observed in treatment P₀ (Control).
- ❖ Significantly, maximum flowering duration was recorded in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank during both the tested years and pooled mean data respectively. The maximum flowering duration was observed under treatment P₆ (GA₃ 200 ppm). Whereas, minimum flowering duration was recorded under treatment P₀ (Control) during both the year of investigation as well as pooled mean basis respectively.
- ❖ In case of cultivar, the maximum number of flowers per plant, yield of flower per plant, yield of flower per plot and yield of flower hectare were observed in cultivar (V₂) Arka Archana and minimum number of flowers

per plant, yield of flower per plant, yield of flower per plot and yield of flower hectare were recorded in cultivar (V₁) Arka Shashank. It showed significant response with application of plant growth regulators, the highest number of flowers per plant, yield of flower per plant, yield of flower per plot and yield of flower hectare was observed under treatment P₆ (GA₃ 200 ppm) and it was found significantly superior over other plant growth regulators. Whereas, the minimum number of flowers per plant, yield of flower per plant, yield of flower per plot and yield of flower hectare was noted under treatment P₀ (Control).

5.1.3 Quality parameters

- ❖ Amongst the cultivars of China aster, differs significantly on stalk length. The maximum stalk length was observed in cultivar (V₁) Arka Shashank. The minimum stalk length was obtained from cultivar (V₂) Arka Archana. The plant growth regulators showed significant response on stalk length during both the years as well as pooled mean analysis. The maximum stalk length and weight of flowers with stalk were recorded under treatment P₆ (GA₃ 200 ppm) which was found statistically *at par* with treatment P₅ (GA₃ 150 ppm). The minimum stalk length was noticed in treatment P₀ (Control).
- ❖ Cultivars differs significantly on fresh and dry weight of 10 flowers. The highest fresh and dry weight of flowers were observed in cultivar (V₂) Arka Archana as compare to cultivar (V₁) Arka Shashank respectively in both the years as well as on pooled mean basis. The maximum fresh and dry weight of 10 flowers was recorded under treatment P₆ (GA₃ 200 ppm). The minimum fresh and dry weight of 10 flowers was recorded in P₀ (Control).
- ❖ Cultivars differs significantly on total weight of fresh and dry flowers. The highest total weight of fresh and dry flowers was observed in (V₁) Arka Archana. The lowest total weight of fresh flowers per plant were obtained from cultivar (V₂) Arka Shashank. Plant growth regulators showed significant response on total weight of fresh and dry flowers, during both the years as well as pooled mean analysis. The maximum total weight of fresh and dry flowers per plant were recorded under treatment P₆ (GA₃ 200

ppm). The minimum total weight of fresh and dry flowers per plant was recorded in treatment P₀ (Control) under this investigation.

- ❖ Amongst the cultivars, they show significant influence on chlorophyll content before and after flowering. The highest chlorophyll content before and after flowering were observed in cultivar (V₂) Arka Archana. The lowest chlorophyll content before and after flowering was obtained from cultivar (V₁) Arka Shashank in both the years as well as pooled mean basis. Plant growth regulators showed significant impact on chlorophyll content before and after flowering during both the years as well as pooled mean analysis. The highest Chlorophyll content before flowering were recorded under P₆ (GA₃ 200 ppm). The lowest Chlorophyll content before flowering was recorded in P₀ (Control).
- ❖ Maximum flower diameter were observed in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank during both the tested years and pooled mean data respectively. In respect to plant growth regulator. The maximum diameter of flowers respectively was observed under treatment P₆ (GA₃ 200 ppm). Whereas, minimum diameter of flowers was recorded under treatment P₀ (Control) during both the year of investigation as well as pooled mean basis.
- ❖ The maximum vase life of flowers in days was recorded under cultivar (V₂) Arka Archana and the minimum vase life in days was recorded under cultivar (V₁) Arka shashank during second year as well as pooled mean analysis. During first year it was found non significant. Plant growth regulators showed significant response on vase life of flowers. The longer vase life of flowers were recorded under treatment P₆ (GA₃ 200 ppm) which was found statistically similar with treatment P₅ (GA₃ 150 ppm) during both the tested years except pooled mean basis. The minimum vase life of flowers was recorded in treatment P₀ (Control) under this investigation.

5.1.4 Economics

The highest net profit was observed under the treatment combination of application of GA₃ 200 ppm with Arka Archana. Whereas, maximum benefit-cost ratio was observed under the treatment combination of application of GA₃ 200 ppm with Arka Archana. The highest gross return of Rs. 240433.33 was found in the treatment combination (V₂P₆) followed by (V₂P₅) of Rs. 222933.33 whereas the lowest (Rs. 123400.00) was observed in control. The highest benefit-cost ratio (1.77) was calculated in (V₂P₆) followed by (V₂P₅) (1.57). Therefore as per economic point of view the combination of GA₃ 200 ppm is best with Arka Archana for more benefit from china aster cultivation in Chhattisgarh plains.

5.1.5. Conclusion

Based on the results obtained from the experiments conducted under Chhattisgarh plains the following conclusions have been drawn:

- The plant height increased when first foliar application of GA₃ 200 ppm was done at 30 and 60 DAT. Whereas, taller plants were observed in Arka Shashank as compared to Arka Archana.
- The number of branches was produced more with the application of GA₃ 200 ppm followed by 1500 ppm cycocel at 30 and 60 DAT and it was also more in cv. Arka Archana.
- The plant spread was observed more with the application of GA₃ 200 ppm followed by cycocel 1500 ppm. Whereas, higher plant spread were observed in Arka Archana as compared to Arka Shashank.
- Maximum fresh and dry weight of plant were obtained on the application of GA₃ 200 ppm. In case of varieties it was also maximum in Arka Archana as compared to Arka Shashank.
- The flowering parameters viz., days to bud appearance, days to first flowering were found early with GA₃ 200 and for cultivars in Arka Archana.

- The vase life of flowers was improved with the application of GA₃ 200 ppm. Similar result was found in Arka Archana.
- Maximum flower diameter of china aster was observed with treatment GA₃ 200 ppm and the same was also found maximum in Arka Archana with respect to Arka Shashank
- The highest chlorophyll content before and after flowering was observed in cultivar Arka Archana and the highest stalk length was found in Arka Shashank.
- The flower yield was recorded maximum with foliar application of GA₃ 200 ppm and in case of cultivars with Arka Archana.
- It can be concluded from the present investigation that cultivar Arka Archana is superior in terms of growth and yield attributes as compared to Arka Shashank.
- Thus, inference can be drawn from the present investigation that, the treatment of GA₃ 200 ppm was found to be suitable for enhancing plant growth, flowering and production of higher yield of better quality flower in China aster. The results obtained from the present investigation are suggestive and need to be studied further for appropriate recommendations.
- The interactions between cultivar and growth regulators were found mostly non- significant for different growth and flowering characters of China Aster. This may be due to the similar effect of plant growth regulator on both the varieties of China aster.

5.2. Experiment II: “Effect on different levels on nitrogen and phosphorus on growth, flowering, yield and quality of China Aster (*Callistephus chinensis* (L.) Nees).”

The experiment was conducted in Factorial Randomized Block Design with 24 treatments comprising of two varieties viz. Arka Shashank and Arka Archana as factor A and 4 levels of Nitrogen, i.e, (120, 140, 160, 180 kg/ha), and 3 levels of Phosphorus (100, 120, 140 kg/ha) as factor B. Half dose of nitrogen and full dose

of P_2O_5 were applied as basal and rest of the nitrogen applied in two split doses at 30 and 45 DAT.

5.2.1 Vegetative characters

- ❖ At 45, 75 and 105 DAT, the maximum plant height was observed in cultivar (V₁) Arka Shashank. Whereas, the minimum plant height was found in cultivar (V₂) Arka Archana. Application of different levels of nitrogen and phosphorus shows significant difference on plant height. The maximum plant height was recorded under the treatment F₁₂ (N₁₈₀: P₁₄₀). The minimum plant height was noticed in F₁ (N₁₂₀: P₁₀₀) under this investigation.
- ❖ At 45, 75 and 105 DAT cultivars showed significant influence on plant spread during both the years as well as pooled mean basis. The plant spread were found maximum in cultivar (V₂) Arka Archana in both the years and pooled mean basis and minimum plant spread was found in cultivar (V₁) Arka Shashank. The results on plant spread at showed significant differences between treatments. Maximum plant spread was observed in treatment F₁₂ (N₁₈₀: P₁₄₀). The minimum plant spread was found under treatment F₁(N₁₂₀: P₁₀₀).
- ❖ The maximum number of primary and secondary branches per plant was recorded under cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank. In respect to application of different levels of nitrogen and phosphorus showed significant impact on number of primary and secondary branches per plant at 45, 75 and 105 DAT. The highest number of primary branches per plant was observed in treatment F₁₂ (N₁₈₀: P₁₄₀). The lowest number of primary branches per plant was recorded under treatment F₁ (N₁₂₀: P₁₀₀).
- ❖ The maximum number of leaves was observed in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank at 45, 75 and 105 DAT. The maximum number of leaves per plant was recorded in treatment

F₁₂ (N₁₈₀: P₁₄₀) and the minimum number of leaves was noticed in treatment F₁ (N₁₂₀: P₁₀₀) during this investigation.

- ❖ At 75 and 105 DAT, the maximum leaf area and leaf area index was observed in cultivar (V₂) Arka Archana and the minimum leaf area and leaf area index was noticed in cultivar (V₁) Arka Shashank. Application of different levels of nitrogen and phosphorus shows significant effect. The maximum leaf area and leaf area index was recorded in treatment F₁₂ (N₁₈₀: P₁₄₀). The minimum leaf area and leaf area index was found under treatment F₁ (N₁₂₀: P₁₀₀) during both the years and pooled mean analysis.
- ❖ At 75 and 105 DAT, the maximum total dry matter production was obtained in cultivar (V₂) Arka Archana and the minimum dry matter production were noticed in cultivar (V₁) Arka Shashank. Significantly higher total dry matter production of was observed with the application treatment F₁₂ (N₁₈₀: P₁₄₀). The minimum total dry matter production was found under treatment F₁ (N₁₂₀: P₁₀₀) at 75 and 105 DAT during both the year as well as pooled mean data.

5.1.2 Floral and yield characters

- ❖ Amongst the cultivars, there were found significant difference between varieties in both the years as well as pooled mean analysis. Minimum days required for bud initiation and 1st flowering was observed in cultivar (V₂) Arka Archana and maximum days required for bud initiation and 1st flowering were observed in cultivar (V₁) Arka Shashank during both the tested years and pooled mean data respectively. The days taken for commencement of flowering and days for 1st flowering were significantly influenced by application of different levels of nitrogen and phosphorus. The earlier bud initiation was observed in F₂ (N₁₂₀: P₁₂₀) in first year, while it was noticed in the treatment F₁ (N₁₂₀: P₁₀₀) during second as well as pooled mean analysis respectively. The maximum days required for bud initiation and 1st flowering were observed in treatment F₁₂ (N₁₂₀: P₁₂₀)

- ❖ Significantly, maximum flowering duration were recorded in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank during both the tested years and pooled mean data respectively. Flowering duration found significant impact on application of different levels of nitrogen and phosphorus. The maximum flowering duration was observed under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatment F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀). The minimum flowering duration was recorded in treatment F₁ (N₁₂₀: P₁₀₀). .
- ❖ In, case of cultivars, they show significant influence on no. of flowers per plant. The highest no. of flowers were observed in cultivar (V₂) Arka Archana . The lowest number of flowers were obtained from cultivar (V₂) Arka Shashank during both the years as well as pooled mean basis. Nitrogen and phosphorus shows significant response on number of flowers per plant. The maximum no. of flowers were recorded under treatment F₁₂(N₁₈₀: P₁₄₀) and it was observed statistically similar with F₁₁(N₁₈₀: P₁₂₀).The minimum number of flowers was recorded under treatment F₁ (N₁₂₀: P₁₀₀) during this investigation.
- ❖ In case of cultivar, the maximum yield of flower per plant, yield of flower per plot and yield of flower per hectare were observed in cultivar (V₂) Arka Archana and minimum yield of flower per plant, yield of flower per plot and yield of flower per hectare were recorded in cultivar (V₂) Arka Shashank. It showed significant response with application of different levels of nitrogen and phosphorus, the highest yield of flower per plant, yield of flower per plot and yield of flower per hectare was observed under treatment F₁₂(N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatment F₁₁(N₁₈₀: P₁₂₀) during both the years as well as pooled mean analysis. Whereas, the minimum yield of flower per plant, yield of flower per plot and yield of flower per hectare was recorded under treatment F₁ (N₁₂₀: P₁₀₀).

5.1.3 Quality parameters

- ❖ Amongst the cultivars of China aster, differs significantly on stalk length. The highest stalk length were observed in cultivar (V₁) Arka Shashank. The lowest stalk length were obtained from cultivar (V₂) Arka Archana in both the years as well as pooled mean basis. Application of different levels of nitrogen and phosphorus showed significant response on stalk length. The maximum stalk length were recorded under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatment F₁₁(N₁₈₀: P₁₂₀). The minimum stalk length was noticed in treatment F₁ (N₁₂₀: P₁₀₀) in both the years and pooled mean basis.
- ❖ Cultivars differs significantly on fresh and dry weight of 10 flowers. The highest fresh and dry weight of flowers were observed in cultivar (V₂) Arka Archana as compare to cultivar (V₁) Arka Shashank respectively in both the years as well as on pooled mean basis. As far as fertilizer application, the maximum fresh and dry weight of 10 flowers was recorded under treatment F₁₂ (N₁₈₀: P₁₄₀). The minimum fresh and dry weight of 10 flowers was recorded in F₁ (N₁₂₀: P₁₀₀).
- ❖ Cultivars differ significantly on total weight of fresh and dry flowers. The highest total weight of fresh and dry flowers was observed in (V₂) Arka Archana. The lowest total weight of fresh flowers per plant was obtained from cultivar (V₁) Arka Shashank. Nitrogen and phosphorus significant response on total weight of fresh and dry flowers, during both the years as well as pooled mean analysis. The maximum total weight of fresh and dry flowers per plant were recorded under treatment F₁₂ (N₁₈₀: P₁₄₀). The minimum total weight of fresh and dry flowers per plant was recorded in treatment F₁ (N₁₂₀: P₁₀₀) under this investigation.
- ❖ Amongst the cultivars, they show significant influence on chlorophyll content before and after flowering. The highest chlorophyll content before and after flowering were observed in cultivar (V₂) Arka Archana. The lowest chlorophyll content before and after flowering were obtained from cultivar (V₁) Arka Shashank in both the years as well as pooled mean basis. Different levels of fertilizers showed significant impact on chlorophyll

content before and after flowering during both the years as well as pooled mean analysis. The highest Chlorophyll content before flowering were recorded under $F_{12}(N_{180}: P_{140})$. The lowest Chlorophyll content before flowering was recorded in $F_1 (N_{120}: P_{100})$.

- ❖ Maximum flower diameter were observed in cultivar (V_2) Arka Archana as compared to cultivar (V_1) Arka Shashank. In respect to different levels of nitrogen and phosphorus, the maximum diameter of flowers was observed under treatment $F_{12} (N_{180}: P_{140})$. Whereas, minimum diameter of flowers was recorded under treatment $F_1 (N_{120}: P_{100})$ during both the year of investigation as well as pooled mean basis.
- ❖ The maximum vase life of flowers in days was recorded under cultivar (V_2) Arka Archana and the minimum vase life in days was recorded under cultivar (V_1) Arka shashank. Nitrogen and phosphorus showed significant response on vase life of flowers, The longer vase life of flowers were recorded under treatment $F_{12} (N_{180}: P_{140})$ and it was observed statistically similar with the treatment $F_{10} (N_{180}: P_{100})$ and $F_{11}(N_{180}: P_{120})$ during both the years and pooled mean basis. The minimum vase life of flowers was recorded in treatment $F_1 (N_{120}: P_{100})$ under this investigation.

5.2.4 Economics

The highest net profit was observed under the treatment combination of application of $F_{12} (N_{180}: P_{140})$ with Arka Archana. Whereas, maximum benefit-cost ratio was observed under the treatment combination of application of $F_{12} (N_{180}: P_{140})$ with Arka Archana. The highest gross return of Rs. 226666.67 was found in the treatment combination (V_2F_{12}) followed by (V_2F_{11}) of Rs. 221166.67 whereas the lowest (Rs. 124000.00) was observed in control. The highest benefit-cost ratio (1.64) was calculated in (V_2F_{12}) followed by (V_2F_{11}) (1.58). Therefore as per economic point of view the combination of $F_{12} (N_{180}: P_{140})$ with Arka Archana for more benefit from China aster cultivation in Chhattisgarh plains.

5.2.5. CONCLUSION

On the basis of two years study, it was concluded that optimum doses of nitrogen and phosphorus are necessary for maximizing growth, yield and quality of China aster under Chhattisgarh condition. Among the different treatments, the treatment F₁₂ (N₁₈₀: P₁₄₀) recorded maximum plant height, plant spread, number of primary and secondary branches, number of leaves, dry matter production of leaves, stems and roots, days to bud initiation, days to first flower opening, duration of flowering, flower weight, flower diameter, dry and fresh weight of flowers, chlorophyll content before and after flowering, number of flowers per plant and flower yield per plant.

The study suggested that China aster cv. Arka Archana performed superior as compare to Arka Shashank and application of NPK @ 180:140 and 60 kg ha⁻¹ is the most appropriate dose for attaining high growth, yield and quality of these cultivar of China aster under Chhattisgarh condition.

The interactions between two cultivar and application of different levels of nitrogen and phosphorus were found mostly non- significant for different growth and flowering and yield attributes of China aster. This may be due to the similar effect of nitrogen and phosphorus on both the varieties of China aster under Chhattisgarh conditions.

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APPENDICES

Appendix-I

Dept. of Agricultural Meteorology

Indira Gandhi Agricultural University, Raipur (Chhattisgarh) - 492 012

Station: Labhandi

Weekly Meteorological Data : November 2018- April 2019

Date	Max. Temp. (°C)	Min. Temp. (°C)	Rain- fall (mm)	Wind Velocity (Kmph)	Evapo- ration (mm)	Sun Shine (hours)
05-11 Nov 18	32.3	17.7	0	1.2	23.3	8.5
12-18 Nov 18	31.5	14.4	0	1.1	23.3	9.1
19-25 Nov 18	31.4	15.3	0	1.1	23.2	7.8
26-02 Nov 18	29.3	13.6	0	1	19.7	7.5
03-09 Dec 18	28.2	14.3	0	0.9	17.4	4.4
10-16 Dec 18	27.4	15.7	0	1	13.9	1.2
17-23 Dec 18	22.1	11	47.2	3.1	15.3	4.5
24-31 Dec 18	25.1	8.6	0	1.3	16.6	7.5
01-07 Jan 19	27.4	8.5	0	0.7	16.8	6.6
08-14 Jan 19	27.1	10.2	0	0.9	16.5	6.1
15-21 Jan 19	28.1	9.2	0	0.9	18.7	6.8
22-28 Jan 19	26.3	14.3	23.6	2	18.5	4
29-04 Jan 19	26.4	9.5	0	1.3	20.6	8.2
05-11 Feb 19	28.8	12.5	3.4	1.5	21.3	7.6
12-18 Feb 19	30.2	13.6	9	1.8	20.4	8.3
19-25 Feb 19	33.1	17	0	1.7	30.3	9.1
26-04 Feb 19	31	17.3	0.2	2.4	30.7	7.8
05-11 Mar19	33.3	17.6	0	8.3	40.3	8.9
12-18 Mar19	35.6	21.6	0	3.2	36.7	6.8
19-25 Mar19	34.5	19.8	9.2	2.4	37.1	8.4
26-01 Mar19	38.2	20.6	10.8	2	44.5	8.7
02-08 Apr 19	39.7	23.4	0	3.4	53.2	8.3
09-15 Apr 19	40.8	24.5	0	4.3	60.4	8.3
16-22 Apr 19	38	24.1	11.2	4.3	54.4	9

Appendix-II**Dept. of Agricultural Meteorology****Indira Gandhi Agricultural University, Raipur (Chhattisgarh) - 492 012****Station: Labhandi****Weekly Meteorological Data : November 2019- March 2020**

Date	Max. Temp. (°C)	Min. Temp. (°C)	Rain- fall (mm)	Wind Velocity (Kmph)	RH I (%)	RH II (%)
05-11 Nov 19	30.6	23	81.6	3	91	65
12-18 Nov 19	29.6	15.5	0	1.8	90	38
19-25 Nov 19	30.2	15.2	0	1.4	89	38
26-02 Nov 19	29.7	16.3	0	2	90	43
03-09 Dec 19	28	13.3	0	2.4	84	34
10-16 Dec 19	29.5	15.3	0	1.7	91	48
17-23 Dec 19	26.7	14.1	0.8	1.9	88	42
24-31 Dec 19	26.1	11.9	0	2.5	81	35
01-07 Jan 20	23.3	12.9	19.4	4.1	84	55
08-14 Jan 20	25.1	10.8	3.2	2.1	90	46
15-21 Jan 20	28.6	14.1	0	1.8	88	48
22-28 Jan 20	28.8	13.4	0	1.8	87	39
29-04 Jan 20	26.1	13.9	0	2.9	76	46
05-11 Feb 20	21.3	13.6	49.6	4.1	94	66
12-18 Feb 20	29.7	11.9	0	2.2	88	27
19-25 Feb 20	31.4	15.5	35.8	2.7	87	45
26-04 Feb 20	30	16.3	0.2	1.9	87	39
05-11 Mar20	30.1	19.4	1.8	3.7	87	52
12-18 Mar 20	31.2	20.8	37.2	3	89	54
19-25 Mar20	33.6	20	1.6	3	84	37
26-01 Mar20	35.1	21.9	8.4	3.4	78	36

Appendix-III

Cost of cultivation

Sl. No.	Common Cost	Quantity/Time/ Amount	unit	Rate (Rs)		Total Cost (Rs/ha)	
				2017-18	2018-19	2017-18	2018-19
				Rate (Rs)	Rate (Rs)		
1.	Land Preparation						
	i. One Ploughing by soil turning ploughing by tractor	4hr	4	375	375	1500	1500
	ii. Two Ploughing by tractor drawn cultivator	8hr	8	350	350	2800	2800
	iii. Levelling by tractor	2hr	2	375	400	750	800
	Total average land preparation cost					5100	
2	Nursery Preparation						
	i. Bed Preparation by labour	05 Labour	05	175	175	700	700
	ii. Irrigation by labours	10 Labour	10	175	175	1750	1750
	iii. Sparing of fungicide	1 Labour	1	175	175	175	175
	Total average Nursery Preparation cost					2625	
3	Transplanting						
	i. Labour for Transplanting	15 labour	15	175	175	2625	2625
	ii. Irrigation by labours	10 Labour	10	175	175	1750	1750
	Total average transplanting cost					4375	
4	Manures and Fertilizers						
	i. FYM	20t	20	650	700	13000	14000

	ii	Nitrogen through Urea (as per treatment)	391.5 kg	391.5	10	10	3915	3915
	iii	Phosphorous through DAP	750 kg	750	15	15	11250	11250
	iv	Potash through MOP	100 kg	100	15	15	1500	1500
	v	Mixing of FYM and chemical fertilizers by labours	20 unit	20	175	175	3500	3500
Total average manures and fertilizers cost								34165
5	Cultural Practices							
	i.	Irrigation by tube well	5 irrigation	5	300	300	1500	1500
	ii.	Labour for irrigation	10 labour	10	175	175	1750	1750
	iii.	Weeding for 3 times	15 labour	15	175	175	2625	2625
	iv.	Labour for earthing up	6 labour	6	175	175	1050	1050
	v.	Labour for staking up	6 labour	6	175	175	1050	1050
Total average cultural practices cost								7975
6	Plant Protection							
	i.	Cost of Dimethoate (0.04%) 2 spray	2 litre	2	500	500	1000	1000
	ii.	Cost of Clorophyliphos (0.02%)	1 liter	2	632	632	1264	1264
	iv.	Spray unit	6 labour	12	175	175	2100	2100
Total average plant protection cost								4364
7	Harvesting							
	i.	Harvesting of flowers	40 unit	40	175	175	7000	7000
	ii.	Transport charge for carrying						

		flower to the market											
	iii.	Lifting of flowers	30 unit	30	175	175	5250	5250				5250	
	iv.	Rental value of land (12 month)	1 years	1	10000	10000	10000	10000				10000	
	v.	Miscellaneous charges 1% of the total cost cultivation					2000	2000				2000	
Total average harvesting cost													17250
	vi.	Total cost of cultivation						75854				75854	
	vii.	Interest on cultivation cost @12%	12 months	12	12%	12%	9102.48	9102.48				9102.48	
	viii	Grand total cost of cultivation						84956.48				84956.48	
	ix.	Total average cost 2017-18 and 2018-19						84956.48				84956.48	

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Effect of varieties and plant growth regulators on vegetative growth of China aster (*Callistephus chinensis* (L.) Nees) under Chhattisgarh conditions

Sunna Deepti, Dr. T Tirkey and Abhinav Kumar

Abstract

The present investigation entitled “Standardization of different concentrations of plant growth regulators and levels of nitrogen, phosphorus on growth, flowering, yield and quality of China Aster (*Callistephus chinensis* (L.) Nees) under Chhattisgarh conditions” was conducted at the Horticultural Research cum Instructional Farm, Department of Floriculture and Landscape Architecture, College of Agriculture, IGKV, Raipur (C.G.). The Experiment-I entitled “Effect on different concentrations of plant growth regulators on growth, flowering, yield and quality of China Aster” was conducted during winter season of 2018-19 and 2019-20. The experimental field was laid out in (Factorial Randomized Block Design) (FRBD) with 3 replications. There were 14 treatment combinations of two varieties viz. Arka Shashank and Arka Archana as factor A and three plant growth regulators with two doses each i.e. Cycocel @ 1500, 1000 ppm, NAA @ 50, 100 ppm and GA₃ @ 150, 200 along with water spray (control) as factor B.

Under transitional Chhattisgarh plains, there is a need to standardize production technology involving systematic research to evaluate acceptable variety and to evaluate the effect of plant growth regulators on growth, flowering, yield and quality of China aster flower production under the Chhattisgarh plains.

The result were indicated that China aster cv. Arka Archana performed superior as compare to Arka Shashank and the treatment P₆ (GA₃ @ 200 ppm) performed significantly better in growth characters viz. plant height(cm), plant spread (cm), maximum number of primary and secondary branches plant⁻¹, number of leaves /plant, leaf area and leaf area index.

Keywords: Arka shashank and Arka Archana, Chhattisgarh plains, vegetative growth, China Aster

1. Introduction

China aster (*Callistephus chinensis* (L.) Nees) belongs to the family compositae and its origin is China. China aster is one of the most important annual flower crops used commercially as cut flower, and for interior decoration. It is also used for bedding and potting purpose. Flowers are used for decoration, landscaping, in window boxes and used as loose flower in worship. China aster are usually propagated by seeds. seedlings are raised in seed beds. The plants need rich porous well drained loamy soil. It loves the sun and hence it should be grown in an open sunny environment. Proper fertilizer applications help in better growth and flowering, watering should be done in the morning or in the evening. The flowers of aster have wide range of type, size, shape, colour and have good keeping quality. Most of the colours except pure yellow are present in aster. The latest variations of pink, primrose, light blue, mauve, black, scarlet, creamy white, plain white and violet are available in different sizes, styles and a wide variety of colour ranges. (Dua and Pal 2003.)^[3]

Genus *Callistephus* derived from two Greek words, ‘*Kalistos*’ and ‘*Steophos*’ which means beautiful and crown respectively. It was introduced in Europe in 1731 by Jesult missionary. French florist contributed much in development of quilled flowers. The comet type introduced in 1886 subsequently replaced by Quilled flowers. China aster is short day plant and it requires less than 12 hrs light for improved vegetative growth and early flowering. Flower initiation took place at a temperature of 15 °C above. Flowers show geitonogamous type of self-pollination. Plant growth regulators are unique in action, i.e. the behaviour and reaction of each type of plant according to the concentration and composition of compounds is found to be highly variable. Many products with active ingredients have been produced as commercial products and, in compliance with the instructions, may be used for specific purposes. It has been found that plant growth regulators are rapidly absorbed into the various parts of the plant. There are different methods for using plant growth regulators. The most widespread is foliar use. It is simple, convenient, cheap and economical.

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Over the last three quarters of a century, technical developments relating to growth regulators have advanced rapidly. Plant growth regulators can, when used in small amounts, alter or monitor physiological processes in the plant. Plant growth regulators are found to be absorbed easily by the various parts of the plant. In practice, there are different strategies for using growth regulators. The foliar application is the most common because it is simple, convenient, inexpensive and economical. By modifying the growth, flowering, seed set and seed yield of plants, it has played a significant role.

Methods and Materials

The present investigations were carried out at the Horticulture Research cum Instructional Farm, Department of Floriculture and Landscape Architecture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G) during two rabi seasons of 2018-19 and 2019-20. Geographically, Raipur is situated in the transitional tract of Chhattisgarh at 21.29 North latitude and 81.82 East longitude at an altitude of 250-300 m above the mean sea level. The climate of Chhattisgarh is tropical. It is hot and humid because of its proximity to the Tropic of Cancer and its dependence on the monsoons for rains. Summer temperatures in Chhattisgarh can reach up to 45 °C (113 °F). The atmospheric relative humidity is relatively high during the months of June - October. Chhattisgarh receives an average of 1,29 millimetres (50.9 in) of rain. Winter is from November to January. Winters are pleasant with low temperatures and less humidity. The maximum and minimum temperatures were 40.8°C in 3rd week of April and 8.5°C in 1st week of January, respectively during (2018-19). The maximum and minimum temperatures were 35.1°C in 4th week of April and 10.8 °C in 2nd week of January, respectively during (2019-20). The average wind velocity ranges from 3.8-4.4 (Kmph) during (2018-19) and 3.9-4.5 (Kmph) during (2019-20) respectively. The weather conditions during the course of investigation remained favourable for the growth, development and production of China Aster.

The experimental field was laid out in Factorial Randomized Block Design (FRBD) with three replications. There were 14 treatment combinations of two varieties viz. Arka Shashank and Arka Archana as factor A and three plant growth regulators with two doses each i.e., Cycocel @ 1500, 1000 ppm, NAA @ 50, 100 ppm and GA₃ @ 150, 200 along with water spray (control) as factor B. 45 days old healthy and uniformly grown seedlings were used for transplanting with a spacing of 30 cm x 30 cm @ one seedling per hill. There are seven PGR doses which were applied in two varieties of China Aster, hence there are 14 treatments combinations. V₁P₀ (Arka Shashank + Control), V₁P₁ (Arka Shashank+ Cycocel @ 1000ppm), V₁P₂ (Arka Shashank+ Cycocel @ 1500 ppm), V₁P₃ (Arka Shashank+ NAA @ 50 ppm), V₁P₄ (Arka Shashank+ NAA @ 100 ppm), V₁P₅ (Arka Shashank+ GA₃ @ 150 ppm) V₁P₆ (Arka Shashank + GA₃ @ 200 ppm), V₂P₀ (Arka Archana + Control), V₂P₁ (Arka Archana + Cycocel @ 1000ppm), V₂P₂ (Arka Archana + Cycocel @ 1500 ppm), V₂P₃ (Arka Archana + NAA @ 50 ppm), V₂P₄ (Arka Archana + NAA @ 100 ppm), V₂P₅ (Arka Archana + GA₃ @ 150 ppm), V₂P₆ (Arka Archana + GA₃ @ 200 ppm).

Nitrogen, phosphorus and potassium, respectively, were added in the form of urea, single superphosphate and murate of potash. At the time of transplantation, half a dose of N and the full dose of P and K were applied in a circular band of approximately 3-4 cm around each plant and, after 30 days of transplantation, the crop was top-dressed with the remaining

half a dose of N. By repeated ploughing and harrowing, the land was carried to a fine tilth. A spacing of 0.50 m between two replications and 1.00 m between two plots was provided for lying out of irrigation channels and bunds respectively. The entire experimental land was divided into plots measuring 1.5 m x 1.5 m there were totally 42 plots. Timely and effective plant protection steps have been taken to protect experimental plants from pest and disease attacks. Harvesting the flowers for the purpose of observation on flower and yield components was commenced after 100 days of transplanting and only two harvestings were done. The obtained data had statistically analyzed adopting procedure as given by Panse, V.G. and Sukhatme, B.V. (1985) ^[10].

Results and Discussion

The data on plant height at 45, 75 and 105 DAT influenced by varieties of China aster and plant growth regulators are presented in Table 1.

Cultivars shows significant response on plant height at 45, 75 and 105 DAT, during both the years as well as in pooled mean basis. The maximum plant height respectively was observed in cultivar (V₁) Arka Shashank. Whereas, the minimum plant height was found in cultivar (V₂) Arka Archana. The variation in plant height between China aster varieties might be due to congenial environment to plant that express the dominant genes in the genotypes and different genetic makeup of the varieties. The observations are in conformity with the findings of Bhanu Pratap *et al.* (1999) ^[1], Sreekala *et al.* (2002) ^[14], Rao *et al.* (2005) ^[11], Nursude *et al.* (2010) ^[9] in African marigold and Namita *et al.* (2008) ^[7] in French marigold.

The perusal of the data reveals that at 45, 75 and 105 DAT there was significant difference on plant height due to plant growth regulators during both the year and on pooled mean basis. The maximum plant height was recorded under the treatment P₆ (GA₃ 200 ppm). The minimum plant height was noticed in P₃ (CCC 1500 ppm) under this investigation. The interactions between cultivar and growth regulators were found significant for plant height during both the years and pooled mean basis.

The maximum plant height was obtained by spraying with GA₃@ 200 ppm This might be due to the fact that an application of gibberellic acid at different concentrations might have enhanced the plant height by increasing the internodal length as a result of increased cell elongation and faster cell division which may be enhance the plant growth and ultimately increases the plant height. The results are in conformity with the findings of Kadam *et al.* (2002) ^[5], Nandre *et al.* (2009) ^[8], Gupta *et al.* (2015) ^[4] and Kumar *et al.* (2015) in China aster, Palei *et al.* (2016) in African marigold and Sajid *et al.* (2016) in *Chrysanthemum morifolium*.

The result on plant spread was influence by cultivars and plant growth regulators are presented in Table 2.

At 45, 75 and 105 DAT variety showed significant influence on plant spread during both the years as well as pooled mean basis. The plant spread were found maximum in cultivar (V₂) Arka Archana in both the years and pooled mean basis and minimum plant was found in cultivar (V₁) Arka Shashank.. The difference in plant spread per plant is a varietal trait as it is governed by the genetical makeup of the plant. Similar variations in plant spread among varieties were also observed in china aster reported by Rao and Negi (1990) ^[11] and Ravikumar (2002).

Maximum plant spread was observed in treatment P₆ (GA₃ 200 ppm) during this investigation and the minimum plant spread was found in the treatment P₀ (control) at 45, 75 and 105 DAT.

The interactions between two cultivar and growth regulators were found non-significant at 45 and 75 DAT for plant spread and it was found significant at 105 DAT.

Maximum spread of plant might be due to the favorable environment to express the dominant genes in the genotypes and different genetic makeup of the variety. The chlorophyll content in leaves might have increased the synthesis of carbohydrates, amino acids etc. from which phytochrome may have been synthesized resulting in increase in vegetative characters. The present research work confirms the findings of Bhanu Pratap *et al.* (1999) ^[1], Nand- Kishore and Mohanti (2002), Sreekala *et al.* (2002) ^[14], Rao *et al.* (2005) ^[11] and Nursude *et al.* (2010) ^[9] in African marigold.

The results on number of primary branches plant⁻¹ were significantly influenced by varieties and application of growth regulators are presented in Table 3 and Table 4.

The perusal of the data on the influence of varieties on number of primary and secondary branches per plant revealed that at 75 and 105 DAT, it showed significant effect during both the year as well as pooled mean basis of investigation. The maximum number of primary and secondary branches plant⁻¹ was recorded under cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank. From the above findings, significantly maximum number of primary and secondary branches was observed in Arka Archana at all the growth stages, and the increasing in primary branches might be due to the pleasant environment to express the dominant genes in the genotypes and different genetic makeup of the variety. The present research work confirms with the findings of Bhanu Pratap *et al.* (1999) ^[1], Nand- Kishore and Mohanti (2002), Sreekala *et al.* (2002) ^[14], Rao *et al.* (2005) ^[11] and Nursude *et al.* (2010) ^[9] in African marigold

In case of Plant growth regulators, it showed significant impact on number of primary and secondary branches plant⁻¹ at 75 and 105 DAT. The highest number of primary and secondary branches per plant was observed in treatment P₆ (GA₃ 200 ppm). Lowest number of primary and secondary branches plant⁻¹ was recorded under treatment P₀ (Control). The interaction between the varieties and plant growth regulators shows non- significant impact on number of primary branches plant⁻¹ at 75 and 105 DAT during both the tested year as well as pooled mean analysis.

Maximum number of branches were found with GA₃ at 200 ppm compared to all other treatments. The increase in number of primary branches per plant with application of GA₃ seems to be due to enhanced cell division and cell enlargement, promotion of protein synthesis coupled with higher dry matter accumulation in the plant. Similar results were reported by Lal and Mishra (1986) ^[6] in aster and marigold, Shivaprasad Shetty (1995) ^[12] and Doddagoudar (2002) ^[2] in China aster.

The data on number of leaves per plant at different growth stages are presented in Table 5. The perusal of the data revealed that at 45, 75 and 105 DAT there was significant effect on number of leaves per plant due to cultivars during both the years and on pooled mean basis. The maximum number of leaves was observed in cultivar (V₂) Arka Archana as compared to cultivar (V₁) Arka Shashank during this investigation. Maximum number of leaves was found with the GA₃ treatment at 200 ppm compared to all other treatments and this is due to the increase in plant height and number of branches per plant. Similar results were recorded by earlier research workers (Lal and Mishra, 1986 and Shyamal *et al.* (1990) ^[6, 13] in aster.

Table 1: Effect of Varieties and plant growth regulators on Plant height (cm)

Treatments	45 days			75 days			105 days		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
V ₁	18.3	18.8	18.6	46.9	48	47.5	54.3	54.4	54.3
V ₂	17.5	17.8	17.6	36.8	37.5	37.2	47.5	46.8	47.1
SEm±	0.24	0.28	0.17	0.52	0.57	0.57	0.55	0.65	0.69
CD at 5%	0.7	0.83	0.5	1.53	1.67	1.67	1.61	1.89	2.02
P ₀	15.6	16.8	16.2	34.7	36	35.3	44.1	43.9	44
P ₁	15.4	16	15.7	33.5	34	33.7	42	41.8	41.9
P ₂	13.9	14.2	14	32.1	34.6	33.3	41	41.3	41.1
P ₃	17.9	18.2	18.1	41.8	42.9	42.3	49.9	48.9	49.4
P ₄	19	19.6	19.3	44.2	44.3	44.3	51	49.6	50.3
P ₅	20.8	21.4	21.1	52.2	53.3	52.7	63.8	63.2	63.5
P ₆	22.6	22.1	22.3	54.7	54.6	54.6	64.5	65.5	65
SEm±	0.45	0.53	0.32	0.98	1.07	1.07	1.03	1.22	1.3
CD at 5%	1.32	1.56	0.93	2.87	3.12	3.13	3.01	3.55	3.78
V ₁ P ₀	15.13	17.36	16.25	36.17	36.43	36.3	42.6	44.4	43.5
V ₁ P ₁	14.90	16.13	15.51	35.13	37.17	36.15	40.53	42.4	41.47
V ₁ P ₂	13.93	14.36	14.15	32.9	34.73	33.82	39.8	40.1	39.95
V ₁ P ₃	18.50	18.53	18.51	48.1	48.33	48.22	53.53	52.4	52.97
V ₁ P ₄	20.26	20.16	20.21	51.1	50.17	50.63	55	54.33	54.67
V ₁ P ₅	21.26	22.23	21.75	61.5	63.87	62.68	73.93	72.37	73.15
V ₁ P ₆	23.9	23.13	23.51	63.63	65.63	64.63	74.5	74.93	74.72
V ₂ P ₀	16.06	16.26	16.16	33.17	35.47	34.32	45.57	43.3	44.43
V ₂ P ₁	15.80	15.86	15.83	31.83	30.73	31.28	43.5	41.23	42.37
V ₂ P ₂	13.83	13.93	13.88	31.3	34.4	32.85	42.23	42.43	42.33
V ₂ P ₃	17.23	17.93	17.58	35.47	37.43	36.45	46.23	45.47	45.85
V ₂ P ₄	17.73	19.03	18.38	37.27	38.5	37.88	46.97	44.8	45.88
V ₂ P ₅	20.36	20.46	20.41	42.80	42.67	42.73	53.67	54.07	53.87
V ₂ P ₆	21.33	21	21.16	45.77	43.47	44.62	54.43	56.13	55.28
SEm±	0.64	0.76	0.45	1.39	1.52	1.52	1.46	1.72	1.84
CD at 5%	1.86	NS	NS	4.06	4.42	4.43	4.26	5.02	5.43

Table 2: Effect of Varieties and plant growth regulators on Plant Spread (cm)

Treatments	45 days			75 days			105 days		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
V ₁	17.6	17.93	17.77	22.1	21.6	21.85	25.97	26.49	26.23
V ₂	21.69	21.74	21.72	27.92	28.1	28.01	36.48	36.4	36.45
SEm±	0.50	0.63	0.40	0.50	0.55	0.37	0.52	0.53	0.37
CD at 5%	1.03	1.29	0.8	1.02	1.13	0.74	1.06	1.08	0.74
P ₀	15.20	14.98	15.09	18.66	18.16	18.42	22.9	22.76	22.83
P ₁	20.18	20.3	20.24	25.61	26.21	25.92	31.93	30.43	31.18
P ₂	21.46	21.25	21.36	27.16	26.86	27.02	33.25	31.88	32.57
P ₃	16.28	17.03	16.66	22.81	22.05	22.43	27.9	27.86	27.88
P ₄	18.98	19.43	19.21	24	23.35	23.68	28.98	29.7	29.34
P ₅	22.22	22.33	22.28	27.81	27.98	27.9	36.16	37.8	36.98
P ₆	23.2	23.56	23.38	29.03	29.33	29.18	37.46	39.7	38.58
SEm±	0.94	1.17	0.75	0.93	1.03	0.69	0.97	0.98	0.69
CD at 5%	1.92	2.41	1.5	1.92	2.11	1.39	1.99	2.02	1.38
V ₁ P ₀	12.3	12.03	12.17	15.53	15.06	15.3	19.16	19.26	19.22
V ₁ P ₁	18.56	18.96	18.77	23.4	22.36	22.88	26.73	26.2	26.47
V ₁ P ₂	20	19.8	19.9	24.43	23.26	23.85	28.46	27.86	28.17
V ₁ P ₃	13.73	14.93	14.33	20.5	19.63	20.07	23.46	23.3	23.38
V ₁ P ₄	16.63	17.03	16.83	21.63	20.33	20.98	24.23	23.43	23.83
V ₁ P ₅	20.33	20.86	20.6	24	24.36	24.18	28.8	31.83	30.32
V ₁ P ₆	21.66	21.93	21.8	25.26	26.16	25.72	30.93	33.53	32.23
V ₂ P ₀	18.1	17.93	18.02	21.8	21.26	21.53	26.63	26.26	26.45
V ₂ P ₁	21.8	21.63	21.72	27.83	30.06	28.95	37.13	34.66	35.9
V ₂ P ₂	22.93	22.7	22.82	29.9	30.46	30.18	38.03	35.9	36.97
V ₂ P ₃	18.83	19.13	18.98	25.13	24.46	24.8	32.33	32.43	32.38
V ₂ P ₄	21.33	21.83	21.58	26.36	26.36	26.37	33.73	35.96	34.85
V ₂ P ₅	24.13	23.8	23.97	31.63	31.6	31.62	43.53	43.76	43.65
V ₂ P ₆	24.73	25.2	24.97	32.8	32.5	32.65	44	45.86	44.93
SEm±	1.32	1.66	1.06	1.32	1.45	0.98	1.37	1.39	0.98
CD at 5%	NS	NS	NS	NS	NS	NS	2.81	2.86	1.96

Table 3: Effect of Varieties and plant growth regulators on Number of primary branches

Treatments	75 days			105 days		
	2018	2019	Pooled	2018	2019	Pooled
V ₁	15.11	15.13	15.12	22.23	22.44	22.34
V ₂	17.88	17.78	17.83	27.15	26.98	27.07
SEm±	0.38	0.55	0.34	0.55	0.59	0.40
CD at 5%	0.77	1.14	0.67	1.13	1.22	0.81
P ₀	11.86	11.60	11.73	16.26	16.05	16.16
P ₁	16.76	16.86	16.82	25.10	25.43	25.27
P ₂	18.60	17.83	18.22	26.86	27.48	27.18
P ₃	13.01	13.55	13.28	21.2	20.01	20.61
P ₄	14.80	14.28	14.54	22.88	23.35	23.12
P ₅	19.60	19.43	19.52	29.33	28.86	29.10
P ₆	20.85	21.63	21.24	31.20	31.81	31.51
SEm±	0.71	1.04	0.63	1.03	1.11	0.76
CD at 5%	1.45	2.13	1.26	2.11	2.28	1.52
V ₁ P ₀	10.90	11.50	11.20	15.76	14.86	15.32
V ₁ P ₁	15.23	15.16	15.20	21.70	22.63	22.17
V ₁ P ₂	16.66	15.70	16.18	22.83	24.46	23.65
V ₁ P ₃	12.03	12.96	12.5	18.86	17.5	18.18
V ₁ P ₄	13.83	13.83	13.83	19.9	20.8	20.35
V ₁ P ₅	17.63	16.83	17.23	27.10	26.66	26.88
V ₁ P ₆	19.50	19.93	19.72	29.46	30.20	29.83
V ₂ P ₀	12.83	11.70	12.27	16.76	17.23	17.00
V ₂ P ₁	14.00	14.13	14.07	23.53	22.53	23.03
V ₂ P ₂	15.76	14.73	15.25	25.86	25.9	25.88
V ₂ P ₃	18.30	18.56	18.43	28.50	28.23	28.37
V ₂ P ₄	20.53	19.96	20.25	30.90	30.50	30.70
V ₂ P ₅	21.56	22.03	21.80	31.56	31.06	31.32
V ₂ P ₆	22.20	23.33	22.77	32.93	33.43	33.18
SEm±	1.00	1.47	0.89	1.45	1.57	1.07
CD at 5%	NS	NS	NS	2.99	NS	NS

Table 4: Effect of Varieties and plant growth regulators on Number of Secondary branches

Treatments	75 days			105 days		
	2018	2019	Pooled	2018	2019	Pooled
V ₁	19.30	19.80	19.55	27.84	28.57	28.21
V ₂	22.48	22.60	22.54	30.07	31.70	31.39
SEm±	0.43	0.45	0.31	0.65	0.69	0.47
CD at 5%	0.89	0.93	0.63	1.33	1.42	0.95
P ₀	16.28	15.85	16.07	23.05	22.95	23.00
P ₁	21.10	21.41	21.26	29.81	30.43	30.13
P ₂	22.43	23.50	22.97	30.81	31.36	31.09
P ₃	19.71	19.38	25.85	26.78	26.32	19.71
P ₄	20.43	20.25	27.91	28.28	28.10	20.43
P ₅	23.26	23.43	23.35	33.96	33.88	33.93
P ₆	24.06	24.05	24.06	34.78	37.28	36.03
SEm±	0.81	0.84	0.58	1.21	1.29	0.89
CD at 5%	1.66	1.74	1.17	2.49	2.66	1.78
V ₁ P ₀	15.83	16.36	16.10	21.70	22.43	22.07
V ₁ P ₁	19.43	20.20	19.82	27.46	28.46	27.97
V ₁ P ₂	20.36	21.76	21.07	28.03	29.90	28.97
V ₁ P ₃	17.56	17.93	17.75	25.66	25.26	25.47
V ₁ P ₄	18.56	18.5	18.53	26.56	27.06	26.82
V ₁ P ₅	21.26	22.23	21.75	32.16	32.166	32.17
V ₁ P ₆	22.13	21.60	21.87	33.30	34.73	34.02
V ₂ P ₀	16.73	15.33	16.03	24.40	23.46	23.93
V ₂ P ₁	20.53	21.50	21.02	26.03	28.30	27.17
V ₂ P ₂	21.56	22.36	21.97	29.26	29.50	29.38
V ₂ P ₃	22.76	22.63	22.70	32.16	32.40	32.28
V ₂ P ₄	24.50	25.23	24.87	33.60	32.83	33.22
V ₂ P ₅	25.26	24.63	24.95	35.76	35.60	35.68
V ₂ P ₆	26.00	26.50	26.25	36.26	39.83	38.05
SEm±	1.15	1.19	0.83	1.71	1.83	1.25
CD at 5%	NS	NS	NS	NS	NS	NS

Conclusion

The plant height increased when first foliar application of GA₃ @200 ppm was done at 45, 75 and 105 DAT. Whereas, taller plants were observed in Arka Shashank as compared to Arka Archana. The number of branches was produced more with the application of GA₃ 200 ppm followed by 1500 ppm cycocel at 45, 75 and 105 DAT and it was also more in cv. Arka Archana. The plant spread were observed more with the application of GA₃@200 ppm followed by cycocel @1500 ppm. Whereas, higher plant spread were observed in Arka Archana as compared to Arka Shashank.

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Standardization of different levels of nitrogen and phosphorus on flowering and yield attributes of China aster (*Callistephus chinensis* (L.) Nees) under Chhattisgarh conditions

Sunna Deepti and Dr. T Tirkey

Abstract

The present investigation entitled “Standardization of different concentrations of plant growth regulators and levels of nitrogen, phosphorus on growth, flowering, yield and quality of China Aster (*Callistephus chinensis* (L.) Nees) under Chhattisgarh conditions” was conducted at the Horticultural Research cum Instructional Farm, Department of Floriculture and Landscape Architecture, College of Agriculture, IGKV, Raipur (C.G.). The Experiment-II entitled “Effect on different levels of nitrogen and phosphorus on growth, flowering, yield and quality of China Aster” was conducted during winter season of 2018-19 and 2019-20. The experiment was conducted in Factorial Randomized Block Design with 24 treatments” comprising of two varieties viz. Arka Shashank and Arka Archana as factor A and four levels of Nitrogen, i.e., (120, 140, 160, 180 kg/ha), and three levels of Phosphorus (100, 120, 140 kg/ha) as factor B. The doses of Nitrogen and Phosphorus were applied in two splits with constant dose of potassium (60kg/ha) were applied in the field.

Plants have to be exposed to proper climatic factors in order to get optimum and economic flower yields. Therefore, under transitional Chhattisgarh plains, there is a need to standardize production technology involving systematic research to evaluate acceptable variety, standardize fertilizer levels on growth, flowering, yield and quality of China aster flower production under the Chhattisgarh plains.

Keywords: Standardization, nitrogen, phosphorus, aster

Introduction

China aster (*Callistephus chinensis* (L.) Nees) belongs to the family compositae and its origin is China. Genus *Callistephus* derived from two Greek words, ‘*Kalistos*’ and ‘*Steophos*’ which means beautiful and crown respectively. Asters have been developed from a single form of wild species. According to Emsweller *et al* (1937) [3] the evolution of China aster was a record of remarkable variations. The original plant had single flowers with blue, violet or white-ray florets in two or four rows. The height was 18 to 24 inches long or medium tall. The prolongation or development of the central florets and the creation of quilted flowers were the first developments in this type of flower. During the 18th century, Germans produced dual forms of aster so they, often referred to as “German asters”. This was attributed to the success of the growth of asters and the cultivation of large seeds by the Germans. The introduction of branching forms, tall types, medium tall and dwarf types resulted in the great evolutionary improvement of the aster. Branching forms were introduced in USA, which was the main hub for the growth of this plant as well as for the development of seeds.

Balanced nutrition is very critical in the midst of various factors affecting China aster’s growth and flowering. In the growth and development of plants, fertilizers such as nitrogen, phosphorus and potassium play a crucial role. The chemical and biological properties of the soil are enhanced by these essential nutrients, thus increasing plant yields. To enhance their efficiency or productivity, Silberbush *et al.* (2003) [12], Kim *et al.* (1998) [7] and Engelbrecht (2004) [4], have emphasized the need to supply nutrients to the soil during plant development. Generally speaking, growth, development and production rely on their judicious feeding habits. In particular, the focus should be on nitrogen during the early stage (vegetative growth). Throughout the growing cycle, plants require phosphorus and it should be applied as a basal dose. The plant needs potassium till flowering. When applied in the field, China aster responds differently to different doses of fertilizer, either alone or in the combination.

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Methods and Materials

The present investigations were carried out at the Horticulture Research cum Instructional Farm, Department of Floriculture and Landscape Architecture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G) during two rabi seasons of 2018-19 and 2019-20. The experimental area comes under the 7th Agro - climatic region of India i.e. "Eastern Plateau and Hills" which is classified as sub-humid with hot summer and cold winter. The climate of Chhattisgarh is tropical. It is hot and humid because of its proximity to the Tropic of Cancer and its dependence on the monsoons for rains. Summer temperatures in Chhattisgarh can reach up to 45 °C (113 °F). The atmospheric relative humidity is relatively high during the months of June - October. Chhattisgarh receives an average of 1,29 millimetres (50.9 in) of rain. Winter is from November to January. Winters are pleasant with low temperatures and less humidity.

During both the years of study composite soil samples from 0-15 cm soil depth were collected before start of experiment. After crop harvesting during both the years of experimentation soil samples from 0-15 cm soil depth from each plot were collected to ascertain the effect of NPK levels on pH, electrical conductivity, organic carbon, available N, P, K. Collected soil samples were air dried in shade and ground with the help of pestle and mortar, passed through 2mm sieve and stored in polythene bags for further analysis as per the method. The soil of the experimental field was clay-loam in texture (vertisols), having good drainage capacity and locally known as "Kanhar". The soil was neutral in reaction and available nitrogen, phosphorus and potassium content were low, medium and high, respectively.

The experiment was conducted in Factorial Randomized Block Design with 24 treatments comprising of two varieties viz. Arka Shashank and Arka Archana as factor A and four levels of Nitrogen, i.e. (120, 140, 160, 180 kg/ha), and three levels of Phosphorus (100, 120, 140 kg/ha) as factor B. The doses of Nitrogen and Phosphorus were applied in two splits with constant dose of potassium (60kg/ha) were applied in the field. 45 days old healthy and uniformly grown seedlings were used for transplanting with a spacing of 30 cm x 30 cm @ one seedling per hill. There are twelve fertilizer doses which were applied in two varieties of China Aster, hence there are 24 treatments combinations. V₁F₁ (Arka Shashank+ N₁₂₀: P₁₀₀), V₁F₂ (Arka Shashank+ N₁₂₀: P₁₂₀), V₁F₃ (Arka Shashank+ N₁₂₀: P₁₄₀), V₁F₄ (Arka Shashank+ N₁₄₀: P₁₀₀), V₁F₅ (Arka Shashank+ N₁₄₀: P₁₂₀), V₁F₆ (Arka Shashank+ N₁₄₀: P₁₄₀), V₁F₇ (Arka Shashank+ N₁₆₀: P₁₀₀), V₁F₈ (Arka Shashank+ N₁₆₀: P₁₂₀), V₁F₉ (Arka Shashank+ N₁₆₀: P₁₄₀), V₁F₁₀ (Arka Shashank+ N₁₈₀: P₁₀₀), V₁F₁₁ (Arka Shashank+ N₁₈₀: P₁₂₀), V₁F₁₂ (Arka Shashank+ N₁₈₀: P₁₄₀), V₂F₁ (Arka Archana+ N₁₂₀: P₁₀₀), V₂F₂ (Arka Archana + N₁₂₀: P₁₂₀), V₂F₃ (Arka Archana + N₁₂₀: P₁₄₀), V₂F₄ (Arka Archana + N₁₄₀: P₁₀₀), V₂F₅ (Arka Archana + N₁₄₀: P₁₂₀), V₂F₆ (Arka Archana + N₁₄₀: P₁₄₀), V₂F₇ (Arka Archana + N₁₆₀: P₁₀₀), V₂F₈ (Arka Archana + N₁₆₀: P₁₂₀), V₂F₉ (Arka Archana + N₁₆₀: P₁₄₀), V₂F₁₀ (Arka Archana + N₁₈₀: P₁₀₀), V₂F₁₁ (Arka Archana + N₁₈₀: P₁₂₀), V₂F₁₂ (Arka Archana + N₁₈₀: P₁₄₀).

Nitrogen, phosphorus and potassium, respectively, were added in the form of urea, single superphosphate and murate of potash. At the time of transplantation, half a dose of N and the full dose of P and K were applied in a circular band of approximately 3-4 cm around each plant and, after 30 days of transplantation, the crop was top-dressed with the remaining half a dose of N. By repeated ploughing and harrowing, the

land was carried to a fine tilth. A spacing of 0.50 m between two replications and 1.00 m between two plots was provided for lying out of irrigation channels and bunds respectively. The entire experimental land was divided into plots measuring 1.5 m x 1.5 m there were totally 42 plots. Timely and effective plant protection steps have been taken to protect experimental plants from pest and disease attacks. Harvesting the flowers for the purpose of observation on flower and yield components was commenced after 100 days of transplanting and only two harvestings were done. The obtained data had statistically analyzed adopting procedure as given by Panse, V.G. and Sukhatme, B.V. (1985).

Results and Discussion

The data on Days to bud initiation were recorded and are presented in Table 1

Amongst the cultivars, there were found significant difference between varieties in both the years as well as pooled mean analysis. Maximum days required for bud initiation (68.61, 69.3 and 68.97) respectively were observed in cultivar (V₁) Arka Shashank. Minimum days required for bud initiation was observed in cultivar (V₂) Arka Archana (64.67, 67.52 and 66.09) during both the tested years and pooled mean data respectively. Nitrogen and phosphorus showed significant influence on days to bud initiation during both the years and pooled mean basis. The earlier bud initiation (60.57, 60.95 and 60.90) was observed in F₂ (N₁₂₀: P₁₂₀) in first year, while it was noticed in the treatment F₁ (N₁₂₀: P₁₀₀) during second as well as pooled mean analysis respectively. Interaction between both the cultivars and nitrogen and phosphorus showed non-significant variation on days to bud initiation in both the years as well as pooled mean analysis.

The earlier bud initiation was observed in F₂ (N₁₂₀: P₁₂₀) in first year, while it was noticed in the treatment F₁ (N₁₂₀: P₁₀₀) during second as well as pooled mean analysis respectively. It is quite obvious that an increase in nitrogen supply resulted in vigorous growth of the plants which delayed the bud formation and opening of the flowers as well. Similar findings were observed by (Mengel and Kirkby, 1987)^[8] and Gaikwad *et al.* (2004)^[5].

It is clear from the data presented in Table 2 that the Days to 1st flowering were significantly influenced by different levels of cultivars and nitrogen and phosphorus.

In case of cultivars, there were found significant difference between cultivars in both the years as well as pooled mean analysis. Maximum days required for 1st flowering (79.05, 79.15, 79.10) respectively were observed in cultivar (V₁) Arka Shashank. Minimum days required for 1st flowering was observed in cultivar (V₂) Arka Archana (77.54, 78.29, 77.92) during both the tested years and pooled mean data respectively. In respect to nitrogen and phosphorus showed significant influence on days to 1st flowering during both the years and pooled mean basis. The days to 1st flowering (71.37, 71.58 and 71.48) was earlier in treatment F₁ (N₁₂₀: P₁₂₀) which was found statistically *at par* with treatments F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀) during both the year and pooled mean basis treatments. The maximum days (84.32, 84.6 and 84.46) required for 1st flowering were observed in treatment F₁₂ (N₁₈₀: P₁₄₀). Interaction between both the cultivars and nitrogen and phosphorus were showed non-significant variation on days to bud 1st flowering in both the years as well as pooled mean analysis.

Earlier flowering was observed in F₁ (N₁₂₀: P₁₂₀). The increasing levels of N, P showed significant effect on days

taken for first flower opening. Reduction in days taken for flowering due to low level of nitrogen and phosphorus was reported by Singatkar *et al.* (1995) ^[13] in *gaillardia*. Early emergence of flower buds might be due to increased availability of nitrogen, easy uptake of nutrients and simultaneous transport of growth-promoting substances like cytokinin's to axillary buds, resulting in breakage of apical dominance and facilitated better sink for faster mobilization of photosynthates and early transformation of plant parts from vegetative to reproductive phase.

The data on Flowering Duration were recorded and are presented in Table 3. Significantly, maximum flowering duration (31.01, 31.76, and 31.38) were recorded in cultivar (V₁) Arka Shashank as compared to cultivar (V₂) Arka Archana (27.35, 27.56 and 27.45) during both the tested years and pooled mean data respectively. It is vivid from the data that the flowering duration was significantly influenced by nitrogen and phosphorus during both the year and on pooled mean basis. The maximum flowering duration (32.82, 33.48 and 33.15 respectively) was observed under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatment F₁₀ (N₁₈₀: P₁₀₀) and F₁₁ (N₁₈₀: P₁₂₀). The minimum flowering duration (26.06, 26.70 and 26.38) respectively was recorded in treatment F₁ (N₁₂₀: P₁₀₀). The interaction between variety and nitrogen and phosphorus were found significant for first year as well as pooled mean analysis. The maximum flowering duration (35.57 and 35.76) respectively were recorded under treatment combination (V₁F₁₁) during first year and pooled mean basis. The minimum flowering duration (25.44 and 25.56) respectively was recorded in (V₂F₁) under first year and pooled mean basis. Interaction effect was found non-significant for second year.

The duration of bloom of individual variety might be due to different genetic makeup of varieties and prevailing favourable environment. Similar findings were also noticed by Pattnaik and Mohanti (2002) ^[9], Singh *et al.* (2003), Khanvilkar *et al.* (2003) ^[6], Ra *et al.* (2005) in African marigold, and Raghuvanshi and Sharma (2011) in French marigold.

The data on number of flowers per plant are presented in table 4 revealed that the cultivar and nitrogen and phosphorus and their interaction exhibited significant impact on number of flower per plant.

In, case of cultivars, they show significant influence on number of flowers per plant. The highest number of flowers (59.64, 61.92 and 60.78) respectively was observed in cultivar (V₂) Arka Archana. The lowest number of flowers per plant (52.90, 53.06 and 52.98) respectively was obtained from cultivar (V₁) Arka Shashank during both the years as well as pooled mean basis. As far as, application of nitrogen and phosphorus showed significant response on number of

flowers per plant, during both the years as well as pooled mean analysis. The maximum number of flowers (67.92, 67.88 and 67.90) respectively were recorded under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with F₁₁ (N₁₈₀: P₁₂₀). The minimum number of flowers (47.84, 47.39 and 47.61) respectively was recorded under treatment F₁ (N₁₂₀: P₁₀₀) during this investigation. The interaction between variety and application of nitrogen and phosphorus were found non-significant during both the years as well as pooled mean analysis.

The two years results indicated that there was highly significant difference in number of flowers plant per plant within the varieties. The maximum number of flowers was obtained from Arka Archana. It could be stated that variation within the varieties for number of flowers plant⁻¹ might be due to genotypic and environmental differences. Similar results were reported by Choudhary *et al.* (2013) ^[2] Nursude *et al.* (2010) ^[10], Beniwal and Dahiya (2012) ^[1], Singh *et al.* (2004) ^[14] and Singh and Misra (2009) in marigold.

It was evident from data presented in Table 5 that there was a significant difference in respect to yield of flower per plant due to cultivars and nitrogen and phosphorus.

In case of cultivar, the maximum yield of flower per plant were observed in cultivar (V₂) Arka Archana (170.63, 174.01 and 172.32) and minimum yield of flower per plant (143.59, 148.75 and 146.17) respectively were recorded in cultivar (V₂) Arka Shashank in both the years as well as pooled mean analysis. In respect to nitrogen and phosphorus, the highest yield of flowers per plant (190.63, 195.24 and 192.93) was observed under treatment F₁₂ (N₁₈₀: P₁₄₀) and it was observed statistically similar with the treatment F₁₁ (N₁₈₀: P₁₂₀) during both the years as well as pooled mean analysis and it showed significant difference with rest of the other treatments. Whereas, the minimum yield of flowers per plant (128.07, 127.06 and 127.57) respectively was recorded under treatment F₁ (N₁₂₀: P₁₀₀). The interaction between cultivars and application of nitrogen and phosphorus was found significant during both the years as well as pooled mean basis under this investigation.

The highest yield of flowers per plant was observed under treatment F₁₂ (N₁₈₀: P₁₄₀). The increase in levels of N and P exerted the significant effect on flower yield. The increase in flower yield might be attributed to the greater leaf area and more number of leaves per plant as well as plant spread would have resulted in production and accumulation of maximum photosynthates, resulting the production of more number of flowers. Similar finding have been reported by Deshmukh *et al.* 2008 in *gaillardia*, Meshram *et al.* 2008 in *chrysanthemum*, Ravindra *et al.* 2013 and Maheta *et al.* 2016 in China aster.

Table 1: Effect of Varieties and Nitrogen and phosphorus on Days to bud initiation

Treatments	2018	2019	Pooled
V ₁	68.61	69.32	68.97
V ₂	64.67	67.52	66.09
S.Em±	0.92	0.77	0.60
CD at 5%	1.86	1.55	1.19
F ₁	60.85	60.95	60.9
F ₂	60.57	62.33	61.45
F ₃	64.60	63.57	64.08
F ₄	65.27	65.22	65.24
F ₅	65.82	67	66.41
F ₆	67.35	68.95	68.15

F ₇	68.53	70.43	69.48
F ₈	67.05	71.35	69.2
F ₉	68.2	72.42	70.31
F ₁₀	69.45	72.48	70.97
F ₁₁	70.88	72.6	71.74
F ₁₂	71.1	73.73	72.42
S.Em±	2.26	1.88	1.47
CD at 5%	4.55	3.79	2.92
V ₁ F ₁	59.2	60.33	59.77
V ₁ F ₂	59.9	62.23	61.07
V ₁ F ₃	67	63.37	65.18
V ₁ F ₄	66.43	66.3	66.37
V ₁ F ₅	68.43	68.33	68.38
V ₁ F ₆	70.13	71.3	70.72
V ₁ F ₇	71.73	71.8	71.77
V ₁ F ₈	69.07	72.4	70.73
V ₁ F ₉	71.73	73.9	72.82
V ₁ F ₁₀	72	73.67	72.83
V ₁ F ₁₁	73.37	73.57	73.47
V ₁ F ₁₂	74.33	74.63	74.48
V ₂ F ₁	62.5	61.57	62.03
V ₂ F ₂	61.23	62.43	61.83
V ₂ F ₃	62.2	63.77	62.98
V ₂ F ₄	64.1	64.13	64.12
V ₂ F ₅	63.2	65.67	64.43
V ₂ F ₆	64.57	66.6	65.58
V ₂ F ₇	65.33	69.07	67.2
V ₂ F ₈	65.03	70.3	67.67
V ₂ F ₉	64.67	70.93	67.8
V ₂ F ₁₀	66.9	71.3	69.1
V ₂ F ₁₁	68.4	71.63	70.02
V ₂ F ₁₂	67.87	72.83	70.35
S.Em±	3.19	2.67	2.08
CD at 5%	NS	NS	NS

Table 2: Effect of Varieties and Nitrogen and phosphorus on Days to first flowering

Treatments	2018	2019	Pooled
V ₁	79.05	79.15	79.10
V ₂	77.54	78.29	77.92
S.Em±	0.73	0.79	0.54
CD at 5%	1.47	1.58	1.06
F ₁	71.37	71.58	71.48
F ₂	72.52	72.75	72.63
F ₃	74.07	75.43	74.8
F ₄	76.4	77	76.7
F ₅	77.43	77.03	77.23
F ₆	79.23	79.43	79.33
F ₇	79.67	79.42	79.54
F ₈	80.25	80.42	80.33
F ₉	79.48	80.67	80.08
F ₁₀	82.17	82.67	82.42
F ₁₁	82.63	83.55	83.09
F ₁₂	84.32	84.6	84.46
S.Em±	1.78	1.93	1.31
CD at 5%	3.59	3.88	2.61
V ₁ F ₁	72.07	73.1	72.58
V ₁ F ₂	74	73.8	73.9
V ₁ F ₃	75.17	75.17	75.17
V ₁ F ₄	76.87	77.77	77.32
V ₁ F ₅	77.43	77	77.22
V ₁ F ₆	79.97	80.47	80.22
V ₁ F ₇	82.23	81.9	82.07
V ₁ F ₈	82.43	81.17	81.8
V ₁ F ₉	80.23	81.6	80.92
V ₁ F ₁₀	82.4	81.67	82.03
V ₁ F ₁₁	82.03	82.43	82.23
V ₁ F ₁₂	83.77	83.73	83.75

V ₂ F ₁	70.67	70.07	70.37
V ₂ F ₂	71.03	71.7	71.37
V ₂ F ₃	72.97	75.9	74.43
V ₂ F ₄	75.93	76.23	76.08
V ₂ F ₅	77.43	77.07	77.25
V ₂ F ₆	78.5	78.4	78.45
V ₂ F ₇	77.1	76.93	77.02
V ₂ F ₈	78.07	79.67	78.87
V ₂ F ₉	78.73	79.73	79.23
V ₂ F ₁₀	81.93	83.67	82.8
V ₂ F ₁₁	83.23	84.67	83.95
V ₂ F ₁₂	84.87	85.47	85.17
S.Em±	2.52	2.72	1.86
CD at 5%	NS	NS	NS

Table 3: Effect of Varieties and Nitrogen and phosphorus on flowering duration

Treatments	2018	2019	Pooled
V ₁	31.01	31.76	31.38
V ₂	27.35	27.56	27.45
S.Em±	0.37	0.44	0.29
CD at 5%	0.75	0.88	0.57
F ₁	26.06	26.70	26.38
F ₂	27.07	27.56	27.31
F ₃	27.44	27.71	27.57
F ₄	27.66	27.75	27.70
F ₅	28.54	28.69	28.62
F ₆	28.93	29.11	29.02
F ₇	28.43	29.89	29.16
F ₈	29.63	30.00	29.82
F ₉	29.92	30.72	30.32
F ₁₀	31.28	31.60	31.84
F ₁₁	32.41	32.66	32.54
F ₁₂	32.82	33.48	33.15
S.Em±	0.91	1.07	0.70
CD at 5%	1.84	2.15	1.39
V ₁ F ₁	26.67	27.72	27.20
V ₁ F ₂	28.10	29.08	28.59
V ₁ F ₃	28.65	29.01	28.83
V ₁ F ₄	28.37	29.17	28.77
V ₁ F ₅	29.40	30.47	29.94
V ₁ F ₆	30.56	31.03	30.79
V ₁ F ₇	31.18	32.47	31.83
V ₁ F ₈	31.23	32.31	31.77
V ₁ F ₉	32.93	33.25	33.09
V ₁ F ₁₀	34.31	34.35	34.33
V ₁ F ₁₁	35.57	35.94	35.76
V ₁ F ₁₂	35.11	36.28	35.69
V ₂ F ₁	25.44	25.67	25.56
V ₂ F ₂	26.03	26.04	26.04
V ₂ F ₃	26.22	26.41	26.31
V ₂ F ₄	26.94	26.34	26.64
V ₂ F ₅	27.67	26.92	27.29
V ₂ F ₆	27.29	27.19	27.24
V ₂ F ₇	25.67	27.30	26.49
V ₂ F ₈	28.02	27.69	27.86
V ₂ F ₉	26.92	28.19	27.55
V ₂ F ₁₀	28.26	28.86	28.56
V ₂ F ₁₁	29.25	29.38	29.32
V ₂ F ₁₂	30.53	30.69	30.61
S.Em±	1.29	1.51	0.99
CD at 5%	2.60	NS	1.97

Table 4: Effect of Varieties and Nitrogen and phosphorus on No. of flowers per plant

Treatments	2018	2019	Pooled
V ₁	52.90	53.06	52.98
V ₂	59.64	61.92	60.78
S.Em±	0.89	0.73	0.58
CD at 5%	1.80	1.47	1.14
F ₁	47.84	47.39	47.61
F ₂	49.48	50.23	49.85
F ₃	47.06	51.57	49.31
F ₄	50.91	52.10	51.51
F ₅	53.55	53.70	53.62
F ₆	55.48	53.81	54.64
F ₇	57.36	55.98	56.67
F ₈	57.12	60.29	58.71
F ₉	62.22	64.07	63.14
F ₁₀	62.21	64.00	63.73
F ₁₁	64.13	67.59	65.86
F ₁₂	67.92	67.88	67.90
S.Em±	2.19	1.78	1.41
CD at 5%	4.40	3.59	2.80
V ₁ F ₁	42.99	43.73	43.36
V ₁ F ₂	44.52	45.82	45.17
V ₁ F ₃	45.40	46.53	45.96
V ₁ F ₄	47.01	46.88	46.95
V ₁ F ₅	50.88	47.38	49.13
V ₁ F ₆	53.89	48.89	51.39
V ₁ F ₇	55.07	51.56	53.32
V ₁ F ₈	53.82	57.04	55.43
V ₁ F ₉	54.64	59.99	57.32
V ₁ F ₁₀	61.37	61.36	61.37
V ₁ F ₁₁	62.15	63.17	62.66
V ₁ F ₁₂	63.03	64.33	63.68
V ₂ F ₁	52.68	51.04	51.86
V ₂ F ₂	54.43	54.63	54.53
V ₂ F ₃	48.72	56.60	52.66
V ₂ F ₄	54.81	57.32	56.06
V ₂ F ₅	56.21	60.02	58.11
V ₂ F ₆	57.07	58.73	57.90
V ₂ F ₇	59.64	60.41	60.02
V ₂ F ₈	60.42	63.54	61.98
V ₂ F ₉	69.80	68.14	68.97
V ₂ F ₁₀	63.05	69.14	66.10
V ₂ F ₁₁	66.11	72.00	69.06
V ₂ F ₁₂	72.80	71.44	72.12
S.Em±	3.09	2.52	2.00
CD at 5%	NS	NS	NS

Table 5: Effect of Varieties and Nitrogen and phosphorus on Yield of flower per plant

Treatments	2018	2019	Pooled
V ₁	143.59	148.75	146.17
V ₂	170.63	174.01	172.32
S.Em±	1.66	1.46	1.11
CD at 5%	3.35	2.94	2.20
F ₁	128.07	127.06	127.57
F ₂	134.39	136.31	135.35
F ₃	136.46	138.10	137.28
F ₄	141.92	146.92	144.42
F ₅	148.99	149.35	149.17
F ₆	155.03	158.79	156.91
F ₇	157.87	163.62	160.74
F ₈	163.18	169.49	166.33
F ₉	167.73	176.21	171.97
F ₁₀	177.25	182.18	179.71
F ₁₁	183.86	193.31	188.58
F ₁₂	190.63	195.24	192.93
S.Em±	4.08	3.58	2.71
CD at 5%	8.20	7.21	5.39

V ₁ F ₁	112.53	110.92	111.72
V ₁ F ₂	119.94	118.85	119.40
V ₁ F ₃	122.99	124.58	123.79
V ₁ F ₄	129.92	133.53	131.73
V ₁ F ₅	133.13	133.00	133.07
V ₁ F ₆	138.51	144.63	141.57
V ₁ F ₇	140.42	150.66	145.54
V ₁ F ₈	146.19	157.69	151.94
V ₁ F ₉	151.03	168.88	159.96
V ₁ F ₁₀	165.36	175.76	170.56
V ₁ F ₁₁	177.42	181.98	179.70
V ₁ F ₁₂	185.65	184.54	185.10
V ₂ F ₁	143.62	143.20	143.41
V ₂ F ₂	148.83	153.77	151.30
V ₂ F ₃	149.92	151.63	150.78
V ₂ F ₄	153.91	160.30	157.11
V ₂ F ₅	164.84	165.71	165.27
V ₂ F ₆	171.55	172.96	172.26
V ₂ F ₇	175.31	176.57	175.94
V ₂ F ₈	180.16	181.30	180.73
V ₂ F ₉	184.43	183.54	183.99
V ₂ F ₁₀	189.14	188.59	188.86
V ₂ F ₁₁	190.29	204.63	197.46
V ₂ F ₁₂	195.60	205.94	200.77
S.Em±	5.76	5.06	3.84
CD at 5%	NS	NS	NS

Conclusion

On the basis of two years study, it was concluded that optimum doses of nitrogen and phosphorus are necessary for maximizing growth, yield and quality of China aster under Chhattisgarh condition. Among the treatments, the treatment F₁₂ (N₁₈₀: P₁₄₀) recorded days to bud initiation, days to first flower opening, days to 50% flowering, duration of flowering, flower weight, number of flowers per plant and flower yield per plant.

The study suggested that China aster cv. Arka Archana performed superior as compare to Arka Shashank and application of NPK @ 180:140 and 60 kg ha⁻¹ is the most appropriate dose for attaining high growth, yield and quality of these cultivar of China aster under Chhattisgarh condition.

The interactions between two cultivar and application of nitrogen and phosphorus were found mostly non- significant for different growth and flowering and yield attributes of China aster. This may be due to the similar effect of nitrogen and phosphorus on both the varieties of China aster under Chhattisgarh conditions.

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