STUDY ON THE PERFORMANCE OF CHINA ASTER [*Callistephus chinensis* (L.) Nees] CV. KAMINI UNDER INTEGRATED NUTRIENT MANAGEMENT

AMRUTHA TOMY

B.Sc. (Hort.)

MASTER OF SCIENCE IN HORTICULTURE

(FLORICULTURE AND LANDSCAPE ARCHITECTURE)

DEPARTMENT OF FLORICULTURE AND LANDSCAPE ARCHITECTURE

COLLEGE OF HORTICULTURE, RAJENDRANAGAR, HYDERABAD -500 030

SRI KONDA LAXMAN TELANGANA STATE HORTICULTURAL UNIVERSITY

SEPTEMBER, 2018

STUDY ON THE PERFORMANCE OF CHINA ASTER [*Callistephus chinensis* (L.) Nees] CV. KAMINI UNDER INTEGRATED NUTRIENT MANAGEMENT

BY

AMRUTHA TOMY

B.Sc. (Hort.)

THESIS SUBMITTED TO THE
SRI KONDA LAXMAN TELANGANA STATE HORTICULTURAL UNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

MASTER OF SCIENCE IN HORTICULTURE

(FLORICULTURE AND LANDSCAPE ARCHITECTURE)

DEPARTMENT OF FLORICULTURE AND LANDSCAPE ARCHITECTURE
COLLEGE OF HORTICULTURE, RAJENDRANAGAR, HYDERABAD - 500 030
SRI KONDA LAXMAN TELANGANA STATE HORTICULTURAL UNIVERSITY

SEPTEMBER, 2018

CERTIFICATE

Ms. AMRUTHA TOMY has satisfactorily prosecuted the course of research and that the thesis entitled **"STUDY ON THE PERFORMANCE OF CHINA ASTER [*Callistephus chinensis* (L.) Nees] CV. KAMINI UNDER INTEGRATED NUTRIENT MANAGEMENT"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination.

I certify that neither the thesis nor its part here of has been previously submitted by her for a degree of any university.

Date: **(Dr. R. CHANDRASEKHAR)**

Place: **Chairman**

CERTIFICATE

This is to certify that the thesis entitled **"STUDY ON THE PERFORMANCE OF CHINA ASTER [*Callistephus chinensis* (L.) Nees] CV. KAMINI UNDER INTEGRATED NUTRIENT MANAGEMENT"** submitted in partial fulfilment of the requirements for the degree of Master of Science in Horticulture (Floriculture and Landscape Architecture) of Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, is a record of the bonafide research work carried out by **Ms. AMRUTHA TOMY** under our guidance and supervision.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part and all assistance received during the course of the investigations have been duly acknowledged by the author of the thesis.

Thesis approved by the Student Advisory Committee

Chairman: **Dr. R. CHANDRASEKHAR**
Controller of Examinations &
Director of Extension
Administrative Office
College of Horticulture, SKLTSHU
Rajendranagar, Hyderabad. ____________________

Member: **Dr. A. GIRWANI**
Associate Dean
College of Horticulture, Mojerla
SKLTSHU, Rajendranagar, Hyderbad ____________________

Member: **Dr. R. PURNIMA MISHRA**
Technical Officer
Department of Agricultural Engineering
College of Horticulture, SKLTSHU
Rajendranagar, Hyderabad. ____________________

Date of final viva –voce:

DECLARATION

I, **Ms. AMRUTHA TOMY**, hereby declare that the thesis entitled **"STUDY ON THE PERFORMANCE OF CHINA ASTER [*Callistephus chinensis* (L.) Nees] CV. KAMINI UNDER INTEGRATED NUTRIENT MANAGEMENT"** submitted to Sri Konda Laxman Telangana State Horticultural University**,** Rajendranagar, for the Degree of Master of Science in Horticulture (Floriculture and Landscape Architecture) is the result of original research work done by me. I declare that no material contained in the thesis has been published earlier in any manner.

Place: Rajendranagar

Date:

Name: AMRUTHA TOMY

I.D.No: RHM/16-04

ACKNOWLEDGEMENTS

I, express my laurels to the GOD ALMIGHTY who made everything possible. I owe it all to Almighty God for granting me the wisdom, health and strength to undertake this research and enabling me to its completion.

At this moment of accomplishment, first of all I pay homage to my guide and chairman **Dr. R. CHANDRASEKHAR,** Controller of examinations and Director of Extension, S.K.L.T.S.H.U, Hyderabad for his valuable guidance, scholarly inputs and consistent encouragement I received throughout the research work. This work would not have been possible without his guidance, support and encouragement. With an amicable and positive disposition, sir has always made himself available to clarify my doubts despite of his busy schedules and I consider it as a great opportunity to do my master's degree programme under his guidance and to learn from his research and expertise.

I sincerely extend my profound gratitude and appreciation to the members of my advisory committee **Dr. A. GIRWANI** Associate Dean, College of Horticulture Mojerla, SKLTSHU, Hyderabad and **Dr. R. PURNIMA MISHRA**, Technical Officer, Dept of Agricultural Engineering, S.K.L.T.S.H.U, Hyderabad their assistance, well timed suggestions, suggestive encouragement, unstinted cooperation and meticulous guidance during the course of investigation and affectionate counselling that positively inspired me to finish the task successfully.

I owe my gratitude and unforgettable thanks to the help and cooperation rendered by **Dr. A. KIRAN KUMAR,** Associate Dean, College of Horticulture, S.K.L.T.S.H.U, Rajendranagar, Hyderabad, for his meticulous guidance, sagacious advice and sustained encouragement during the course of study as well as investigation and in the execution of the thesis.

I sincerely extend my profound gratitude and appreciation to **Dr. Veena Joshi, Smt. K. Venkatalaksmi,** and other professors and staff for their valuable advice and help rendered be it personally or academically.

I owe a lot to my parents, who encouraged and helped me at every stage of my personal and academic life, and longed to see this achievement come true.

I avail this opportunity to thank and honour my beloved parents ***Sri. Tomy Joseph*** *and* ***Smt. Ancy*** *and my brother* ***Akash Tomy*** *whose everlasting affection and encouragement brings out best in every one of my endeavours including the present research.*

*It is a pleasure to acknowledge the affection and inspiration rendered by my best friends****, Devi Suresh, Reshma Ann Mathew, Ayesha Siddiqua*** *and my cousin* ***Bharath. P. Mathew*** *who made considerable contribution for fruitful completion of my M.Sc. degree programme.*

Words are scarce to express my ardent sentiments to my seniors ***A. Nirmala, Sravan Kumar, K. Divya,*** *and classmates* ***Shiwangi, Afreen, Sushmita****,* ***Ambika, Jyothi, Sowmya, Chandana, Archana, Sravanthi*** *and* ***Rachana*** *for their timely help and moral support. I wish to accord my warmest thanks to my juniors* ***Haripriya, Jayalakshmi, Reshma, Bhavana, Sreelakshmy, Keerthana, Fathima, Janu, Shibila, Akshaya, Ashitha*** *and* ***Akhila*** *for rendering me the needy help for completion of a great milestone in my career.*

Mere quoting of words is not enough to express my sincere thanks and gratitude to ***C. Sai baba, Harsha Vardhan, K. Vinod, Priyanka, Vanitha, Uma, Savithri,*** *Academic section, COH, Rajendranagar for their valuable guidance, encouragement and constant help throughout the P.G Programme.*

I also express my gratitude to ***Ravinder, Ratnam*** *(Farm inchargers),* ***Benjamin, Sagar, Krishna, Gopal, Naveen*** *and* ***Narasimha*** *(lab assistants) for their assistance during the research work.*

The financial help rendered by Sri Konda Laxman Telangana State Horticultural University in the form of stipend is greatly acknowledged.

Finally, I wish my humble thanks to one and all who have directly and indirectly contributed in the conduct of my research work.

(AMRUTHA TOMY)

LIST OF CONTENTS

LIST OF TABLES

5.3	Effect of post harvest application of 4% sucrose + $Al_2(SO_4)_3$ @ 200 ppm on flower diameter (cm) during vase life period of China aster CV. Kamini	
5.4	Effect of post harvest application of 4% sucrose + $Al_2(SO_4)_3$ @ 200 ppm on transpirational loss of water (g/f) during vase life period of China aster CV. Kamini	
5.5	Effect of post harvest application of 4% sucrose + $Al_2(SO_4)_3$ @ 200 ppm on fresh weight change (% of initial weight) during vase life period of China aster CV. Kamini	
5.6	Effect of post harvest application of 4% sucrose + $Al_2(SO_4)_3$ @ 200 ppm on TSS of petals (^{0} Brix) during vase life period of China aster CV. Kamini	
5.7	Effect of post harvest application of 4% sucrose + $Al_2(SO_4)_3$ @ 200 ppm on electrolyte leakage (%) during vase life period of China aster CV. Kamini	
5.8	Effect of post harvest application of 4% sucrose + $Al_2(SO_4)_3$ @ 200 ppm on microbial count (cfu/ml) during vase life period of China aster CV. Kamini	
5.9	Effect of post harvest application of 4% sucrose + $Al_2(SO_4)_3$ @ 200 ppm on vase life (days) of China aster CV. Kamini	

LIST OF ILLUSTRATIONS

2.4	Effect of integrated nutrient management on China aster CV. Kamini on flower stalk length (cm)	
2.5	Effect of integrated nutrient management on China aster CV. Kamini on number of flowers per plant	
2.6	Effect of integrated nutrient management on China aster CV. Kamini on number of harvesting	
2.7	Effect of integrated nutrient management on China aster CV. Kamini on flowering duration (days)	
2.8	Effect of integrated nutrient management on China aster CV. Kamini on weight of 100 flowers (g)	
2.9	Effect of integrated nutrient management on China aster CV. Kamini on flower field life (days)	
2.10	Effect of integrated nutrient management on China aster CV. Kamini on flower weight per plot (kg)	
2.11	Effect of integrated nutrient management on China aster CV. Kamini on flower yield per hectare (t/ha)	
3.1	Effect of integrated nutrient management on China aster CV. Kamini on chlorophyll content (mg/g FW) at 50% flowering	
3.2	Effect of integrated nutrient management on China aster CV. Kamini on % NPK in leaves after harvest	
5.1	Effect of post harvest application of sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm on fresh weight (g) during vase life period of China aster CV. Kamini	

5.2	Effect of post harvest application of sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm on flower diameter (cm) during vase life period of China aster CV. Kamini	
5.3	Effect of post harvest application of sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm on water uptake (g/f) during vase life period of China aster CV. Kamini	
5.4	Effect of post harvest application of sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm on transpirational loss of water (g/f) during vase life period of China aster CV. Kamini	
5.5	Effect of post harvest application of sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm on fresh weight change (% of initial weight) during vase life period of China aster CV. Kamini	
5.6	Effect of post harvest application of sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm on TSS of petals (^{0}Brix) during vase life period of China aster CV. Kamini	
5.7	Effect of post harvest application of sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm on electrolyte leakage (%) during vase life period of China aster CV. Kamini	
5.8	Effect of post harvest application of sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm on microbial count (cfu/ml) during vase life period of China aster CV. Kamini	
5.9	Effect of post harvest application of sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm on vase life period (days) of China aster CV. Kamini	

LIST OF PLATES

APPENDICES

LIST OF SYMBOLS AND ABBREVIATIONS

@	:	At the rate of
%	:	Percentage
&	:	and
^0C	:	Degree Celsius
±	:	Plus or minus
$Al_2(SO_4)_3$	:	Aluminium sulphate
AMC	:	Arka Microbial Consortium
ARI	:	Agriculture Research Station
Azo	:	*Azospirillum*
B:C/BCR	:	Benefit cost ratio
CC	:	Caster Cake
CD	:	Critical difference
cfu	:	Colony forming unit
cm	:	Centimetre
cm^2	:	Square centimetre
CPV	:	Cocopeat, Perlite,Vermiculite
CRD	:	Completely Randomized Design
CV/cv	:	Cultivar
DAP	:	Days after Planting
DMSO	:	Dimethyl Sulphoxide
dSm^{-1}	:	Deci Simons per meter
EC	:	Electrical conductivity
EL	:	Electrolyte leakage
EDTA	:	Ethylene Diamene Tetra-acetic Acid
et al.	:	and others
etc	:	and so on, and other people/things
E-W	:	East-West
Fig	:	figure
F-test	:	Fisher test
FYM	:	Farm yard manure

FW	:	Fresh Weight
FWC	:	Fresh Weight Change
GA_3	:	Gibberellic Acid
g	:	gram
g/f	:	Gram per flower
g/m^2	:	Gram per metre square
ha	:	hectare
ha^{-1}	:	Per hectare
Hcl	:	Hydrochloric acid
HQC	:	Hydroxyquinoline Citrate
i.e.	:	that is
IIHR	:	Indian Institute of Horticultural Research
K	:	potassium
kg	:	Kilogram
Kg ha^{--1}	:	Kilogram per hectare
KMB	:	Potassium Mobilizing Bacteria
K_2O	:	Potassium Oxide
L	:	Linnaeus
l	:	litre
mg	:	milligram
mgl^{-1}	:	Milligram per litre
ml	:	millilitre
mm	:	millimetre
m^2	:	Square metre
MN	:	Micronutrient mixture
MOP	:	Muriate of Potash
N	:	Nitrogen
N	:	Normal
NC	:	Neem Cake
No.	:	Number
N-S	:	North-South
P	:	Phosphorous

P.E	:	Pan Evaporation
pH	:	Hydrogen ion Concentration
PHB	:	Pusa Hydrogel
PMB	:	Phosphate Mobilizing Bacteria
P_2O_5	:	Phosphorous pentoxide
ppm	:	Parts per million
PSB	:	Phosphorous Solubilizing Bacteria
PSC	:	Paddy Straw Compost
q/ha	:	Quintal per hectare
RDF	:	Recommended Dose of Fertilizers
RDN	:	Recommended Dose of Nitrogen
RH	:	Relative Humidity
RBD	:	Randomized Block Design
S.Em ±	:	Standard Error of Mean
SKLTSHU	:	Sri Konda Laxman Telangana State Horticulture University
SSP	:	Single Super Phosphate
SMC	:	Spent Mushroom Compost
TLW	:	Transpirational Loss of Water
TSS	:	Total Soluble Sugars
t/ha	:	tonnes per hectare
VAM	:	Vesicular Arbuscular Mycorrhiza
var.	:	variety
VC	:	Vermicompost
Viz.,	:	Namely
WSF	:	Water Soluble Fertilizers
WU	:	Water Uptake
Zn	:	Zinc

Author : **AMRUTHA TOMY**

Title of the thesis : **STUDY ON THE PERFORMANCE OF CHINA ASTER [*Callistephus chinensis* (L.) Nees] CV. KAMINI UNDER INTEGRATED NUTRIENT MANAGEMENT**

Degree : **MASTER OF SCIENCE IN HORTICULTURE**

Faculty : **HORTICULTURE**

Major Field : **FLORICULTURE AND LANDSCAPE ARCHITECTURE**

Chairperson : **Dr. R.CHANDRASEKHAR**

University : **SRI KONDA LAXMAN TELANGANA STATE HORTICULTURAL UNIVERSITY**

Year of Submission : **2018**

ABSTRACT

The present investigation entitled **"Study on the performance of China aster [*Callistephus chinensis* (L.) Nees] CV. Kamini under integrated nutrient management"** was undertaken to evaluate the growth and yield of China aster cv. Kamini under different combinations of water soluble fertilizers through fertigation, vermicompost and Arka microbial Consortium during October 2017- April 2018 at Floricultural Research Station, Rajendranagar, Hyderabad. The study was carried out in two experiments, a field and a laboratory experiment.

The experiment conducted to study the effect of different treatments of water soluble fertilizers, vermicompost and Arka microbial consortium concluded that the treatment 75% WSF + AMC + VC (T_9) recorded significantly increased vegetative parameters like highest plant height at 30 days (9.56 cm), 45 days (16.58 cm), 60 days (37.54cm), 75 days (46.96 cm) and 90 days (57.55 cm) after planting, maximum stem girth at 30 days (3.86 mm), 45 days (6.51 mm), 60 days (10.53 mm), 75 days (11.44 mm) and 90 days (13.12 mm) after planting, highest number of primary branches at 30

days (3.48), 45 days (7.60), 60 days (10.29), 75 days (17.48) and 90 days (26.42) after planting, highest total fresh weight (123.16 g) and total dry weight (41.44 g), plant spread in E-W (28.41) and N-S (26.75) directions at 50% flowering, while the lowest plant height, stem girth, number of branches, total fresh weight, total dry weight and plant spread in E-W and N-S directions at 50% flowering were recorded in the treatment T_1 (50% WSF).

Based on the results on flower parameters the treatment T_9 (75% WSF + AMC + VC) has recorded minimum number of days to first flower bud initiation (61.91days) and 50% flowering (80.67days) while maximum days were recorded in the treatment $T_{1.}$

The treatment T_9 has recorded highest values on flower quality parameters like flower diameter (6.36 cm) and stalk length (30.75 cm) while lowest were recorded in T_1.

Yield parameters like number of flowers per plant (51.40), number of harvestings (5.70), flowering duration (60.56 days), flower field life (18.75 days), weight of hundred flowers (338.54g), flower weight per plot (4.92 kg) and flower yield per hectare (18.80 t/ha) was recorded highest in T_9 followed by T_8 while the lowest were recorded in T_1.

In case of physiological parameters like leaf chlorophyll content at 50% flowering and leaf nutrient composition (NPK) at harvest maximum values were recorded in the treatment T_9 followed by T_8 and minimum in T_1. The available nutrients in soil did not differ significantly with respect to nitrogen, phosphorous and potassium at the time of planting.

Based on the results obtained from evaluation of post harvest life of cut flowers, flowers collected from the treatment 75% WSF + AMC + VC held in 4% sucrose + 200 ppm $Al_2(SO_4)_3$ was recorded significantly maximum vase life as evidenced by significantly highest water uptake, TSS, fresh weight, fresh weight change, flower diameter and significantly lowest transpirational loss of water, microbial count and electrolyte leakage over control.

As far as the economics is concerned the treatment 75% WSF + AMC + VC recorded maximum net returns and B:C ratio (2.23) followed by T_8 (2.01) while minimum net returns and B:C ratio (0.81) was recorded in T_1.

Among the treatments T_9 has shown significant increase in growth, flowering, yield parameters and vase life due to better uptake and utilization of nutrients as well as better translocation of photosynthates as influenced by synergistic effects of fertigation, AMC and vermicompost. Hence this can be recommended to the farmers as it is a cost effective method for the commercial cultivation of China aster.

CHAPTER - I

INTRODUCTION

China aster [*Callistephus chinensis* (L.) Nees], is a member of the family Asteraceae, with chromosome No 2n=18. It is one of the important commercial flower crops of our country. It is native to China and has spread to Europe and other tropical countries .The present day asters have been developed from single form of wild species, [*Callistephus chinensis* (L.) Nees]. The generic name of China aster *Callistephus* was derived from two Greek words 'Kalistos' which means 'most beautiful' and 'Stephus' which means a 'crown', referring to the large and colourful flower heads. The genus *Callistephus* includes only one species '*chinensis'*.

It is hardy, free blooming annual, grown all over the world for its attractive flowers. The wide spectrum of forms, colours (pink, blue, violet and white) and their long vase life have made it popular. In India, it is grown for its diverse forms and colours. Its cultivation is becoming popular around the cities for its extensive use as cut flower as well as loose flowers for making bouquets and garlands. In ornamental gardening, it is used as a bedding plant, edging pot plant and herbaceous border. Further, aster is a short duration crop acclimatized to varying agro climatic conditions. It is widely popular among the small and marginal farmers since flower fetches very good price when its production coincides with festivals. Aster is also found suitable for intercropping in coconut and jackfruit gardens. In India, it is being grown on a large scale in Karnataka, Tamil Nadu, Telangana, Maharashtra and West Bengal. In India, it is estimated to be grown in an area of 3500 ha.

Application of fertilizers and manures in required quantities is important for proper growth, yield and quality of flowers in China aster. In Karnataka, the recommended fertilizer dose is 90 kg Nitrogen, 60 kg phosphorous and 60 kg potash per hectare which should be applied at the time of field preparation. A top dressing of nitrogen at 90kg/ha 40 days after transplanting proved beneficial. Balanced nutrition is one of the most important factors affecting the growth and productivity in China aster. The optimum levels at which the nutrients are to be applied and sources from which they have been derived are equally important.

The concept of fertigation which combines irrigation with fertilizer application is well recognized as the most effective and convenient means of maintaining optimum fertility level and water supply according to the specific requirement of each crop and soil, resulting in higher yields and better quality. The fertilizer applied through this system reach the active root zone, thus helping easy absorption and its efficient utilization. However, the fertilizers applied must be completely soluble in water and should not have any adverse effect on the crop. It also helps in economizing the use of water and fertilizers and reducing the cost of cultivation by reducing the cost of fertilizers, labor and energy. However excessive use of fertilizers for increasing the flower production has led to nutrient leaching causing soil hazards, besides increasing cost of production.

In view of the above, there is an increasing awareness about alternative agricultural system in the present decade, known variably as biological/ organic/ ecological/ regenerative/ biodynamic/ Low External Input Sustainable Agriculture (LEISA) and farmers are showing an inclination to revert back to traditional farming with the least usage of synthetic chemicals. Indian soils are poor in organic matter and in major plant nutrients. Soil organic matter is the key to soil fertility and productivity.

Under these circumstances, integrated soil fertility management practices involving judicious combination of organic manures, biofertilizers and chemical fertilizers coupled with fertigation seems to be a feasible option for sustained agriculture on a commercial and profitable scale. In addition, they are eco-friendly, easily available and cost effective. Therefore, emphasis is now focused on the use of organic manures such as Vermicompost, Green Leaf Manures, farm yard manures and biofertilizers. Arka Microbial Consortium is a carrier based product developed by IIHR, Bangalore which contains N-fixing, P & Zn solubilizing and plant growth-promoting microbes as a single formulation. The novelty of this technology is that farmers need not apply N-fixing, phosphorous solubilizing and growth promoting bacterial inoculants individually thereby saving 25% inorganic nitrogen and phosphorous. Apart from AMC, vermicompost also harbours certain nitrogen and phosphorous solubilizing bacteria that promotes plant growth. In addition, it is also rich in nutrients, vitamins, enzymes, antibiotics and growth hormones that turn vermicompost to a valuable soil amendment.

In view of the paucity of research documentation on integrated fertigation studies in China aster, this study was formulated with the following objectives:

Objectives

1. To study the effect of different levels of water soluble fertilizers, organic manures and Arka Microbial Consortium (AMC) on growth, flowering, yield and vase life of China Aster.
2. To study the plant nutrient uptake with different water soluble fertilizers, organic manures and bio-inoculants.
3. To study the cost economics of fertigation under integrated nutrient management (INM) practices.

CHAPTER-II

REVIEW OF LITERATURE

In this chapter, an attempt has been made to present the research work done on integrated nutrient management studies in China aster and other floriculture crops. The brief view of various experimental findings pertaining to different aspect of the present study has been reviewed under following heads.

2.1. Effect of fertigation and water soluble fertilizers on growth, flowering, yield, plant nutrient uptake, fresh weight, dry matter and vase life

2.1.1 Effect of fertigation and water soluble fertilizers on growth/vegetative parameters

2.1.2 Effect of fertigation and water soluble fertilizers on flower and yield parameters

2.1.3 Effect of fertigation and water soluble fertilizers on plant nutrient uptake

2.1.4 Effect of fertigation and water soluble fertilizers on fresh weight and dry matter

2.1.5 Effect of fertigation and water soluble fertilizers on vase life

2.2. Effect of organic manures on growth, flowering, yield, fresh weight, dry matter and vase life

2.2.1 Effect of organic manures on growth/vegetative parameters

2.2.2 Effect of organic manures on flower and yield parameters

2.2.3 Effect of organic manures on fresh weight and dry matter

2.2.4 Effect of organic manures on vase life

2.3 Effect of bio inoculants on growth, flowering, yield, plant nutrient uptake, fresh weight, dry matter and vase life

2.3.1 Effect of bio inoculants on growth/vegetative parameters

2.3.2 Effect of bio inoculants on flower and yield parameters

2.3.3 Effect of bio inoculants on nutrient uptake

2.3.4 Effect of bio inoculants on fresh weight and dry matter

2.3.5 Effect of bio inoculants on vase life

2.4 Effect of integrated nutrient management on growth, flowering, yield, plant nutrient uptake, fresh weight, dry matter and vase life

2.4.1 Effect of integrated nutrient management on growth/vegetative parameters

2.4.2 Effect of integrated nutrient management on flower and yield parameters

2.4.3 Effect of integrated nutrient management on plant nutrient uptake

2.4.4 Effect of integrated nutrient management on fresh weight and dry matter

2.4.5 Effect of integrated nutrient management on vase life

2.5 Effect of Sucrose and Aluminium sulphate [$Al_2(SO_4)_3$] on post harvest studies

2.6 Cost economics under fertigation and integrated nutrient management.

2.1. Effect of fertigation and water soluble fertilizers on growth, flowering, yield, plant nutrient uptake, fresh weight, dry matter and vase life

2.1.1 Effect of fertigation and water soluble fertilizers on growth/vegetative parameters

Sujatha *et al.* (2002) conducted an experiment to study the effect of fertigation with straight and WSF in gerbera and concluded that fertigation with 80% WSF recorded maximum plant height (36.60 cm) in gerbera.

Thamara, (2008) studied the influence of levels of fertigation on China aster (cv. Kamini) and found that higher levels of fertigation (120% recommended dose of fertilizer) resulted in significantly higher plant height (57.76 cm) and more number of branches (29.53).

Qasim *et al.* (2008) investigated the effect of levels of NPK fertigation with different intervals on rose (*Rosa hybrida)* cultivars Amalia and Anjleeq. His findings concluded that plant height and number of branches were maximum with 500 ml at 2 days interval of fertigation.

Talukdar *et al.* (2010) reported that an increase in the plant height and maximum number of leaves in spray chrysanthemum and a significant increase in plant height was recorded in standard chrysanthemum under 75% fertigation which was significantly superior over conventional method.

Jainag *et al.* (2011) concluded that higher fertigation level of 120 per cent recommended dose of fertilizer + 12 litres of water/day/ plant recorded higher plant height, leaf length and number of leaves per plant in bird of paradise.

According to Waiker and Jadhav (2012), maximum number of branches per plant was recorded with the application of 60% of K_2O through fertigation over regular farm practice supplied through drenching under protected cultivation in rose.

Arvinder *et al.* (2013) revealed that plants receiving treatment of 250 ppm N and K fertigation through urea and MOP + 250 ppm NPK foliar spray through Sujala once a week showed significant increase in the vegetative growth characteristics (plant height and stem length) in Carnation.

Ganesh *et al*. (2014) reported that 75% recommended dose of fertilizers @ 12:3:12 g NPK/m^2 along with 0.2 % EDTA micronutrient mixture as foliar spray significantly enhanced the plant height and root length in cut chrysanthemum (*Dendranthema gradiflora* Tzelev) var. Amalfi.

Zehra Salma *et al.* (2014) investigated the effect of different levels of fertigation in gerbera cultivars (Amelia and Galileo) and observed that maximum plant height (50.43 cm) was recorded with 100% WSF through fertigation under polyhouse condition.

Palaniswamy (2015) revealed that the morphological parameters like plant height, number of leaves, leaf area, plant spread, suckers number and plant density had progressive increase at different stages of plant growth at 100% RDF + 0.004% MN Mixture + 0.2% humic acid in gerbera.

Divya *et al.* (2017) concluded that the application of 75% of recommended dose of fertilizers (RDF) in water soluble form (WSF) promoted maximum plant height and number of primary branches, maximum leaf nitrogen and plant spread in marigold cv. Pusa Naranagi Gainda.

Raja Babu *et al.* (2018) conducted an experiment on the effect of fertigation, irrigation and mulching. His observations revealed that the fertigation with water soluble fertilizers @ 100% RDF and polyethylene mulching recorded highest values for parameters like plant height (51.10 cm), primary branches (8.05), plant spread (89.54 cm) and stem girth (10.07 cm) in African marigold.

Tushar *et al.* (2018) conducted an experiment to study the effect of different doses of fertilizer on growth and flowering of African marigold (*Tagetes eracta* L. cv. Seracole). The experimental results revealed that combination dose of 75% Water Soluble Fertilizer + 25% Straight Fertilizer showed maximum stem girth (1.30 cm) while the maximum plant height (35.53 cm) and plant spread (N-S: 39.13 cm and E-W: 49.20 cm) were recorded in 50% Water Soluble Fertilizer + 50% Straight Fertilizer (T_5). The treatment 125% of Water Soluble Fertilizer (T_3) showed maximum number of primary branches/plant (9.33).

2.1.2 Effect of fertigation and water soluble fertilizers on flower and yield parameters

Gopinath (2001) revealed that under greenhouse condition, higher level of fertilizer with fertigation (120% recommended dose of fertilizer) resulted in high yield in carnation due to better vegetative growth. While straight fertilizers resulted in delayed harvest, water soluble fertilizers resulted in early harvest.

Kore *et al*. (2003) conducted an experiment at Agricultural Research and Development foundation at Met Tal Wada to know the effect of GA_3 and fertigation on flower quality and yield of China aster (cv. Ostrich plume mixed). Significantly maximum number of petals per flowers (159.47), highest flower stalk length (57.60cm), maximum fresh and dry weight of flowers (49.49 and 13.61g respectively) and maximum yield (49.6 q/ha) were recorded by application of GA_3 (200ppm) along with 75% water soluble fertilizers.

Shashidhar (2004) revealed that the single type Shringar with higher level of fertigation (100% recommended dose) resulted in induction of early flower initiation (151.53 days) and spike emergence (127.66 days) whereas, Suvasini (double) with higher fertigation level reported maximum spike length (83.65 cm), flower diameter (1.42cm), number of florets per spike (54.48) and floret weight (211.27g/100 florets).

Thamara *et al.* (2008) studied the influence of levels of fertigation on china aster (cv. Kamini) and found that higher levels of fertigation (120%

recommended dose of fertilizer) resulted in significantly higher stalk length (28.70cm), more number of flowers per plant (51.53) and lowest number of days taken for first flowering (45.86 days).

Gopinath and Chandra Shekhar (2009) conducted a study to know the influence of different levels of fertigation and sources of nutrient *i.e.* straight (Urea, SSP and MOP) and water soluble fertilizers in standard carnation cv. Trendy and concluded that the application of 80% RDF resulted in high number of petals (67.25/flower head), maximum diameter of cut flowers (5.97 cm) during winter season, high cumulative yield of first grade cut flowers (265.36/m^2), lowest cumulative yield of second grade cut flowers (3.02/m^2).

Talukdar *et al.* (2010) reported that a significant influence on early flowering, maximum blooming period, highest yield/100 m^2 and maximum fertigation efficiency were recorded under 75% fertigation in standard chrysanthemum. Similarly maximum diameter of flower and highest yield/100 m^2 were recorded in 75% fertigation in spray chrysanthemum which was significantly superior over conventional method.

Vijay Kumar *et al.* (2010) studied the influence of drip irrigation and fertigation in China aster cv. Kamini and Violet Cushion and concluded that least number of days taken for first flowering (46.83 and 43.64 days), days taken for 50% flowering (58.39 and 65.89 days), maximum duration of flowering (64.83 and 61.32 days) and average fresh weight of flower (6.81 and 5.08g) were recorded in the treatment that received 8 litres of irrigation with 120% RDF in china aster cv. Kamini and Violet Cushion respectively.

Jainag *et al.* (2011) concluded that higher fertigation level of 120 per cent recommended dose of fertilizer + 12 litres of water/day/ plant} recorded emergence of inflorescence, early flower initiation, maximum number of inflorescence per plant per month and maximum number of florets per inflorescence in bird of paradise.

Arvinder *et al.* (2013) revealed that plants receiving treatment of 250 ppm N and K fertigation through urea and MOP + 250 ppm NPK foliar spray through

Sujala once a week stimulated flowering parameters, reduced the number of days to bud formation and first flowering, enhanced the number of flowers per plant, flower size, reduced the number of days to harvesting stage, increased the duration of flowering and weight of cut flower stem per plant.

Ganesh *et al*. (2014) reported that 75% recommended dose of fertilizers @ 12:3:12 g NPK/m^2 along with 0.2 % EDTA micronutrient mixture as foliar spray significantly enhanced the growth, physiology and yield parameters. Also an increased recommended dose of fertilizers i.e. 100 % RDF improved the flower diameter, flower stalk length and stalk girth in cut chrysanthemum (*Dendranthema gradiflora* Tzelev) var. Amalfi.

Muhammed *et al.* (2015) conducted experiment on effect different levels of fertigation on two rose varieties Amelia and Anjleelq. His studies revealed that Maximum rose production, flowering and chemical constituent occurred due to 400 ml fertigation treatment followed by 300 ml. He also concluded that the fertigation technique with different level has potential to enhance and significantly affected all parameters of two rose hybrids Amelia and Anjleeq.

Palaniswamy (2015) revealed that 75% RDF + 0.004% MN Mixture + 0.2% humic acid had induced the first flowering while 100% RDF + 0.004% MN Mixture + 0.2% humic acid recorded the highest flower yield, longest flower stalk length, flower stalk girth and largest flower diameter under fertigation in cut gerbera.

Khalid *et al.* (2016) revealed that flowering characteristics increased significantly with increasing N level up to 120 kg ha^{-1} under surface and sub surface drip irrigaton in *Zinnia elegans.*

2.1.3 Effect of fertigation and water soluble fertilizers on plant nutrient uptake

Qasim *et al.* (2008) investigated the effect of levels of NPK fertigation with different intervals on rose (*Rosa hybrid)* cultivars Amalia and Anjleeq and concluded that maximum leaf nitrogen, phosphorous and potassium were recorded with 500 ml at 2 days interval of fertigation.

In a study conducted by Ahmed *et al.* (2011) revealed that higher leaf nitrogen content (2.5%), and phosphorous content (0.59%) were recorded with 15:20:10 g/m^2 NPK application and higher potassium content (0.59%) was recorded with 15:20:10, 15:10:10, 5:20:10 and 10:20:10g/m^2 of NPK application respectively in African marigold.

Jhuma Das *et al.* (2012) investigated the effect of different levels of fertigation on nutrient uptake of Anthurium varieties (Fire and Carnival) and reported that application of 100% RDF recorded highest N (0.86, 2.29 g/m^2).

Arvinder *et al.* (2013) revealed that plants receiving treatment of 250 ppm N and K fertigation through urea and MOP + 250 ppm NPK foliar spray through Sujala once a week showed significant increase in leaf nitrogen, phosphorous and potassium content as compared to the recommended practices in carnation.

Kaplan *et al.* (2016) conducted an experiment on the effect of nitrogen, phosphorus and potassium (NPK) fertilizer with different nitrogen forms on NPK use, uptake and growth of potted chrysanthemum plants during three vegetation phases. His studies had shown the positive effect of NPK fertilizer containing half nitrogen amount in urea form, on growth and plant nutrient uptake. This effect of nitrogen urea form was confirmed by both the highest uptake of N, P and K.

2.1.4 Effect of fertigation and water soluble fertilizers on fresh weight and dry matter

Kore *et al*. (2003) conducted an experiment at Agricultural Research and Development foundation at Met Tal Wada to know the effect of GA_3 and fertigation on flower quality and yield of China aster (cv. Ostrich plume mixed). The results concluded that the maximum fresh and dry weight of flowers (49.49 and 13.61g respectively) were recorded with the application of GA_3 (200 ppm) along with 75% water soluble fertilizers.

Talukdar *et al.* (2010) reported that highest fresh weight and dry weight was recorded in 75% fertigation in spray chrysanthemum which was significantly higher over conventional method.

Divya *et al.* (2017) concluded that the application of 75% of recommended dose of fertilizers (RDF) in water soluble form (WSF) recorded maximum leaf nitrogen, phosphorous and potassium percentage per plant in marigold.

Raja Babu *et al.* (2018) conducted an experiment on the effect of fertigation, irrigation and mulching on African marigold. He revealed that the fertigation with water soluble fertilizers @ 100% RDF and polyethylene mulching recorded highest dry matter production (66.21 g).

2.1.5 Effect of fertigation and water soluble fertilizers on vase life

Talukdar *et al.* (2010) reported that maximum vase life was recorded under 75% fertigation in standard chrysanthemum while, highest vase life was recorded in 75% fertigation in spray chrysanthemum which significantly differed over conventional method.

Arvinder *et al.* (2013) revealed that plants receiving treatment of 250 ppm N and K fertigation through urea and MOP + 250 ppm NPK foliar spray through Sujala once a week showed significant increase in vase life of carnation.

Shrikant *et al*. (2014) investigated the effect of different levels of fertigation and bio stimulants on quality parameters of gerbera (*Gerbera jamesonii* bolus ex hooker F.) var Debora and concluded that 100% RDF + 3% Panchgavya + 0.3% humic acid recorded highest vase life.

Lakshmi Durga *et al*. (2016) reported that the fertigation with 0.4% MN-EDTA along with foliar application of 0.2% MN-EDTA at fortnightly intervals recorded maximum vase life of flowers (16.20 and 16 days).

2.2. Effect of organic manures on growth, flowering, yield, fresh weight, dry matter and vase life

2.2.1 Effect of organic manures on growth/vegetative parameters

According to Asciutto *et al.* (2006) treatments with 100-75% of vermicompost showed increased leaf area and plant height in *Impatients wallerana.*

Anil *et al.* (2009) concluded that the use of sand and FYM (1:1) produced maximum plant height, number of sprouts per plant, number of leaves per plant and diameter of shoot and in wax Begonia.

Ali Salehi (2014) concluded that 60% vermicompost medium had significant positive effects on leaf growth and higher photosynthetic pigments chlorophyll a and b in African marigold.

Chauhan *et al.* (2014) revealed that the soil media amended with normal soil + rice husk + coco peat + castor cake + vermicompost (1:1:1:1) recorded maximum plant height (24.50 cm) and plant spread (34.49 and 42.07 cm^2, respectively) at first flower appearance as well as highest number of leaves and suckers per plant (17.13 and 3.61, respectively) in gerbera.

Pandey *et al.* (2017) worked on the effect vermicompost and biofertilizers on growth and flowering on dahlia. The findings revealed the maximum plant height (65.07 cm), number of primary branches (9.67), number of leaves (33.67), plant spread (43.73cm) were recorded with the plants that received Vermicompost @ 2.5 t per ha + Azotobacter @ 2.0 kg per ha + Phosphorous Solubilizing Bacteria @ 2.0 kg per ha.

2.2.2 Effect of organic manures on flower and yield parameters

Gharat *et al.* (2008) reported that in chrysanthemum, application of 180 kg N 90 kg P and 60 kg K + 5.0 t vermicompost/ha resulted in highest flower yield (75.30 q/ha).

Sonawane *et al*. (2009) reported in China aster that the application of nitrogen @ 200 kg/ha, phosphorus @ 75 kg/ha and FYM @ 10 t/ha was found best to achieve significantly maximum flower yield, flower diameter and stalk length.

Sindhu *et al.* (2010) revealed that the soil medium amended with soil + FYM + vermicompost + samridhi + sawdust took maximum number of days (9.81days) for the appearance of first new leaf.

Patel *et al.* (2011) reported that application of 160 kg N/ha with 10 t/ha vermicompost minimized days to 50% flowering (64.25), increased the number of flowers (58.38), flower yield (203.42 g/plant and 8.7 t/ha) and flower diameter (7.60 cm) in Africian marigold cv. Sierra yellow.

Arvind Kumar *et al*. (2013) conducted an experiment to evaluate the combined effect of amended media and vermiwash on growth and flowering of landscape gerbera grown under greenhouse condition. The results concluded that the appearance of first true leaf in newly transplanted plants (3.67 d), number of leaves per plant at first flower appearance (16.33), appearance of first true leaf after harvest (4.00 days), leaf area per leaf (82.80 cm2), maximum number of primary roots (42.00), were recorded on CPV + PHG + VC with 20% vermiwash sprayed.

Amita Chattopadhyay (2014) concluded that the combination of vermicompost and vermiwash showed maximum positive effects on the growth and flowering of *Zinnia sp*.

Chauhan *et al.* (2014) revealed that the soil media amended with normal soil + rice husk + coco peat + castor cake + vermicompost (1:1:1:1:1) recorded lowest number of days to the appearance of first flower bud, first flower opening (50.16 and 56.83 days, respectively), longest flowering span (141.97 days), diameter of flower (12.03 cm), length of flower stalk (54.59 cm), stalk thickness (6.44 mm), number of ray florets per flower (190.09), longevity (15.70 days) and number of flowers per plant and per sq. m. in gerbera.

According to the investigation by Premkumar *et al.* (2016) on the response of chrysanthemum cultivar Dolly White to different sources and combinations of organic manures, the observations concluded that the treatment receiving vermicompost (20t/ha) and Goat manure (25t/ha) recorded the highest number of flowers/ plant (70.93), highest number of flowers/ plot (638.37) and highest number of flowers/ hectare.

Pandey *et al.* (2017) worked on the effect of vermicompost and biofertilizers on growth and flowering on dahlia. The findings revealed the maximum number of flowers (8.13), duration of flowering (10.53), flower yield ha $^{-1}$(33.65), weight of tuber (56.67 g), number of tubers (4.87) and tuber yield (13.80 t ha^{-1}) were recorded with the plants that received Vermicompost @ 2.5 t per hectare + Azotobacter @ 2.0 kg per ha + Phosphorous Solubilizing Bacteria @ 2.0 kg per hectare.

2.2.3 Effect of organic manures on fresh weight and dry matter

According to Asciutto *et al.* (2006) treatments with 100-75% of vermicompost showed highest fresh and dry weight of aerial and subterranean organs in *Impatients wallerana.*

Arvind Kumar *et al*. (2013) conducted an experiment to evaluate the combined effect of amended media and vermiwash on growth and flowering of landscape gerbera grown under greenhouse condition. The results concluded that maximum fresh and dry weight of plant was recorded on CPV + PHG + VC with 20% vermiwash sprayed.

Chauhan *et al.* (2014) revealed that the soil media amended with normal soil + rice husk + coco peat + castor cake + vermicompost (1:1:1:1:1) recorded highest fresh and dry weight of cut flower.

2.2.4 Effect of organic manures on vase life

Sonawane *et al*. (2009) reported in China aster that the application of nitrogen @ 200 kg/ha, phosphorus @ 75 kg/ha and FYM @ 10 t/ha was found best to achieve maximum vase life of flowers.

Chauhan *et al.* (2014) revealed that the soil media amended with normal soil + rice husk + coco peat + castor cake + vermicompost (1:1:1:1:1) recorded maximum vase life (10.31 days) in gerbera.

Patel *et al.* (2011) reported that application of 160 kg N/ha with 10 t/ha vermicompost reported high keeping quality (9.28 days) in Africian marigold cv. Sierra yellow.

2.3 Effect of bio inoculants on growth, flowering, yield, plant nutrient uptake, fresh weight, dry matter and vase life

2.3.1 Effect of bio inoculants on growth/vegetative parameters

Naik *et al.* (2009) reported that application of NPK with *Azospirillum*, phosphobacteria each at 2 g/plant significantly increased the number of leaves and leaf area in anthurium.

Thakur *et al*. (2016) carried out studies to evaluate the interactive effect of biofertilizers and organic potting media on growth and flowering of Calendula (*Calendula officinalis* Linn.). His findings concluded that maximum plant height (33.70 cm), plant spread (41.96 cm) and number of branches/plant (29.13) were observed in Cocopeat + VC + PSB.

Warade *et al.* (2007) observed that height of plant, number of leaves/plant and spread of plant were superior in the plants receiving vermicompost 500 g with PSB 25 g/plot in dahlia.

Panchal *et al*. (2010) reported that application of 175 Kg N/ha + *Azospirillum* + *Azotobacter* (T_{13}) produced significantly maximum plant height (96.23 cm), number of branches per plant (50.59), plant spread (79.08 cm in North - South direction and 78.79 cm in East - West direction), Relative growth rate (0.032 g/g/day), leaf area index (21.32cm2) and harvest index (4.32%) in annual white chrysanthemum.

Bhatt *et al.*(2016) conducted an experiment to study the effect of bioinoculants on growth and yield of African marigold (*Tagetes erecta* L.) cv. ‘Pusa Narangi Gainda’ with sixteen treatment combinations, consisting two levels of nitrogen *i.e.* full N (200 kg N/ha) and 3/4th N (150 Kg/ha) and two levels of Phosphorus *i.e.* full P_2O_5 (60 kg P_2O_5/ha) and 3/4th P_2O_5 (45 kg P_2O_5/ha) with bioinoculants *i.e. Azotobacter* and Phosphate Solubilizing Bacteria (PSB). The results revealed that the vigorous growth in terms of plant height (167.40 cm), number of branches per plant (43.20) and plant spread (N-S) (102.60 cm) were recorded significantly high in plants treated with *Azotobacter* + PSB + 3/4th dose of N + full dose of P_2O_5.

Manoj *et al.* (2017) conducted a field experiment during winter season of 2014-15 to study the effect of NPK, biofertilizers and plant spacings on growth and, yield of African marigold. Application of 100%, RDF of NPK + *Azotobacter* + PSB gave , significantly higher values of plant height (82.75 cm), number of primary branches per plant (16.18 cm), plant spread of 68.54 cm in E-W direction to 62.22 cm in N-S direction.

2.3.2 Effect of bio inoculants on flower and yield parameters

Naik *et al.* (2009) reported that application of NPK with *Azospirillum*, phosphobacteria each at 2 g/plant significantly increased the number flowers and early flowering in Anthurium.

Panchal *et al.* (2010) reported that application of 175 Kg N/ha + *Azospirillum* + *Azotobactor* (T_{13}) produced significantly minimum days for first flower initiation (37.00 days), maximum number of flowers per plant (161.28), maximum flower diameter (7.37 cm), weight of individual flower (3.26 g), flower yield per plant (569.55 g) as well as per hectare (22.56 t) in annual white chrysanthemum.

Prasad *et al.* (2012) observed that inoculation of plants with biofertilizers and recommended dose of superphosphate significantly improved the growth parameters. Inoculation with *A. laevis* + *P. fluorescens* at medium concentration of superphosphate in *Chrysanthemum indicum* showed maximum height.

Wasim *et al.* (2014) carried out a study to evaluate the influence of bio-fertilizers on growth and flowering of tuberose (*Polianthes tuberosa* L.) cv. Mexican single at different levels of inorganic fertilizers. The experimental results revealed significant variations among the treatments in respect of floral characters like number of spikes per plant, number of florets per spike, length of spike, length of rachis, days required for first flowering, first floral spike to emerge and fifty percent flowering and flowering duration.

Bhatt *et al.*(2016) conducted an experiment to study the effect of bioinoculants on growth and yield of African marigold (*Tagetes erecta* L.) cv. 'Pusa Narangi Gainda' with sixteen treatment combinations, consisting two levels of nitrogen *i.e.* full N (200 kg N/ha) and 3/4thN (150 Kg/ha) and two levels of Phosphorus and dry matter content of plant (68.40%) was recorded significantly high in plants treated with *Azotobacter* + PSB + 3/4th dose of N + full dose of P_2O_5.

Thakur *et al*. (2016) carried out studies to evaluate the interactive effect of biofertilizers and organic potting media on growth and flowering of Calendula (*Calendula officinalis* Linn.). Different media compositions comprising Cocopeat + Paddy Straw Compost (PSC), Cocopeat + Spent Mushroom Compost (SMC), Cocopeat + Vermicompost (VC) and Soil + Farm Yard Manure (FYM) were used in definite ratios (1:1). His findings revealed that maximum duration of flowering (125.00) was observed in Cocopeat + VC + PSB. However, early bud appearance (27.60 days), more number of flowers per plant (55.6) and maximum presentable life of a pot plant (82.4 days) were observed in Cocopeat + VC + Control (no inoculation), Cocopeat + VC + *Azospirillum* and Cocopeat + VC + *Azotobacter*, respectively.

2.3.3 Effect of bio inoculants on nutrient uptake

Prasad et al. (2012) observed that inoculation of plants with *G. mosseae* + *A. laevis* + *P. fluorescens* in *Chrysanthemum indicum* showed percent phosphorus uptake in shoot and root.

2.3.4 Effect of bio inoculants on fresh weight and dry matter

Prasad *et al*. (2012) observed that inoculation of plants with *A. laevis* + *P. fluorescens* at medium concentration of superphosphate in *Chrysanthemum indicum* showed maximum fresh and dry root weight whereas fresh and dry shoot weight were maximum in the treatment (*G. mosseae* + *A. laevis* + *P. fluorescens*) at low concentration of superphosphate.

2.3.5 Effect of bio inoculants on vase life

Panchal *et al.* (2010) reported that application of the treatment 150 Kg N/ha + *Azospirillum* produced flowers with maximum shelf life (4.33 days).

Harish *et al.* (2015) conducted an experiment on the effect of biofertilizer coating of different sized corms of gladiolus cv. Piccardy on the vase life of spikes. The results revealed that mean maximum water uptake of 59.08 g was found in treatment VAM+ *Azospirillum*+ *Azotobacto*r + large size corm+ RDF (T_{15}) harvested spikes in three percent sucrose vase solution as compared with control (no inoculation) +small size+ RDF (49.99 g) in distilled water and maximum vase life of (10.66 days) was recorded in spikes harvested from VAM+ A*zospirillum*+ *Azotobactor* + large size corm+ RDF treated plots in 3% vase solution.

Soumya and Prasad (2017) concluded that the application of bio-fertilizers significantly enhanced nitrogen content in leaves of China aster cv. Shashank.

2.4 Effect of integrated nutrient management on growth, flowering, yield, plant nutrient uptake, fresh weight, dry matter and vase life

2.4.1 Effect of integrated nutrient management on growth/vegetative parameters

Salathia (2005) observed that significant increase in plant height and spread due to combined application of *Azospirillum*, PSB and inorganic fertilizers has been reported earlier in *Valeriana jatamansi.*

Parya *et al.* (2010) observed maximum plant height, number of leaf, suckers and number of flower stalk per plant in golden rod (*Soildago canadensis*) when plants treated with reduced level of chemical fertilizer (75% of RDF) along with 3 t/ha of vermicompost, which was at par with treatment receiving 75% of RDF in conjunction with 3 t/ha of FYM. The findings also revealed that in presence of organic manure even at lower level 1.5 t/ha along with 75% RDF showed statistically similar response that to 100% RDF.

Narendra Chaudhary *et al*. (2013) observed that maximum plant height was recorded in plants that received 75% RDF + FYM, 20 tonnes/ha+ vermicompost, 10 tonnes/ha and vermicompost, 20 tonnes/ha in gladiolus.

According to the experiment conducted by Neelima *et al*. (2013) the treatment receiving 75 per cent N + 75 per cent P + 100 per cent K + VC at 1.25t/ha + CC at 0.875t/ha + *Azotobacter* at 2kg/ha + PSB at 2kg/ha recorded the highest plant height, plant spread (NS -EW), number of branches and number of suckers in chrysanthemum.

Kumar (2014) reported that application of 75% RDF + 25% VC + 2.0 g/plant *Azospirillum* + 2.0 g/ plant PSB, significantly increased the height of plant, number of leaves per plant and length of longest leaf per plant in gladiolus cv. Peter Pears. However, plants that received 50% RDF+ 50% VC + 2.0 g/plant *Azospirillum* + 2.0 g/plant PSB was recorded significantly maximum diameter of leaf in gladiolus.

Prashant Singh *et al*. (2015) concluded that the maximum height of the plant (94.84 cm), plant spread (49.41 cm), leaf area (49.46 cm) and number of branches (15.92) were recorded maximum under the treatment 75% recommended dose of NPK (75 Kg N, 75 Kg P_2O_5 and 75 Kg K_2O ha-1)+ vermicompost 80 q ha-1 + *Azotobacter* 3.3 Kg ha^{-1} in marigold cv. Pusa Basanti.

Anand *et al.* (2016) revealed that that application of common basal dose (N:P:K 30:10:10) + FYM 1.0 Kg per pot + Decomposed Coir Compost 100g per pot + Biofertilizers (VAM + *Azospirillum* + *Trichoderma viride* 20g per pot) + 3% Panchakavya + 3% Manchurian tea produced maximum plant height, number of leaves per plant in *Cymbidium giganteum.*

According to Gaurav *et al.* (2016), application of *Azospirillum* + Phosphate-Solubilizing Bacteria + 5% Cow Urine + 50% recommended dose of “N” through Vermicompost + 50% recommended dose of NPK fertilizer was most effective in increasing vegetative growth parameters, such as plant height, number of branches and plant spread.

Yathindra *et al.* (2016) concluded that maximum leaf length, leaf width, number of leaves, number of suckers and plant spread were observed in plants that received 80 per cent RDF through fertigation plus organic source of nutrients like Vermicompost (300g) along with different biofertilizers such as *Azotobacter*, PSB and KMB as compared in plants received 100 per cent RDF as normal fertilizers through soil application.

2.4.2 Effect of integrated nutrient management on flower and yield parameters

Munikrishnappa *et al.* (2004) stated that the application of 50 per cent of recommended dose of fertilizer (RDF) along with vermicompost at 5 tonnes per hectare had improved the flower characters viz., spike length, rachis length, florets diameter, number of florets per spike and flower yield of tuberose.

Padanagur et al. (2005) observed that plants which received vermicompost either alone or in combination with ½ RDF had earlier flowering, while higher flower spike yield (1.12 and 1.16 lakh per hectare was obtained with the application of 3 kg vermicompost per square metre along with 50% recommended dose of fertilizers in tuberose.

Chamani *et al*. (2008) observed that increasing the vermicompost content in the base media decreased flower numbers in petunia.

Mittal *et al.* (2010) conducted an experiment with treatments that comprised of three biofertilizers (*Azotobacter*, *Azospirillum* and PSB) three levels of vermicompost (2.0, 3.0 and 4.0 t ha-1) and three levels of NPK (60, 70 and 80 % of RDF) including control (RDF). The results revealed that application of 70% RDF + 3 t/ha vermicompost + *Azotobacter* + *Azospirillium* + PSB (T_7) produced significantly maximum flower diameter, number of pickings, average flower weight (g), number of flowers per plant, flower yield per plant (g) and per hectare (t) as compared to control, whereas the treatment of 60% RDF + 4 t/ha vermicompost + *Azotobacter* + *Azospirillium* + PSB recorded early flower initiation and 50% flowering as compared to other treatments in marigold.

Parya *et al.* (2010) observed maximum flower stalk per plant in golden rod (*Soildago canadensis*) when plants treated with reduced level of chemical fertilizer (75% of RDF) along with 3t/ha of vermicompost.

Sunitha and Hunje (2010), revealed that the treatment 50% RDF+VC had a significant effect on the number of flowers per plant in marigold.

Narendra Chaudhary *et al.* (2013) observed that minimum number of days to first floret opening and 50% plants to sprout were recorded in plants that received 75% RDF + FYM, 20 tonnes/ha+ vermicompost, 10 tonnes/ha and vermicompost, 20 tonnes/ha whereas the application of 50% RDF (60:40:40 kg/ha NPK) + 10 tonnes/ha each of FYM and vermicompost + 2 g/plant each of *Azospirillum* and PSB produced significantly maximum length of spike, number of florets per spike, duration of flowering and yield of corms in gladiolus.

According to the experiment conducted by Neelima *et al.* (2013) the treatment receiving 75 per cent N + 75 per cent P + 100 per cent K + VC at 1.25t/ha + CC at 0.875t/ha + *Azotobacter* at 2kg/ha + PSB at 2kg/ha recorded early flower bud initiation, first flower opening, 50 per cent flowering, longest flowering duration, number of flowers per plant, flower weight per plant, flower yield ha^{-1}, stalk length and *in situ* longevity whereas maximum flower diameter was recorded with the treatment 100% N + 75% P + 100 % K + PSB at 2kg/ha in chrysanthemum cv. IIHR-6.

Basoli *et al*. (2014) investigated the impact of integrated nutrient management on gladiolus cv. Novalux. The results revealed that application of ½ recommended dose of N, P and K+ *Azotobacter* + PSB + KSB recorded the maximum number of florets opened per spike.

Kumar (2014) reported that the plants that received 50% RDF+ 50% VC + 2.0 g/plant *Azospirillum* + 2.0 g/plant PSB reported earlier spike emergence while minimum days required for opening of first flower on spike was reported with the treatment 75% RDF + 25% Leaf Mould + 2.0 g/plant *Azospirillum*.+ 2.0 g/plant PSB in gladiolus.

Kumar *et al.* (2015) concluded that 50% RDF+ 50% vermicompost + 2g/plant *Azospirillum* + 2g/plant PSB produced maximum diameter of flower, number of flowers/spike, diameter of spikes/ bulb, while 75% RDF+ 25% VC + 2g each *Azospirillum* and PSB gave longer spike and maximum bulbs in tuberose cv. Vaibhav.

Pansuriya and Chauhan (2015) concluded that minimum number of days to first spike emergence (72.10 days) maximum number of spikes per plant (2.20), number of spikes per square meter (19.82), yield of spikes per hectare (2.87 lacks), fresh weight of whole spikes (90.03 gm), diameter of floret (7.98 cm) and length of floret rachis (55.24 cm) were recorded with the application of 75% RDF + NC @ 1 t/ha + *Azoto*. @ 2 kg/ha + PSB @ 2 kg/ha in gladiolus cv. Psittacinus Hybrid.

Prashant Singh *et al.* (2015) concluded that maximum flower diameter (6.7 cm), weight of flower plant^{-1} (45.97 g), number of flowers (58.32), per cent weight (3.99g) and yield of flowers plant^{-1} (368.29g), yield of flowers (26.48 tonne ha^{-1}) were recorded maximum under the treatment 75 % recommended dose of NPK (75 Kg N, 75 Kg P_2O5 and 75 Kg K_2O ha^{-1})+ vermicompost 80 q ha^{-1} + *Azotobacter* 3.3 Kg ha^{-1} in marigold cv. Pusa Basanti.

Gaurav *et al*. (2016) concluded that the application of *Azospirillum* + Phosphate-Solubilizing Bacteria + 5% Cow Urine + 50% recommended dose of “N” through Vermicompost + 50% recommended dose of NPK fertilizer was most effective in increasing flower yield parameters like number of flowers, flower diameter, fresh and dry weight of flowers, flower yield and flowering duration in African marigold.

Madinat-ul-Nisa *et al*. (2016) evaluated the response of integrative nutrient application on overall yield of gladiolus. Significant differences were observed amongst all the treatments. The results endorsed that the treatment *Azotobacter* 1 litre/10 kg + *Azospirillium* 1 litre/10 kg + 80% N +100% PK significantly improved the number of florets spike^{-1} (14.20), number of spikes per square metre (32.00), corms plant^{-1} (3.2) and corms m^{-2} (74.70) in gladiolus.

2.4.3 Effect of integrated nutrient management on plant nutrient uptake

Muthamizhselvi *et al.* (2006) reported that the combined application of 50% recommended dose of fertilizers at 62.5:60:12.5 kg NPK/ha + vermicompost at 500 g/m² + 3% panchagavya at 15 days intervals from 30th days after transplanting till peak flowering as foliar spray significantly influenced the leaf nutrient content and uptake in chrysanthemum.

Chaitra (2006) noticed significantly higher available nutrients (N, P_2O_5, K_2O) and their uptake by China aster plants receiving *Azospirillum*, PSB and vermicompost along with 50% recommended NPK.

2.4.4 Effect of integrated nutrient management on fresh weight and dry matter

Verma et al. (2011) concluded that the treatment receiving *Azospirillum*, Phosphate Solubilising Bacteria (PSB), vermicompost and 50 per cent recommended NPK recorded highest dry matter accumulation in Chrysanthemum cv. Raja.

According to the experiment conducted by Neelima *et al.* (2013) the treatment receiving 75 % N + 75 % P + 100 % K + VC at 1.25t/ha + CC at 0.875t/ha + *Azotobacter* at 2kg/ha + PSB at 2kg/ha recorded the highest fresh weight and dry matter accumulation.

Pansuriya and Chauhan (2015) concluded that maximum fresh and dry weight of plant (161.36 gm and 46.37 gm, respectively) were recorded under the treatment 75% RDF + NC @ 1 t/ha + *Azoto*. @ 2 kg/ha + PSB @ 2 kg/ha in gladiolus cv. Psittacinus Hybrid.

According to Prashant Singh *et al*. (2015) highest total dry matter (39.03 g/plant) was recorded under the treatment 75 % recommended dose of NPK (75 Kg N, 75 Kg P_2O_5 and 75 Kg K_2O ha-1)+ vermicompost 80 q ha^{-1} + *Azotobacter* 3.3 Kg ha^{-1} in marigold cv. Pusa Basanti.

2.4.5 Effect of integrated nutrient management on vase life

Jawaharlal and Padmadevi (2003) observed highest vase life in Anthurium when plants were treated with *Azospirillum,* phosphobacteria, VAM along with inorganic nutrients and growth regulators.

Thane et al. (2007) reported that the application of 70% RDF+ *Azotobacter* + PSB recorded maximum vase life (8.95) days in gerbera.

Mittal *et al.* (2010) conducted an experiment with treatments that comprised of three biofertilizers (*Azotobacter, Azospirillum* and PSB) three levels of vermicompost (2.0, 3.0 and 4.0 t ha-1) and three levels of NPK (60, 70 and 80 % of RDF) including control (RDF). The results revealed that the application of 60% RDF + 4 t/ha vermicompost + *Azotobacter* + *Azospirillium* + PSB recorded maximum shelf life and vase life of marigold.

Chougala (2011) recorded maximum vase life (5.12 days) in the treatment receiving Azo + PSB + VC equivalent to 50% RD'N' + 50% RDF in double daisy (*Aster amellus* L.).

Laishram (2011) reported maximum vase life (23.10 days) in chrysanthemum cv. Ajay with 15 g/m² each of NPK + Vermicompost (1 kg/m²) + biofertilizers.

Verma *et al.* (2011) reported that application of *Azospirillum* + PSB + VC equivalent 50% RD'N' + 50% RDF + 50% FYM resulted in maximum shelf life (51.53 hrs in ambient condition) of garland chrysanthemum flowers.

Neelima *et al.* (2013) concluded that the treatment receiving the treatment receiving 75 % N + 75 % P + 100 % K + VC at 1.25t/ha + CC at 0.875t/ha + Azotobacter at 2kg/ha + PSB at 2kg/ha recorded highest shelf life of loose flowers, vase life of cut flowers of chrysanthemum cv. IIHR-6.

Kumar (2014) reported that application of 75% RDF+ 25% VC + 2.0 g/plant *Azospirillum* + 2.0 g/ plant PSB recorded maximum longevity of spike in gladiolus.

Rahul Singh *et al*. (2014) concluded that vase life of cut flower at room temperature and longevity of spike was also noted with the treatment using 75% RDF, (NPK 225:150:150 kg/ha) + 2 tonnes of Vermicompost + PSB, (2.5kg/ha) + *Azotobacter* (2.5kg/ha) in gladiolus.

Gaurav Sharma *et al*. (2017) observed that the application of *Azospirillum* + Phosphate Solubilizing Bacteria + 5% Cow Urine + 50% recommended dose of 'N' through Vermicompost + 50% recommended dose of NPK recorded maximum shelf life of 7.89 days in African marigold.

2.5 Effect of Sucrose and Aluminium sulphate [$Al_2(SO4)_3$] on post harvest quality and vase life of cut flowers studies

Bhaskar and Rao (1998) and Bhaskar *et al.* (1999) reported that $Al_2(SO4)_3$ was effective in maintaining the higher fresh weight and thereby increasing the vase life of cut tuberose spikes.

Liao *et al*. (2001) examined the effects of aluminum sulphate at concentrations of 50, 100, and 150 mgl^{-1} on cut Lisianthus (*Eustoma grandiflorum*) and concluded that 150 mgl^{-1} of aluminium sulphate extended vase life up to 15.4 days, in addition to which it enhanced water uptake as well as fresh weight.

Arora and Kushal Singh (2002) recommended sucrose 4% + $Al_2(SO_4)_3$ 300 ppm for improved post harvest life and quality of gladiolus spikes.

Ranvir Singh and Sashikala (2002) reported that using various post harvest chemicals viz., $Al_2(SO_4)_{3,}$ Calcium sulphate and silver nitrate in combination with sucrose 4%, among the treatments maximum floret diameter was recorded with sucrose 4% + $Al_2(SO_4)_3$ 300 ppm in gladiolus cut spikes.

Anjupal *et al.* (2003) indicated that 4% Sucrose + 300 ppm $Al_2(SO_4)_3$ as floral preservatives significantly increased longevity and floret opening duration in gladiolus cv. Pink Friendship.

Namita *et al.* (2006) revealed that pulsing of spikes with sucrose 4% + $Al_2(SO_4)_3$ 400 ppm recorded maximum floret diameter and extended vase life over control in gladiolus cv. Jacksonville Gold.

Bantikumar *et al.* (2007) concluded that using 4% sucrose + 200 ppm $Al_2(SO_4)_3$ is the most effective treatment to increase the post harvest quality and vase life of cut flower spikes in tuberose cv. Pearl Double.

Khan *et al.* (2007) studied the effect of aluminium sulphate and sucrose on the properties of tulip (*Tulipa hybrida*) and concluded that aluminium sulphate increased the relative water content in leaves and petals 64.5% & 58.7% respectively.

Varu and Barad (2008) concluded that spikes treated with 500 ppm aluminium sulphate + 4% sucrose recorded maximum vase life, highest water uptake and fresh weight of spike in tuberose cv. Suvasini.

Suresha *et al.* (2009) reported that combination of 4% sucrose + 300 ppm $Al_2(SO_4)_3$ + 8-HQC recorded maximum vase life and better water uptake in chrysanthemum cv. White Fizii.

Kumar *et al.* (2012) studied on the influence of different floral preservatives on water relations and vase life of cut tulip cv. Yellow Purissima and their findings concluded that the preservatives 300 ppm 8-HQC and 300 ppm aluminium sulphate recorded improved water uptake and thereby maintained better water balance leading to improved fresh weight and vase life.

Davood (2014) studied on effect of essential oils, 8-HQC and Aluminum sulphate on vase life and postharvest characteristics of cut carnation cv. Tempo and his findings revealed that $100 mgl^{-1}$ aluminium sulphate, 200 mg l^{-1} 8-HQC and 12 % Artemisia is recorded with maximum vase life, water uptake and reduced bacterial population on stem.

2.6 Cost economics under fertigation and integrated nutrient management

Shubha (2006) reported that in marigold maximum net return and B: C ratio was maximum in the treatment combination of vermicompost (12.5 % N) + poultry manure (12.5 % N) + *Azospirillum* along with 75% RDN/ha.

Meshram *et al.* (2008) recorded high B:C ratio on application of 80% NPK + *Azospirillum* + Azotobacter + PSB 5 kg each per hectare in annual chrysanthemum.

Gopinath and Chandrasekhar (2009) concluded a study to know the influence of different levels of fertigation and sources of nitrogen i.e. straight (Urea, SSP and MOP) and water soluble fertilizers in standard carnation cv. Trendy and concluded the application of 80% of RDF as WSF recorded maximum revenue (Rs. 1.06.748/100m^2/annum), net profit (Rs. 72,213 per 100 m^2 per annum) and benefit cost ratio (2.09) in carnation.

Kumar *et al.* (2009) in African marigold cv. African Giant Double Orange found that treatment receiving PSB + Azotobactor + 50% N and P + 100% K + FYM showed maximum B:C ratio in both the years (2.66 and 2.67, respectively).

Patil *et al.* (2010) conducted a study to investigate the optimum level of irrigation and fertilizer dose for gerbera and revealed that treatment combination of 0.60 P.E X 80% RDF recorded maximum benefit cost ratio of 1.59 followed by benefit cost ratio of 1.57 in 0.40 PE X 80% under protected cultivation in gerbera.

Chougala (2011) reported in double daisy that net return/ha and B: C ratio was higher on treatment with *Azo* + PSB + VC equivalent to 50% RDN + 50% RDF (Rs. 386430.72).

Verma *et al.* (2011) in chrysanthemum indicated that net return per hectare and B:C ratio was maximum with *Azospirillum* + PSB + VC equivalent 50% RD‘N’ + 50% RDF + 50% FYM (Rs. 3,28,504 and 6.04, respectively).

According to the study conducted by Jadhav *et al.* (2014) the maximum gross returns (5, 32,853.40 ha^{-1}), net returns (4, 51,733.40 per ha) and benefit cost ratio (1:5.57) were recorded in the treatment 75% RDF + 60 kg P_2O_5 per hectare + 60 kg of K_2O per hectare + Azotobacter + enriched banana pseudo stem sap in African marigold cv. Pusa Narangi Gainda..

According to Lal Singh *et al.* (2015) maximum gross returns (1, 23,070), net return (91,476) and benefit cost ratio (3.89) were recorded with application of 120:80:40 kg of NPK per hectare along with border strip method of irrigation in marigold var. Pusa Narangi Gainda.

Vishnu et al. (2016) reported that application of 75% of RDF + 25% vermicompost recorded maximum gross return, net return and benefit cost ratio (2.52:1) in African Marigold.

In a study conducted by Gaurav *et al.* (2017) revealed that maximum benefit cost ratio was recorded with application of *Azospirillum* + Phosphate solubilizing bacteria + 5% cow urine + 50% RDN through vermicompost +50% RDF in African marigold.

Kumari and Prasad (2017) revealed that maximum benefit - cost ratio (1:2.46) when plants were treated with *Azotobactor* + PSB +PMB + NPK 120: 90:60 in Petunia var. Picotee.

CHAPTER-III

MATERIALS AND METHODS

An investigation entitled **"Study on the performance of China aster [*Callistephus chinensis* (L.) Nees] CV. Kamini under integrated nutrient management"** was carried out at Floricultural Research Station, Rajendranagar, Hyderabad, during rabi season of 2017-18. The details of the materials and methods adopted during the entire research period are presented in this chapter.

3.1 GEOGRAPHICAL LOCATION OF THE EXPERIMENTAL SITE

The experimental site is located at Floricultural Research Station. Rajendranagar, Hyderabad which falls under semi-arid tropical climate zone with an average rainfall of 613.6 mm per annum. The experimental site is located at an altitude of 542.30 m above mean sea level at latitude of 17.90^0 North and longitude of 78.23^0 East. The mean monthly meteorological data during the crop growing period are presented in Appendix I.

3.2 SOIL CHARACTERISTICS OF THE EXPERIMENTAL SITE

The experimental field had an even topography. The soil samples were drawn randomly before commencement of the experiment from different spots in the field at the depth of 15-30 cm and a composite sample was prepared and analyzed for the physical and chemical properties of the soil.

The experimental soil was sandy loam with good drainage and moderately low water holding capacity. The soil pH is 7.2 and E.C. is 0.27 dSm^{-1}. The available nitrogen of the soil is at 228 kg/ha, phosphorous at 52 kg/ha and potassium at 285 kg/ha.

3.3 DETAILS OF THE EXPERIMENT-I

"Study on the performance of China aster [*Callistephus chinensis* (L.) Nees] CV. Kamini under integrated nutrient management"

Crop : China aster

Variety : Kamini

Design : RBD

Number of treatments : 9

Number of replications : 3

Spacing : 30 cm x 30 cm

Plot Size : 2.7 m X 1.0 m

Number of plants per plot : 30

3.3.1 DETAILS OF THE EXPERIMENT-II

"Post Harvest vase life studies of China aster [*Callistephus chinensis* (L.) Nees] CV. Kamini"

Location	:	PG Research Laboratory, College of Horticulture, Rajendranagar
Crop	:	China aster
No. of treatments	:	10 (9 treatments + control)
No. of replications	:	3
Holding Solution	:	4% Sucrose + 200 ppm $Al_2(SO_4)_3$
Design	:	Completely Randomized design with Factorial concept

Treatment Details

T_1 – 50% Water Soluble Fertilizers

T_2 – 75% Water soluble Fertilizers

T_3 – 100% Water soluble Fertilizers - Control

T_4 - 50% Water soluble Fertilizers + Arka Microbial Consortium

T_5 – 75% Water soluble Fertilizers + Arka Microbial Consortium

T_6 – 50% Water soluble Fertilizers + Vermicompost

T_7 – 75% Water soluble Fertilizers + Vermicompost

T_8 - 50% Water soluble Fertilizers + Arka Microbial Consortium + Vermicompost

T_9 – 75% Water soluble Fertilizers + Arka Microbial Consortium + Vermicompost

3.3.2 Varietal Description

China aster [*Callistephus chinensis* (L.) Nees] CV. Kamini was identified and released by the varietal identification and release committee of the Indian Institute of Horticultural Research, Bangalore. It is an erect growing and branching annual with alternatively arranged, broad ovate and serrated leaves. It bears deep pink flower heads at the end of relatively long stalks. The flower heads are comet type having flat disc flowers with long spreading loose ray florets.

3.3.3 Details of Fertilizers

Fertilizers were supplied through drip once a week.

Recommended Dose of Fertilizer: 180:60:60 kg of NPK ha^{-1}

As water soluble fertilizers : 180:15*:60 kg of NPK ha^{-1}

*45kg/ha Phosphorous was supplied through SSP at the time of field preparation.

Level of Application	Fertilizers	Quantity (kg/ha)
100% NPK	19 :19:19	79
	13:0:45	59
	Urea	330
75% NPK	19 :19:19	100
	13:0:45	75
	Urea	248
50% NPK	19 :19:19	135
	13:0:45	102
	Urea	165

RDF: 180:15*:60

Fig 2: Level of application of fertilizers and its quantity

I. Application of chemical nutrients.

*****25% of total recommended dose of phosphorous (15kg/ha) along with recommended doses of nitrogen and potassium were supplied through fertigation at weekly interval after transplanting.

II. Vermicompost Application

Vermicompost at the rate of 2.5t/ha was supplied to the soil at the time of planting as per the treatment specifications.

III. Arka Microbial Consortium (AMC)

AMC was applied at the rate of 7.5l/ha through foliar application once in 10 days till flowering as per the treatment specifications.

3.4 EXPERIMENTAL PROCEDURE

China aster was grown in open condition by adopting the recommended package of practices following different levels of fertigation with water soluble fertilizers, organic manures and bio inoculants.

3.4.1 Nursery

Seedlings of China aster cv. 'Kamini' were raised by sowing the seeds on seed beds. The seeds were sown in lines and sand mixed FYM was spread above the seeds. Soil drenching was done with 0.1 per cent of Bavistin. Watering was done daily with a rose can. The seedlings were ready for transplanting at 45 days after sowing.

3.4.2 Installation of Drip Irrigation System and Fertigation Unit

The drip irrigation system and ventury injector fertigation unit were installed as per the experimental layout and treatments. The inline drippers were 16 mm lateral pipes were laid out at an interval of 30 cm spacing with 4 litres per hour discharge capacity.

3.4.3 Preparation of main field under open condition

The entire plot was thoroughly dug and brought to a fine tilth after removing the weeds and stubbles prior to planting. Farm yard manure (FYM) was applied and mixed well with the soil. Raised beds of 2.7 X 1.0 m and 15 cm height were prepared with 30 cm distance between the beds. The experiment was laid out in Randomized Block design. 75% of total recommended dose of phosphorous was supplied as basal dose through SSP at the time of bed preparation along with recommended dose of vermicompost as per the treatment specifications. The beds were then covered with plastic mulch to prevent weeds and to conserve moisture.

3.4.4 Transplanting

Twenty five days old healthy uniform seedlings of China aster were transplanted on beds according to the recommended spacing of 30 cm X 30 cm. The treatments were replicated thrice randomly.

3.4.5 Fertilizer and AMC application

Treatments T_1, T_4, T_6 and T_8 consisting of the recommended dose fertilizers at 50% were supplied through drip fertigation at weekly interval from the date of transplanting through water soluble form, while T_4 and T_8 were supplied with AMC as foliar application once in 10 days.

Treatments T_2, T_5, T_7 and T_9 consisting of recommended dose of fertilizers at 75% were supplied through drip fertigation at weekly interval from the date of transplanting in water soluble form, while the treatments T_7 and T_9 were supplied with AMC as foliar application once in 10 days respectively.

Treatment T_3 consisting of recommended dose of fertilizers at 100% was supplied through water soluble form through fertigation at weekly intervals from the date of transplanting.

3.4.6 Weeding and Plant Protection Measures

The weeds grown in the gap between the beds were removed manually at regular intervals. Timely and suitable plant protection measures were given to protect the experimental plants from the attack of pests and diseases.

3.4.7 Irrigation

The plots were irrigated at an interval of two to three days depending upon the weather, growth and stage of the crop. Irrigation was provided through the drip system.

3.4.8 Harvesting

Flowers were harvested early in the morning or evening hours as and when they were fully opened.

3.5 OBSERVATIONS RECORDED IN EXPERIMENTS I AND II.

Observations were recorded on various growth and flowering traits. Five plants were randomly selected from each treatment in each replication for recording the data.

3.5.1 Vegetative Parameters

3.5.1.1. Plant Height (cm)

Height of the plant was measured from the base (ground level) to the tip of the growing point of the plant at 15 days interval ie., at 30, 45, 60, 75 and 90 days after planting and average was worked out and expressed in centimeters.

3.5.1.2. Stem Girth (mm)

Stem girth was measured using vernier calipers at 15 days interval ie., at 30, 45, 60, 75 and 90 days after planting and average was worked out and expressed in millimeters.

3.5.1.3. Plant Spread (cm)

It was measured by measuring spread of the plant in the East –West and North- South directions of tagged plants at first flower bud initiation and the mean of plant spread was worked out.

3.5.1.4. Number of primary branches per plant

The number of primary branches per plant arising from the main stem was counted from tagged plants and recorded at 15 days interval ie., at 30, 45, 60, 75 and 90 days after planting. The mean number of primary branches per plant was then calculated and expressed in number.

3.5.1.5. Fresh weight of plant (g) at final harvest stage

Fresh weight was determined separately for vegetative parts (leaves, stem and root) and reproductive parts (flowers) at final harvest stage. Five plants were uprooted randomly from each plot and the vegetative and reproductive parts were separated and was weighed using a digital weighing balance and the averages were worked out and expressed in grams. Total fresh weight was calculated by adding fresh weights of different parts and expressed in grams.

3.5.1.6. Dry weight of plant (g) at final harvest stage

Dry matter production was determined separately for vegetative parts (leaves, stem and root) and reproductive parts (flowers) at final harvest stage. Five plants were uprooted randomly from each plot and the vegetative and reproductive parts were separated and oven dried separately at 60^0C till they obtained constant weight. Dry matter accumulation in different parts of the plants was recorded and expressed in grams. Total dry matter was calculated by adding dry weights of different plant parts.

3.5.2. Flower Parameters

3.5.2.1 Number of days to first flower bud appearance

This observation was recorded by counting the number of days from the day of transplanting to the stage at which the first flower bud was formed in each treatment from the tagged plants.

3.5.2.2. Days to 50% flowering (days)

The number of days taken for 50 per cent of the plants to produce flowers in each plot was recorded from each plot by counting the days from the date of transplanting and expressed in number of days**.**

3.5.2.3. Flower Diameter (cm)

Diameter of the flower was measured at the point of maximum breadth. This was measured by using vernier calipers and average diameter was expressed in centimeters in and computed.

3.5.2.4. Stalk Length (cm)

The length of the stalk of the flower was taken from the origin of the stalk from the main stem to the neck of the flower and expressed in centimeters.

3.5.2.5. Number of flowers per plant

Number of flowers harvested from the tagged plants was counted and the average was worked out and expressed as the number of flowers per plant.

3.5.2.6. Number of harvestings

Number of times flowers harvested from each plot per month was recorded.

3.5.2.7. Flowering Duration (Days)

Number of days taken from the first flowering to the last flowering was recorded as the total duration of flowering in each treatment and expressed in number of days.

3.5.2.8. Weight of Hundred flowers (g)

Weight of hundred fresh flowers from each treatment was recorded and expressed in grams.

3.5.2.9. Flower Field vase life (days)

Number of days the flower in each plot remain fresh in the field was recorded and the average was worked out and expressed in number of days.

3.5.2.10. Flower Weight per plot (kg)

Flower weight per plot was calculated on the basis of pooled fresh weight of flowers harvested from each plot during all harvests and expressed in kilograms.

3.4.2.11. Flower yield per hectare (t/ha)

This was worked out by totaling the weight of flowers recorded from the net plots and expressed in tones.

3.5.3. Physiological/Biochemical Parameters

3.5.3.1. Total Leaf chlorophyll content (mg/g FW)

Total chlorophyll, chlorophyll 'a' and 'b' contents of the leaves were determined following dimethyl sulfoxide (DMSO) method as described by Hiscox and Israeistam (1979). Fresh, fully mature leaves were brought in polythene bags at 50% flowering from the field and were cut into pieces. One hundred mg of leaf bits (devoid of veins) were incubated in 7.0 ml of DMSO at 65 ^{o}C for 60 minutes. After incubation, extract was decanted discarding the leaf tissue. Then the volume was made up to 10 ml with DMSO. The absorbance of the extract was read at 645 and 663 nm in a spectrophotometer using DMSO as a blank. The chlorophyll contents (mg/g fresh wt) were calculated using the formula of Shoaf and Lium (1976).

3.5.3.2. Leaf Nutrient Composition (NPK) after harvest

The leaves were collected from plants after final harvest and were decontaminated by washing thoroughly with tap water and then with 0.2% detergent (Teepol laboratory grade), 0.1N HCl to remove the dust and again washed with distilled water and finally with double distilled water. They were wiped with blotting paper and air dried. Later they were dried in oven at 60^{0}C till constant weight was obtained. The dried material was pound by using pestle and mortar. The powdered samples were analyzed for N, P and K by following standard procedures.

3.5.3.2.1 Total Nitrogen (%)

Modified Kjeldahl method as described by Chapman and Pratt (1961) was adopted to analyse nitrogen content in leaf.

3.5.3.2.2 Total Phosphorous (%)

Phosphorous content in leaf was determined by the Venabado molybdate yellow colour method (Jackson, 1967).

3.5.3.2.3 Potash (%)

Flame photometer method was used for the determination of potash content in leaf. (Jackson,1967).

3.5.3.3. Available Nutrients in the soil (NPK) at the time of planting

Soil samples were collected from the plot before imposing treatments.

3.5.3.3.1 Available Nitrogen

Available nitrogen in soil was estimated by Kjeldahl method (Jackson, 1967).

3.5.3.3.2 Available Phosphorous

Available phosphorous is soil was extracted with 0.5 M sodium bicarbonate (1:2) and determined calorimetrically (Olsen *et al.* 1954).

3.5.3.3.3 Available Potassium

Available potassium was extracted from soil by using Flame photometer as described by Jackson (167).

3.5.3.4. Soil pH

The soil pH was measured with the help of EC meter (Richard, 1954).

3.5.3.5. Soil Electrical Conductivity

The soil EC was measured with the help of EC meter (Jackson, 1967).

3.5.4 Water Uptake (WU)

Difference between consecutive weights of bottle with solution (without cut flower stalks) represented the uptake of water by the cut flower stalk and expressed in grams (g).

3.5.5. Transpiration Loss of water (TLW)

The difference between the consecutive weight of bottle with solution and flower stalks represented the transpiration loss of water through flowers and expressed in grams (g).

3.5.6. Fresh weight Change (FWC)

The difference between the weight of the container + solution + flower and the weight of container + solution recorded once in two days to measure the fresh weight change of flower during that particular period and expressed in as percentage of the initial weight.

3.5.7. Total soluble solids TSS) (^{o}Brix)

Total soluble solids of petals was measured once in three days using a digital refractometer.

3.5.8. Electrolyte Leakage

The rate of ion leakage is expressed as percentage of total conductance following petal destruction.

$$\text{Electrolyte leakage} = \frac{\text{Conductivity before autoclaving } (EC_1)}{\text{Conductivity after autoclaving } (EC_2)} \times 100$$

3.5.9. Microbial population in vase solution (cfu/ml)

Samples of vase water were collected at the beginning of the experiment and at the end of the experiment (on the final day). The total colony count, referred as colony forming units (cfu) was calculated as below:

cfu = y/dx

Where,

y = Number of colonies formed

d = Dilution

x = Volume of sample

3.5.10. Vase life (days)

Vase life was expressed in terms of days from the time of harvest till the flowers were found unfit for continuing in vase i.e., just before they start showing the symptoms of wilting.

3.6. Economics

3.6.1. Benefit Cost Ratio.

In order to assess the effects of each treatment with the combination of water soluble fertilizers, organic manure and bio inoculants, the cost of cultivation was worked out. This included the cost of fertilizer (urea, SSP 19:19:19 and 13:0:45), the cost of organic manures and bio fertilizers, taken at the current existing rates. The labour cost, including fertilizer application, irrigation and plant protection, weeding etc., during the cropping period were worked out.

The yield obtained under each treatment was taken into consideration for working out the economics. Based on the total cost of cultivation and gross returns obtained, the net returns and cost:benefit ratio were worked out and was computed per hectare.

3.7. Statistical Analysis

The data on all characters of first (I) experiment was subjected to statistical analysis of variance for Randomized Block Design (RBD) as described by Panse and Sukhatme (1967) to know the degree of variation amongst all the treatments. Appropriate standard error of mean SE (m) was calculated in each case and the critical difference at five percent level of significance.

The results obtained from first (I) experiment was subjected to analysis of variance for completely randomized design (C.R.D) with factorial concept outlined by Panse and Sukhatme (1985). The appropriate standard error of mean SE(m) was calculated in each case and the critical difference (C.D.) at five percent level of significance was worked out to compare the two treatment means where the treatment effects were significant.

CHAPTER -IV

RESULTS AND DISCUSSION

EXPERIMENT - I

An experiment entitled "**Study on the performance of China aster [*Callistephus chinensis* L. *Nees*] CV. Kamini under integrated nutrient management**" was conducted at Floricultural Research Station, Rajendranagar. The experiment was laid out in Randomized block design under three replications.

The entire recorded data was subjected to statistical analysis to obtain the mean values for on the performance of the cultivar under various parameters. The observations recorded under various parameters have been presented in this chapter along with its respective tables and graphs under the following titles.

4.1. Vegetative Parameters

4.2. Flower Parameters

4.3. Physiological/Biochemical Parameters

4.4. Economics

4.1 Studies on the effect of integrated nutrient management on vegetative parameters of the China aster CV. Kamini.

4.1.1 Plant Height (cm)

The plant height differed significantly at various stages of plant growth under different treatments. The height of the tagged plants was recorded at 15 days interval.

4.1.1.1 Plant height (cm) at 30 days after transplanting

The data recorded on plant height of China aster cv. Kamini at 30 DAP is presented in the table 1.1.1 and in fig 1.1.1

From the data it is evident that the plant height is significantly influenced by different treatments at 30 DAP. Among the treatments T_9 (75% WSF + AMC + VC) recorded the highest plant height (9.56 cm) followed by the treatment T_8 (9.31 cm). The treatment T_1 has recorded the lowest plant height (7.54cm) followed by T_2 (7.84cm).

4.1.1.2 Plant height at 45 days after transplanting

Effect of different treatments on plant height of China aster cv. Kamini at 45 DAP is presented in the table 1.1.2 and fig 1.1.1

Significant differences were observed on plant height at 45 DAP under different treatments. The treatment T_9 (75% WSF + AMC + VC) recorded the highest plant height (16.58 cm) followed by T_8 (16.34 cm). The lowest plant height was recorded in the treatments T_1 (13.92 cm) followed by T_2 (14.61cm). Among the treatments T_5 and T_4 were on par.

4.1.1.3 Plant height at 60 days after transplanting

The data recorded on plant height of China aster cv. Kamini at 45 DAP is presented in the table 1.1.3 and in fig. 1.1.1

It is evident from the data that plant height is significantly influenced by different treatments at 60 DAP. Significantly maximum plant height (37.54 cm) was recorded in the treatment T_9 (75% WSF +AMC + VC) followed by T_8 (36.73 cm). The treatment T_1 recorded significantly lowest plant height (25.73 cm) followed by T_2 (27.91 cm).

4.1.1.4 Plant height at 75 days after transplanting

The plant height of the China aster cv. Kamini at 75 DAP is presented in the table 1.1.4 and in fig 1.1.1.

It is evident from the data that plant height is significantly influenced by different treatments at 75 DAP. The highest plant height (46.96 cm) was recorded in the treatment 75% WSF +AMC +VC (T_9) followed by T_8 (45.50 cm). The treatment T_1 recorded significantly lowest plant height (36.96 cm) followed by T_2 (39.47 cm).

Table 1.1.1: Effect of integrated nutrient management on plant height (cm) of China aster CV. Kamini at 30 DAP

Notation	Treatments	Plant Height (cm) at 30 DAP
T_1	50% WSF	7.54
T_2	75% WSF	7.84
T_3	100%WSF-Control	8.06
T_4	50%WSF+AMC	8.65
T_5	75%WSF+AMC	8.99
T_6	50% WSF+VC	8.24
T_7	75%WSF+VC	8.49
T_8	50%WSF+AMC+VC	9.31
T_9	75%WSF+AMC+VC	9.56
	SE(m) ±	0.267
	C.D at 5%	0.808

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

Table 1.1.2: Effect of integrated nutrient management treatments on plant height (cm) of China aster CV. Kamini at 45 DAP

Notation	**Treatments**	**Plant Height (cm) at 45 DAP**
T_1	50% WSF	13.92
T_2	75% WSF	14.61
T_3	100%WSF-Control	14.95
T_4	50%WSF+AMC	15.59
T_5	75%WSF+AMC	15.99
T_6	50% WSF+VC	15.29
T_7	75%WSF+VC	15.57
T_8	50%WSF+AMC+VC	16.34
T_9	75%WSF+AMC+VC	16.58
	SE(m) ±	0.477
	C.D at 5%	1.443

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

Table 1.1.3: Effect of integrated nutrient management treatments on plant height (cm) of China aster CV. Kamini at 60 DAP

Notation	Treatments	Plant Height (cm) at 60 DAP
T_1	50% WSF	25.73
T_2	75% WSF	27.91
T_3	100%WSF-Control	29.22
T_4	50%WSF+AMC	34.35
T_5	75%WSF+AMC	35.77
T_6	50% WSF+VC	30.93
T_7	75%WSF+VC	32.90
T_8	50%WSF+AMC+VC	36.73
T_9	75%WSF+AMC+VC	37.54
	SE(m) ±	0.801
	C.D at 5%	2.423

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

Table 1.1.4: Effect of integrated nutrient management treatments on plant height (cm) of China aster CV. Kamini at 75 DAP

Notation	Treatments	Plant Height (cm) at 75 DAP
T_1	50% WSF	36.96
T_2	75% WSF	39.47
T_3	100%WSF-Control	40.19
T_4	50%WSF+AMC	42.78
T_5	75%WSF+AMC	43.49
T_6	50% WSF+VC	41.79
T_7	75%WSF+VC	42.59
T_8	50%WSF+AMC+VC	45.50
T_9	75%WSF+AMC+VC	46.96
	SE(m) ±	1.349
	C.D at 5%	4.080

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

4.1.1.5 Plant height at 90 days after transplanting

The plant height of the China aster cv. Kamini at 90 DAP is presented in the table 1.1.5 and in fig 1.1.1.

It is evident from the data that the plant height is significantly influenced by different treatments at 90 DAP. Significantly maximum plant height (57.55 cm) was recorded in the treatment T_9 75% WSF +AMC +VC (T_9) followed by T_8 (55.27 cm). The treatment T_1 recorded significantly lowest plant height (45.23 cm) followed by T_2 (47.37 cm).

From the above results it has been revealed that there is a significant increase in the height of the plants that received water soluble fertilizers (WSF), vermicompost (VC) and Arka Microbial Consortium (AMC) due the synergistic effect of its combination. The increase in plant height may be due to the plant growth promoting microbes and the nitrogen and phosphorous solubilizing bacteria present in AMC in making micronutrients available for the plant growth thereby increasing the meristamatic activity and hence the vegetative growth. Similar results of positive effects of bio inoculants and vermicompost were reported by Pansuriya and Chauhan (2015) in gladiolus and Chaitra and Patil (2007) in China aster. Moreover application of inorganic fertilizers through fertigation made the macro nutrients available to the plants directly to the root zone triggered the plant growth. This is in confirmation with the earlier report of Divya *et al.* (2017) in gerbera and Talukdar *et al.* (2010) and Ganesh *et al.* (2014) in chrysanthemum.

4.1.2 Stem girth (mm)

Stem girth of China aster cv. Kamini differed significantly under different treatments at various stages of growth. The stem girths of the plants were recorded at 15 days interval.

4.1.2.1 Stem girth (mm) at 30 DAP

The data recorded on the stem girth of China aster cv. Kamini at 30 DAP is presented in the table 1.2.1 and fig 1.2.1

Table 1.1.5: Effect of integrated nutrient management treatments on plant height (cm) of China aster CV. Kamini at 90 DAP

Notation	Treatments	Plant Height (cm) at 90 DAP
T_1	50% WSF	45.23
T_2	75% WSF	47.37
T_3	100%WSF-Control	49.50
T_4	50%WSF+AMC	53.15
T_5	75%WSF+AMC	53.84
T_6	50% WSF+VC	51.52
T_7	75%WSF+VC	52.14
T_8	50%WSF+AMC+VC	55.27
T_9	75%WSF+AMC+VC	57.55
	SE(m) ±	1.689
	C.D at 5%	5.106

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

Table 1.2.1: Effect of integrated nutrient management treatments on stem girth (mm) of China aster CV. Kamini at 30 DAP

Notation	Treatments	Stem girth (mm) at 30 DAP
T_1	50% WSF	2.16
T_2	75% WSF	2.33
T_3	100%WSF-Control	2.56
T_4	50%WSF+AMC	3.26
T_5	75%WSF+AMC	3.42
T_6	50% WSF+VC	2.78
T_7	75%WSF+VC	3.07
T_8	50%WSF+AMC+VC	3.68
T_9	75%WSF+AMC+VC	3.86
	SE(m) ±	0.267
	C.D. at 5%	0.807

WSF: Water soluble Fertilize VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

It is evident from the data that stem girth is significantly influenced by different treatments at 30 DAP. The highest stem girth (3.86 mm) was recorded in the treatment T_9 (75% WSF +AMC + VC) followed by T_8 (3.68 mm). The treatment T_1 recorded lowest stem girth (2.16 mm) followed by T_2 (2.33mm). Among the treatments T_5 and T_4 were recorded on par.

4.1.2.2 Stem girth (mm) at 45 DAP

The data recorded on stem girth of China aster cv. Kamini at 45 DAP is presented in the table 1.2.2 and fig 1.2.1.

It is evident from the data that stem girth is significantly influenced by different treatments at 45 DAP. The highest stem girth (6.51 mm) was recorded in the treatment T_9 (75% WSF +AMC + VC) followed by T_8 (6.34 mm). The treatment T_1 recorded lowest stem girth (4.36 mm) followed by T_2 (4.66 mm). Among the treatments T_5 and T_4 were on par.

4.1.2.3 Stem girth (mm) at 60 DAP

The data recorded on the stem girth of China aster cv. Kamini at 60 DAP is presented in the table 1.2.3 and fig 1.2.1.

It is evident from the data that stem girth is significantly influenced by different treatments at 60 DAP. The highest stem girth (10.53 mm) was recorded in the treatment T_9 (75% WSF +AMC + VC) followed by T_8 (10.32 mm). The treatment T_1 recorded lowest stem girth (8.19 mm) followed by T_2 (8.41 mm). Among the treatments T_5 and T_4 were on par.

4.1.2.4 Stem girth (mm) at 75 DAP

The data recorded on stem girth of China aster cv. Kamini at 75 DAP is presented in the table 1.2.4 and fig 1.2.1.

From the data it is evident that stem girth significantly differed under different treatments at 75 DAP. The treatment T_9 (75% WSF+ AMC+ VC) recorded highest stem girth (11.44 mm) followed by T_8 (11.21 mm).

Table 1.2.2: Effect of integrated nutrient management treatments on stem girth (mm) of China aster CV. Kamini at 45 DAP

Notation	Treatments	Stem girth (mm) at 45 DAP
T_1	50% WSF	4.36
T_2	75% WSF	4.66
T_3	100%WSF-Control	5.09
T_4	50%WSF+AMC	5.69
T_5	75%WSF+AMC	6.19
T_6	50% WSF+VC	5.21
T_7	75%WSF+VC	5.37
T_8	50%WSF+AMC+VC	6.34
T_9	75%WSF+AMC+VC	6.51
	SE(m) ±	0.281
	C.D. at 5%	0.848

WSF: Water soluble Fertilizers   VC: Vermicompost

AMC: Arka Microbial Consortium   DAP: Days after planting

Table 1.2.3: Effect of integrated nutrient management treatments on stem girth (mm) of China aster CV. Kamini at 60 DAP

Notation	Treatments	Stem girth (mm) at 60 DAP
T_1	50% WSF	8.19
T_2	75% WSF	8.41
T_3	100%WSF-Control	8.71
T_4	50%WSF+AMC	9.32
T_5	75%WSF+AMC	9.62
T_6	50% WSF+VC	9.11
T_7	75%WSF+VC	9.26
T_8	50%WSF+AMC+VC	10.32
T_9	75%WSF+AMC+VC	10.53
	SE(m) ±	0.383
	C.D. at 5%	1.159

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

Table 1.2.4: Effect of integrated nutrient management treatments on stem girth (mm) of China aster CV. Kamini at 75 DAP

Notation	Treatments	Stem girth (mm) at 75 DAP
T_1	50% WSF	9.25
T_2	75% WSF	9.43
T_3	100%WSF-Control	9.80
T_4	50%WSF+AMC	10.36
T_5	75%WSF+AMC	10.55
T_6	50% WSF+VC	10.19
T_7	75%WSF+VC	10.28
T_8	50%WSF+AMC+VC	11.21
T_9	75%WSF+AMC+VC	11.44
	SE(m) ±	0.349
	C.D. at 5%	1.056

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

The treatment T_1 recorded lowest stem girth (9.25 mm) followed by T_2 (9.43 mm). Among the treatments T_5 and T_4 were on par.

4.1.2.5 Stem girth (mm) at 90 DAP

The data recorded on stem girth of China aster cv. Kamini 90 DAP is presented in the table 1.2.5 and fig 1.2.1.

From the data it is evident that stem girth significantly differed under different treatments at 90 DAP. The treatment T_9 (75% WSF + AMC + VC) recorded highest stem girth (13.12 mm) followed by T_8 (12.47 mm). The treatment T_1 recorded lowest stem girth (10.49 mm) followed by T_2 (10.62 mm). Among the treatments T_5 and T_4 were on par.

From the above recorded observations it is evident that the organic manures in combination with inorganic nutrients and bio inoculants played significant role in providing positive effect on vegetative growth parameters. Application of inorganic nutrients through fertigation ensures better uptake of nutrients since the nutrients are being supplied directly to the root zone. Moreover AMC that is rich in phosphate and nitrogen solubilizing and plant growth promoting bacteria ensures the uptake and utilization of nitrogen and phosphorous making it available for the plant growth through cell division and cell enlargement. This combined effect of organic and inorganic manures along with bio inoculants augmented the plant growth thereby stem girth. These observations are in confirmation with the findings of Divya *et al.* (2017) in marigold, Chaitra and Patil (2007) in China aster and Ashwin *et al.* (2013) in marigold.

4.1.3 Total number of primary branches

Total number of primary branches differed significantly under different treatments at various stages of plant growth. The total numbers of primary branches were recorded at 15 days interval.

4.1.3.1 Total number of primary branches at 30 DAP

The data recorded on the total number of primary branches of China aster cv. Kamini at 30 DAP is presented in the table 1.3.1 and fig 1.3.1.

Table 1.2.5: Effect of integrated nutrient management treatments on stem girth (mm) of China aster CV. Kamini at 90 DAP

Notation	Treatments	Stem girth (mm) at 90 DAP
T_1	50% WSF	10.49
T_2	75% WSF	10.62
T_3	100%WSF-Control	10.84
T_4	50%WSF+AMC	11.52
T_5	75%WSF+AMC	12.20
T_6	50% WSF+VC	11.21
T_7	75%WSF+VC	11.35
T_8	50%WSF+AMC+VC	12.47
T_9	75%WSF+AMC+VC	13.12
	SE(m) ±	0.295
	C.D. at 5%	0.893

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

Table 1.3.1: Effect of integrated nutrient management treatments on total number of primary branches of China aster CV. Kamini at 30 DAP

Notation	Treatments	No. of primary branches at 30 DAP
T_1	50% WSF	2.28
T_2	75% WSF	2.58
T_3	100%WSF-Control	3.35
T_4	50%WSF+AMC	3.22
T_5	75%WSF+AMC	3.28
T_6	50% WSF+VC	2.73
T_7	75%WSF+VC	2.93
T_8	50%WSF+AMC+VC	3.42
T_9	75%WSF+AMC+VC	3.48
	SE(m) ±	0.194
	C.D at 5%	0.585

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

From the data it is evident that total number of primary branches significantly differed under different treatments at 30 DAP. The treatment T_9 (75% WSF+ AMC+ VC) recorded maximum number of primary branches (3.48) followed by T_8 (3.42). The treatment T_1 recorded lowest stem girth (2.28) followed by T_2 (2.58). Among the treatments T_5 and T_4 were on par.

4.1.3.2 Total number of branches at 45 DAP

The data recorded on the total number of primary branches of China aster cv. Kamini at 45 DAP is presented in the table 1.3.2 and fig 1.3.1.

It is evident from the data that total number of primary branches is significantly influenced by different treatments at 45 DAP. The highest number of primary branches were (7.60) recorded in the treatment T_9 (75% WSF +AMC + VC) followed by T_8 (7.48). The treatment T_1 recorded lowest number of branches (4.23) followed by T_2 (4.54). Among the treatments T_5 and T_4 were on par.

4.1.3.3 Total number of branches at 60 DAP

The data recorded on total number of primary branches of China aster cv. Kamini at 60 DAP is presented in the table 1.3.3 and fig 1.3.1.

It is evident from the data that total number of primary branches is significantly influenced by different treatments at 60 DAP. The highest number of primary branches (10.29) was recorded in the treatment T_9 (75% WSF +AMC + VC) followed by T_8 (9.32 mm). The treatment T_1 recorded lowest number of primary branches (5.66) followed by T_2 (6.42). Among the treatments T_5 and T_4 were on par.

4.1.3.4 Total number of branches at 75 DAP

The data recorded on total number of primary branches of China aster cv. Kamini at 75 DAP is presented in the table 1.3.4 and fig 1.3.1.

Table 1.3.2: Effect of integrated nutrient management treatments on total number of primary branches of China aster CV. Kamini at 45 DAP

Notation	Treatments	No. of primary branches at 45 DAP
T_1	50% WSF	4.23
T_2	75% WSF	4.54
T_3	100%WSF-Control	4.93
T_4	50%WSF+AMC	6.23
T_5	75%WSF+AMC	6.76
T_6	50% WSF+VC	5.36
T_7	75%WSF+VC	5.70
T_8	50%WSF+AMC+VC	7.48
T_9	75%WSF+AMC+VC	7.60
	SE(m) ±	0.258
	C.D at 5%	0.779

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

Table 1.3.3: Effect of integrated nutrient management treatments on total number of primary branches of China aster CV. Kamini at 60 DAP

Notation	Treatments	No. of primary branches at 60 DAP
T_1	50% WSF	5.66
T_2	75% WSF	6.42
T_3	100%WSF-Control	6.56
T_4	50%WSF+AMC	8.63
T_5	75%WSF+AMC	8.90
T_6	50% WSF+VC	7.09
T_7	75%WSF+VC	7.43
T_8	50%WSF+AMC+VC	9.32
T_9	75%WSF+AMC+VC	10.29
	SE(m) ±	0.320
	C.D at 5%	0.968

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

Table 1.3.4: Effect of integrated nutrient management treatments on total number of primary branches of China aster CV Kamini at 75 DAP

Notation	Treatments	No. of primary branches at 75 DAP
T_1	50% WSF	11.72
T_2	75% WSF	12.92
T_3	100%WSF-Control	13.48
T_4	50%WSF+AMC	15.28
T_5	75%WSF+AMC	15.53
T_6	50% WSF+VC	14.39
T_7	75%WSF+VC	14.75
T_8	50%WSF+AMC+VC	16.47
T_9	75%WSF+AMC+VC	17.48
	SE(m) ±	0.437
	C.D at 5%	1.323

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

It is evident from the data that total number of primary branches is significantly influenced by different treatments at 75 DAP. The highest number of primary branches (17.48) was recorded in the treatment T_9 (75% WSF +AMC + VC) followed by T_8 (16.47). The treatment T_1 recorded lowest number of primary branches (11.72) followed by T_2 (12.92). Among the treatments T_5 and T_4 were on par.

4.1.3.5 Total number of branches at 90 DAP

The data recorded on total number of primary branches of China aster cv. Kamini at 90 DAP is presented in the table 1.3.5 and fig 1.3.1.

It is evident from the data that total number of primary branches is significantly influenced by different treatments at 90 DAP. The highest number of primary branches (26.42) was recorded in the treatment T_9 (75% WSF +AMC + VC) followed by T_8 (25.28). The treatment T_1 recorded lowest number of primary branches (19.56) followed by T_2 (20.77). Among the treatments T_5 and T_4 were on par.

From the above observations it has been clearly understood that the there is a significant influence of integrated nutrient management treatments on the total number of primary branches. The phyto hormones present in the microbial consortia as well as the enzymatic activity facilitated by the vermicompost might have decelerated the process of apical dominance thereby triggering the growth of side branches. More over supply of macro nutrients through fertigation might have triggered the uptake of nutrients thereby increasing cell growth, cell division and cell differentiation resulting in more vegetative growth. More number of branches determines the number of flowers produced per plant. These findings are in confirmation with the earlier reports of Pandey *et al.* (2017) in Dahlia, Prashant Singh *et al*. (2015) in marigold, and Thakur *et al* (2016) in Calendula.

Table 1.3.5: Effect of integrated nutrient management treatments on total number of primary branches of China aster CV. Kamini at 90 DAP

Notation	Treatments	No. of primary branches at 90 DAP
T_1	50% WSF	19.56
T_2	75% WSF	20.77
T_3	100%WSF-Control	21.62
T_4	50%WSF+AMC	23.55
T_5	75%WSF+AMC	24.12
T_6	50% WSF+VC	23.13
T_7	75%WSF+VC	23.25
T_8	50%WSF+AMC+VC	25.28
T_9	75%WSF+AMC+VC	26.42
	SE(m) ±	0.612
	C.D at 5%	1.850

WSF: Water soluble Fertilizers VC: Vermicompost

AMC: Arka Microbial Consortium DAP: Days after planting

4.1.4 Plant spread (cm) in E-W and N-S directions at 50% flowering

The data recorded on plant spread (cm) of the China aster cv. Kamini on E-W and N-S directions at 50% flowering is presented in the table 1.4 and fig 1.4

Significant differences were observed on plant spread at 50% flowering under different treatments. The highest plant spread in E-W (28.41cm) and N-S (26.75 cm) directions were recorded in the treatment T_9 (75% WSF + AMC + VC) followed by T_8 in E-W (27.67 cm) and N-S (26.44 cm) directions. The lowest plant spread was recorded with T_1 in E-W (19.14 cm) and N-S directions (18.84 cm) followed by T_2. Among the treatments T_5 and T_4 were on par.

The results confirm that the integrated nutrient management that contains a combination of organic manures, inorganic fertilizers and bio fertilizers augments the vegetative plant growth during its growing period. The increased plant spread may be due to the effective functioning of biofertilizers which produce bioactive substances that has similar results to that of plant growth regulators. Moreover the nitrogen and phosphorous solubilizing bacteria fixes the atmospheric nitrogen and phosphorous making it available to the plant growth. Vermicompost which is higher source of organic carbon, humic acid, macro nutrients and micro nutrients also facilitated nutrient uptake. Ferigation with water soluble fertilizers also assures higher nutrient availability and uptake which attribute to the sufficient quantity of nutrient flow into the plants. These findings are in confirmation with the reports of Divya *et al.* (2017) in marigold, Prashant Singh *et al.* (2007) in Dahlia, Salathia (2005) in *Valeriana jatamansi*, Bhatt *et al.* (2016) in marigold and Neelima *et al.* (2013) in chrysanthemum.

4.1.5 Total Fresh weight (g) at final harvest

The data recorded on total fresh weight (g) of the China aster cv. Kamini at final harvest is presented in the table 1.5 and fig 1.5

Significant differences were observed on the total fresh weight of the plant at final harvest under different treatments. The treatment T_9 recorded the maximum total fresh weight at final harvest (123.16 g) followed by T_8 (121.30g).

Table 1.4: Effect of integrated nutrient management treatments on plant spread (cm) in E-W & N-S directions of China aster CV. Kamini at 50% flowering

Notation	Treatments	Plant Spread (cm)	
		E-W	**N-S**
T_1	50% WSF	19.14	18.84
T_2	75% WSF	21.02	20.18
T_3	100%WSF-Control	23.83	22.53
T_4	50%WSF+AMC	26.63	24.87
T_5	75%WSF+AMC	27.50	25.39
T_6	50% WSF+VC	24.37	22.86
T_7	75%WSF+VC	25.35	24.22
T_8	50%WSF+AMC+VC	27.67	26.44
T_9	75%WSF+AMC+VC	28.41	26.75
	SE(m) ±	**0.324**	**0.323**
	C.D. at 5%	**0.981**	**0.976**

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

Table 1.5: Effect integrated nutrient management treatments on total fresh weight (g) of China aster CV. Kamini at final harvest

Notation	Treatments	Total Fresh weight (g) at final harvest
T_1	50% WSF	98.59
T_2	75% WSF	103.33
T_3	100%WSF-Control	109.39
T_4	50%WSF+AMC	115.63
T_5	75%WSF+AMC	118.52
T_6	50% WSF+VC	112.52
T_7	75%WSF+VC	113.61
T_8	50%WSF+AMC+VC	121.30
T_9	75%WSF+AMC+VC	123.16
	SE(m) ±	2.944
	C.D at 5%	8.901

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

The treatment T_1 (98.59 g) recorded minimum total fresh weight followed by T_2 (103.33 g). Among the treatments T_5 and T_4 were on par.

From the data it is evident that the combined application of organic manures along with inorganic nutrients and bio inoculants significantly increased the fresh weight of the plants. This might be due to the effect of phosphate and nitrogen solubilizing bacteria as well as plant growth promoters present in the consortia in facilitating the nutrient uptake thereby increasing the vegetative growth. Apart from the consortia, the vermicompost which is a rich source of macro and micro nutrients along with inorganic nutrients also added up on the nitrogen content within the plants thereby adding up to the luxurious vegetative growth as well as reproductive growth during all stages of plant growth resulting in high fresh weight at the final harvest. These observations are in confirmation with respect to the earlier reports of Pansuriya and Chauhan (2015) in Gladiolus, Neelima *et al*. (2013) in chrysanthemum, Ali Salehi (2014) in Calendula and Talukdar *et al*. (2010) in Chrysanthemum.

4.1.6 Total Dry weight (g) at final harvest

The data recorded on total dry weight (g) of the China aster cv. Kamini at final harvest is presented in the table 1.6 and fig 1.6.

Significant differences were observed in the total dry weight of the plant at final harvest under different treatments. The treatment T_9 (75% WSF + AMC + VC) recorded highest total dry weight (41.44 g) followed T_8 (40.54 g). The treatment T_1 (32.26 g) recorded the lowest total dry weight at final harvest followed by T_2 (33.80 g). Among the treatments T_5 and T_4 were on par.

The treatments clearly indicate the significant effect of combinations of organic nutrients, inorganic fertilizers and bio inoculants. The resulting high dry matter accumulation may be due to the high nitrogen fixation rate by the nitrogen solubilizing bacteria and growth promoters released by the bio inoculants. Moreover the supply of macronutrients through fertigation and vermicompost has resulted in more nutrient uptake thereby augmenting the vegetative growth through high rate of photosynthesis. This results in photosynthates being

Table 1.6: Effect of integrated nutrient management treatments on total dry weight (g) of China aster CV. Kamini at final harvest

Notation	Treatments	Total Dry weight (g) at final harvest
T_1	50% WSF	32.26
T_2	75% WSF	33.80
T_3	100%WSF-Control	35.59
T_4	50%WSF+AMC	36.96
T_5	75%WSF+AMC	38.24
T_6	50% WSF+VC	34.33
T_7	75%WSF+VC	36.61
T_8	50%WSF+AMC+VC	40.54
T_9	75%WSF+AMC+VC	41.44
	SE(m) ±	1.194
	C.D at 5%	3.610

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

transported to different plant parts during entire course of the plant growth that might have resulted in high dry matter accumulation at the final stage of harvest. These findings are in agreement with the reports of Prashant *et al.* (2015) in marigold, Pansuriya and Chauhan (2015) in Gladiolus, Ali Salehi (2014) in Calendula and Talukdar *et al*. (2010) in Chrysanthemum.

4.2. Studies on the effect of integrated nutrient management on flower parameters of China aster CV. Kamini

4.2.1 Number of days to first flower bud appearance

The data recorded on the number of days taken to first flower bud appearance in China aster cv. Kamini as influenced by different treatments is presented in the table 2.1 and fig 2.1

It is evident from the data that there were significant differences on the number of days taken to first flower bud appearance under different treatments. The minimum number of days to first flower bud appearance (61.91 days) was recorded in the treatment T_9 (75% WSF + AMC +VC) followed T_8 (62.29 days). The maximum number of days to first flower bud appearance was recorded in the treatment T_1 (72.03 days) followed by T_2 (70.83 days). Among the treatments T_5 and T_4 were on par.

The number of days to first flower bud appearance was significantly influenced by bio inoculants, vermicompost and water soluble fertilizers. This could be attributed to the vigorous and luxurious plant growth due to balanced nutrient combination with bio inoculants, organic manure and inorganic nutrients. Early bud appearance in the plants may be due to the better sink source relationship in which photosynthates being transported to the reproductive parts from the vegetative parts resulting in change of growth phase. Phosphate solubilizing bacteria might have played a crucial role in transporting phosphorus which is a key element for flower initiation. Moreover the supply of potassium through water soluble fertilizers also facilitated nutrient uptake resulting in an early reproductive phase. These findings are in close confirmation with the reports of Divya *et al*. (2017) in marigold and Neelima *et al.* (2013) in

Table 2.1: Effect of integrated nutrient management treatments on number of days to first flower bud initiation of China aster CV. Kamini

Notation	Treatments	No of days to first Flower bud initiation
T_1	50% WSF	72.03
T_2	75% WSF	70.83
T_3	100%WSF-Control	69.11
T_4	50%WSF+AMC	64.17
T_5	75%WSF+AMC	63.04
T_6	50% WSF+VC	68.10
T_7	75%WSF+VC	66.07
T_8	50%WSF+AMC+VC	62.29
T_9	75%WSF+AMC+VC	61.91
	SE(m) ±	1.973
	C.D. at 5%	5.965

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

Chrysanthemum, Pansuriya Chauhan (2015) in gladiolus, Thamara (2008) in China aster and Kumar (2014) in gladiolus.

4.2.2 Days to 50% flowering

The data recorded on the number of days taken to 50% flowering in China aster cv. Kamini as influenced by different treatments is presented in the table 2.2 and fig 2.2.

It is evident from the data that number of days to 50% flowering differed significantly due to different treatments. The minimum number of days to 50% flowering (80.67 days) was recorded in the treatment T_9 (75% WSF + AMC + VC) followed by the treatment T_8 (81.45 days). The maximum number of days to 50% flowering was recorded in the treatment T_1 (92.16 days) followed by T_2 (89.77 days). Among the treatments T_5 and T_4 were on par.

Phosphorous and potassium are important nutrients required during reproductive phase especially at the time of flowering. The Phosphate solubilizing bacteria in the bio inoculants as well as the supply of potassium through fertigation has ensured continuous and constant supply of these nutrients available to the plants with higher nutrient uptake rate. This might have resulted most of the plants to reach early bud stage and to early flowering. These results are in close confirmation with Naik *et al.* (2009) in anthurium, Neelima *et al.* (2013) in chrysanthemum, Wasim *et al.* (2014) in tuberose and Narendra Chaudhary *et al*. (2013) in gladiolus.

4.2.3. Flower Diameter (cm)

The data recorded on the flower diameter of China aster cv. Kamini as influenced by different treatments is presented in the table 2.3 and fig 2.3.

From the data it is evident that flower diameter significantly differed under different treatments. The treatment T_9 (75% WSF + AMC + VC) recorded highest flower diameter (6.36 cm) followed by T_8 (5.83 cm). The lowest flower diameter was recorded in the treatment T_1 (4.72 cm) followed by T_2 (4.81 cm).

Table 2.2: Effect of integrated nutrient management treatments on number of days to 50% flowering of China aster CV. Kamini

Notation	Treatments	Number of days to 50% flowering
T_1	50% WSF	92.16
T_2	75% WSF	89.77
T_3	100%WSF-Control	88.31
T_4	50%WSF+AMC	84.79
T_5	75%WSF+AMC	82.85
T_6	50% WSF+VC	87.09
T_7	75%WSF+VC	86.24
T_8	50%WSF+AMC+VC	81.45
T_9	75%WSF+AMC+VC	80.67
	SE(m) ±	**1.125**
	C.D. at 5%	**3.402**

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

Table 2.3: Effect of integrated nutrient management treatments on diameter (cm) of China aster CV. Kamini

Notation	Treatments	Diameter (cm)
T_1	50% WSF	4.72
T_2	75% WSF	4.81
T_3	50%WSF+AMC	4.95
T_4	100% WSF - Control	5.40
T_5	75%WSF+AMC	5.65
T_6	50% WSF+VC	5.18
T_7	75%WSF+VC	5.29
T_8	50%WSF+AMC+VC	5.83
T_9	75%WSF+AMC+VC	6.36
	SE(m) ±	0.277
	C.D. at 5%	0.838

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

Among the treatments T_5 (75% WSF + AMC) and T_4 (50% WSF + AMC) were on par.

The maximum flower diameter recorded may be due to the increased phyto hormonal effect and uptake of phosphorous by PSB making it available to the plants and also the large quantity of potassium availability through fertigation also added up to this process.

This result can be attributed to the better source sink relationship that might have enhanced the quality of the flowers. These results are similar to the findings of Divya *et al.* (2017) in marigold, Talukdar *et. al* (2010) in chrysanthemum, Patel *et al.* (2011) in marigold and Pansuriya and Chauhan (2015) in gladiolus.

4.2.4. Flower stalk length (cm)

The data recorded on flower stalk length (cm) of China aster cv. Kamini as influenced by different treatments is presented in the table 2.4 and fig 2.4.

From the data it is evident that flower stalk length differed significantly due to different treatments. The highest flower stalk length (30.75 cm) was recorded with the treatment T_9 (75% WSF + AMC +VC) followed by T_8 (29.70cm). The lowest stalk length was recorded in the treatment T_1 (22.03 cm) followed by T_2 (23.81 cm). Among the treatments T_5 (75% WSF + AMC) and T_4 (50% WSF + AMC) were on par.

The increase in stalk length may be due to the uptake of nutrients through water soluble fertilizers as well as interaction of bio inoculants and vermicompost resulting in translocation of nutrients to the flower heads and stalks. The large quantity of nutrient supply through water soluble fertilizers as well as vermicompost in addition to the growth promoting substances might have significant effect on the increase of stalk length. These findings are in confirmation with the findings of Pansuriya and Chauhan (2015) in gladiolus, Kore *et al*. (2003) in china aster, Ganesh *et al.* (2014) in chrysanthemum and Bellubbi *et al.* (2015) in gerbera.

Table 2.4: Effect of integrated nutrient management treatments on flower stalk length (cm) of China aster CV. Kamini

Notation	Treatments	Flower stalk length (cm)
T_1	50% WSF	22.03
T_2	75% WSF	23.81
T_3	100%WSF-Control	25.83
T_4	50%WSF+AMC	28.20
T_5	75%WSF+AMC	28.86
T_6	50% WSF+VC	26.53
T_7	75%WSF+VC	27.50
T_8	50%WSF+AMC+VC	29.70
T_9	75%WSF+AMC+VC	30.75
	SE(m) ±	0.788
	C.D. at 5%	2.384

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

4.2.5. Number of flowers per plant

The data recorded on number of flowers per plant in China aster cv. Kamini as influenced by different treatments is recorded in the table 2.5 and fig 2.5.

Significant differences were recorded on the number of flowers per plant under different treatments. The maximum number of flowers per plant (51.40) was recorded in the treatment T_9 (75% WSF + AMC +VC) followed by T_8 (49.50). The minimum number of flowers per plant (38.30) was recorded in the treatment T_1 followed by T_2 (39.93). Among the treatments T_5 (75% WSF + AMC) and T_4 (50% WSF + AMC) were recorded on par.

The increase in number of flowers per plant might be due to the role of nitrogen solubilizing bacteria in fixing atmospheric nitrogen triggering vegetative growth. Higher photosynthesis might have enhanced food accumulation, which might have resulted in better plant growth and subsequently higher number of flowers per plant. This increase in flower number can also be attributed to higher availability of soil moisture, optimum NPK nutrients and uptake when supplied through fertigation which renders easy accessibility as required by the crop. These results are in close confirmation with the earlier reports of Bellubbi *et al.* (2015) in gerbera Pandey *et al*. (2017) in Dahlia and Patel *et. al* (2011) in marigold.

4.2.6. Number of harvesting

The data recorded on number of harvesting in China aster cv. Kamini as influenced by different treatments is recorded in the table 2.6 and fig 2.6.

It is evident from the data recorded the number of harvestings differed significantly due to different treatments. The maximum number of harvesting (5.70) was recorded with the treatment T_9 (75% WSF + AMC + VC) followed by T_8 (5.27). The minimum harvesting was recorded in the treatment T_1 (3.60) followed by T_2 (4.26). Among the treatments T_5 (75% WSF + AMC) and T_4 (50% WSF + AMC) were on par.

Table 2.5: Effect of integrated nutrient management treatments on number of flowers per plant of China aster CV. Kamini

Notation	Treatments	Number of flowers per plant
T_1	50% WSF	38.30
T_2	75% WSF	39.93
T_3	100%WSF-Control	42.74
T_4	50%WSF+AMC	47.53
T_5	75%WSF+AMC	48.30
T_6	50% WSF+VC	45.71
T_7	75%WSF+VC	46.23
T_8	50%WSF+AMC+VC	49.40
T_9	75%WSF+AMC+VC	51.40
	SE(m) ± **C.D. at 5%**	**1.448** **4.378**

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

Table 2.6: Effect of integrated nutrient management treatments on number of harvesting of China aster CV. Kamini

Notation	Treatments	Number of harvesting
T_1	50% WSF	3.60
T_2	75% WSF	4.26
T_3	100%WSF-Control	4.37
T_4	50%WSF+AMC	4.80
T_5	75%WSF+AMC	4.97
T_6	50% WSF+VC	4.52
T_7	75%WSF+VC	4.58
T_8	50%WSF+AMC+VC	5.27
T_9	75%WSF+AMC+VC	5.70
	SE(m) ±	**0.218**
	C.D. at 5%	**0.659**

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

The higher uptake of nitrogen and potassium through water soluble fertilizers have resulted more photosynthetic rate [Divya *et al.* (2017)] which in combination with bio inoculants and vermicompost have resulted in translocating the photosynthates to the reproductive parts resulting in more number number of flowers thereby increasing the number of harvest. These results are in confirmation with Neelima *et al.* (2013) in chrysanthemum, Prashant singh *et al.* (2015) in marigold and Mittal *et al.* (2010) in marigold.

4.2.7. Flowering Duration (days)

The data recorded on duration of flowering in China aster cv. Kamini as influenced by different treatments is presented in the table 2.7 and fig 2.7.

Significant differences were recorded on the flowering duration under different treatments. Maximum flowering duration (60.56 days) was recorded in the treatment T_9 (75% WSF + AMC + VC) followed by T_8 (59.30 days). Minimum duration of flowering was recorded in the treatment T_1 (50.06 days) followed by T_2 (52.25 days). Among the treatments T_5 and T_4 were on par.

It is evident from the results that the combined effect of organic manures, bio inoculants and inorganic nutrients has significantly influenced the nutrient uptake and nutrient translocation within the plant parts resulting in longer flower duration. This might be due to the continuous and large quantity of nutrients made available to the plants by plant growth promoting substances produced by bio inoculants, enzymatic activity of the vermicompost microbes as well as nutrient supply through water soluble fertilizers. These observations are in close conformity with the findings of Wasim *et al.* (2014) in tuberose, Narendra Chaudhary *et al.* (2013) in gladiolus, Gaurav *et al.* (2016) in African marigold and Neelima *et al.* (2013) in chrysanthemum.

4.2.8. Weight of 100 flowers (g)

The data recorded on weight of 100 flowers in China aster cv. Kamini as influenced by different treatments is presented in the table 2.8 and fig 2.8.

Table 2.7: Effect of integrated nutrient management treatments on flowering duration (days) of China aster CV. Kamini

Notation	Treatments	Flowering Duration (days)
T_1	50% WSF	50.06
T_2	75% WSF	52.25
T_3	100%WSF-Control	53.28
T_4	50%WSF+AMC	56.14
T_5	75%WSF+AMC	57.15
T_6	50% WSF+VC	53.84
T_7	75%WSF+VC	54.90
T_8	50%WSF+AMC+VC	59.30
T_9	75%WSF+AMC+VC	60.56
	SE(m) ±	**1.637**
	C.D. at 5%	**4.951**

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

Table 2.8: Effect of integrated nutrient management treatments on weight of 100 flowers (g) of China aster CV. Kamini.

Notation	Treatments	Weight of 100 flowers (g)
T_1	50% WSF	316.46
T_2	75% WSF	317.37
T_3	100%WSF-Control	319.66
T_4	50%WSF+AMC	329.43
T_5	75%WSF+AMC	331.39
T_6	50% WSF+VC	320.19
T_7	75%WSF+VC	326.62
T_8	50%WSF+AMC+VC	335.41
T_9	75%WSF+AMC+VC	338.54
	SE(m) ±	1.041
	C.D. at 5%	3.147

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

Data on weight of 100 flowers differed significantly due to different treatments. The maximum weight (338.54g) was recorded in the treatment T_9 (75% WSF + AMC +VC) followed by T_8 (335.41g). The minimum weight (316.46 g) was recorded in the treatment T_1 followed by T_2 (317.37 g). Among the treatments T_5 and T_4 were on par.

It is understood from the observations that there has been a significant uptake and translocation of photosynthates within the plants as influenced by the organic manure, water soluble fertilizers and bio inoculants. The higher nutrient uptake especially nitrogen and phosphorous are the major coinstituents of amino acids and carbohydrates and their utilization can result in more vegetative as well as reproductive growth which in turn might have increased the flower weight. These findings are in close conformity with Prashant Singh *et al*. (2015) in marigold, Pansuriya and Chauhan (2015) in gladiolus, Gaurav *et al*. (2016) in African marigold and Panchal *et al*. (2010) in annual white chrysanthemum.

4.2.9. Flower field life (days)

The data recorded on the field life of China aster cv. Kamini as influenced by different treatments is presented in the table 2.9 and fig 2.9.

It is evident from the data that flower field differed significantly due to different treatments. The highest flower field life (18.75 days) was recorded with the treatment T_9 (75% WSF + AMC + VC) followed by T_8 (17.64 days). The lowest flower field life (12.84 days) was recorded in the treatment T_1 (50% WSF) followed by T_2 (13.54 days). Among the treatments T_5 (75% WSF + AMC) and T_4 (50% WSF + AMC) were on par.

Higher flower field life may be due to the influence of plant growth promoting substances released by the bio inoculants in combination with the continuous supply of nitrogen, phosphorous and potassium through water soluble fertilizers and other micro and macronutrients through vermicompost resulting in better nutrient uptake and translocation of sugars and photosynthates to the flowers resulting longer field life. Similar results were reported by Neelima *et al.* (2013) in chrysanthemum and Chauhan *et al.* (2014) in marigold.

Table 2.9: Effect of integrated nutrient management treatments on flower field life (days) of China aster CV. Kamini.

Notation	Treatments	Flower field life (days)
T_1	50% WSF	12.84
T_2	75% WSF	13.54
T_3	100%WSF-Control	14.25
T_4	50%WSF+AMC	15.58
T_5	75%WSF+AMC	16.12
T_6	50% WSF+VC	14.62
T_7	75%WSF+VC	15.23
T_8	50%WSF+AMC+VC	17.64
T_9	75%WSF+AMC+VC	18.75
	SE(m) ± **C.D. at 5%**	**0.577** **1.746**

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

4.2.10. Flower weight per plot (kg)

The data recorded on flower weight per plot of China aster cv. Kamini is presented in the table 2.10 and fig 2.10.

Significant differences were observed on the flower weight per plot under different treatments. The treatment T_9 (75% WSF + AMC +VC) recorded highest flower weight per plot (4.92 kg) followed by the treatment T_8 (4.36 kg). The treatment T_1 recorded lowest flower weight per plot (2.21 kg) followed by T_2 (2.72 g). Among the treatments T_5 and T_4 were on par on flower weight per plot.

4.2.11. Flower yield per hectare

The data recorded on flower yield per hectare of China aster cv. Kamini is presented in the table 2.11 and fig 2.11.

Significant differences were observed on the flower yield per hectare under different treatments. The treatment T_9 (75% WSF + AMC +VC) recorded maximum flower yield per ha (18.80 t/ha) followed by the treatment T_8 (16.79 t/ha). The minimum flower yield was recorded in the treatment T_1 (9.16 t/ha) followed by T_2 (10.28 t/ha). Among the treatment T_5 (75% WSF + AMC) and T_4 (50% WSF + AMC) were on par.

The increase in flower production might be due to significant increase in growth parameters. Adequate supply of nitrogen to the plant resulted in proper development of photosynthetic system through water soluble fertilizers [Divya *et al.* (2017) and Kore *et al*. (2003)]. Further interpretation of data reveals that biofertilizers application might have influenced the flower yield per plant resulting in overall yield per hectare. Higher photosynthesis enhanced food accumulation, which might have resulted in better plant growth and subsequently higher number of flowers per plant and hence, more flower yield per hectare. These findings are in close conformity with Neelima *et al.* (2013) in chrysanthemum, Pansuriya and Chauhan (2015) in gladiolus, Prashant singh *et al.* (2015) in marigold.

Table 2.10: Effect of integrated nutrient management treatments on flower weight per plot (kg) of China aster CV. Kamini

Notation	Treatments	Flower weight per plot (kg)
T_1	50% WSF	2.21
T_2	75% WSF	2.72
T_3	100%WSF-Control	2.91
T_4	50%WSF+AMC	3.61
T_5	75%WSF+AMC	3.97
T_6	50% WSF+VC	3.20
T_7	75%WSF+VC	3.53
T_8	50%WSF+AMC+VC	4.36
T_9	75%WSF+AMC+VC	4.92
	SE(m) ±	0.286
	C.D. at 5%	0.864

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

Table 2.11: Effect of integrated nutrient management treatments on flower Yield per hectare (t/ha) of China aster CV. Kamini

Notation	Treatments	Flower yield (t/ha)
T_1	50% WSF	9.16
T_2	75% WSF	10.28
T_3	100%WSF-Control	11.36
T_4	50%WSF+AMC	13.62
T_5	75%WSF+AMC	14.81
T_6	50% WSF+VC	12.15
T_7	75%WSF+VC	13.60
T_8	50%WSF+AMC+VC	16.79
T_9	75%WSF+AMC+VC	18.80
	SE(m) ±	0.671
	C.D. at 5%	2.029

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

4.3. Studies on the effect of integrated nutrient management on Physiological and Biochemical parameters of China aster CV. Kamini

4.3.1 Chlorophyll (mg/g FW) at 50% flowering

The data recorded on the chlorophyll content of China aster cv. Kamini at 50% flowering is presented in the table 3.1and fig 3.1

Significant differences were observed on chlorophyll content under different treatments. Treatment T_9 (75% WSF + AMC +VC) recorded maximum leaf chlorophyll content (1.38 mg/g FW) followed by the treatment T_8 (1.33 mg/g FW) at 50% flowering. The lowest chlorophyll content was recorded in the treatment T_1 (1.05 mg/g FW) followed by T_2 (1.09 mg/g FW). Among the treatments T_5 (75% WSF + AMC) and T_4 (50% WSF + AMC) were on par on chlorophyll content.

These results attributed to the highest nutrient uptake especially nitrogen through water soluble fertilizers and vermicompost as well as the atmospheric nitrogen and phosphorous fixation by the nitrogen and phosphate solubilizing bacteria that resulted in more chlorophyll pigments being synthesized in the plants resulting in more photosynthesis. These reports are in close confirmation with the findings of Ali Salehi (2014) in calendula.

4.3.2 Leaf Nitrogen (% N, P & K) after harvest

The data recorded on the leaf nutrient content (NPK) at final harvest as influenced by different treatments is presented in the Table 3.2 and fig 3.2.

The data revealed that available nitrogen, phosphorous and potassium in leaves differed significantly under different treatments. The treatment T_9 (75% WSF + AMC + VC) was recorded highest N (4.32%), P (0.45%) and K (2.43%) content in leaves after harvest followed by the treatment T_8 [N (4.26%), P (0.43%) and K (2.42%)]. The lowest leaf nutrient content was recorded in the treatment T_1 (50% WSF) followed by T_2 (75% WSF). The results show that there has been significantly high nutrient uptake by the leaves due to the combined

Table 3.1: Effect of integrated nutrient management treatments on chlorophyll content (mg/g FW) at 50% flowering of China aster CV. Kamini

Notation	Treatments	Chlorophyll (mg/g FW)
T_1	50% WSF	1.05
T_2	75% WSF	1.09
T_3	100%WSF-Control	1.14
T_4	50%WSF+AMC	1.23
T_5	75%WSF+AMC	1.27
T_6	50% WSF+VC	1.14
T_7	75%WSF+VC	1.21
T_8	50%WSF+AMC+VC	1.33
T_9	75%WSF+AMC+VC	1.38
	SE(m) ± **C.D. at 5%**	**0.051** **0.153**

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

Table 3.2: Effect of integrated nutrient management treatments on leaf nutrient content (% NPK) after harvest of China aster CV. Kamini

Notation	Treatments	N (%)	P (%)	K (%)
T_1	50% WSF	3.58	0.23	2.14
T_2	75% WSF	3.66	0.23	2.16
T_3	100%WSF-Control	3.89	0.25	2.22
T_4	50%WSF+AMC	4.16	0.37	2.33
T_5	75%WSF+AMC	4.20	0.39	2.37
T_6	50% WSF+VC	3.96	0.28	2.26
T_7	75%WSF+VC	4.02	0.31	2.29
T_8	50%WSF+AMC+VC	4.26	0.43	2.42
T_9	75%WSF+AMC+VC	4.32	0.45	2.43
	SE(m) ±	**0.044**	**0.023**	**0.058**
	C.D. at 5%	**0.134**	**0.070**	**0.175**

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

effect of bio inoculants, vermicompost and water soluble fertilizers. The nitrogen and PSB have facilitated the nutrient uptake and atmospheric nitrogen fixation making it available to the plants. Moreover nutrient supply through fertigation and vermicompost also have resulted significant increase in leaf nutrient status. These observations are similar to the reports of Qasim *et al.* (2008) in rose, Divya *et al*. (2017) in marigold, Muthamizhselvi *et al.* (2006) in marigold, Chaitra (2006) in China aster and Kaplan *et al.* (2016) in chrysanthemum.

4.4. Studies on the effect of integrated nutrient management on Benefit Cost Ratio of China aster CV. Kamini

4.4.1 Benefit Cost Ratio

The data recorded on the Benefit cost ratio of China aster cv. Kamini as influenced by different treatments is presented in the table 4.1.

It is evident from the data that benefit cost ratio differed significantly under different treatments. The highest B:C ratio (2.23) was recorded in the treatment T_9 (75% WSF+ AMC + VC) followed by the treatment T_8 (2.01). The lowest B:C ratio (0.81) was recorded in the treatment T_1 followed by T_2 (0.93).

The results confirm that fertigation through water soluble fertilizers not only reduce the water requirement but also the excess requirement of fertilizers. Fertigation ensures optimum supply of nutrients to the plants reducing the fertilizer and irrigation cost Patil *et al*. (2010). Moreover the application of vermicompost ensures supply of macro and micronutrients as well as the enzymatic activity resulting in more photosynthates as well as the application of bio inoculants have ensured atmospheric nitrogen and phosphorous availability to the plants along with plant growth promoting substances. These combinations ensure higher flower yield hence the net returns per hectare Premkumar *et al*. (2016) in chrysanthemum and Kumari and Prasad (2017) in marigold.

Table 4.1: Effect of integrated nutrient management treatments on Benefit Cost Ratio of China aster CV. Kamini.

Notation	Treatments	Yield/ha (kg)	Gross returns in rupees	Total cost of cultivation in Rupees	Net Returns in Rupees	B:C
T_1	50% WSF	9,170	2,29,250	1,26,540	1,02,710	0.81
T_2	75% WSF	10,280	2,57,000	1,32,946	1,24,054	0.93
T_3	100% WSF	11,370	2,84,250	1,39,770	1,44,480	1.03
T_4	50% WSF + AMC	13,610	3,40,250	1,26,715	2,13,533	1.69
T_5	75% WSF + AMC	14,810	3,70,250	1,33,121	2,37,129	1.70
T_6	50% WSF + VC	12,150	3,03,750	1,39,040	1,64,710	1.18
T_7	75% WSF + VC	13,620	3,40,500	1,45,446	1,95,054	1.34
T_8	50% WSF + AMC + VC	16,793	4,19,285	1,39,215	2,80,070	2.01
T_9	75% WSF + AMC +VC	18,800	4,70,000	1,45,621	3,24,379	2.23

WSF: Water soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

EXPERIMENT - II

4.5 Post Harvest Vase Life Studies of China aster [*Callistephus chinensis* (L.) Nees] CV. Kamini

An experiment was conducted on post harvest application of sucrose 4% + $Al_2(SO4)_3$ @ 200ppm on vase life of China aster cv. Kamini in post graduate laboratory of college of horticulture, Rajendranagar, Hyderabad during the year 2018.

Consumers prefer those flowers that stay fresh for a long time. This can be achieved through proper post harvest handling which includes the usage of proper chemicals and vase solutions to maintain the water relations (Mayak 1979).

The results pertaining to the effect of sucrose 4% + $Al_2(SO4)_3$ at 200ppm on fresh weight, water uptake, flower diameter, transpirational loss of water, fresh weight change (FWC), TSS, electrolyte leakage, microbial count and vase life are presented in this chapter.

4.5.1. Fresh weight of the flower (g)

The data recorded on the fresh weight during the vase life of China aster cv. Kamini held in Sucrose 4% + $Al_2 (SO_4)_3$ at 200 ppm solution is presented in the table 5.1 and fig 5.1.

From the data it is evident that fresh weight of the China aster flowers significantly differed with treatments. Significant highest fresh weight (10.77g) was recorded in the flowers collected from 75% WSF + AMC+ VC (T_9) plot followed by the flowers collected from 50% WSF + AMC +VC (T_8) plot (10.41g). Significantly lowest fresh weight (5.99g) was recorded in control.

There were significant differences in the fresh weight during different days of vase life of China aster flowers. The fresh weight significantly decreased from 2nd day to 6th day at each successive interval of observation. Significantly highest fresh weight was recorded on 2^{nd} day (9.68g) whereas significantly lowest fresh weight was recorded on 6^{th} day (7.16g).

The interaction between treatment and days was also found significant. The flowers collected from 75% WSF+AMC+VC (T_9) plot recorded significantly highest fresh weight on 2^{nd} day (11.82g), 4^{th} day (10.62g) and 6^{th} day (9.88g) of experimentation followed by the flowers collected from 50% WSF + AMC + VC (T_8) plot on 2^{nd} day (11.45g), 4^{th} day (10.23g) and 6^{th} day (9.57g). Control recorded minimum fresh weight on 2^{nd} day (7.51g), 4^{th} day (5.93g) and 6^{th} day (4.54g) of experimentation. The fresh weight of all other treatments on all the dates of observation was found intermediate.

It is evident from the data that the flowers collected from 75% WSF + AMC+VC (T_9) plot recorded highest fresh weight from day 2 to day 6 of the experiment. This might be attributed to the physiological and biochemical efficiency of the plant such as improved rate of photosynthesis due to more vegetative growth and high chlorophyll content which in turn controlled the photorespiration and transpiration thereby increasing the vase life due to, plant growth promoting substances released by AMC and continuous supply of inorganic fertilizers through fertigation. These findings are in confirmation with Harish *et al*. (2015) in gladiolus, Chauhan *et al*. (2014) in gerbera.

Further increase in fresh weight might be due to the synergistic effect of sucrose 4% + Al_2 $(SO_4)_3$ at 200 ppm solution. Increase in water uptake by sucrose due to translocated sugars accumulated in flowers, increase in the osmotic potential and improvement in the ability of flowers to absorb water and $Al_2(SO_4)_3$, which decreases the pH of petals, stabilize the anthocyanin and acidify the holding solution, thus reduces the bacterial growth. Reduced microbial growth triggers more water uptake. These results are in confirmation with the findings of Kumar *et al*. (2012) in cut tulip, Liao *et al*. (2001) in cut Lisianthus, Davood (2014) in cut carnation, Varu and Barad (2008) in tuberose and Khan *et al*. (2007) in tulip.

Table 5.1: Effect of post harvest application of 4% sucrose + $Al_2(SO4)_3$ @ 200 ppm on fresh weight of the flower (g) during vase life period of China aster CV. Kamini

Notation	Treatments	Days			
		2^{nd}	4^{th}	6^{th}	Mean
T_1	50% WSF	7.83	6.82	4.87	6.50^{i}
T_2	75% WSF	8.44	7.25	5.68	7.12^{h}
T_3	100%WSF-Control	8.73	7.46	6.22	7.47^{g}
T_4	50%WSF+AMC	10.46	9.44	7.84	9.24^{d}
T_5	75%WSF+AMC	10.87	9.71	8.93	9.83^{c}
T_6	50% WSF+VC	9.58	8.84	6.45	8.29^{f}
T_7	75%WSF+VC	10.12	9.21	7.69	9.00^{e}
T_8	50%WSF+AMC+VC	11.45	10.23	9.57	10.41^{b}
T_9	75%WSF+AMC+VC	11.82	10.62	9.88	10.77^{a}
T_{10}	Control	7.51	5.93	4.54	5.99^{j}
	Mean	9.68^{a}	8.55^{b}	7.16^{c}	-

Factors	SE(m) ±	C.D at 5%
Treatments (T)	0.033	0.095
Days (D)	0.018	0.052
(T X D)	0.058	0.164

WSF: Water Soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

4.5.2 Flower Diameter (cm)

The data recorded on the flower diameter during the vase life period of China aster cv. Kamini held in Sucrose 4% + $Al_2 (SO_4)_3$ at 200 ppm solution is presented in the table 5.2 and fig 5.2.

There was a significant difference in the flower diameter due to different treatments during vase life period of China aster flowers kept in the solution containing 4% sucrose + $Al_2(SO_4)_3$. The flowers collected from 75% WSF + AMC +VC (T_9) plot recorded significantly highest flower diameter (6.00 cm) followed by the flowers collected from 50% WSF + AMC +VC (T_8) plot (5.88 cm). Significantly minimum flower diameter was recorded in control (3.98 cm).

There was significant difference in flower diameter during different days of vase life period of China aster cv. Kamini. The flower diameter significantly decreased from 2nd day to 6th day at each successive interval of observations. Significantly highest flower diameter was recorded on 2nd day (5.29 cm) whereas significantly lowest flower diameter was recorded on 6th day (4.26 cm) of experimentation.

The diameter of the flowers changed significantly with respect to different days and treatment interaction. On 2nd day, there was an increase in diameter recorded in all the treatments. Significantly highest diameter was recorded in the flowers collected from 75% WSF + AMC +VC (T_9) plot on 0th day (5.94 cm), 2nd (6.18 cm), 4th (6.11 cm) and 6th day (5.79 cm) followed by the treatment T_8 flowers collected from 50% + WSF + AMC +VC plot on 0th day (5.89 cm), 2nd (6.07 cm), on 4th day (5.93 cm) and 6th day (5.66 cm). Control was recorded with significantly lowest flower diameter on 0th day (4.52 cm), 2nd day (4.55 cm), 4th day (3.75 cm) and 6th day (3.12 cm) of experimentation.

It is evident from the results that the flowers collected from 75%WSF + AMC +VC (T_9) recorded maximum flower diameter during the entire vase life

Table 5.2: Effect of post harvest application of 4% sucrose + $Al_2(SO4)_3$ @ 200 ppm on flower diameter (cm) during vase life period of China aster CV. Kamini

Notation	Treatments	Days				
		0^{th}	**2^{nd}**	**4^{th}**	**6^{th}**	**Mean**
T_1	50% WSF	4.62	4.68	3.88	3.23	4.10^{i}
T_2	75% WSF	4.76	4.81	3.95	3.41	4.23^{h}
T_3	100%WSF-Control	4.88	4.91	4.12	3.55	4.36^{g}
T_4	50%WSF+AMC	5.42	5.49	4.98	4.52	5.10^{d}
T_5	75%WSF+AMC	5.67	5.72	5.36	5.09	5.46^{c}
T_6	50% WSF+VC	5.18	5.22	4.34	4.21	4.73^{f}
T_7	75%WSF+VC	5.27	5.31	4.73	4.32	4.76^{e}
T_8	50%WSF+AMC+VC	5.89	6.07	5.93	5.66	5.88^{b}
T_9	75%WSF+AMC+VC	5.94	6.18	6.11	5.79	6.00^{a}
T_{10}	Control	4.52	4.55	3.75	3.12	3.98^{j}
	Mean	5.21^{b}	5.29^{a}	4.71^{c}	4.26^{d}	

Factors	**S.Em ±**	**C.D at 5%**
Treatments (T)	0.029	0.081
Days(D)	0.018	0.051
(T X D)	0.057	0.163

WSF: Water Soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

period. This must be attributed to the better water uptake and translocation of sugars as influenced by the growth promoting substances in AMC and vermicompost as well as the constant inorganic nutrient supply through fertigation that triggered better vegetative and physiological efficiency of the plants thereby improving the flower quality. These findings are in confirmation with Harish *et al.* (2015) in gladiolus, Chauhan *et al.* (2014) in gerbera and Rahul Singh *et al.* (2014) in gladiolus.

The synergistic effect of sucrose 4% + $Al_2 (SO_4)_3$ at 200 ppm solution might have improved the water retention of the flowers contributing to more water uptake resulting in tissue turgidity and hence more flower diamater. Sucrose is the main carbohydrate source which decreases the water potential and thus improves the water uptake and flower petal turgidity. These results are in confirmation with the findings of Kumar *et* al. (2012) in cut tulip, Liao *et al.* (2001) in cut Lisianthus, Davood (2014) in cut carnation, Varu and Barad (2008) in tuberose and Namita *et al.* (2006) in cut gladiolus spikes and Khan *et al.* (2007) in cut tulip.

4.5.3 Water Uptake (WU) of the flower (g/f)

The data recorded on the water uptake (WU) of the China aster flower cv. Kamini held in sucrose 4% + $Al_2 (SO_4)_3$ at 200 ppm is presented in the table 5.3 and Fig 5.3.

The water uptake of China aster flowers significantly differed with treatments. Significant water uptake (6.78 g/f) was recorded in the treatment T_9 flowers collected from the plot that was supplied with 75% WSF + AMC +VC followed by the treatment T_8 flowers collected from the plot supplied with 50% WSF + AMC + VC (6.59 g/f).Control was recorded with the lowest water uptake (3.62 g/f) whereas all other treatments recorded intermediate values.

There was significant difference in water uptake during different days of vase life period. The water uptake significantly decreased from 2nd day to 6th day at each successive interval of observations. Significantly highest water uptake

Table 5.3: Effect of post harvest application of 4% sucrose + $Al_2(SO4)_3$ @ 200 ppm on water uptake (g/f) during vase life period of China aster CV. Kamini

Notation	Treatments	Days			
		2nd	4th	6th	Mean
T_1	50% WSF	4.63	3.95	2.91	3.83[i]
T_2	75% WSF	5.47	4.76	3.42	4.54[h]
T_3	100%WSF-Control	5.55	4.88	3.76	4.73[g]
T_4	50%WSF+AMC	6.44	5.58	4.68	5.56[d]
T_5	75%WSF+AMC	6.65	5.73	4.77	5.71[c]
T_6	50% WSF+VC	5.65	4.94	3.88	4.82[f]
T_7	75%WSF+VC	6.26	5.53	4.25	5.35[e]
T_8	50%WSF+AMC+VC	7.12	6.75	5.92	6.59[b]
T_9	75%WSF+AMC+VC	7.33	6.88	6.13	6.78[a]
T_{10}	Control	4.33	3.78	2.77	3.62[j]
	Mean	5.94[a]	5.27[b]	4.25[c]	

Factors	SE(m) ±	C.D at 5%
Treatments (T)	0.050	0.143
Days (D)	0.027	0.078
(TXD)	0.088	0.249

WSF: Water Soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

was recorded on 2^{nd} day (5.94 g/f) whereas significantly lowest water uptake was recorded on 6th day (4.25 g/f).

The interaction between days and treatments on water uptake was also found significant. The flowers collected from the treatment T_9 recorded highest water uptake on 2^{nd} day (7.33 g/f), 4^{th} day (6.88 g/f) and 6^{th} day (6.13 g/f) followed by T_8 on 2^{nd} day (7.12 g/f), 4^{th} day (6.75 g/f) and 6^{th} day (5.92 g/f). Control recorded lowest water uptake on 2^{nd} day (4.33 g/f), 4^{th} day (3.78 g/f) and 6^{th} day (2.77 g/f).

It is evident from the data that the flowers collected from the treatment T_9 (75% WSF + AMC + VC) plot recorded highest water uptake from 2^{nd} day to 6^{th} day of experiment followed by the treatment T_8.This might be attributed to the physiological/ biochemical efficiency of the plant such as improved rate of photosynthesis due to more vegetative growth and high chlorophyll content which in turn controlled the photorespiration and transpiration thereby increasing the vase life as influenced by the effect of vermicompost, plant growth promoting substances released by AMC and continuous supply of inorganic fertilizers through fertigation. These findings are in confirmation with Harish *et al.* (2015) in gladiolus, Chauhan *et al.* (2014) in gerbera.

Improved water uptake may be due to the synergistic effect of sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm solution. Increase in water uptake by sucrose due to translocated sugars accumulated in flowers, increase in the osmotic potential and improvement in the ability of flowers to absorb water and $Al_2(SO_4)_3$, which decreases the p^H of petals, stabilize the anthocyanin and acidify the holding solution, thus reduces the bacterial growth. It also suppresses the microbial growth there by increasing the water uptake. Similar results were also reported by Anjupal *et al.* (2003) in gladiolus, Liao *et al*.(2001) in cut Lisianthus, Davood (2014) in cut carnation, Suresha *et al*. (2009) in chrysanthemum, Varu and Barad (2008) in tuberose and Khan *et al.* (2007) in tulip.

4.5.4 Transpirational loss of water (TLW) (g/f)

The data recorded on the transpirational loss of water during the vase life of China aster cv. Kamini held in Sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm solution is presented in the table 5.4 and fig 5.4.

There were significant differences among the treatments on transpirational loss of water in China aster flowers during the vase life period. Significantly highest (5.74 g/f) transpirational loss of water was recorded in the flowers collected from the treatment T_9 (75% WSF + AMC +VC) followed by T_8 (5.64 g/f). Control recorded significantly lowest (3.06g/f) transpirational loss of water.

There was significant difference in transpirational loss of water during different days of vase life period. The TLW significantly decreased from 2nd day (5.17 g/f) to 6th day (3.89 g/f) at each successive interval of observations.

The interaction between days and treatments on transpirational loss of water was also found significant. The flowers collected from the treatment T_9 recorded highest transpirational loss of water on 2nd day (6.45 g/f), 4th day (5.57 g/f) and 6th day (5.22 g/f) followed by T_8 on 2nd day (6.33 g/f), 4th day (5.48 g/f) and 6th day (5.11 g/f). Control recorded lowest water uptake on 2nd day (3.94 g/f), 4th day (2.72 g/f) and 6th day (2.53 g/f) of experimentation. The TLW with all other treatments on all the dates of observation was found intermediate.

From the data it is evident that the treatment T_9 (75% WSF + AMC +VC) recorded highest transpirational loss of water from 2nd day to 6th day of experimentation. This might be attributed to the physiological/ biochemical efficiency of the plant such as improved rate of photosynthesis due to more vegetative growth and high chlorophyll content as influenced by the effect of vermicompost, plant growth promoting substances released by AMC and continuous supply of inorganic fertilizers through fertigation which in turn controlled the photorespiration and transpiration of flowers and thereby increasing the vase life. These findings are in confirmation with Harish *et al.* (2015) in gladiolus, Chauhan *et al.* (2014) in gerbera.

Table 5.4: Effect of post harvest application of 4% sucrose + $Al_2(SO4)_3$ @ 200 ppm on Transpirational loss of water (g/f) during vase life period of China aster CV. Kamini

Notation	Treatments	Days			
		2^{nd}	4^{th}	6^{th}	Mean
T_1	50% WSF	4.33	3.35	3.13	3.60^i
T_2	75% WSF	4.57	3.48	3.19	3.74^h
T_3	100%WSF-Control	4.68	3.54	3.22	3.81^g
T_4	50%WSF+AMC	5.54	4.76	4.41	4.90^d
T_5	75%WSF+AMC	5.76	4.95	4.52	5.07^c
T_6	50% WSF+VC	4.74	3.68	3.32	3.91^f
T_7	75%WSF+VC	5.45	4.66	4.25	4.78^e
T_8	50%WSF+AMC+VC	6.33	5.48	5.11	5.64^b
T_9	75%WSF+AMC+VC	6.45	5.57	5.22	5.74^a
T_{10}	Control	3.94	2.72	2.53	3.06^j
	Mean	5.17^a	4.21^b	3.89^c	

Factors	S.Em ±	C.D at 5%
Treatments (T)	0.033	0.095
Days (D)	0.018	0.052
(T X D)	0.058	0.164

WSF: Water Soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

Varu and Barad (2008) reported that $Al_2(SO_4)_3$ and its combination with sucrose might have reduced the transpirational loss of water by inducing the stomatal closure in tuberose. Krishnappa *et al.* (2004) in cut carnation and Barman and Rajni (2006) in cut rose observed that normal rate of transpiration was essential for extending the vase life of cut flowers any processes that hinder the normal transpiration will decrease the keeping quality of flowers.

4.5.5 Fresh Weight Change (%)

The data recorded on the fresh weight change during the vase life of China aster cv. Kamini held in Sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm solution is presented in the table 5.5 and fig 5.5.

From the data it is evident that fresh weight change of the China aster flowers significantly differed with treatments. Significant highest fresh weight change (98.39) was recorded in the treatment T_9 (75% WSF + AMC +VC) followed by T_8 (93.76). Control was recorded with significantly lowest fresh weight change (63.69).

There were significant differences in the fresh weight change during different days of vase life of China aster flowers. The FWC significantly decreased from 2nd day (95.40) to 6th day (68.27) at each successive level of observation.

The interaction between treatment and days was also found significant. The treatment T_9 recorded maximum fresh weight change on 2nd day (108.52) 4th day (97.53) and 6th day (89.12) of experimentation followed by T_8 on 2nd day (105.48), 4th day (91.17) and 6th day (84.64). Control recorded minimum fresh weight change on 2nd day (81.24), 4th day (61.23) and 6th day (48.61) of experimentation. The fresh weight change of all other treatments on all the dates of observation was found intermediate.

It is evident from the data that the flowers collected from the treatment T_9 plot (75% WSF + AMC + VC) recorded highest fresh weight change from 2nd day to 6th day of experiment followed by flowers collected from plot T_8 supplied with 75% WSF + AMC + VC. This might be attributed to the

Table 5.5: Effect of post harvest application of 4% sucrose + $Al_2 (SO4)_3$ @ 200 ppm on Fresh weight change (% of initial weight) during vase life period of China aster CV. Kamini

Notation	Treatments	Days			
		2nd	4th	6th	Mean
T_1	50% WSF	84.38	64.34	54.43	67.71[i]
T_2	75% WSF	86.54	67.48	58.74	70.92[h]
T_3	100%WSF-Control	89.63	74.26	62.15	75.34[g]
T_4	50%WSF+AMC	98.21	80.26	74.36	84.27[d]
T_5	75%WSF+AMC	102.30	82.94	79.44	88.22[c]
T_6	50% WSF+VC	91.35	76.35	63.52	77.07[f]
T_7	75%WSF+VC	95.44	79.28	67.76	80.82[e]
T_8	50%WSF+AMC+VC	105.48	91.17	84.64	93.76[b]
T_9	75%WSF+AMC+VC	108.52	97.53	89.12	98.39[a]
T_{10}	Control	81.24	61.23	48.61	63.69[j]
	Mean	95.40[a]	76.48[b]	68.27[c]	

Factors	**SE(m) ±**	**C.D at 5%**
Treatments (T)	0.327	0.927
Days (D)	0.179	0.508
(T X D)	0.567	1.606

WSF: Water Soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

physiological/ biochemical efficiency of the plant such as improved rate of photosynthesis due to more vegetative growth and high chlorophyll content which in turn controlled the photorespiration and transpiration thereby increasing the vase life as influenced by the effect of vermicompost, plant growth promoting substances released by AMC and continuous supply of inorganic fertilizers through fertigation. These findings are in confirmation with Harish *et al.* (2015) in gladiolus and Chauhan *et al*. (2014) in gerbera.

The synergistic effect of sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm solution might have improved the water retention of the flowers contributing to the fresh weight change. Sucrose is the main carbohydrate source which decreases the water potential and thus improved the water uptake and fresh weight of the spike. These results are in confirmation with the findings of Kumar *et al.* (2012) in cut tulip, Liao *et al.* (2001) in cut Lisianthus, Davood (2014) in cut carnation, Varu and Barad (2008) in tuberose and Namita *et al.* (2006) in cut gladiolus spikes.

4.5.6 Total Soluble Solids of petals (^{0} Brix)

The data recorded on the TSS during the vase life of China aster cv. Kamini held in Sucrose 4% + $Al_2 (SO_4)_3$ at 200 ppm solution is presented in the table 5.6 and fig 5.6

From the data it is evident that the TSS of the China aster flowers significantly differed with treatments. Significant highest TSS (6.20 ^{0} Brix) was recorded in the flowers collected from the plot supplied with 75% WSF + AMC +VC (T_9) followed by the flowers collected from the 50% WSF + AMC +VC (T_8) treated plot (6.05 ^{0}Brix). Significantly lowest TSS (5.14 ^{0} Brix) was recorded in control.

There were significant differences in the TSS during different days of vase life of China aster flowers. On day 0 there was no significant recorded on TSS which subsequently increased on day 2. From day 2 to day 6 TSS decreased significantly at each successive level of observation. Significantly highest TSS was recorded on the 2nd day (6.62^0 Brix). Significantly lowest TSS was recorded on 6th day (4.92^0 Brix).

The interaction between treatment and days on TSS was also found significant. On day 0 there was no significant difference of TSS due to treatments whereas on 2^{nd} day there was a significant increase in TSS of the petals. The flowers collected from the plot supplied with 75% WSF + AMC +VC (T_9) recorded significantly highest TSS on 0^{th} day (5.17 ^{0}Brix), 2^{nd} day (7.32^0 Brix), 4th day (6.71^0 Brix) and 6th day (5.62^0 Brix) of experimentation followed by the flowers collected from the plot supplied with 50% WSF + AMC +VC (T_8) on 0^{th} day (5.16 ^{0}Brix), 2^{nd} day (7.11^0 Brix), 4^{th} day (6.51^0 Brix) and 6^{th} day (5.43 ^{0}Brix). Control recorded significantly lowest TSS on 0^{th} day (5.13 ^{0}Brix), 2^{nd} day (6.16 ^{0} Brix), 4^{th} day (5.19 ^{0}Brix) and 6^{th} day (4.11 ^{0} Brix) of experimentation. The TSS of all other treatments on all the dates of observation was found intermediate.

The data indicates that the flowers collected from the plot supplied with 75% WSF + AMC+ VC (T_9) kept in 4% sucrose + 200 ppm Al_2 $(SO_4)_3$ recorded significantly highest TSS. This might be attributed to the improved physiological efficiency of the plants resulting in better translocation of sugars and photosynthates in petals triggering more water uptake and increase in turgidity of the tissues as influenced by the plant growth promoting substances released by AMC and vermicompost and constant inorganic nutrient supply through fertigation. These findings are in confirmation with the reports of Harish *et al.* (2015) in gladiolus and Chauhan *et al.* (2014) in gerbera.

Increased TSS may be due to the optimum supply of carbohydrate in the form of sucrose and Al_2 $(SO_4)_3$ that might have helped in the optimum uptake and translocation of sugars within petals and stalk. The decrease in TSS in the later stages may be due to the increased respiration and transpirational rate resulting in the total consumption of sugars. Similar results were also observed in Anjupal *et al*. (2003) in gladiolus, Varu and Barad (2008) in tuberose, Namita *et al*. (2006) in gladiolus, Davood (2014) in cut carnation and Kumar *et al*. (2012) in cut tulip.

Table 5.6: Effect of post harvest application of 4% sucrose + $Al_2(SO4)_3$ @ 200 ppm on TSS (^{0}Brix) during vase life period of China aster CV. Kamini

Notation	Treatments	Days				
		0th	**2nd**	**4th**	**6th**	**Mean**
T_1	50% WSF	5.13	6.18	5.20	4.27	5.19^i
T_2	75% WSF	5.13	6.20	5.35	4.48	5.29^h
T_3	100%WSF-Control	5.14	6.38	5.51	4.64	5.42^g
T_4	50%WSF+AMC	5.14	6.73	5.81	4.92	5.65^d
T_5	75%WSF+AMC	5.14	6.82	5.94	5.11	5.75^c
T_6	50% WSF+VC	5.13	6.47	5.64	4.83	5.51^f
T_7	75%WSF+VC	5.13	6.63	5.73	4.87	5.59^e
T_8	50%WSF+AMC+VC	5.16	7.11	6.51	5.43	6.05^b
T_9	75%WSF+AMC+VC	5.17	7.32	6.71	5.62	6.20^a
T_{10}	Control	5.13	6.16	5.19	4.11	5.14^j
	Mean	5.14^c	6.62^a	5.78^b	4.92^d	

Factors	**SE(m)±**	**C.D at 5%**
Treatments (T)	0.021	0.059
Days (D)	0.013	0.037
(TXD)	0.042	0.119

WSF: Water Soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

4.5.7 Electrolyte leakage (%)

The data recorded on the electrolyte leakage (EL) during the vase life period of China aster cv. Kamini held in Sucrose 4% + $Al_2 (SO_4)_3$ at 200 ppm solution is presented in the table 5.7 and fig 5.7

There were significant differences among the treatments in the electrolyte leakage (EL) of China aster on different days of vase life period. Significant lowest electrolyte leakage (40.16%) was recorded in flowers that are collected from the plot supplied with 75% WSF + AMC + VC (T_9) followed by the flowers collected from the T_8 plot supplied with 50% WSF + AMC + VC (41.87 %). Control recorded significantly highest electrolyte leakage (65.18 %).

There were significant differences in EL during different days of vase life period of China aster cv. Kamini. The EL significantly increased from day 0 (27.77 %) to day 6 (87.68 %) at each successive interval of observation.

The interaction between days and treatments on EL was found significant. On day 0 there were no significant differences among all the treatments. The treatment T_9 flowers collected from the plot supplied with 75% WSF + AMC +VC recorded lowest electrolyte leakage on day 0 (21.36%), day 2 (32.36%), day 4 (42.53%) and day 6 (64.41%) followed by the treatment T_8 flowers collected from the plot supplied with 50% WSF + AMC+ VC on day 0 (23.16%), day 2 (34.53%), day 4 (44.35%) and day 6 (65.46%) of experimentation. Control recorded significantly highest electrolyte leakage on 0^{th} day (34.56%), 2^{nd} day (58.72%), 4^{th} day (78.31%) and 6^{th} day (89.16%) of experimentation.

Reduced EL was recorded with the flowers collected from the plot supplied with 75% WSF + AMC + VC (T_9). This could be due to the improved water status in the floral tissue leading to better membrane integrity. Flowers collected from the treatment T_1 supplied with 50% WSF recorded significantly highest EL, which might be due to the disturbed water relations in the floral tissues. The flowers held in control (distilled water) might have produced an ethylene burst with the onset of natural wilting that might have effected many of

Table 5.7: Effect of post harvest application of 4% sucrose + $Al_2(SO4)_3$ @ 200 ppm on electrolyte leakage (%) during vase life period of China aster CV. Kamini

Notation	Treatments	Days				
		0	2nd	4th	6th	Mean
T_1	50% WSF	32.43	53.41	77.42	86.21	62.36[i]
T_2	75% WSF	31.53	48.83	67.22	85.64	58.30[h]
T_3	100%WSF-Control	30.43	47.62	66.33	79.36	55.93[g]
T_4	50%WSF+AMC	25.77	38.36	55.37	73.43	48.23[d]
T_5	75%WSF+AMC	24.60	37.45	47.15	67.31	44.12[c]
T_6	50% WSF+VC	27.50	45.56	64.82	76.33	53.55[f]
T_7	75%WSF+VC	26.43	44.47	58.26	75.42	51.14[e]
T_8	50%WSF+AMC+VC	23.16	34.53	44.35	65.46	41.87[b]
T_9	75%WSF+AMC+VC	21.36	32.36	42.53	64.41	40.16[a]
T_{10}	Control	34.56	58.72	78.31	89.16	65.18[j]
	Mean	27.77[a]	44.13[b]	60.17[c]	87.68[d]	

Factors	S.Em ±	C.D at 5%
Treatment (T)	0.298	0.840
Days (D)	0.188	0.531
(T X D)	0.597	1.682

WSF: Water Soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

the physical and physiological processes in the flower tissues thereby leading to a membrane disintegration and maximum leakage of electrolytes.

The synergistic effect of sucrose and $Al_2\ (SO_4)_3$ also contributed to reduced electrolyte leakage. Similar results were also observed by Bhaskar *et al*. (2000) in tuberose and Prashanth (2006) in cut gerbera cv .Yanara.

4.5.8 Microbial Count

The data recorded on the microbial count during the vase life period of China aster cv Kamini kept in sucrose 4% + $Al_2(SO_4)_3$ at 200 ppm is presented in the table 5.8 and fig 5.8.

The interaction between days and treatments on microbial count was found significant. On day 0 there were no significant differences among all the treatments. On day 0 (2.23 X 10^3 cfu/ml) and on day 15 (9.71 X 10^3 cfu/ml) was recorded in the flowers from treatment T_9 plot kept in 4% Sucrose + 200 ppm $Al_2(SO_4)_3$ followed by the treatment T_8 (2.34 X 10^3 cfu/ml) on day 0 and day 15 (9.25 X 10^3 cfu/ml) during the experimentation. Significantly highest microbial population was recorded in control on day 0 (3.52 X 10^3 cfu/ml) and day 15 (12.79 X 10^3 cfu/ml) during the experimentation.

The results confirm that the chemical solution 4% sucrose + 200ppm aluminium sulphate prevents the microbes from clogging the xylem vessels and extends the vase life [Davood (2014)]. Moreover the influence of INM treatments has improved the flower quality that results in better nutrient uptake and vegetative growth [Harish *et al.* (2015) in gladiolus].

4.5.9 Vase life

The data recorded on vase life (days) during the vase life period of China aster flowers cv. Kamini held in sucrose 4% + $Al_2\ (SO_4)_3$ at 200 ppm is presented in the table 5.9 and fig 5.9.

Table 5.8: Effect of post harvest application of 4% sucrose + $Al_2(SO4)_3$ @ 200 ppm on Microbial count (cfu/ml) during vase life period of china aster CV. Kamini

Notation	Treatments	Days	
		0	15
T_1	50% WSF	$3.48 X 10^{3 i}$	$12.55 X 10^{6 i}$
T_2	75% WSF	$3.41 X 10^{3 h}$	$12.23 X 10^{6 h}$
T_3	100%WSF-Control	$3.27 X 10^{3 g}$	$11.84 X 10^{6 g}$
T_4	50%WSF+AMC	$2.78 X 10^{3 d}$	$10.81 X 10^{6 d}$
T_5	75%WSF+AMC	$2.54 X 10^{3 c}$	$10.42 X 10^{6 c}$
T_6	50% WSF+VC	$3.25 X 10^{3 f}$	$11.45 X 10^{6 f}$
T_7	75%WSF+VC	$3.12 X 10^{3 e}$	$11.23 X 10^{6 e}$
T_8	50%WSF+AMC+VC	$2.34 X 10^{3 b}$	$9.25 X 10^{6 b}$
T_9	75%WSF+AMC+VC	$2.23 X 10^{3 a}$	$9.17 X 10^{6 a}$
T_{10}	Control	$3.52 X 10^{3 j}$	$12.79 X 10^{6 j}$
	Mean	$2.994 X 10^3$	$11.18 X 10^6$
	S.E (m) ±	0.080	0.082
	C.D. at 5%	0.167	0.172

WSF: Water Soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

The vase life period of China aster cv. Kamini differed significantly with flowers collected from different treatments. Among the treatments, flowers collected from the treatment T_9 (75% WSF + AMC +VC) recorded significantly longest vase life (9.11days) followed by T_8 (8.76 days).The treatment T_5 was recorded on par. Control recorded significantly lowest vase life (7.36 days).

It is evident from the data the flowers collected from T_9 (75% WSF + AMC +VC) kept in 4% sucrose + $Al_2(SO_4)_3$ at 200 ppm recorded maximum vase life. This might be due to the increased water uptake, reduced electrolyte leakage and microbial count and increased fresh weight that finally increased the vase life. This might be attributed to the improved physiological efficiency of the plants resulting in better translocation of sugars and photosynthates in petals triggering more water uptake and increase in turgidity of the tissues as influenced by the plant growth promoting substances released by AMC and vermicompost and constant inorganic nutrient supply through fertigation. These findings are in confirmation with the reports of Harish *et al*. (2015) in gladiolus and Chauhan *et al*. (2014) in gerbera.

Increasing vase life is the key issue in post harvest management of cut flowers. Increased vase life may be due to the optimum supply of carbohydrate in the form of sucrose and $Al_2(SO_4)_3$ that reduced the ethylene biosynthesis which delays the flower senescence and also reduction in transpiration and increased water uptake might have added to the freshness and duration. Similar results were also observed in Anjupal *et al.* (2003) in gladiolus, Varu and Barad (2008) in tuberose, Namita *et al.* (2006) in gladiolus, Davood (2014) in cut carnation and Kumar *et al.* (2012) in cut tulip.

Table 5.9: Effect of post harvest application of 4% sucrose + $Al_2 (SO4)_3$ @ 200 ppm on vase life (days) of China aster CV. Kamini

Notation	**Treatments**	**Vase Life (days)**
T_1	50% WSF	7.44^{i}
T_2	75% WSF	7.76^{h}
T_3	100%WSF-Control	7.91^{g}
T_4	50%WSF+AMC	8.23^{d}
T_5	75%WSF+AMC	8.41^{c}
T_6	50% WSF+VC	8.08^{f}
T_7	75%WSF+VC	8.16^{e}
T_8	50%WSF+AMC+VC	8.76^{b}
T_9	75%WSF+AMC+VC	9.11^{a}
T_{10}	Control	7.36^{j}
	S.E(m) ±	**0.231**
	C.D at 5%	**0.687**

WSF: Water Soluble Fertilizers

AMC: Arka Microbial Consortium

VC: Vermicompost

T_9 - 75% WSF + AMC + VC

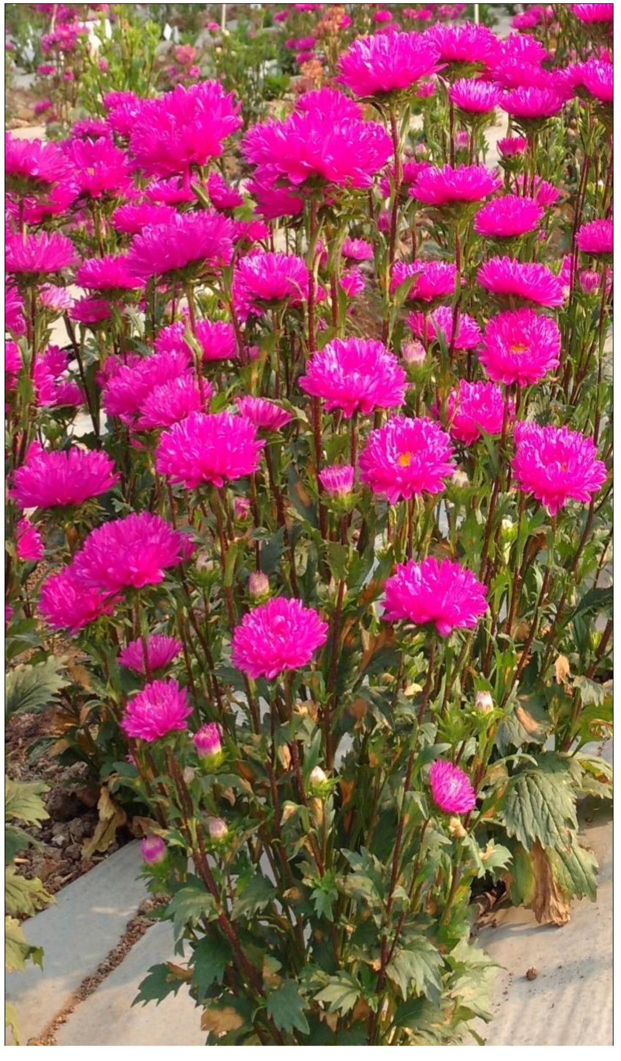
T_8 - 50% WSF + AMC + VC

T_1 – 50% WSF

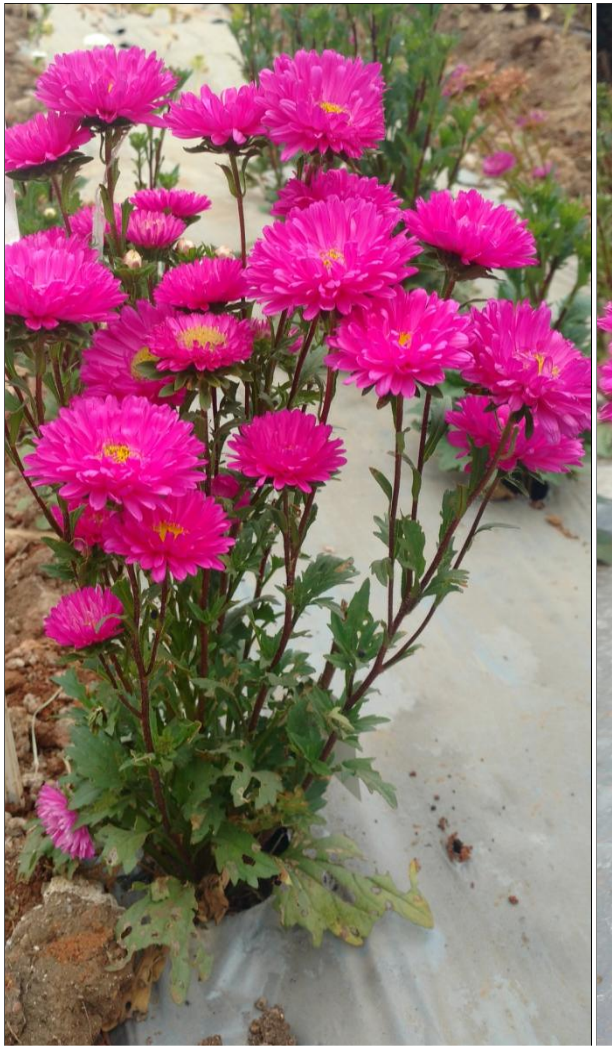
Plate 2: Effect of integrated nutrient management on plant spread (cm) of China aster CV. Kamini at 50% flowering

Plate 1: General view of the Experimental plot

`



T_9 - 75% WSF + AMC + VC



T_8 - 50% WSF + AMC + VC

T_1 – 50% WSF

Plate 4: Effect of integrated nutrient management on number of flowers per plant of China aster CV. Kamini

Plate 6: View of vase life of China aster CV. Kamini

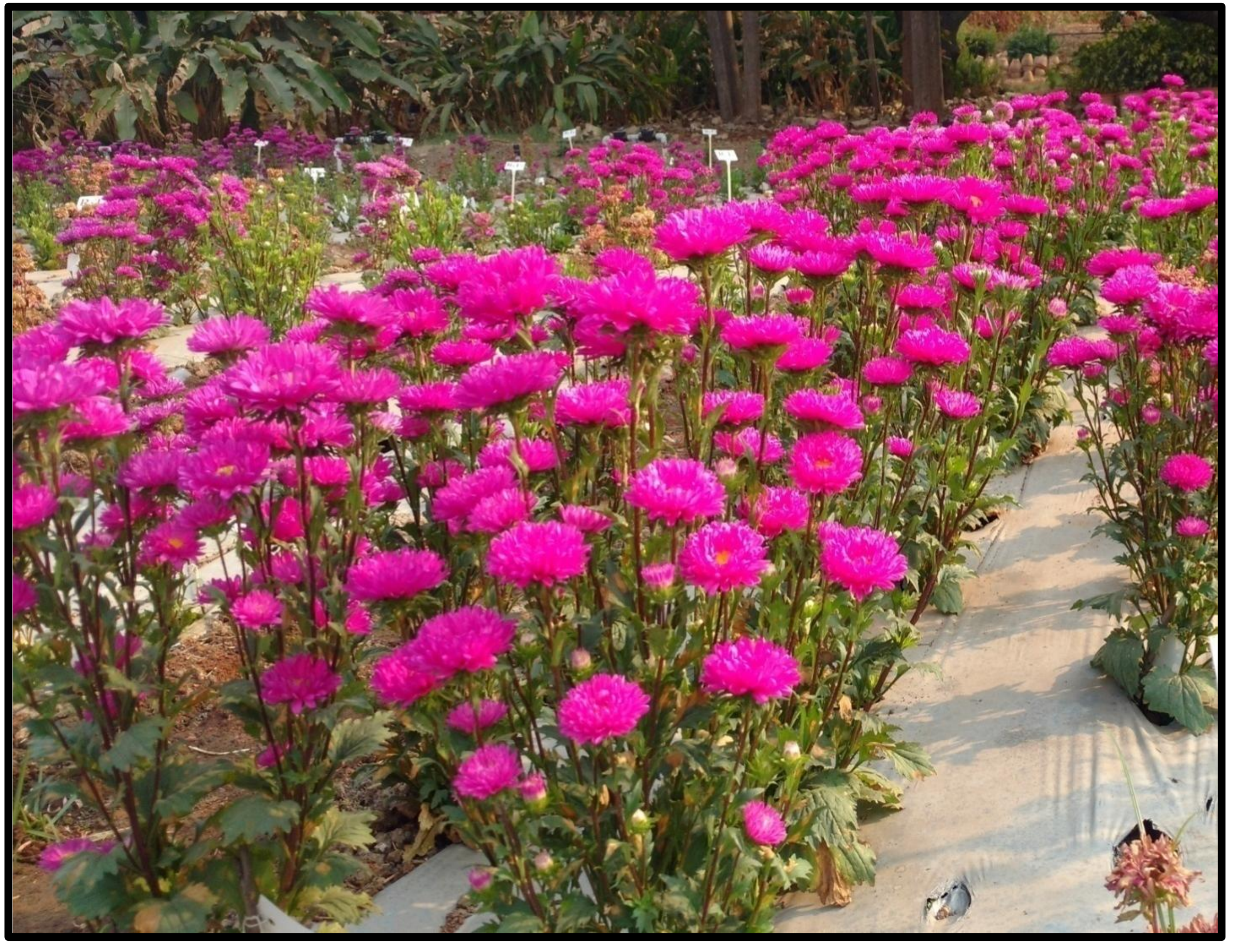


Plate 5: General view of the plot T_9

`

Plate 3: Effect of integrated nutrient management on flower stalk length (cm) China aster CV. Kamini

`

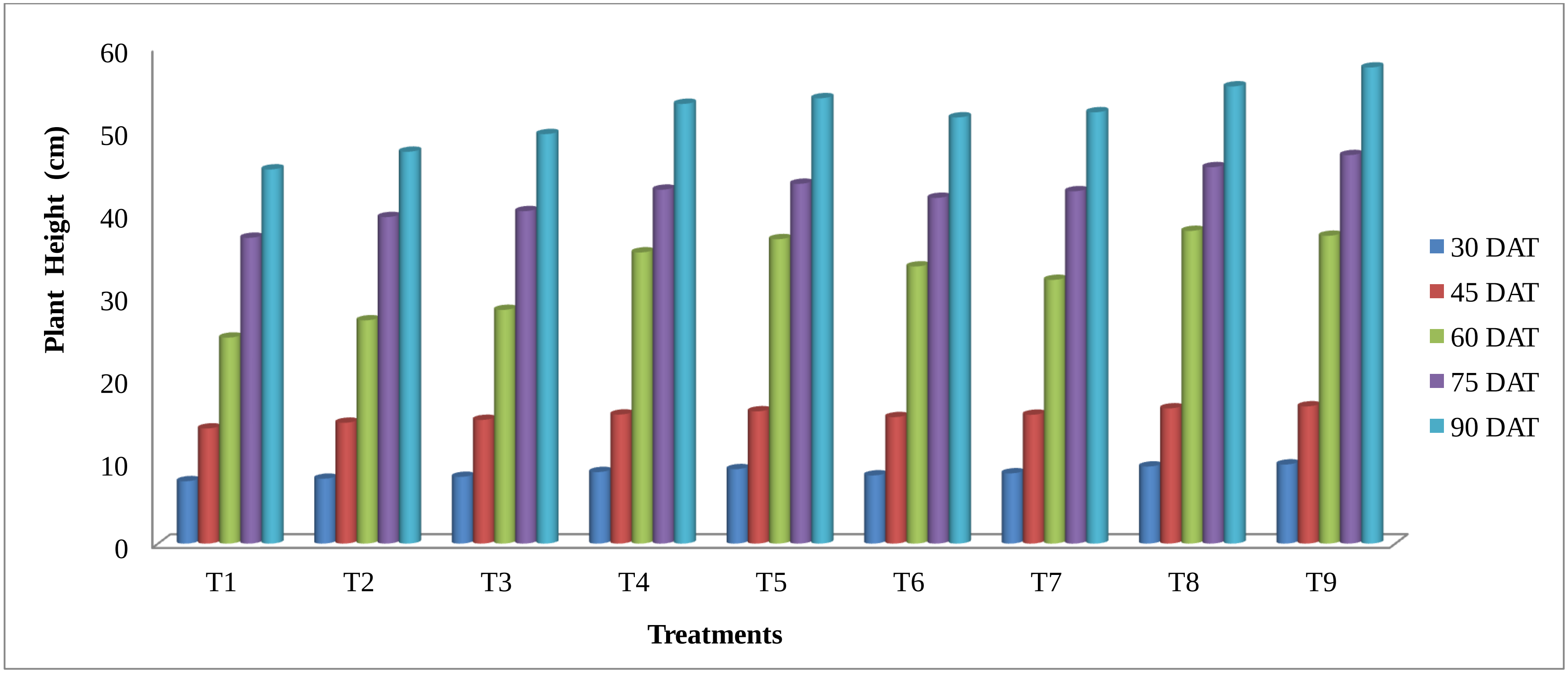


Fig 1.1.1: Effect of Integrated Nutrient Management on plant height (cm) of China aster CV. Kamini at 30, 45, 60, 75 and 90 DAP

T1 – 50% WSF

T2 – 75% WSF

T3 –100% WSF-Control

T4 – 50% WSF + AMC

T5 – 75% WSF + AMC

T6 – 50% WSF + VC

T7 – 75% WSF + VC

T8 - 50% WSF + AMC + VC

T9 – 75% WSF + AMC +VC

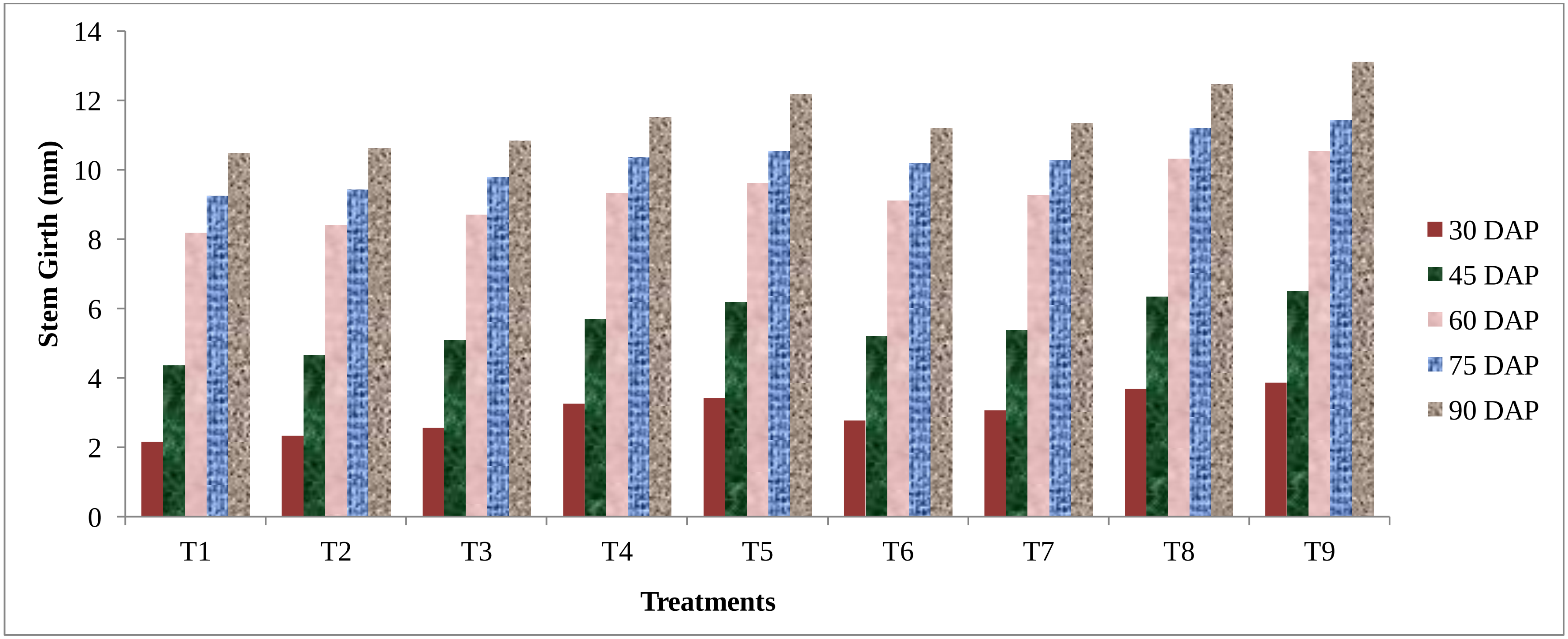


Fig 1.2.1: Effect of Integrated Nutrient Management on stem girth (mm) of China aster CV. Kamini at 30, 45, 60, 75 and 90 DAP

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

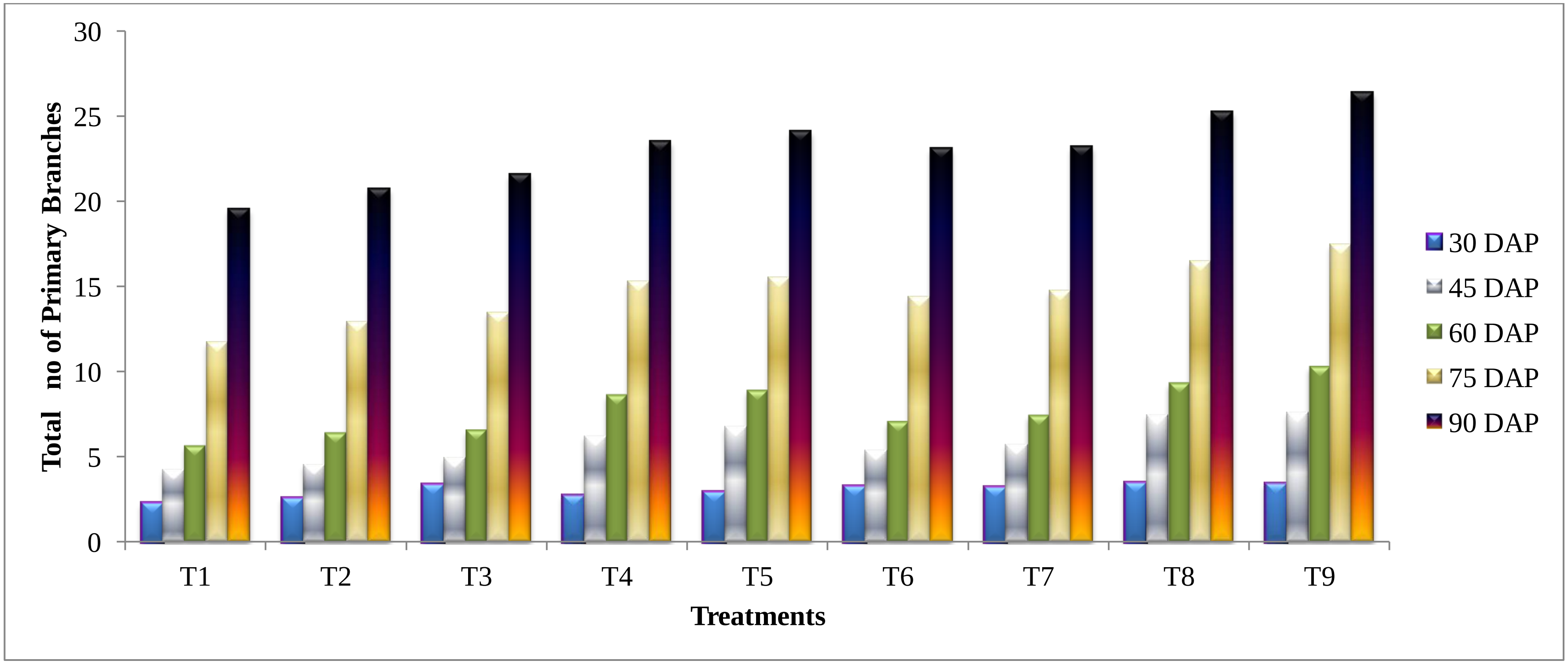


Fig 1.3.1: Effect of Integrated Nutrient Management on total number of primary branches of China aster CV. Kamini at 30, 45, 60, 75 and 90 DAP

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

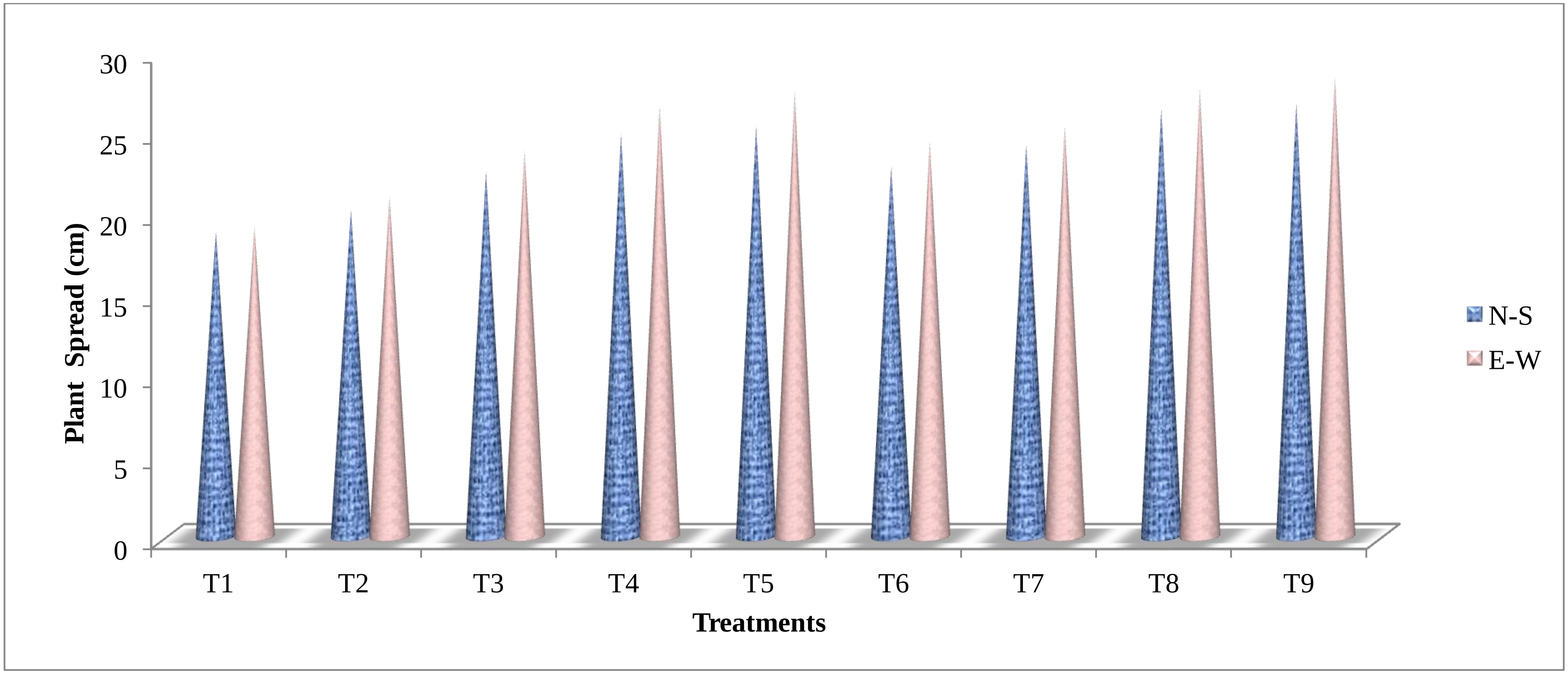


Fig 1.4: Effect of Integrated Nutrient Management on plant spread (cm) of China aster CV. Kamini in N-S and E-W directions at 50% flowering

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

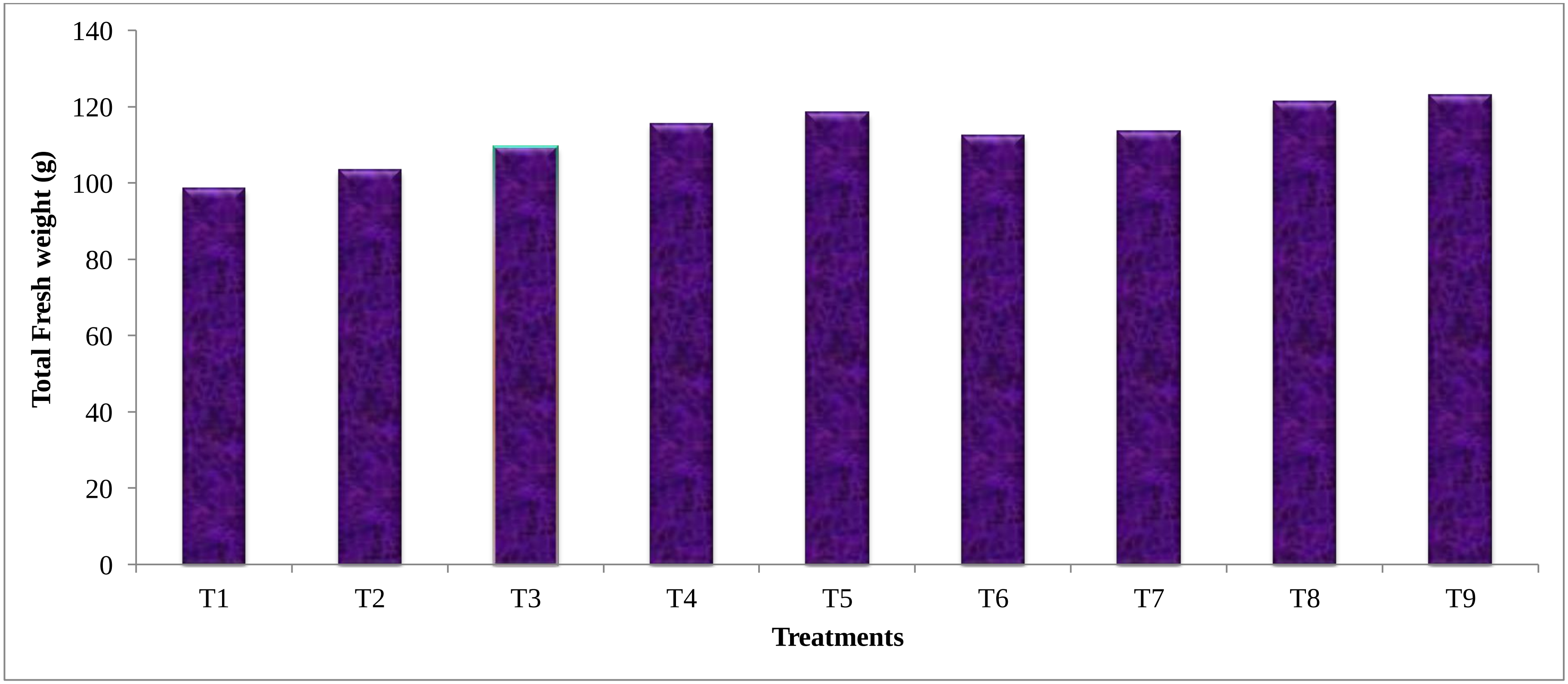


Fig 1.5: Effect of Integrated Nutrient Management on total fresh weight (g) of China aster CV. Kamini at final harvest

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

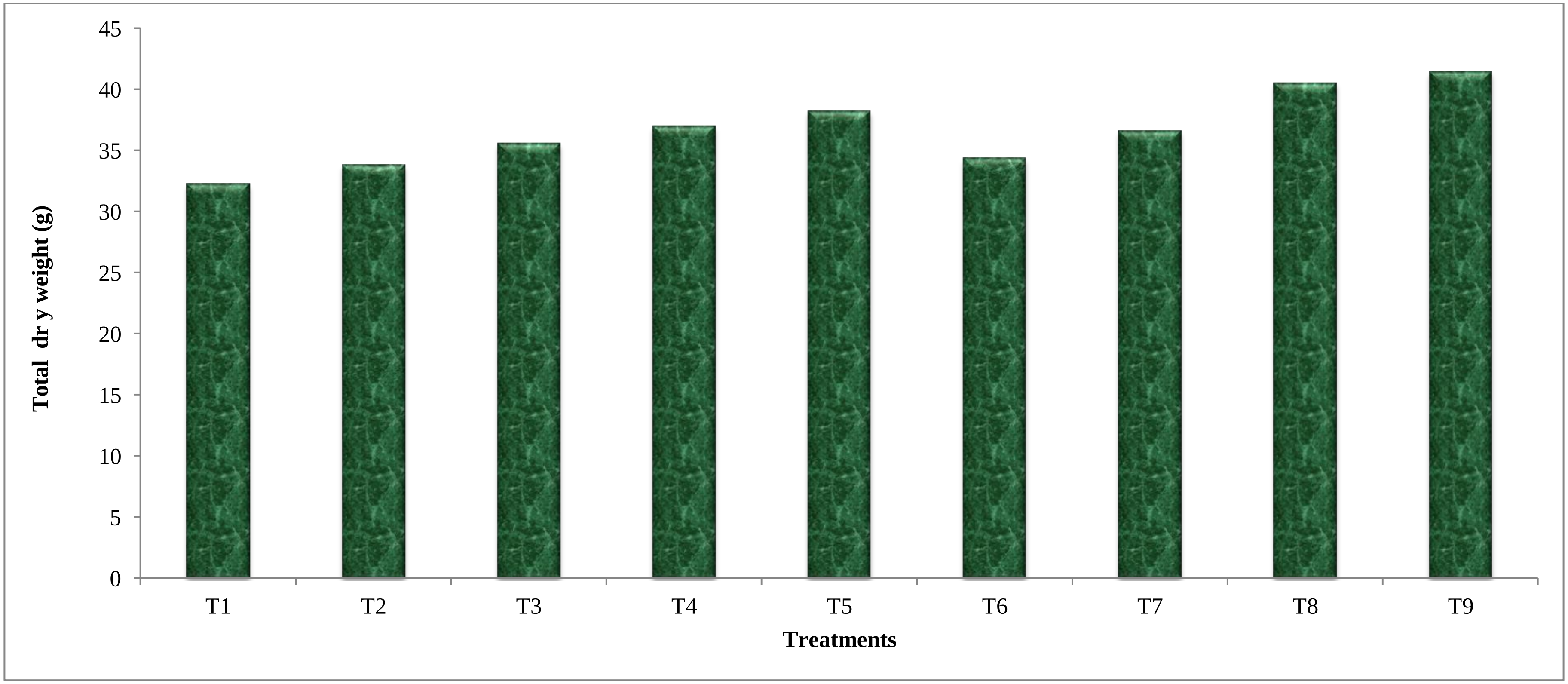


Fig 1.6: Effect of Integrated Nutrient Management on total dry weight (g) of China aster CV. Kamini at final harvest

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

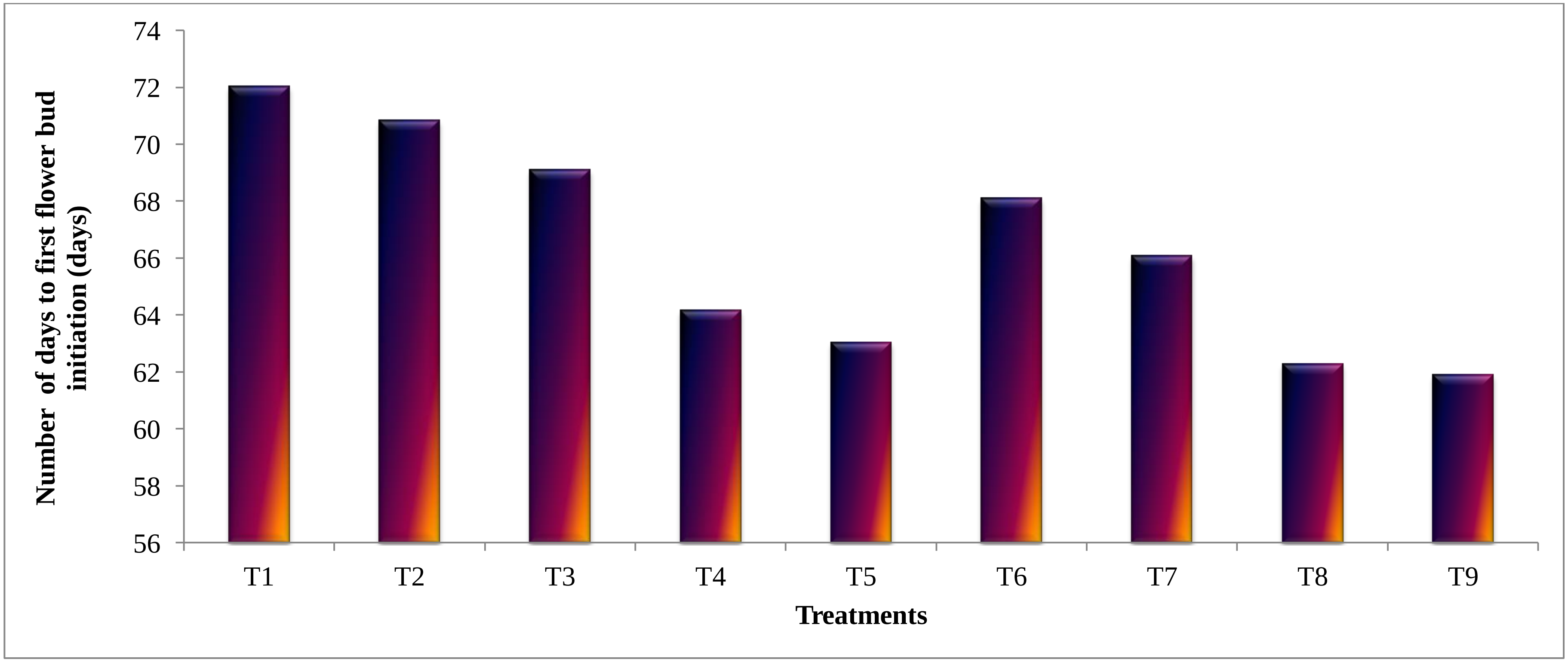


Fig 2.1: Effect of Integrated Nutrient Management on China aster CV. Kamini on number of days to first flower bud initiation

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

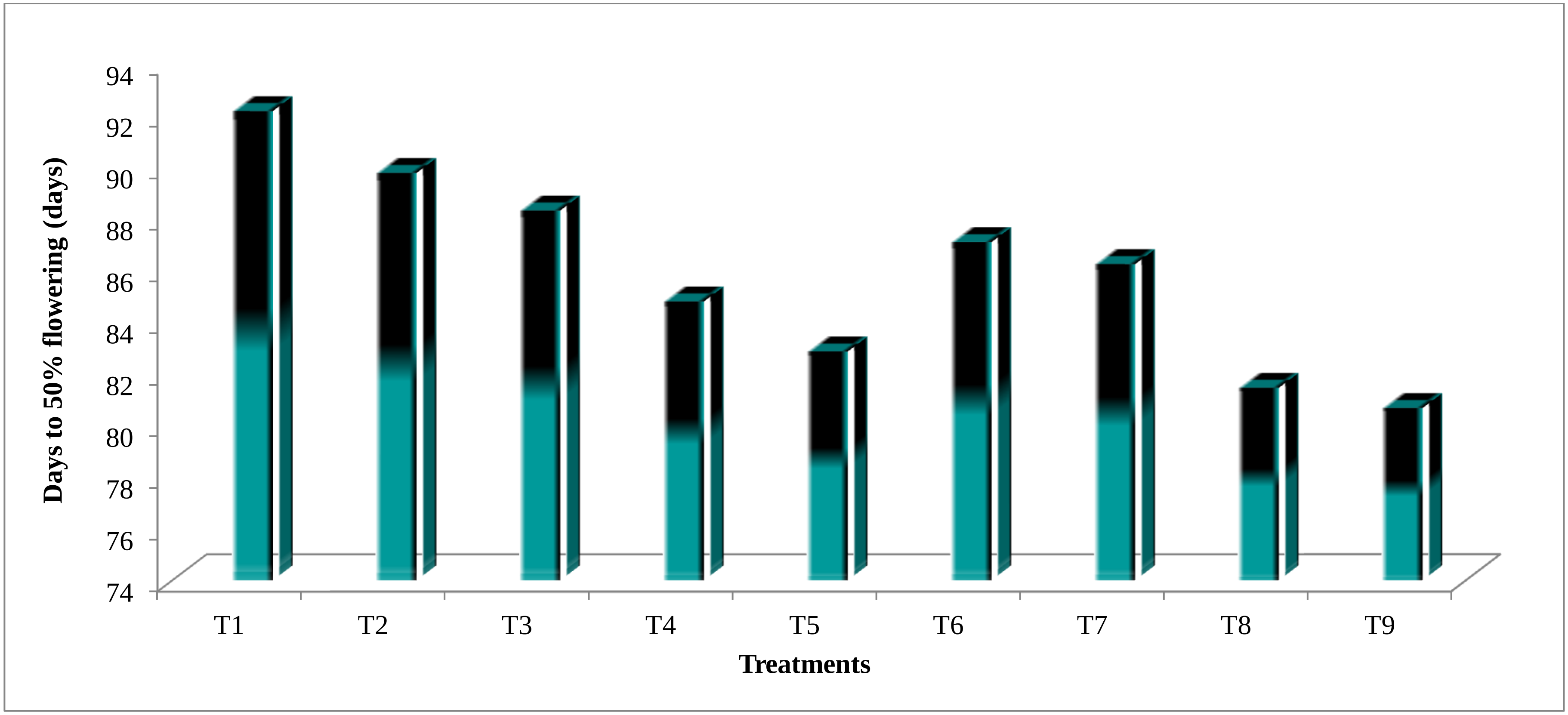


Fig 2.2: Effect of Integrated Nutrient Management on China aster CV. Kamini on number of days to 50% flowering

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

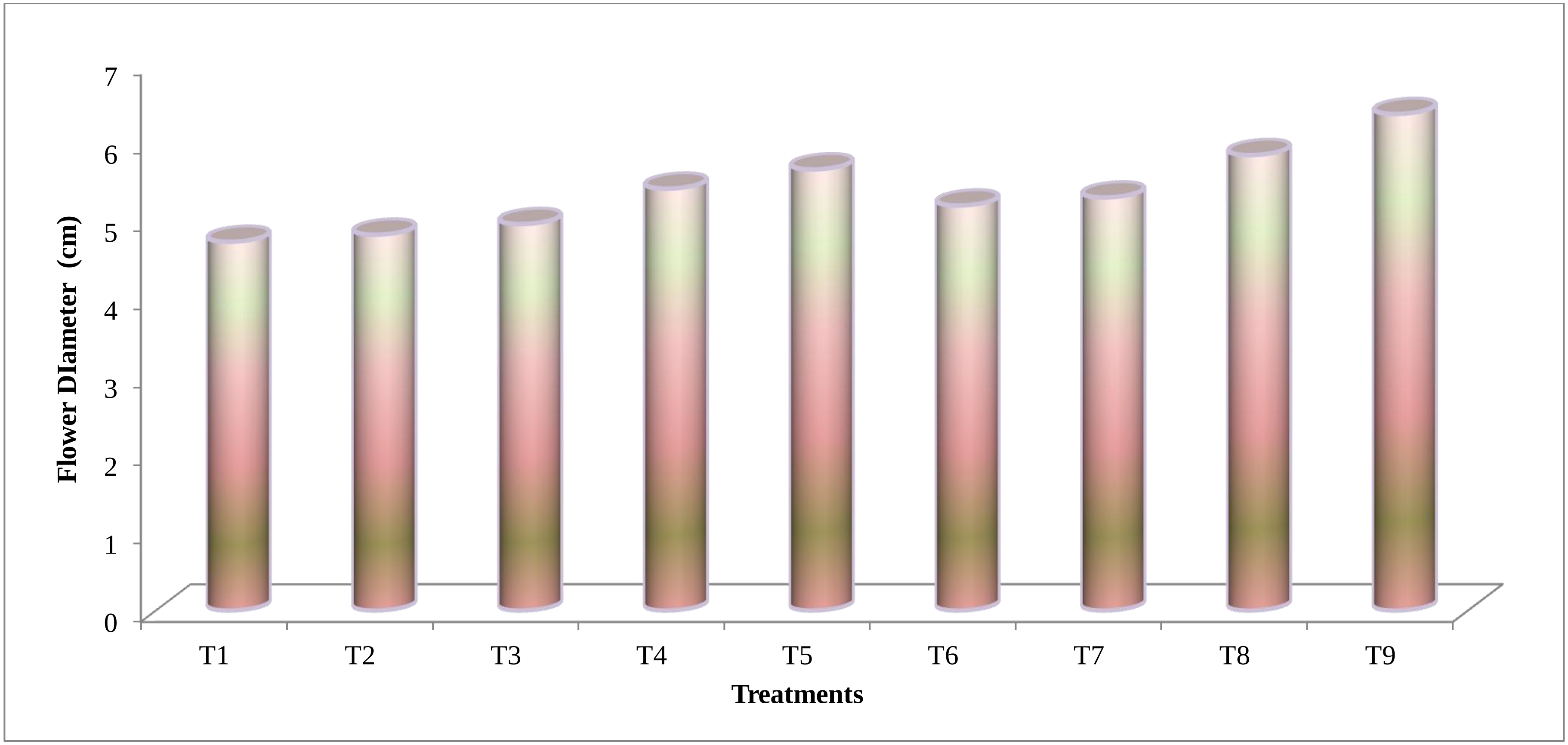


Fig 2.3: Effect of Integrated Nutrient Management on China aster CV. Kamini on flower diameter (cm)

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

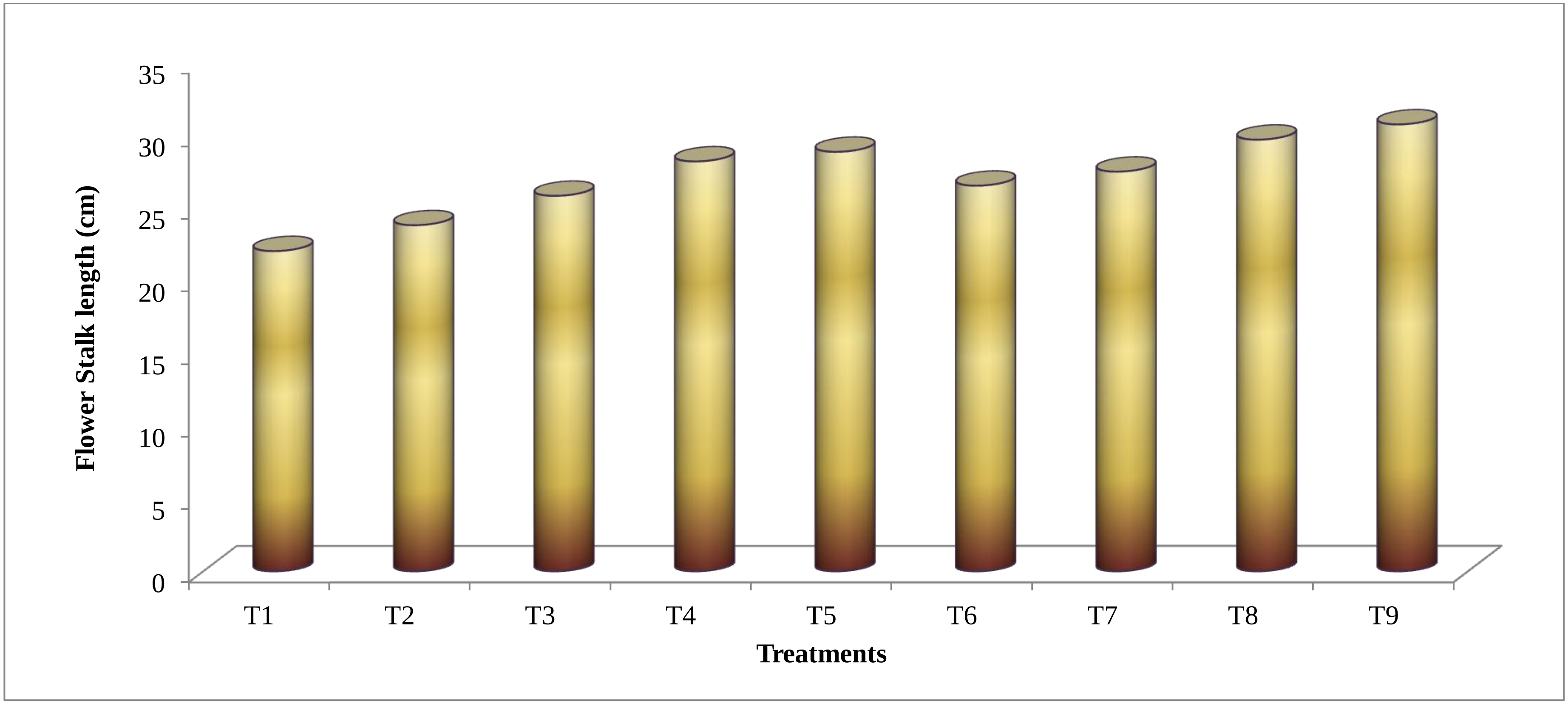


Fig 2.4: Effect of Integrated Nutrient Management on China aster CV. Kamini on flower stalk length (cm)

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

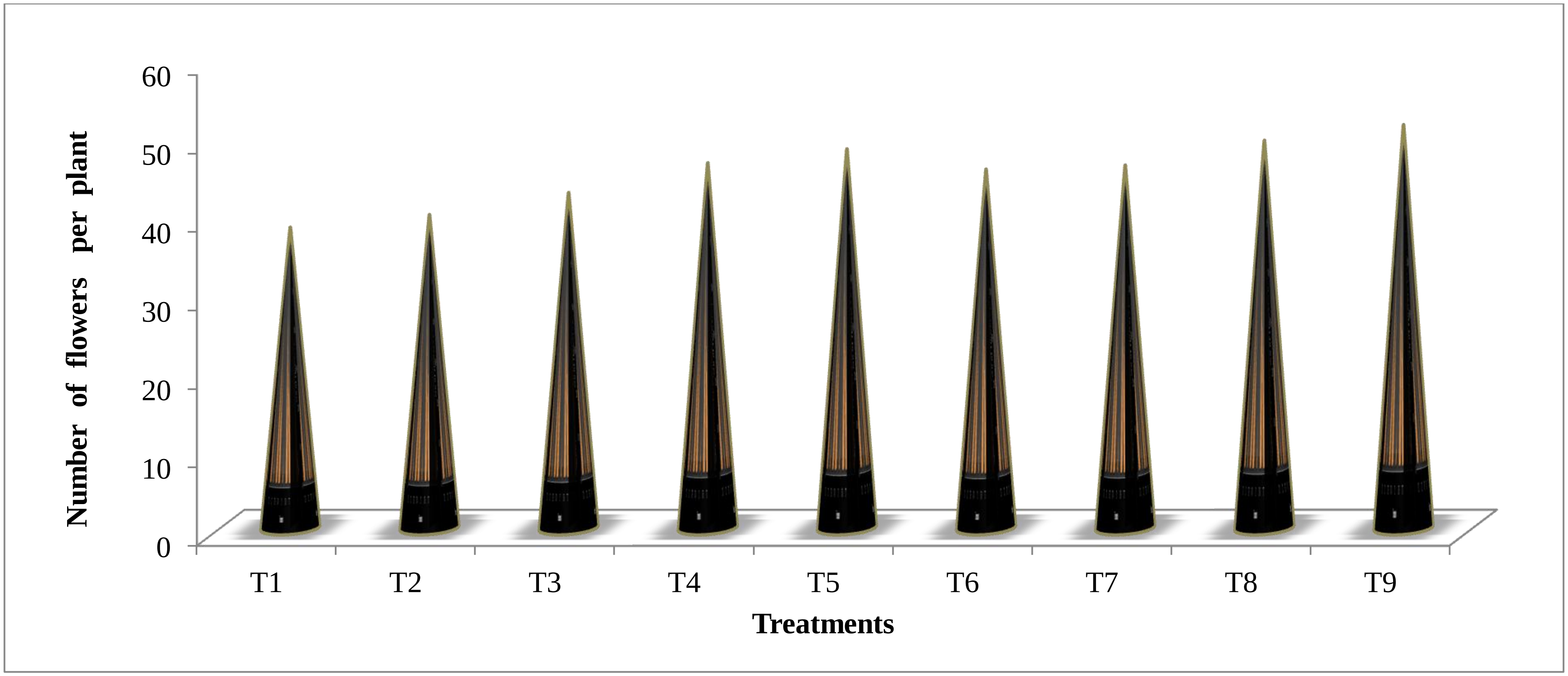


Fig 2.5: Effect of Integrated Nutrient Management on China aster CV. Kamini on number of flowers per plant

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

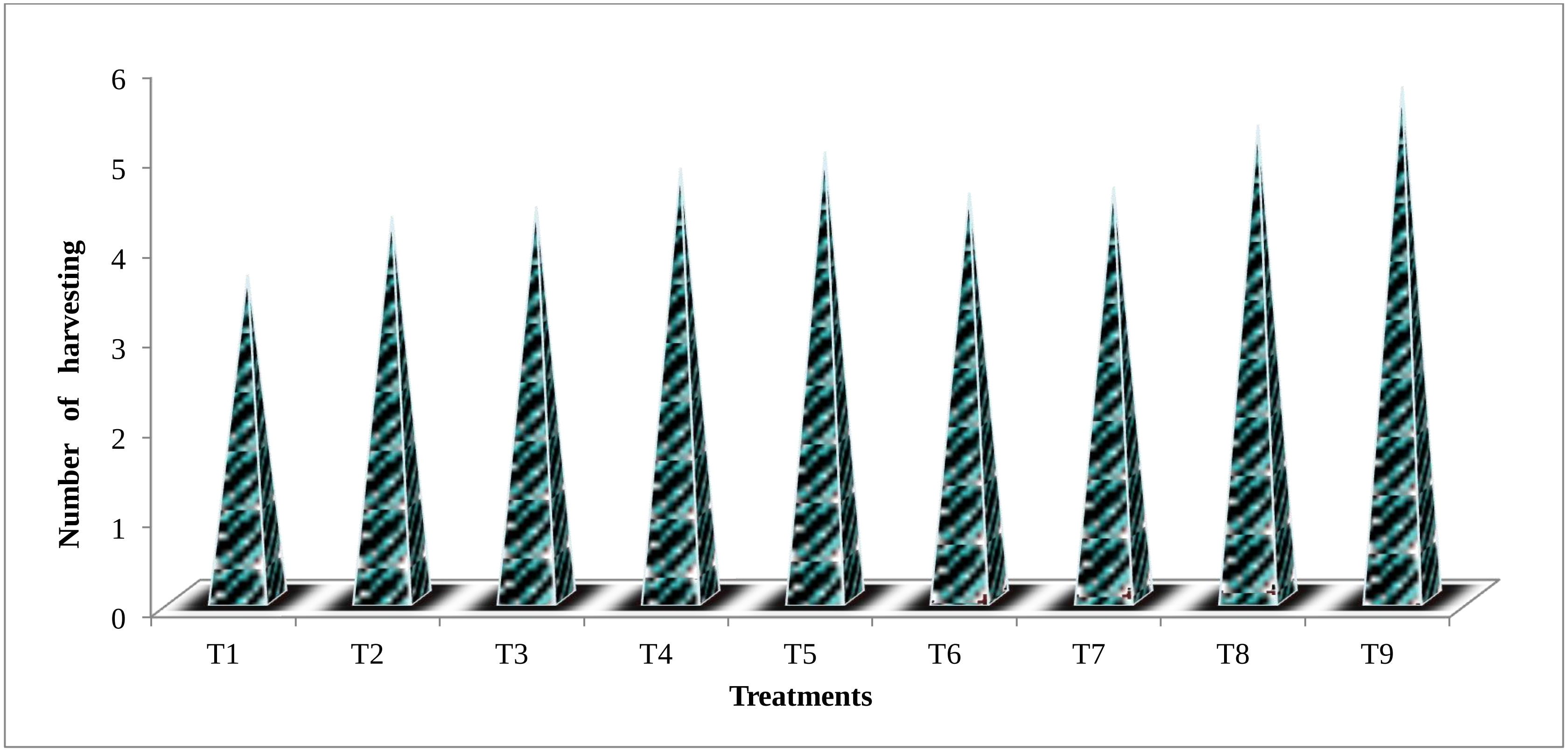


Fig 2.6: Effect of Integrated Nutrient Management on China aster CV. Kamini on number of harvesting

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

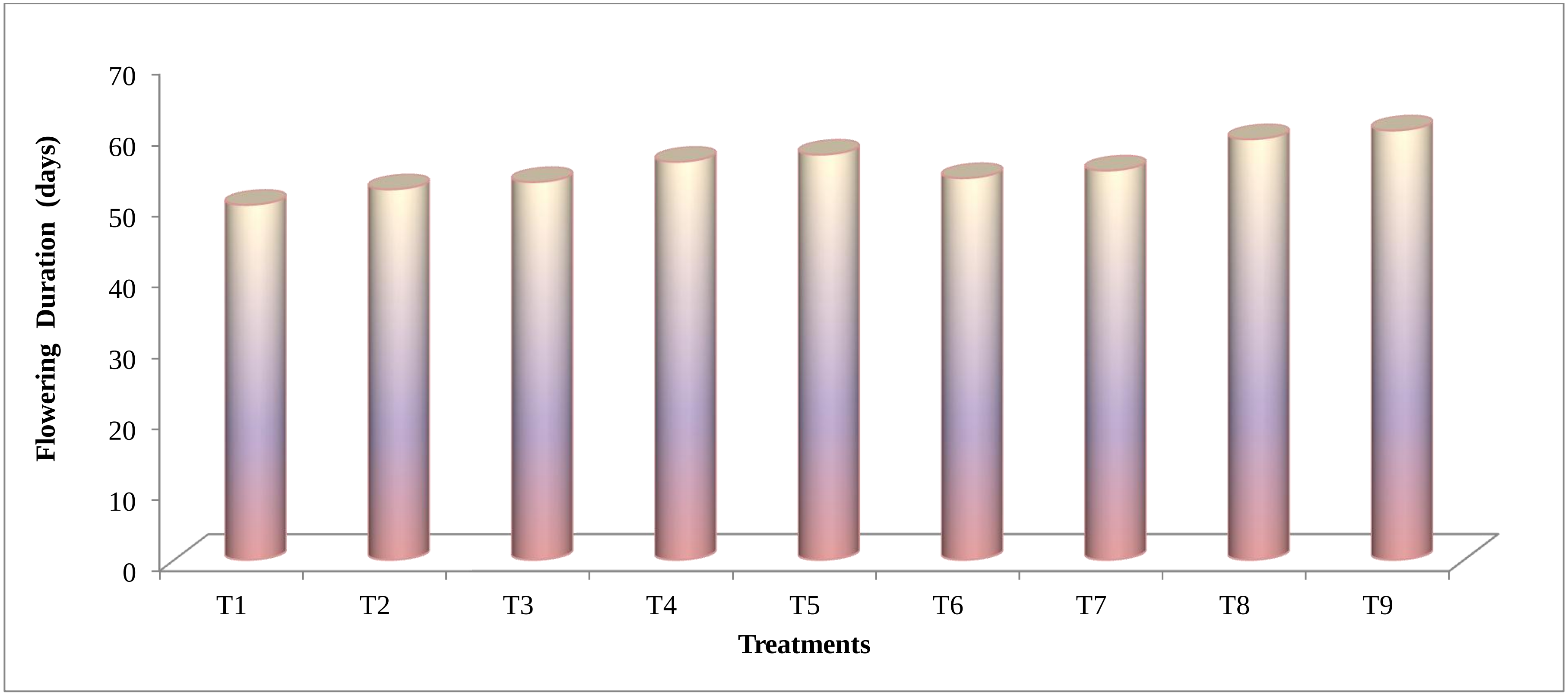


Fig 2.7: Effect of Integrated Nutrient Management on China aster CV. Kamini on flowering duration (days)

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

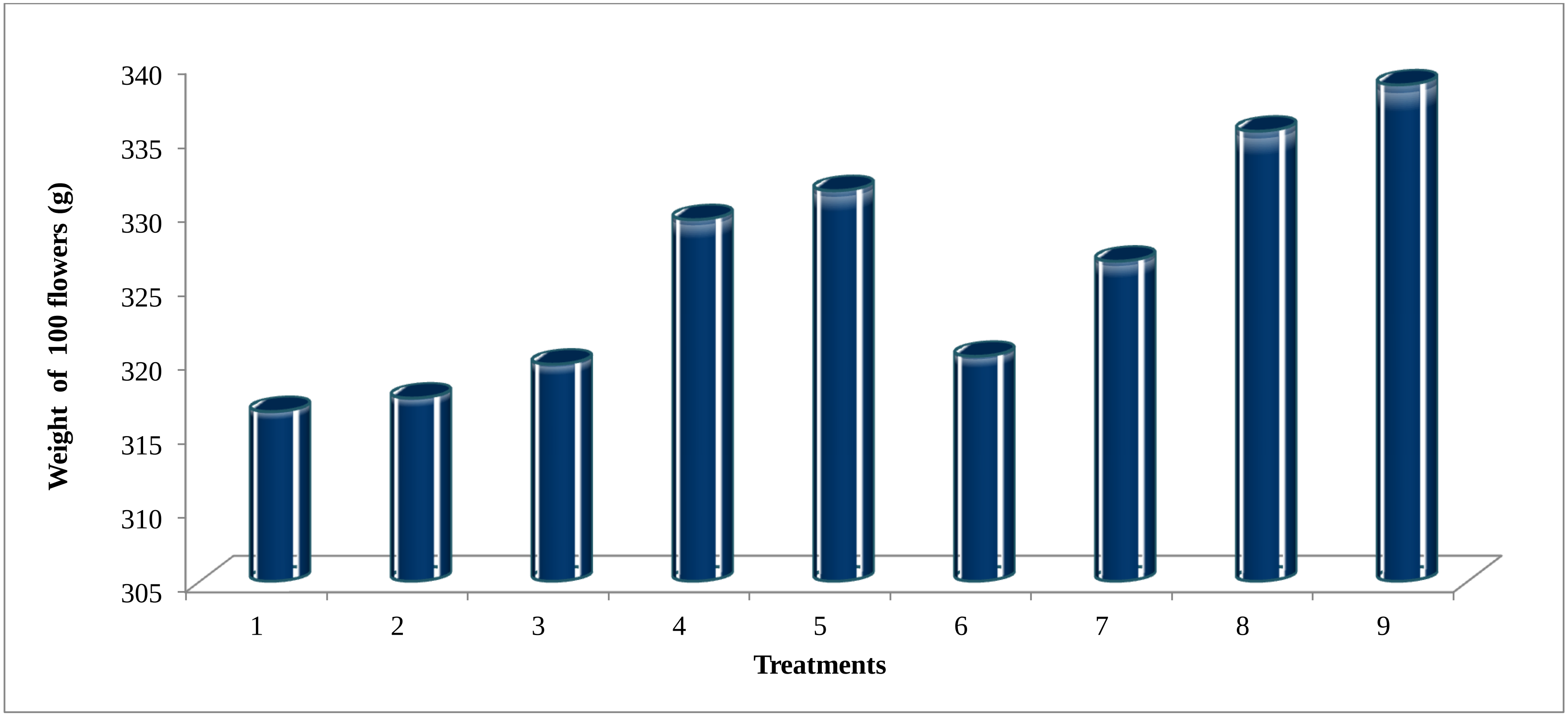


Fig 2.8: Effect of Integrated Nutrient Management on China aster CV. Kamini on weight of 100 flowers (g)

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

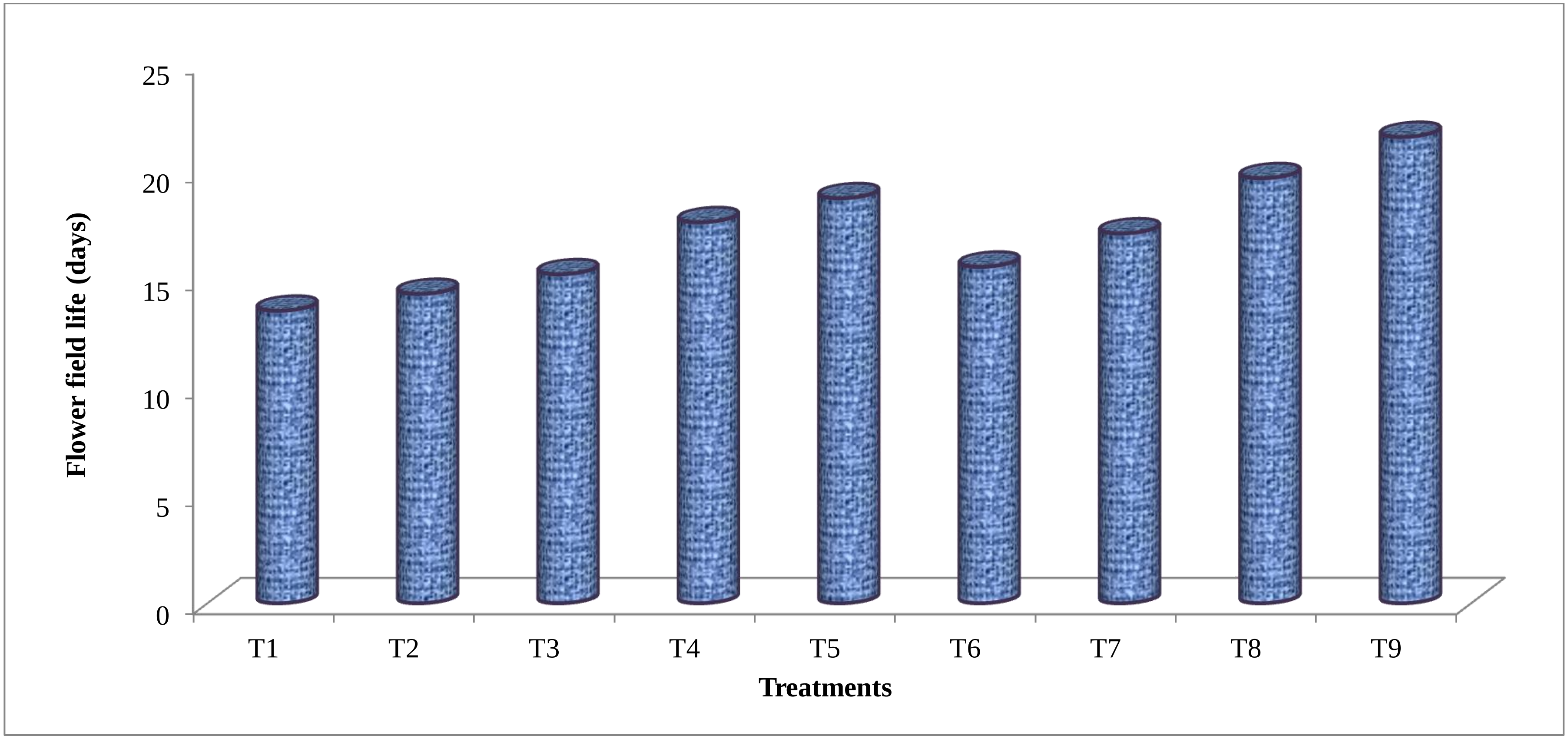


Fig 2.9: Effect of Integrated Nutrient Management on China aster CV. Kamini on flower field life (days)

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

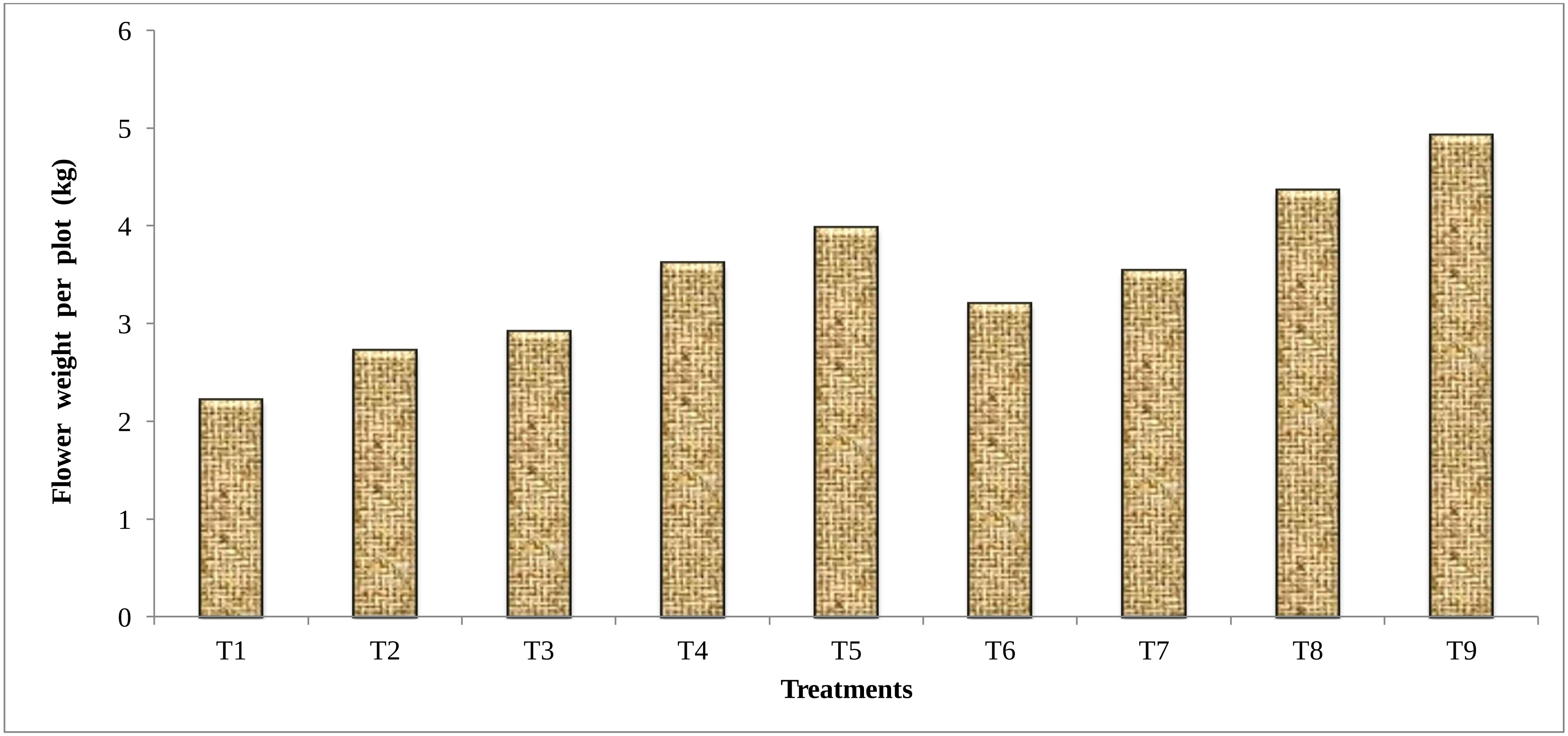


Fig 2.10: Effect of Integrated Nutrient Management on China aster CV. Kamini on flower weight per plot (kg)

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

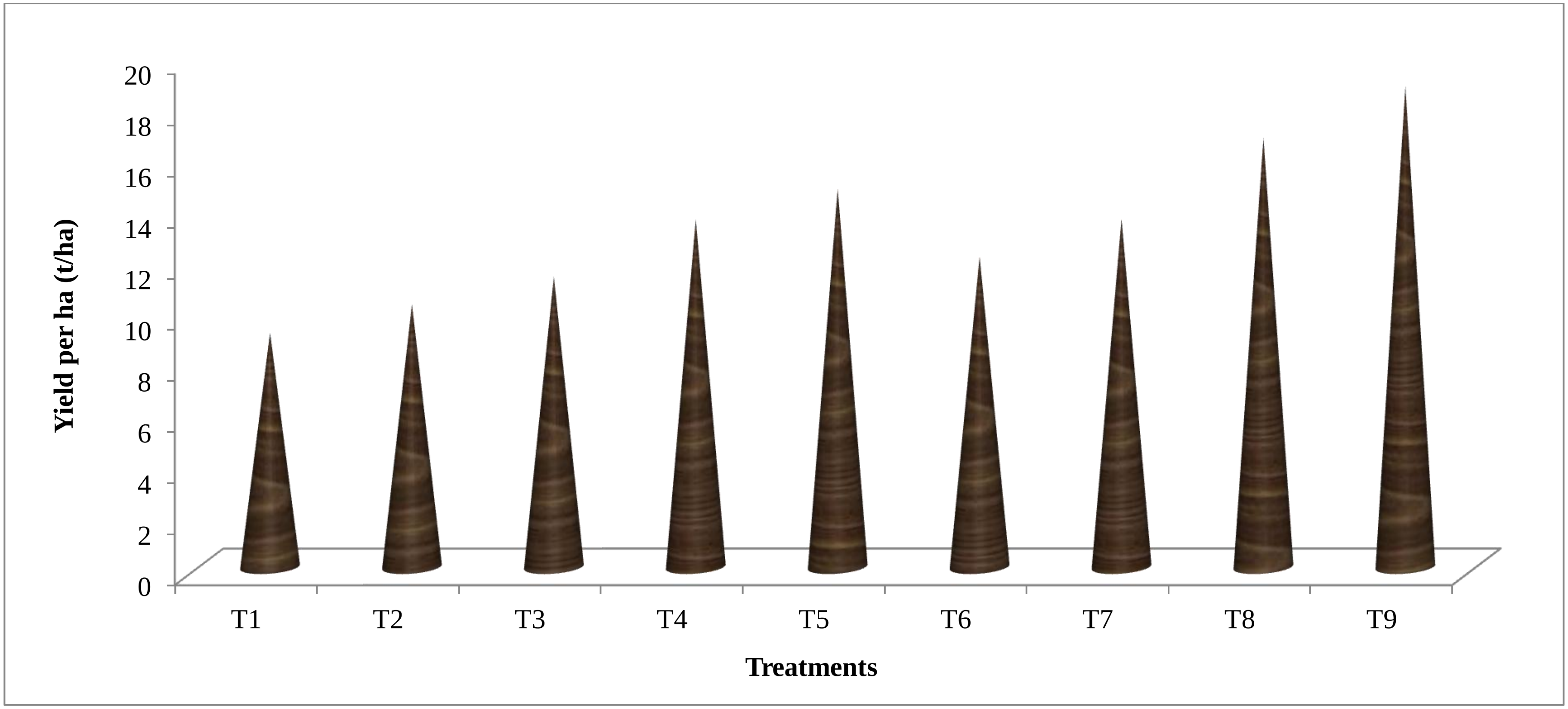


Fig 2.11: Effect of Integrated Nutrient Management on China aster CV. Kamini on flower yield per hectare (t/ha)

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

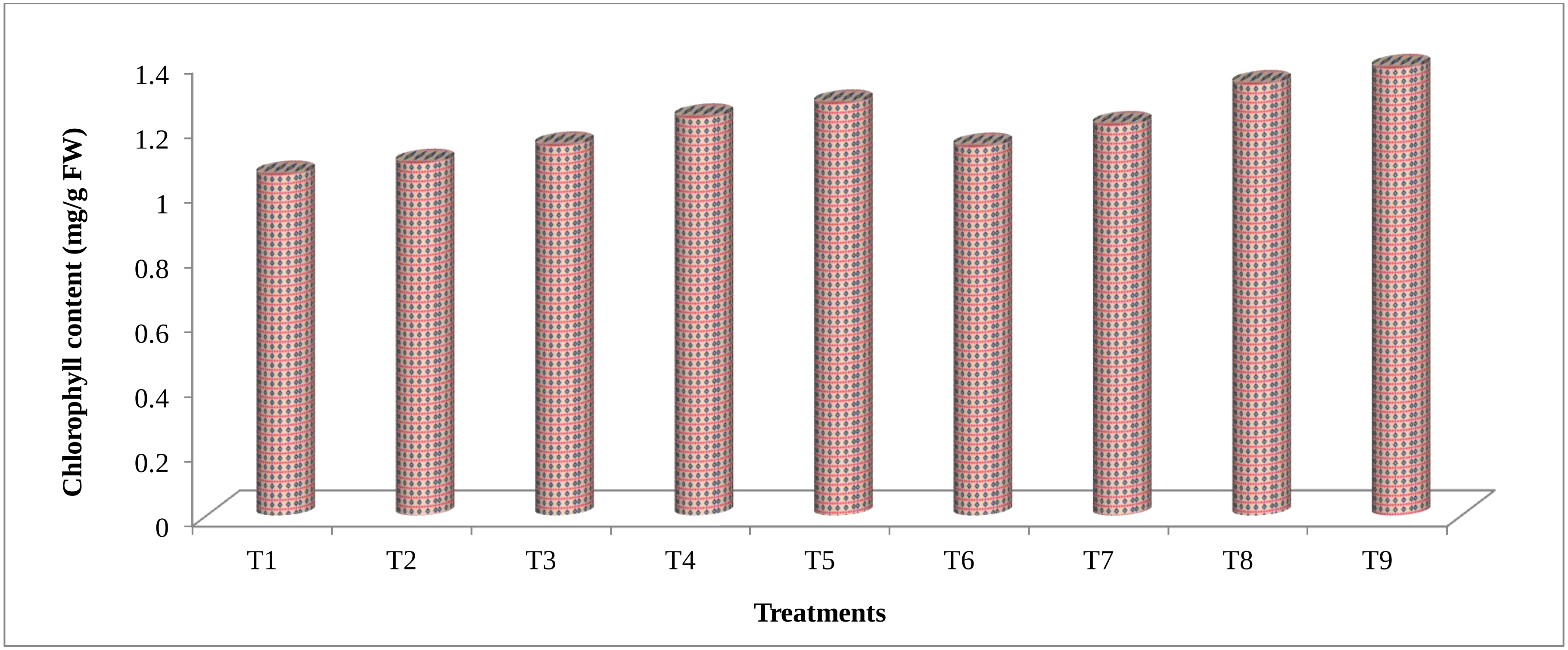


Fig 3.1: Effect of Integrated Nutrient Management on China aster CV. Kamini on chlorophyll content (mg/g FW) at 50% flowering

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

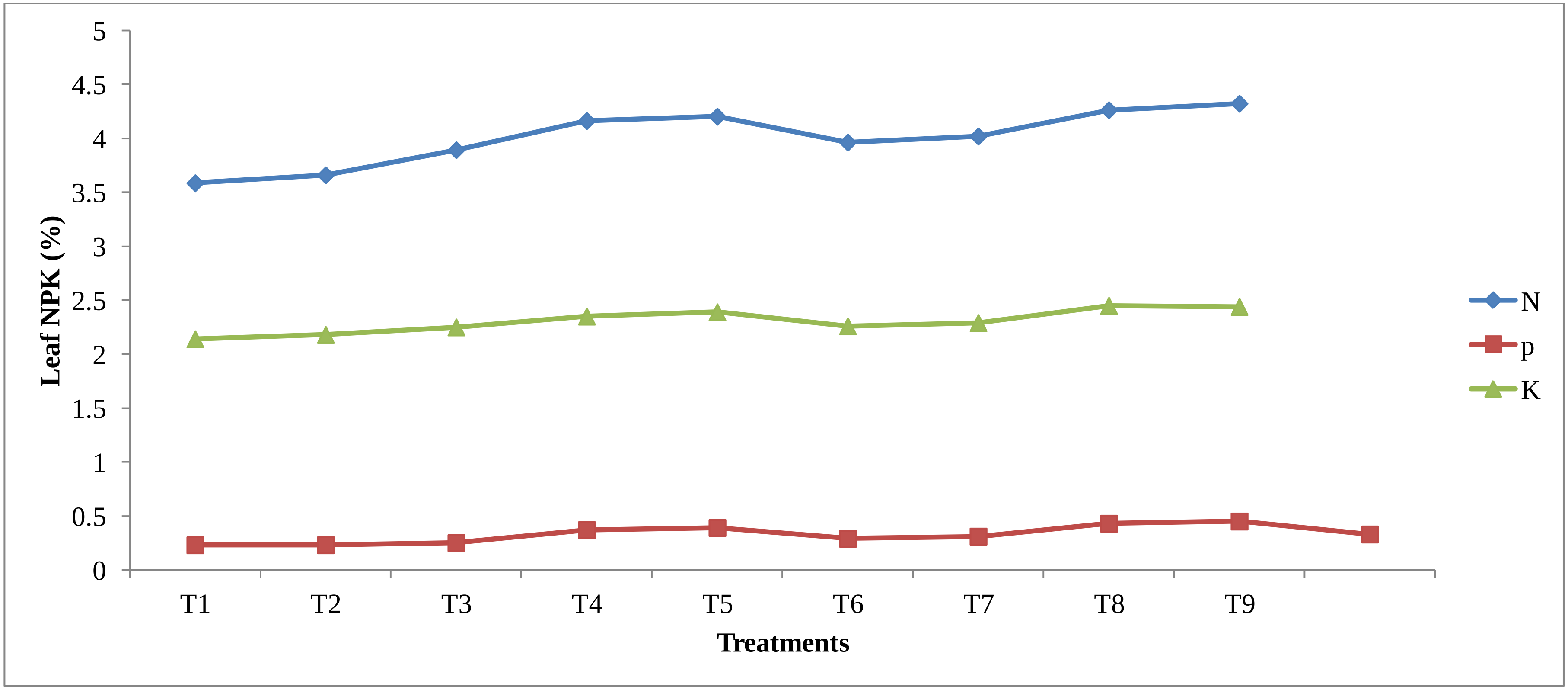


Fig 3.2: Effect of Integrated Nutrient Management on China aster CV. Kamini on % NPK in leaves after harvest

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

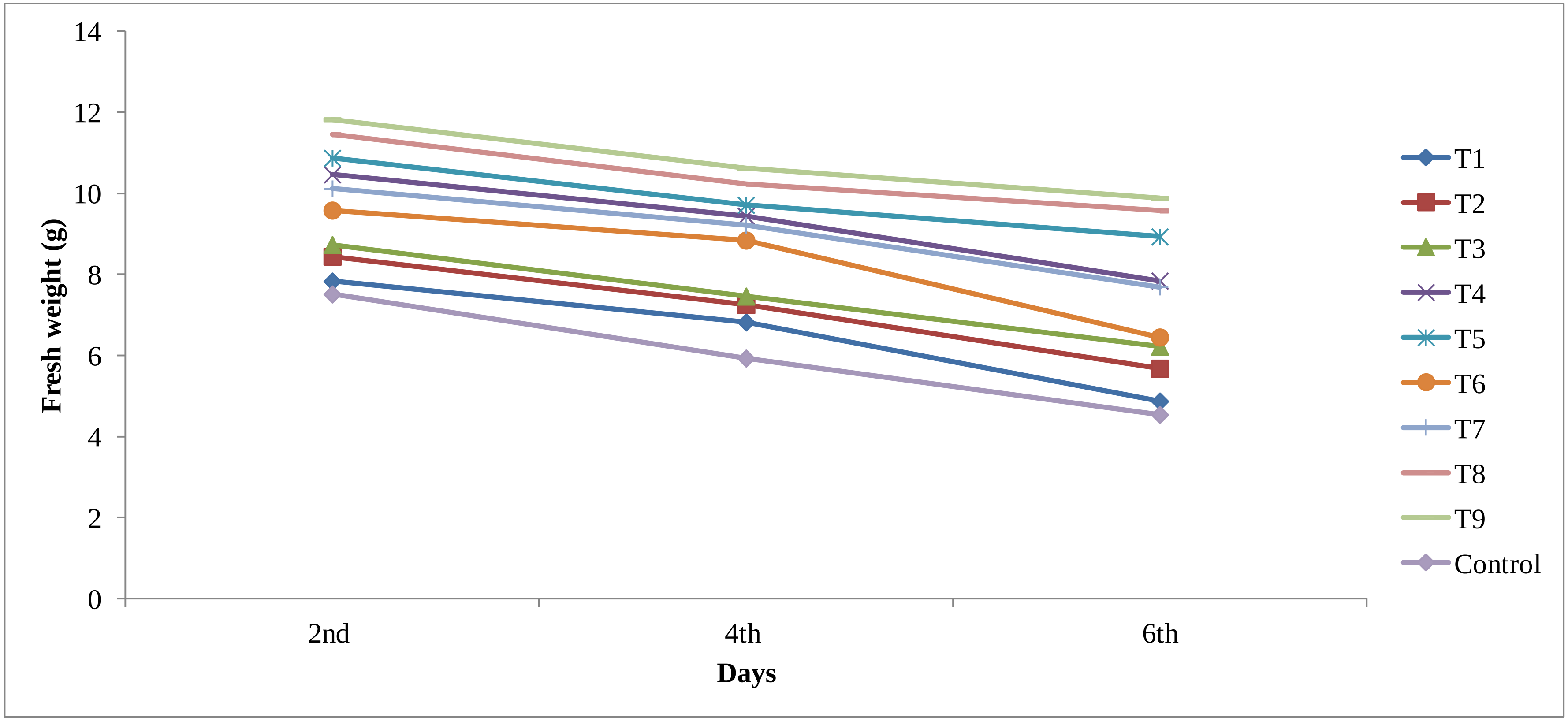


Fig 5.1: Effect of postharvest application of sucrose 4% + $(Al_2SO_4)_3$ @ 200 ppm on fresh weight (g) during vase life period of China aster CV..Kamini.

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

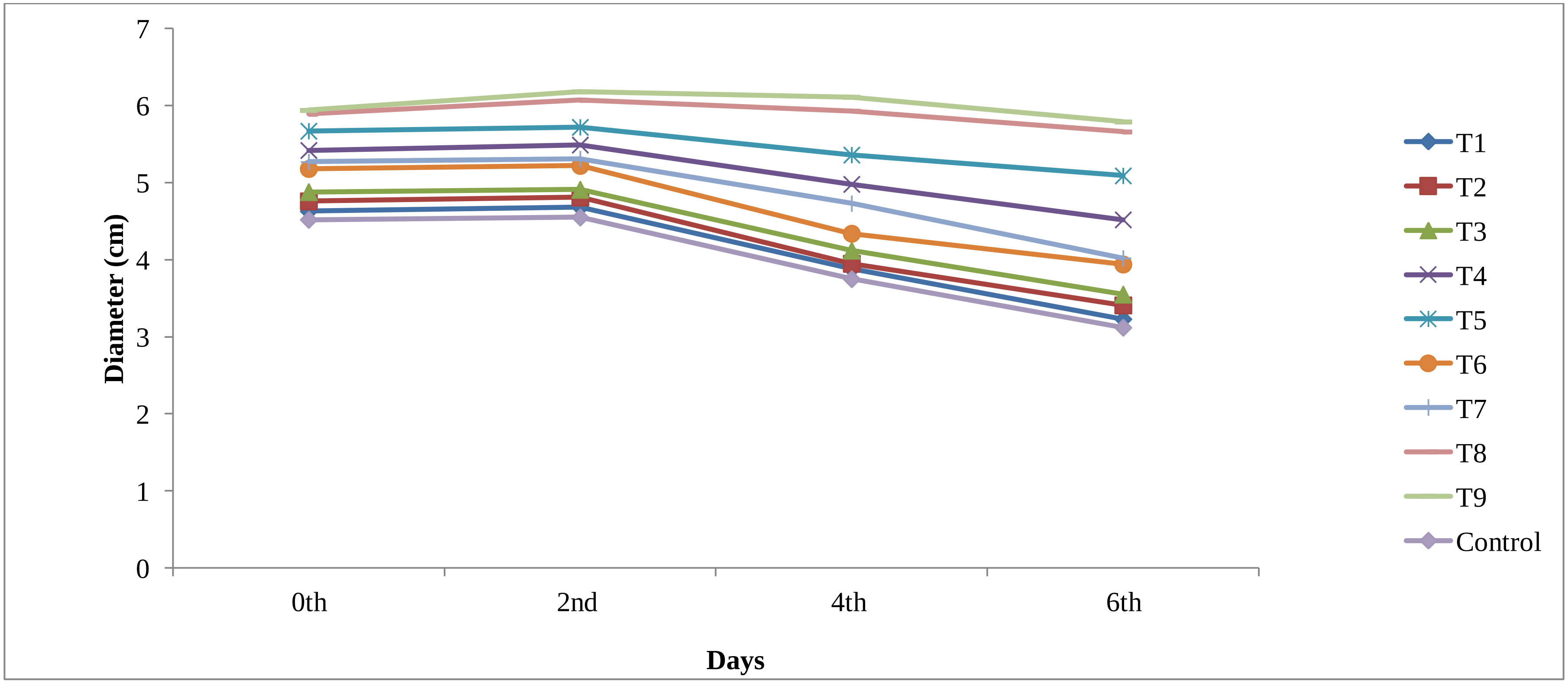


Fig 5.2: Effect of postharvest application of sucrose 4% + $(Al_2SO_4)_3$ @ 200 ppm on flower diameter (cm) during vase life period of China aster CV. Kamini.

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

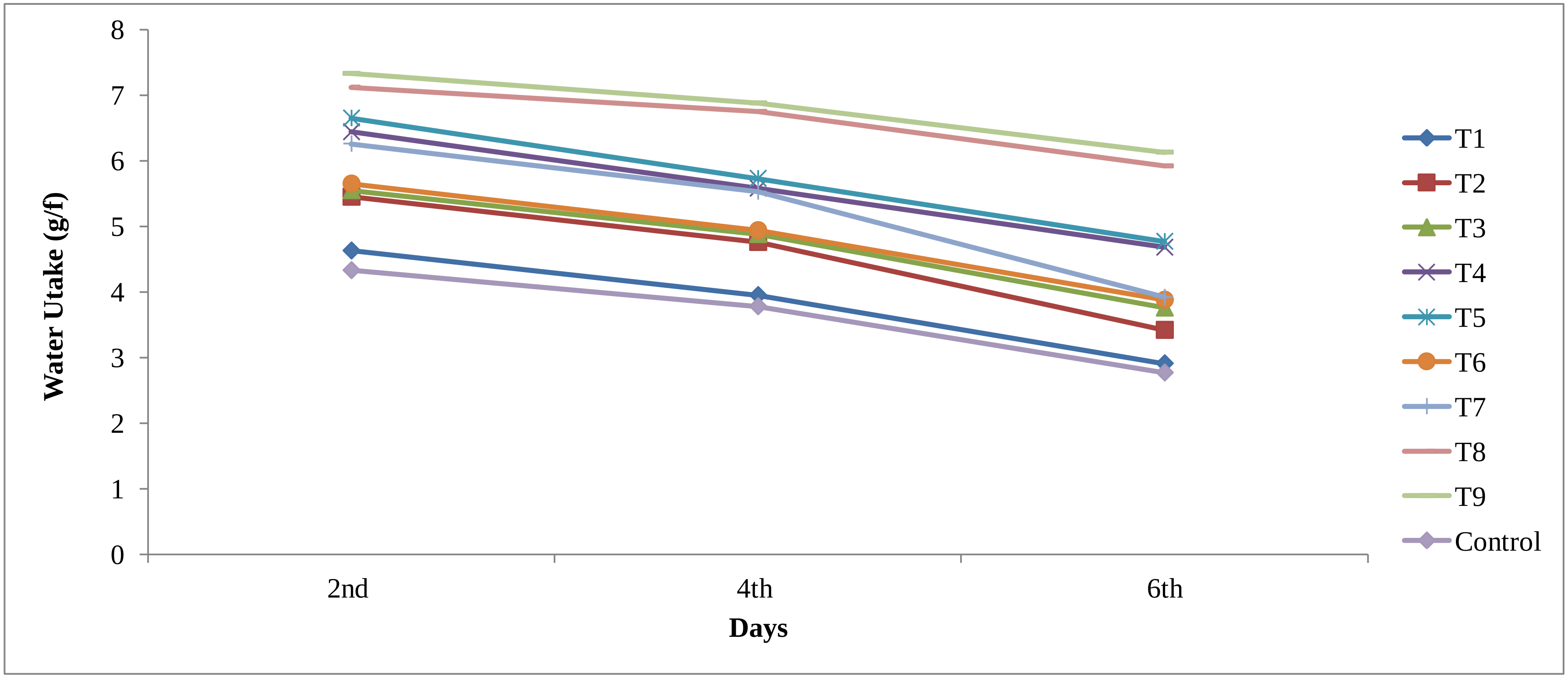


Fig 5.3: Effect of postharvest application of sucrose 4% + $(Al_2SO_4)_3$ @ 200 ppm on water uptake (g/f) during vase life period of China aster CV. Kamini.

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

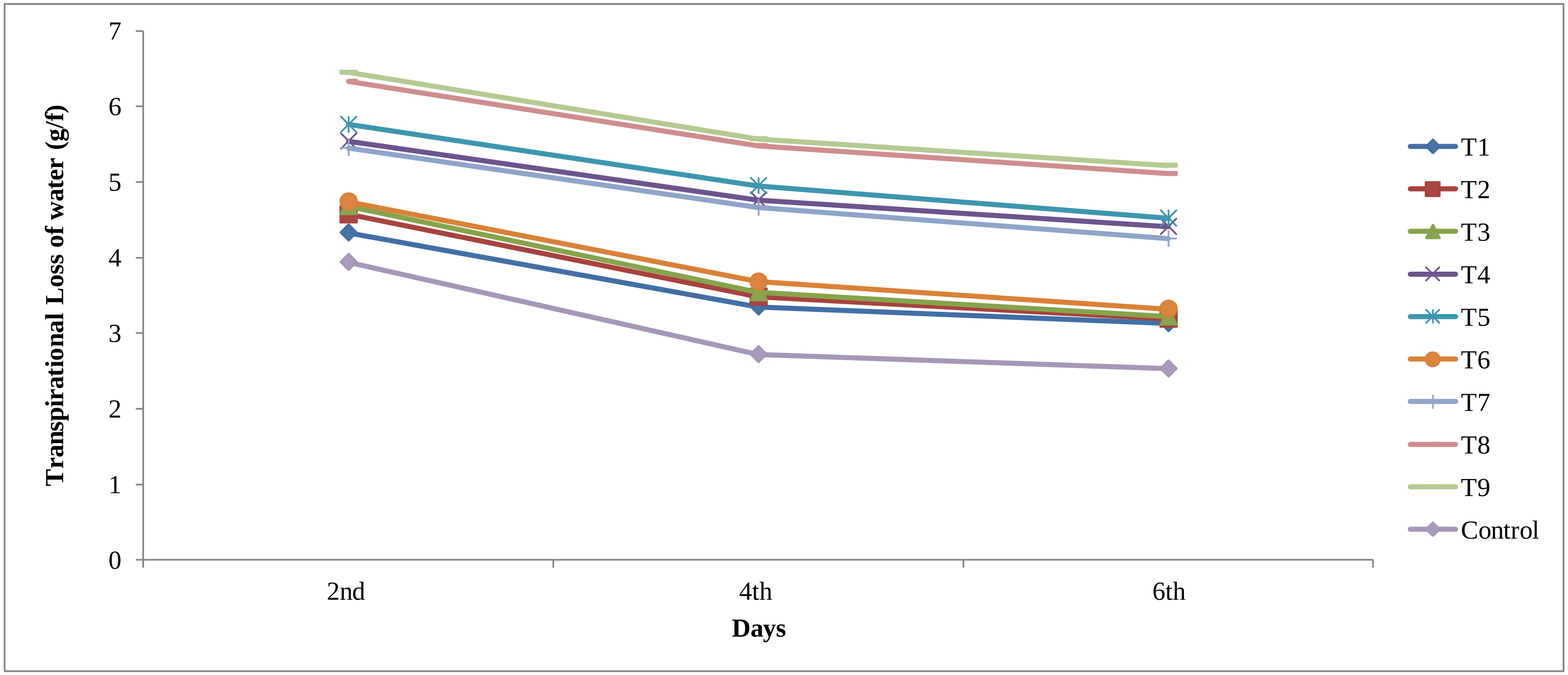


Fig 5.4: Effect of postharvest application of sucrose 4% + $(Al_2SO_4)_3$ @ 200 ppm on transpirational loss of water (g/f) during vase life period of China aster CV. Kamini.

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

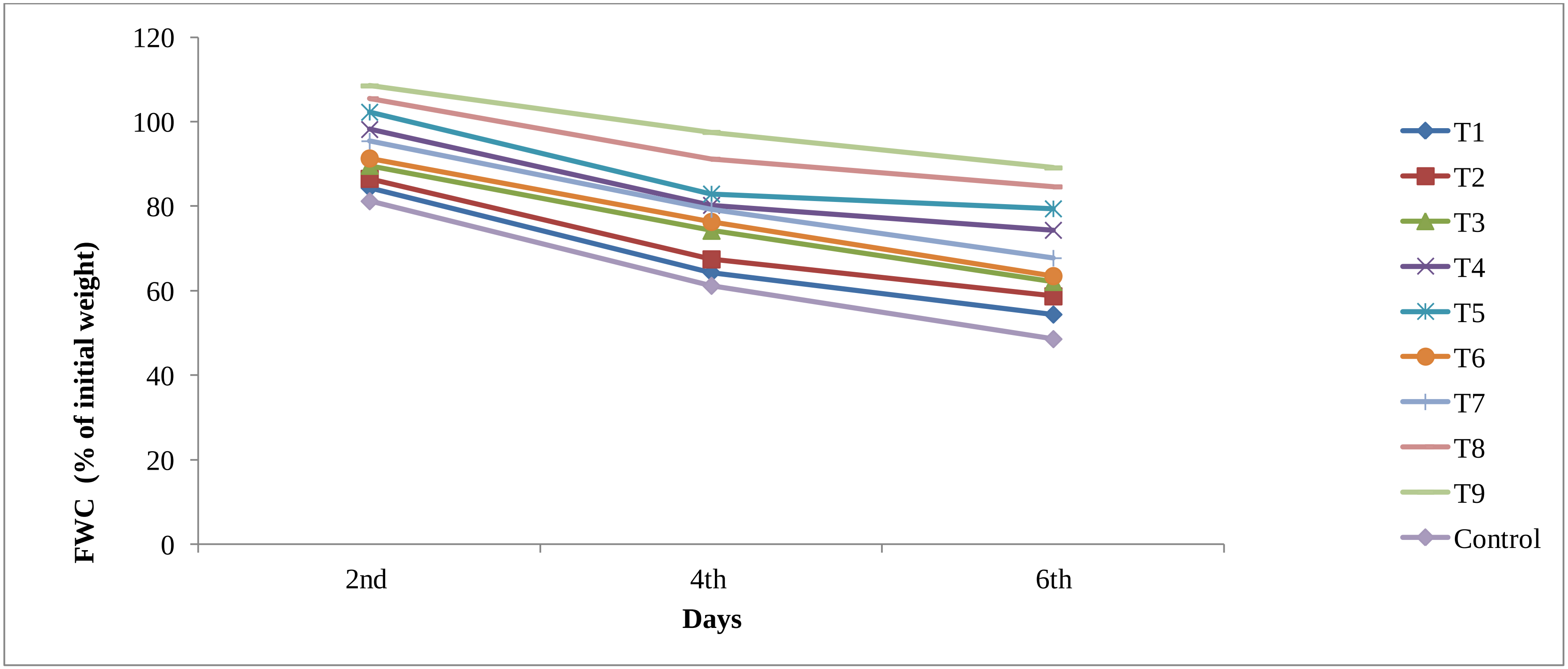


Fig 5.5: Effect of postharvest application of sucrose 4% + $(Al_2SO_4)_3$ @ 200 ppm on Fresh Weight Change (% of initial weight) during vase life period of China aster CV. Kamini.

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

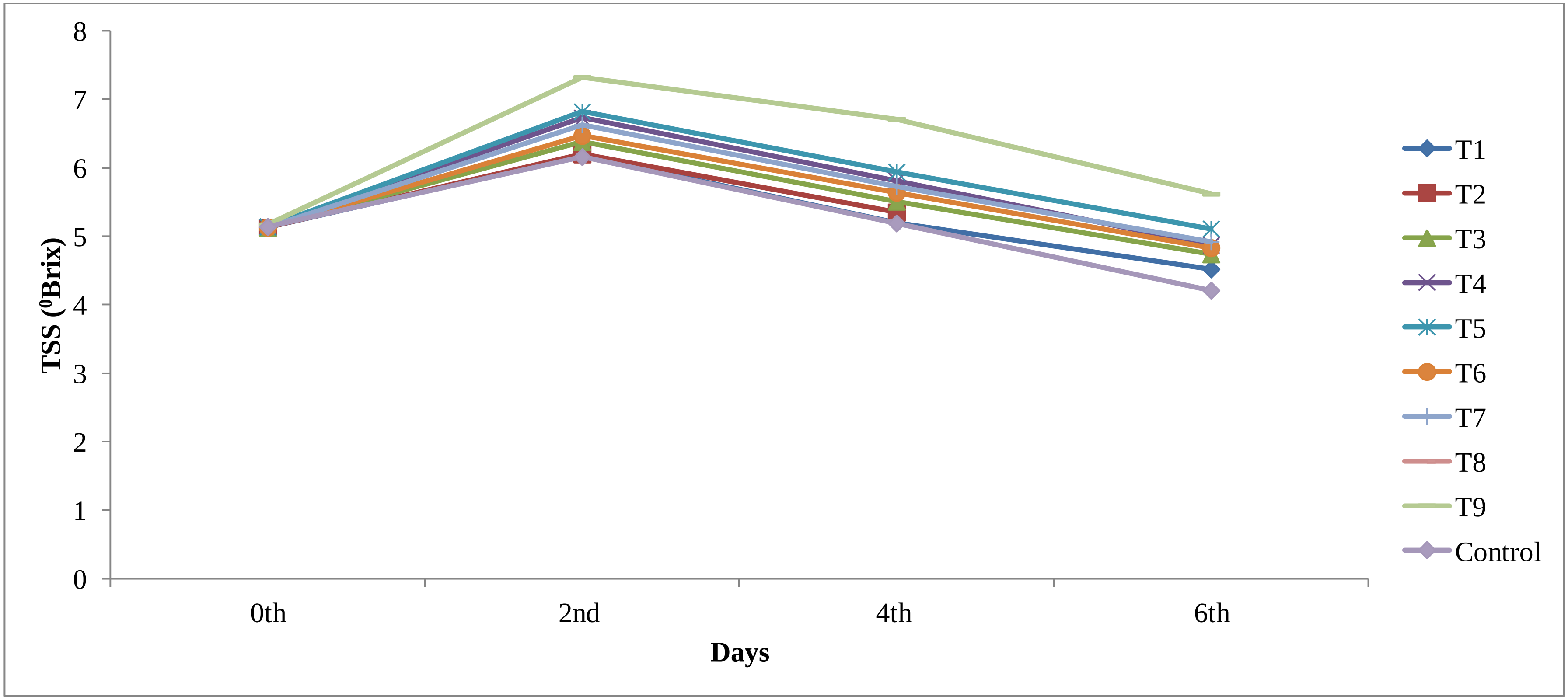


Fig 5.6: Effect of postharvest application of sucrose 4% + $(Al_2SO_4)_3$ @ 200 ppm on Total Soluble Sugars (^{0} Brix) during vase life period of China aster CV. Kamini.

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

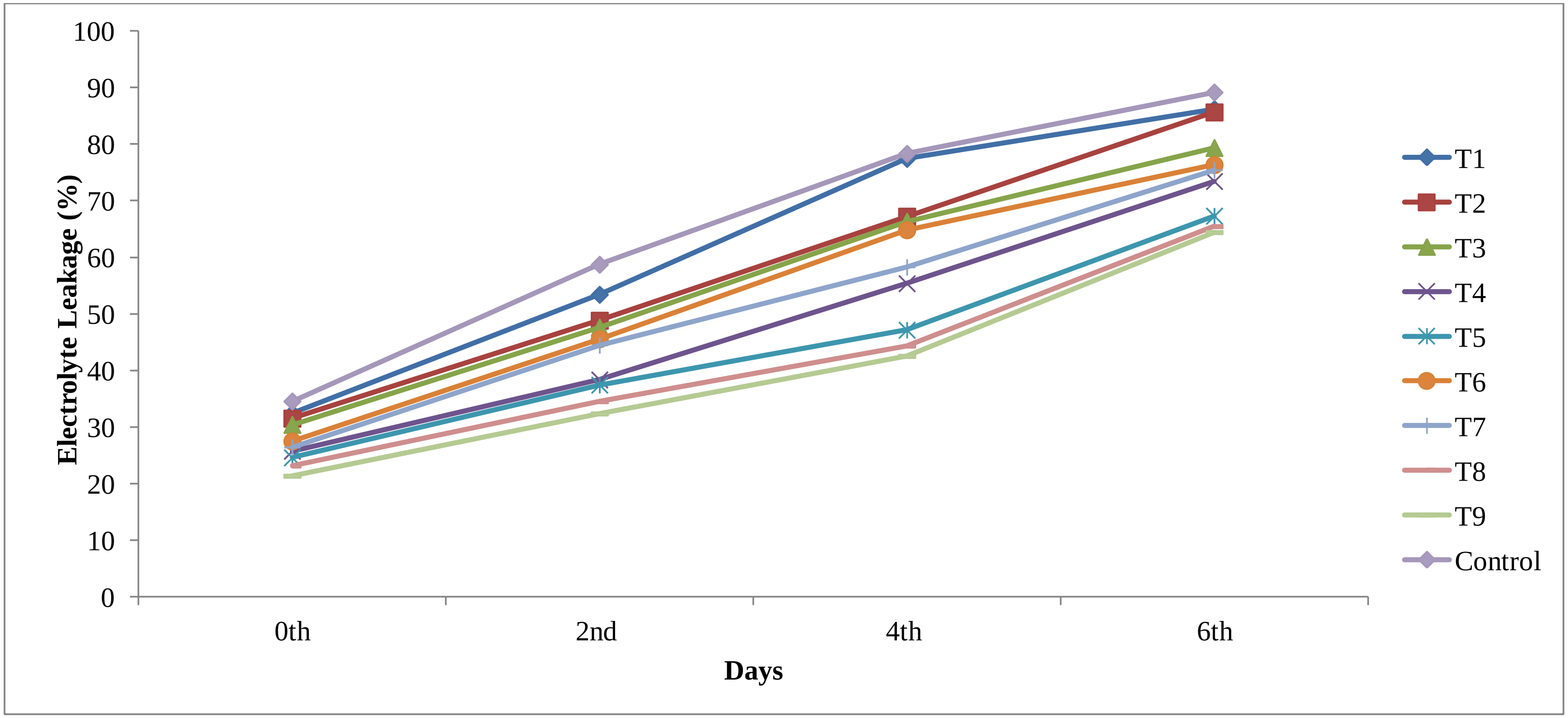


Fig 5.7: Effect of postharvest application of sucrose 4% + $(Al_2SO_4)_3$ @ 200 ppm on Electrolyte leakage (%) during vase life period of China aster CV. Kamini.

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

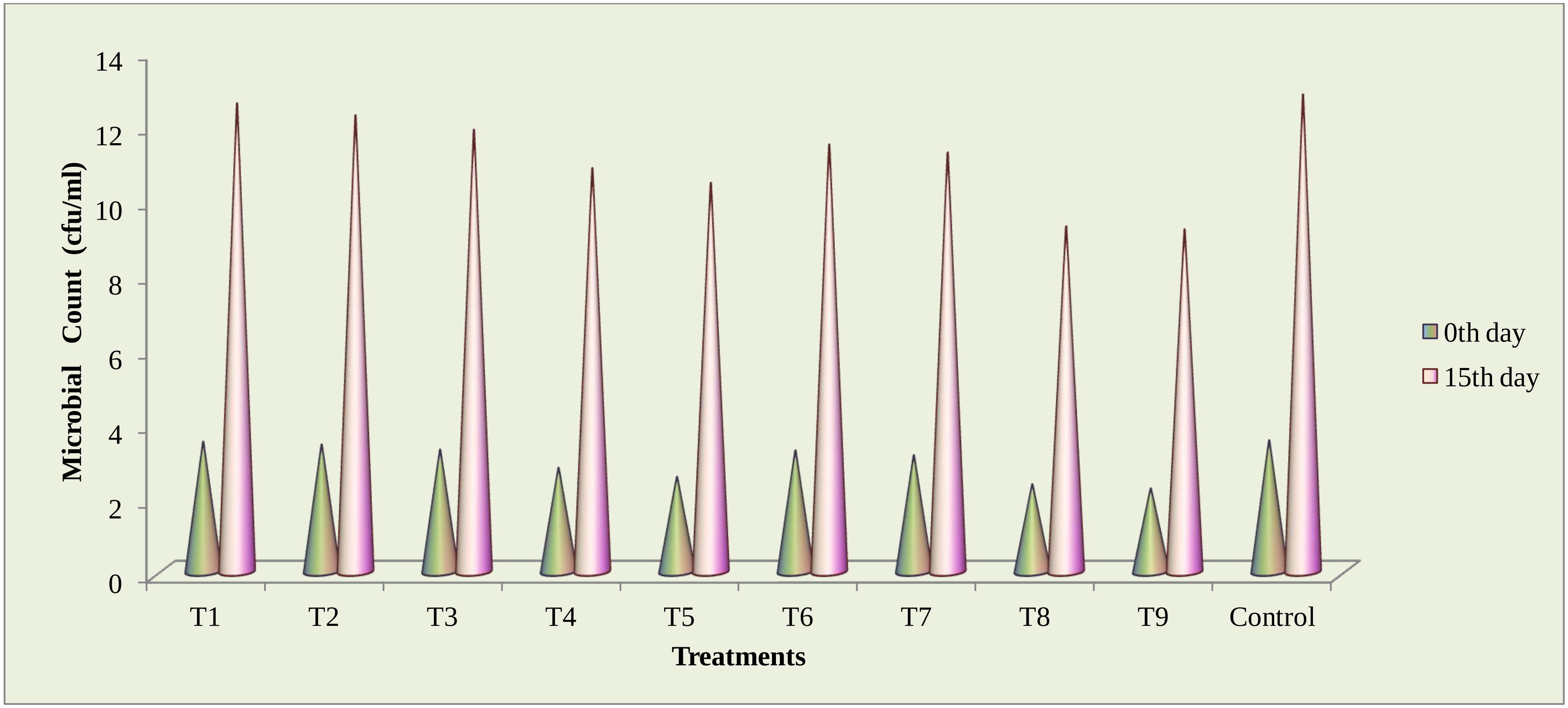


Fig 5.8: Effect of postharvest application of sucrose 4% + $(Al_2SO_4)_3$ @ 200 ppm on microbial count (cfu/ml) during vase life period of China aster CV. Kamini.

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

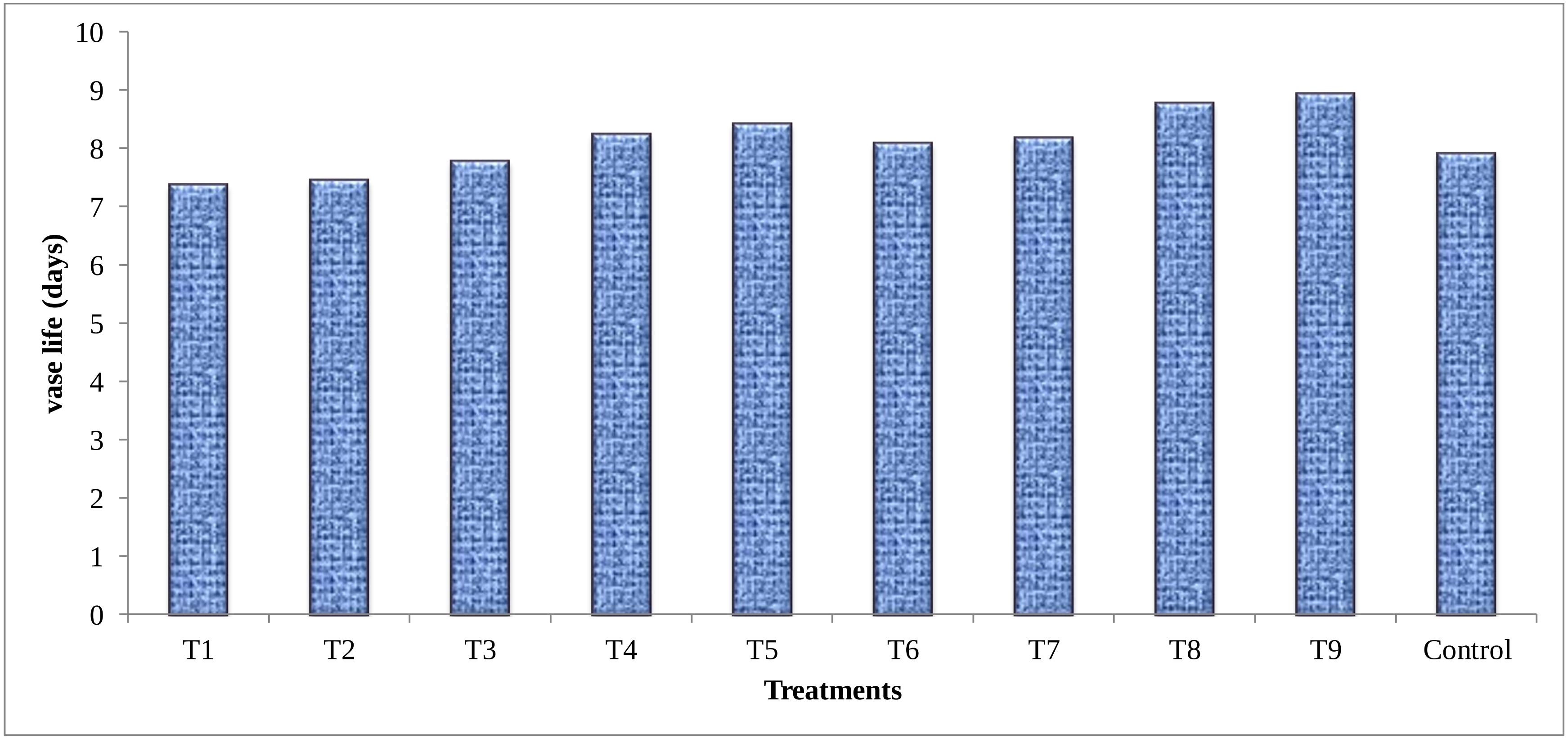


Fig 5.9: Effect of postharvest application of sucrose 4% + $(Al_2SO_4)_3$ @ 200 ppm on vase life period (days) of China aster CV. Kamini.

T_1 – 50% WSF	**T_4 – 50% WSF + AMC**	**T_7 – 75% WSF + VC**
T_2 – 75% WSF	**T_5 – 75% WSF + AMC**	**T_8 - 50% WSF + AMC + VC**
T_3 – 100% WSF-Control	**T_6 – 50% WSF + VC**	**T_9 – 75% WSF + AMC +VC**

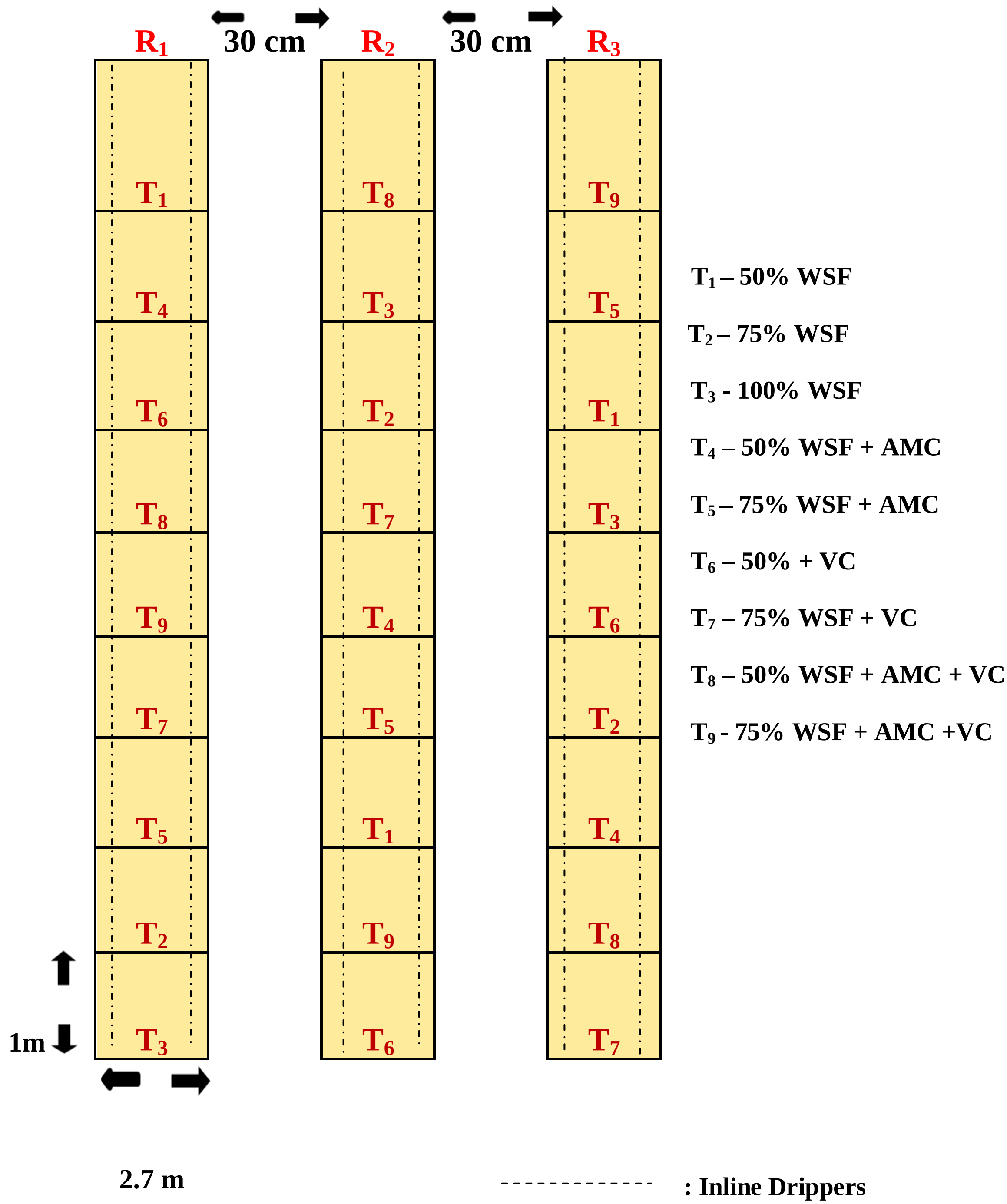


Fig 1: Field layout plan of experiment-I

CHAPTER V

SUMMARY AND CONCLUSION

The present investigation entitled **"Study on the performance of China aster [*Callistephus chinensis* (L.) Nees] CV. Kamini under integrated nutrient management** was undertaken to evaluate the growth and yield of China aster cv. Kamini under different combinations of water soluble fertilizers through fertigation, vermicompost and Arka microbial Consortium during October 2017- April 2018 at Floricultural Research Station, Rajendranagar, Hyderabad. The research aimed at cost effective production technology for quality cut flowers for the domestic market in Telangana and to elicit the information on growth, flowering, yield, benefit cost ratio and vase life of the cut flowers. The study was carried out in two experiments a field and a laboratory experiment. The salient features of the findings are summarized here under.

Among the treatments, 75% Water soluble fertilizers in combination with Arka Microbial Consortiumand vermicompost (T_9) has recorded significantly highest plant height at 30 days (9.56 cm), 45 days (16.58 cm), 60 days (37.54cm), 75 days (46.96 cm) and 90 days (57.55 cm) after planting. This was followed by the treatment 50% water soluble fertilizers in combination with Arka microbial consortium and vermicompost, while the treatment 50% water soluble fertilizers recorded lowest plant height at 30 days (7.54 cm), 45 days (13.92 cm), 60 days (25.73cm), 75 days (36.96 cm) and at 90 days (45.23 cm) after planting.

The highest stem girth was recorded in the treatment 75% Water soluble fertilizersin combination with Arka microbial Consortium and Vermicompostat 30 days (3.86 mm), 45 days (6.51 mm), 60 days (10.53 mm), 75 days (11.44 mm) and 90 days (13.12mm) after planting while the lowest stem girth was recorded in the treatment 50% water soluble fertilizes at 30 days (2.16 mm), 45 days (4.36 mm), 60 days (8.19 mm), 75 days (9.25 mm) and 90 days (10.49 mm) after planting.

The number of branches were highest in the treatment 75% water soluble fertilizers in combination with Arka microbial consortium and vermicompost at 30 days (3.48), 45 days (7.60), 60 days (10.29), 75 days (17.48) and 90 days (26.42) after planting followed by the treatment combination 50% water soluble fertilizers , Arkamicrobial consortium and vermicompost,while the lowest number of branches were recorded in the treatment 50% water soluble fertilizers at 30 days (2.28), 45 days (4.23), 60 days (5.66), 75 days (11.72) and at 90 days (19.56) after planting.

The treatment 75% water soluble fertilizers + Arka microbial consortium + vermicompost recorded maximum total fresh weight (123.16 g) and total dry weight (41.44 g) followed by the treatment 50% water soluble fertilizers in combination with Arka microbial consortium and vermicompost, while the minimum total fresh weight (98.59 g) and total dry weight (32.26 g) were recorded with the treatment 50% water soluble fertilizers.

Among different treatment combinations,the treatment 75% water soluble fertilizers in combination with Arka microbial consortium and vermicompost recorded maximum plant spread in the E-W (28.41) and N-S (26.75) directions at 50% flowering stage followed by the treatment combination 50% water soluble fertilizers, Arka microbial consortium and vermicompost. However the minimum plant spread was with 50% water soluble fertilizers.

The treatment 75% water soluble fertilizers in combination withArka microbial consortium and vermicompost was recorded with minimum number of days to first flower bud appearance (61.91 days) and 50% flowering (80.67 days) followed by the treatment combination 50% water soluble fertilizers, Arka microbial consortium and vermicompost. The maximum number of days for first flower bud appearance (72.03 days) and 50% flowering (92.16 day) was recorded with 50% water soluble fertilizers.

Flower quality parameters like flower diameter (6.36 cm) and flower stalk length (30.75 cm) were highest in the treatment 75% water soluble fertilizers in combination with Arka microbial consortium and vermicompost. This was followed by the treatment combination 50% water soluble fertilizers, Arka microbial consortium and vermicompost while the minimum diameter (4.72 cm) and stalk length (22.03 cm) were with 50% water soluble fertilizers.

In case of yield parameters like number of flowers per plant (51.40), number of harvesting (5.70), weight of 100 flowers (338.54g), flower weight per plot (4.92 kg) and flower yield per hectare (18.80 t/ha) maximum values were recorded with 75% water soluble fertilizers along with Arka Microbial Consortium and Vermicompost followed by the treatment 50% water soluble fertilizers + Arka microbial consortium + vermicompost whereas the lowest values were recorded with 50% water soluble fertilizers.

The treatment 75% water soluble fertilizers + Arka microbial consortium + Vermicompost recorded maximum field vase life (18.75 days) and flowering duration (60.56 days) followed by the treatment 50% water soluble fertilizers + Arka microbial consortium + vermicompost while 50% water soluble fertilizers recorded minimum flower field life (12.84 days) and flowering duration (50.06 days).

In case of physiological parameters like leaf chlorophyll content at 50% flowering and leaf nutrient composition (NPK) at harvest maximum values were recorded in the treatment 75% water soluble fertilizers + Arka microbial consortium + Vermicompost followed by the treatment 50% water soluble fertilizers + Arka microbial consortium + vermicompost while treatment 50% water soluble fertilizers recorded minimum values.

Available nutrients in the soil (NPK) at the time of planting recorded no significant differences with respect to nitrogen, phosphorous and potassium.

The flowers collected from the treatment 75% water soluble fertilizers + Arka microbial consortium + Vermicompost held in 4% sucrose + 200 ppm $Al_2(SO_4)_3$ has recorded significantly maximum vase life as evidenced by significantly highest water uptake, TSS, fresh weight, fresh weight change, flower diameter and significantly lowest transpirational loss of water, microbial count and electrolyte leakage over control due to better utilization of sucrose and reduced microbial growth due to $Al_2(SO_4)_3$ followed by the flowers collected from the treatment 50% water soluble fertilizers in combination with Arka microbial consortium and vermicompost. The minimum values were recorded in the control.

As far as the economics is concerned the treatment 75% water soluble fertilizers + Arka microbial consortium + Vermicompost recorded maximum net returns and B:C ratio (2.23) followed by the treatment 50% water soluble fertilizers + Arka microbial consortium + vermicompost (2.01).The treatment 50% water soluble fertilizers recorded minimum net returns and B:C ratio (0.81).

Based on the above results it can be concluded that the treatment 75% water soluble fertilizers along with vermicompost and Arka Microbial Consortium has found to be promising for better vegetative, flower and yield quality as well as vase life. The same treatment has also recorded higher net returns and benefit cost ratio. These results show that there is an ample scope for the substitution of inorganic fertilizers with water soluble fertilizers through fertigation in combination with organic manure and bio inoculants.

Therefore an integrated approach with specific emphasis on organic manures along with fertigation and bi inoculants should be encouraged to produce maximum vegetative growth, flower and yield with best quality considering the soil health in view for popularizing the cultivation of China aster cv. Kamini. Moreover it has found to be a cost effective method for the commercial cultivation with higher net returns and hence it can be recommended to the farmers.

FUTURE OUTLINE OF WORK

- Standardization of integrated nutrient management practices in China aster.
- Introduction of organic mulching along with fertigation under integrated nutrient management.
- Role of application of organic manure and bio inoculants supplements through fertigation.
- Role of locally available preservatives and mineral salts on vase life of China aster.

LITERATURE CITED

Ali Salehi, Sardoei., Ali Roien., Tayyebeh, Sadeghi., Fatemeh, Shahadadi. and Tayyebeh, Sattaei, Mokhtari. 2014. Effect of Vermicompost on the Growth and Flowering of African Marigold (*Tagetes erecta*). *American-Eurasian J. Agric. & Environ. Sci*. 14 (7): 631-635.

Amita, Chattopadhyay. 2014. Effect of Vermiwash and Vermicompost on an ornamental flower, *Zinnia* sp. *Journal of Horticulture.* 1(3).

Anand, M., Sankari, A. and Arulmozhiyan, A. 2016. Studies on the effect of integrated nutrient management in *Cymbidium giganteum* under shevaroy condition. *The Bioscan*e. 11(1): 439-443.

Anil, K. S., Gupta, S. and Singh, A. K. 2009. Influence of various potting media on vegetative and root characteristics in wax begonia. *Journal of Ornamental Horticulture*, 12 (2): 111-115.

Anjupal, Kumar, S. and Srivastava, R. 2003. Effect of floral preservatives on post harvest management in gladiolus spikes. *Journal of Ornamental Horticulture*. 6(4): 367-371.

Arora, J. S. and Kushal, S. 2002. Pre and post harvest management of cut flowers. *Indian Horticulture*. 1: 20-23

Arvind Kumar, Verma., Sindhu, S.S., Janakiram, T., Singh, M.C., Anupama, Singh., Bhupinder, Singh. and Sharma, R.R. 2013. Influence of vermin-products and pusa hydrogel on growth and flowering of landscape gerbera under green house condition. *Intl.J.Agric. Env. Biotech. 6(1): 109-115.*

Arvinder, singh., Sharma, B. P., Gupta, Y. C., Dilta, B. S. and Nomita, Laishram. 2013. Response of carnation (*Dianthus caryophyllus*) cv. Master to water soluble fertilizer Sujala (19:19:19 NPK). *Indian Journal of Agricultural Sciences* 83 (12): 1364– 1367.

Asciutto,K., Rivera, M.C., Wright, E.R., Morisigue, D. and Lopez, M.V. 2006.Effect of vermicompost on the growth and health of *Impatients wallerana*. *Int.J.Exper.Botany*. 75: 115-123.

Bantikumar., Sunil, Malik., Mukesh, Kumar., Singh, M. K. and Vipin, Kumar. 2007. Post harvest Quality and Vase life of Tuberose (*Polianthes tuberose* Linn.) Cut spikes as affected by vase chemicals. *Journal of Ornamental Horticulture.* 9(4):262-65.

Barman, D. and Rajni, K. 2006. Effect of chemicals and Post harvest life of cut rose cultivar First Red. *Journal of Ornamental Horticultue.* 9(4): 262-65.

Basoli, M., Kumar, P., Kumar, S. 2014. Impact of integrated nutrient management on post- harvest and corm characters of gladiolus cv. Novalux. *Annual of Horticulture,* 7(2): 109-114.

Bellubbi,S.B., Kulkarni,B.S. and Patil, C. P. (2015). Effect of integrated nutrient management on growth and flowering of gerbera (*Gerbera jamesonii* L.) var. Rosalin under naturally ventilated polyhouse condition. *International of Agriculture Science and Veterinary Medicine.* 1(1):69-74.

Bhaskar, V. V. and Rao, P. V. 1998. Effect of plant growth regulators on the post harvest life of tuberose. *Journal of Ornamental Horticulture*. 9(4): 248-52.

Bhaskar, V.V., Rao, P. V. and Reddy, Y.N. 2000. Effect of Certain Chemicals on the post harvest vase life of cut tuberose (*Polianthes tuberose* L.). Cv. Double. *Journal of Ornamental Horticulture.* (New Series). 3(1): 6-11.

Bhaskar, V.V., Rao, P.V. and Reddy, Y.N. 1999. Effect of minerals on the post harvest vase life of cut tuberose cv. Double. *Indian Journal of Horticulture*. 12(1):35-38.

Bhatt, D., Desai, J. R. and Bhakta, D. (2016). Effect of bioinoculants on growth and yield of African marigold (*Tagetes erecta* L.) cv.push narangi gainda. *An International Quarterly Journal of Life Sciences*. 11(1):331-334.

Chaitra, R.. 2006. Effect of integrated nutrient management on growth, yield and quality of China aster (*Callistephus chinensis* Nees) Cv. Kamini. M. Sc. (Agri.) Thesis. *Univ. Agric. Sci.*, Dharwad.

Chaitra,R. and Patil,V.S. 2007. Integrated nutrient management studies in China aster (*Callistephus chinensis* (L.) Nees). *Karnataka Journal of Agricultural Sciences* 20(3): 689-690.

Chamani, E., Joyce, D. C. and Reihanytabar, A. 2008. Vermicompost effects on the growth and flowering of *Petunia hybrida* Dream Neon Rose. *American-Eurasian Journal Agriculture and Environmental Science,* 3 (3): 506 – 512

Chapman, H. D. and Pratt, P. F. 1961. Handbook of reference methods for plant analysis. Ed. Yash Karla, Publication. CRC Press, New York.

Chaudhary,N, Swaroop,K, Janakiram,T, Biswas,D.R. and Singh,G. 2013. Effect of integrated nutrient management on vegetative growth and flowering characters of gladiolus. *Indian Journal of Horticulture.* 70(1):156-159.

Chauhan, R. V., Varu, D. K., Kava, K. P. and Savaliya, V. M. 2014. Effect of different media on growth, flowering and cut flower yield of gerbera under protected condition. *Asian. J. Hort.* 9(1):228-231.

Chougala, V. 2011. Integrated nutrient management studies in Double Daisy (*Aster amellus* L.). *M.Sc (Ag.)Thesis*,UAS, Dharwad, Karnataka.

Davood, Hashemabadi. 2014. Response of Cut Carnation cv. Tempo to Essential Oils and Antimicrobial Compounds. *Journal of Agricultural Engineering and Food Technology*.1(1): 1-6.

Ganesh, S., Kannan, M. and Jawaharlal, M. 2014. Optimization of fertigation schedule for cut chrysanthemum (*Dendranthema grandiflora Tzelev*). *Hort Flora Research Spectrum.* 3(4): 344-348.

Gaurav, S., Naresh, P. S. and Neeraj, S. 2017. Effect of bio organic and inorganic nutrient sources on growth and flower production of African marigold. *Horticulturae.* 3(11): 1-5.

Gopinath, G. (2001). Growth, quality and productivity of carnation (*Dianthus caryophyllus* L.) under cost effective greenhouse as influenced by levels of fertigation, sources of fertilizers and bio inoculants. *Ph.D. (Hort.) Thesis.*UAS Bangalore (India).

Gopinath, G. and Chandrasekhar, S. Y. 2009. Yield of carnation as influenced by levels of fertigation and sources of nutrients of growing standard carnation cv. Trendy under cost effective greenhouse. *Journal of Ornamental Horticulture*. 12(4): 251-255.

Harish, M.S., Shariff, A., Fazulla, Koli, R., Shubha, A.C. and Basavaraju,G.V. (2015).Vase life studies as influenced by biofertilizers in different sized gladiolus seed corms (*Gladiolus grandiflorus* L.) cv. Piccardy. *Trends in Biosciences*. 8(18):4832-4836.

Hiscox, J. D and Israelstam, G. F. 1979. A method for the extraction of chlorophyll from leaf tissue without maceration. *Canadian Journal of Botany.*57(12): 1332-1334.

Ila, Pithiya., Varu D. K. and Mital, Vaghasiya. 2016. Study of INM on growth, yield and quality in China aster [*Callistephus chinensis* (L.) Ness] cv. “Phule Ganesh Pink”. *Green Farming*. 7 (3): 677-679.

Jackson, M. L. 1967. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, pp. 182-92.

Jainag, K., Jayaprasad, K.V., Krishna, manohar, R., Shivanand, Hingal. and Prakash, K. 2011. Effects of levels of fertigation on growth and yield of bird of paradise (*Strelitzia reginae* Ait.). *Asian J. Horti.* 6(1): 118-121.

Jawaharlal, M. and Padmadevi, K. (2003). Effect of bio fertilizers on growth and flowering of anthurium (*Anthurium andreanum* Linn). Cv. Temptation.

National Symposium *Recent advances in Floriculture*. Vellanikara, India, Kerala Agricultural University, p. 32-34.

Jhuma Das, Madhumita, C. T. and Pradip, M. 2012. Effect of fertigation on nutrient uptake on anthurium. *Indian J. Hort.* 69(4): 568-572.

Kaplan, L., Tlustoš, P., Szakova, J., Najmanova, J. and Brendova, K. 2016. The effect of NPK fertilizer with different nitrogen solubility on growth, nutrient uptake and use by chrysanthemum. *Journal of Plant Nutrition*. 39(7).

Khalid, M. Elhindi. 2012. Evaluation of composted green waste fertigation through surface and subsurface drip irrigation systems on pot marigold plants (*Calendula officinalis* L.) grown on sandy soil. *AJCS* 6(8):1249-1259.

Khalid, Elhindi., Salah, El-Hendawy., Eslam, Abdel-Salam., Abdallah, Elgorban. and Mukhtar, Ahme. 2016. Impacts of fertigation via surface and subsurface drip irrigation on growth rate, yield and flower quality of *Zinnia elegans*. *Bragantia.* 75(1).

Khan, F. U., Khan, F. A., Hayat, N. and Bhat, A. 2007. "Influence of certain chemicals on vase life of cut tulip", *Indian Journal of Plant Physiology*. 12: 127-132.

Kore, V.N., Meman, S.I. and Burondkar, M.M. 2003. Effect of GA_3 and fertigation on flower quality and yield of China aster Cv. 'Ostrich Plume Mixed' under Konkan Agro-climatic conditions. *J. Ornamental Hort.*, 31(1): 82.

Krishnappa, K. S., Reddy, S. N. and Anjanappa. 2004. Effect of Floral Preservatives on the vase life of carnation cut flower cultivars. *Karnataka Journal of Agricultural Sciences.* 13: 395-400.

Kumar, D., Singh, B.P. and Singh, D. 2009. Effect of integrated nutrient management on growth, flowering behaviour and yield of African marigold (*Tagetes erecta* L.) cv. African Giant Double Orange. *J. Hort. Sci.* 4 (2): 134-137.

Kumar, M. 2015. Flower and bulb production in tuberose (*Polianthes tuberosa* L.*)* cv. "Vaibhav*"* as influenced by different nutrients sources. *HortFlora Res*. *Spect*. 4(1): 56-59.

Kumar, M. 2014. Effect of different sources of nutrients on growth and flowering in gladiolus (*Gladiolus hybridus* Hort.) cv. Peater Pears. *Annals of Horticulture* 7(2): 154-158.

Kumar, R., Ahmed, N., Singh, D. B. and Sharma, O. C. 2012. Enhancing water relations and vase life of cut tulip (*Tulipa gesneriana* L.) using floral preservatives. *Journal of Applied Horticulture*. 14(2): 152-156.

Kumari, S. and Prasad, V.M. 2017. Effect of bio and chemical fertilizers on plant growth and yield of petunia (*Petunia hybrid*) var. Picotee. *International Journal of Chemical Studies.* 5(4): 1251-1254.

Kurakula, Divya., Girwani, A., Vijaya, D. and Prashanth, P. 2017. Effect of Levels of Fertigation on Growth and Flowering of Marigold (*Tagetes erecta* L.) CV. Pusa Narangi Gainda. *Int.J.Curr.Microbiol.App.Sci*. 6(12): 1146-1151.

Laishram, N. 2011. Studies on Integrated Nutrient Management for Commercial Flower Production of Chrysanthemum (*Dendranthema Grandiflora* Tzelev). *M.Sc. (Ag) Thesis.* YSP Uni. of Hort. & For., Nauni, Solan.

Lakshmi Durga, M., Jawaharlal, M. and Kannan, M. 2016. Coupling effect of fertigation and foliar application of micro nutrients on growth, yield and quality of carnation (*Dianthus caryophyllus*) Cv. Bizet. *Indian Journal of Agricultural Sciences.* 86(10).

Lal Singh., Gurjar, P. K. S., Barholia, A. K., Haldar, A. and Shrivastava, A. 2015. Effect of organic manures and inorganic fertilizers on growth and flower yield of marigold (*Tagetes erecta* L.) var. Pusa Narangi Gainda. *Plant Archives*. 15(2): 779-783.

Liao, L. J., Lin, Y. H., Huang, K. L. and Chen, W. S. 2001. Vase life of *Eustoma grandiflorum* as affected by aluminum sulphate. *Botany Bulletin of Academic Science.* 42: 35-38

Madinat-ul-Nisa., Malik, K.M. and Rather,Z.A. 2016. Effect of biofertilizers on growth, flowering and corm yield in Gladiolus (Tourn.) L. cv. Priscilla. *Green Farming.* 7(5): 1256-1259.

Maninderpal, Singh., Sharma, B. P. and Gupta, Y.C. 2017. Response of China aster (*Callistephus chinensis* (L.) Nees) cv. Kamini to different combinations of NPK and biofertilizers. *Indian Journal of Horticulture*. 74(3): 458.

Manoj, Kumar, Rolaniya., Khandelwal, S. K., Choudhary, A. and Priynka Kumari, Jat. 2017. Response of African marigold to NPK, biofertilizers and spacings. *Journal of Applied and Natural Sciences.* 9(1): 593-597.

Mayak, S.Y, Vaddia .and Dilley, D.R. 1977, Regulation of senescence in carnation (Dianthus caryophyllus L.) to ethylene, Mode of action. *Plant Physiol*. 59:591-593.

Meshram, N., Badge, S., Bhongle, S. A. and Khiratkar, S.D. 2008. Effect of bio inoculants with graded doses of NPK on flowering, yield attributes and economics of annual Chrysanthemum. *J. Soils and Crops.* 18(1): 217-220.

Mittal, R., Patel, H.C., Nayee, D.D. and Sitapara, H.H. (2010). Effect of integrated nutrient management on flowering, yield and vase life of African marigold (*Tagetes erecta* L.) cv. Local under middle Gujarat agro-climatic conditions. *Asian Sciences*. 5(1):22-24.

Muhammad, Tanveer, Ahmad., Muhammad, Yousaf., Adnan, Noor, Shah., Jamil Khan, M., Shah, Fahad., Bashir, Ullah., Zahoor., Jalal-U-Din, Balouch. and Muhammad, Iqbal. 2015. Different Level of Fertigation Influences Rose Flowering and Production. *Journal of Biology and Medical Sciences*. Vol 3.

Munikrishnappa, P.M. and Chandrasekhar, S.Y. 2014. Integrated nutrient management studies in China aster (*Callistephus chinensis* L. Nees): A Review. *Trends in Bioscience*. 7(12): 1217-1221.

Muthamizhselvi, M., Arulmozhiyan, R., Jawaharlal, M. and Mani, S. 2006. Integrated nutrient management on nutrient content of leaves and uptake in chrysanthemum (*Dendranthema grandiflora Tzelev*.) Cv. Co.1. *S. Ind. Hort*. 54 (1-6): 318-322.

Naik, R., Jayanthi, R. and Gangadharswamy, S.D. 2009. Effect of chemical fertilizers, biofertilizers and GA_3 on growth and flowering of anthurium (*Anthurium andrearum* Lind.) cv. Red Crinkle. Paper presented in the *International Conference on Horticulture* held during 9-12 November, 2009, organized by Dr P.N. Agricultural Science Foundation, Bangalore, pp. 189.

Namita, Ramesh, K. and Kushal, S. 2006. Effect of pre storage pulsing on storage life of gladiolus cut spikes. *Journal of Ornamental Horticulture*. 9(4): 258-61.

Narendra, Chaudhary., Kishan, Swaroop., Janakiram, T., Biswas, D. R. and Geeta, Singh. Effect of integrated nutrient management on vegetative growth and flowering characters of gladiolus. *Indian J. Hort*. 70(1): 156-159.

Neelima, Palagani., Barad, A. V., Nilima, Bhosale. and Thumar B.V. 2013. Influence of integrated plant nutrition on growth and flower yield of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. IIHR-6 under Saurashtra condition. The *Asian Journal of Horticulture*. 8(2): 502-506.

Olsen, S. R. 1954. Estimation of available phosphorous in soil by extraction with sodium bicarbonate. *U.S Dept. of Agriculture, Washington D.C.* Circular no.939.

Padaganur, V. G., Mokashi, A. N. and Patil, V. S. 2005. Flowering, flower quality and yield of tuberose (*Polianthes tuberosa* L.) as influenced by vermicompost farmyard manure and fertilizers. *Karnataka journal of Agriculture Science.* 18 (3):729 -734.

Palaniswamy., Kannan, D., Siddharth Shankar, Bhatt. and Naganagouda Patil. 2015. Effect of nutrient concentration on yield and quality of Gerbera (*Gerbera jamesonii bolus* ex hooker.f) under polyhouse in southern hills (Shevaroy). *Indian Horticulture journal*. 5(1/2): 1-5.

Panchal, R.V., Parekh, N.S., Parmar, A.B. and Patel, H.C. (2010). Effect of biofertilizers and nitrogenous fertilizer on growth, flowering and yield of annual white chrysanthemum (*Chrysanthemum coronarium* L.) under middle Gujarat agro-climatic conditions. *Asian J.Hort*. 5(1): 22-25.

Pandey, S.K., Kumari, S., Singh, D., Singh, V.K. and Prasad, V.M. 2017. Effect of biofertilizers and organic manures on plant growth, flowering and tuber production of Dahlia (*Dahlia variabilis* L.) Cv. S.P. Kamala. *Int. J. Pure App. Biosci*. 5(2): 549- 555.

Panse, V. G and Sukhatme, P.V.1967.Statistical Methods for Agricultural Workers ICAR, New Delhi, p.328.

Panse, V. G and Sukhatme, P.V.1985.Statistical Methods for Agricultural Workers, 4th edition, ICAR, New Delhi, p.347.

Pansuriya, P. B. and Chauhan, R. V. 2015. Effect of Integrated Nutrient Management on Growth, Yield and Quality of Gladiolus (*Gladiolus grandiflorus* L.) Cv. Psittacinus Hybrid. *Journal of Horticulture.* 2(2).

Patel, P. R., Patel, N. K., Valia, R. Z. and Chaudhari, S. R. 2011.Effect of nitrogen and vermicompost on floral and yield parameters of African marigold. *The Asian Journal of Horticulture.* 6(2): 478-480.

Patil, R. V., Bhosale, A. B. and Takte, R. L. 2010. Effect of drip irrigation and fertigation levels on growth and yield of gerbera under greenhouse conditions. *Environment and Conservation.* 16(2): 235-237.

Parya, C., Pal, B. K. and Biswas, J. 2010. Influence of integrated nutrient management on flower production efficiency, behaviour and quality of golden rod. *Environment and Ecology*. 28 (4): 2203-2205.

Prasad, K., Aggarwal, A., Yadav, K. and Tanwar, A. 2012. Impact of different levels of superphosphate using arbuscular mycorrhizal fungi and *Pseudomonas fluorescens* on *Chrysanthemum indicum* L. *J. Soil Sci.Plnt Nutr.*12(3): 451- 462.

Prashant. 2006. Studies on effect of different postharvest treatments on physiological and bio chemical changes in cut gerbera Cv. Yanara. *Ph.D (Horti). Thesis* submitted to ANGRAU Hyderabad.

Prashant, Singh., Prakash, S., Mukesh, Kumar., Sunil, Malik., Singh, M.K. and Arvind, Kumar. 2015. Effect of integrated nutrient management (INM) on growth, flowering and yield in marigold (*Tagetes erecta* L.) Cv. Pusa Basanti. *Annals of Horticulture.* 8(1): 73-80.

Premkumar, A., Punetha, Parul., Bohra, Mamta., Upadyay, Sandeep. and Nautiyal, B. P. 2016. Response of chrysanthemum cultivar Dolly White to different sources and combinations of organic manures under the mid hill regions of Uttarakhand. *International Journal of Agriculture Sciences.* 8(59): 3294-3297.

Rahul, Singh., Mukesh, Kumar., Smeeksha, Raj. and Sanjay, Kumar. 2014. Flowering and Corm Production in Gladiolus (*Gladiolus grandiflorus* L.) Cv. “White Prosperity” as influenced by Integrated Nutrient Management (INM). *Annals of Horticulture*. 7(1): 36-42.

Raja Babu, K., Sumangala, H. P., Rupa, T. R., Sangama. and Sujatha, A. Nair. 2018. Effect of Fertigation, Irrigation and Mulching on Growth, Flowering and Yield Parameters in African Marigold. *Int.J.Curr.Microbiol.App.Sci*. (2018) 7(3): 685-692.

Ranvir, singh. and Sashikala, B. 2002. Post harvest life of gladiolus as influenced by floral preservatives. *Journal of Ornamental Horticulture*. 8(2): 115-118.

*Richard, L.A.1954. Diagnosis and improvement of saline-alkali soils. *USDA Hand book No.60. Washington D.C. USA.*

Salathia, V.S. 2005. Studies on organic cultivation of *Valeriana jatamansi*. Jones. http://www.yspuniversity.ac.in/fpu/theis/fpu-mscabstracts.doc.

Shoaf, T. W. and Lium, B. W. 1976. Improved extraction of chlorophyll a and b from algae using di methyl sulfoxide-limnol. *Oceanography*. 21: 926-928.

Shrikant, M. and Jawaharlal, M. 2014. Effect of fertigation level and biostimulants on quality parameters of gerbera var. Debora under polyhouse conditions. *Trends in Bio sciences.*7(11): 1134-1137.

Shubha, B. M. 2006. Integrated Nutrient Management for growth, flowering and xanthophylls yield of marigold (*Tagetes erecta.* Linn). *M.Sc. (Ag) Thesis*, UAS, Dharwad.

Sonawane, S. P., Dabke, D. J., Dabke, S. B. and Dhane, S. S. 2009. Effect of nitrogen, phosphorous and FYM on yield and nutrient uptake by China aster (*Callistephus chinensis* (L.) Nees). *Journal of Maharashtra Agriculture University*. 34 (1): 90-91.

Sowmya, K. A. and Prasad, V. M. 2017. Effect of NPK and Bio-Fertilizers on Growth, Yield, Quality of China Aster (*Callistephus chinensis*) cv. Shashank for Cut Flower Production under Agro Climatic Conditions of Allahabad, India. *Int.J.Curr.Microbiol.App.Sci*. (2017) 6(10): 3204-3210.

Sunitha, H. M. and Hunje. 2010. Effect of plant spacing and integrated nutrient management on yield and quality of seed and vegetative growth parameters in African marigold (*Tagetes erecta* L.). *J. Orn. Hort.* 10(4): 245-249.

Suresha, G. J., Jayaprasad K. V. and Chikkasubbanna, V. 2009. Extension of vase life of cut chrysanthemum (*Chrysamthemum moriifolium* Ramat.) flower cvs. White Fizii and Peach Fizii. *Asian Sciences*. 4(1&2): 62-64.

Talukadar, M. C., Barooah L. and Baruah, P. 2010. Effect of fertigation in production of standard and spray chrysanthemum under polyhouse conditions. *Indian Journal of Horticulture.* 67: 359-361.

Thakur, R., Dubey, R.K., Kukal, S. S. and Kapoor, S. 2016. Interactive effe t of bio fertilizers and organic potting media on growth and flowering of *Calendula officinalis.* Linn). *Indian Journal of Ecology.* 43(1): 245-248.

Thamara, M. P., Kumar, D. P., Ratnayake, U. A. J., Jayaprasad, K. V. and Krishna manohar, R. 2010. Effect of fertigationon flower yield and quality of China aster (*Callistephus chinensis* (L.) Nees) under open condition. *Mysore.J. Agi. Sci.* 44(1): 39-43.

Thane, S.R. Shembekar, R.Z. Bhongle, S.A. and Badge, S.A. 2007. Effect of integrated nutrient management on flower quality, yield and vase life of gerbera (*Gerbera jamesonii* H. Bolus) grown under shade net conditions. *Plant Archives,* 7 (2): 679-680.

Qasim, M., Iftikhar, A. and Tanveer, A. 2008. Optimizing fertigation frequency for *Rosa hybrid* L. *Pakistan Journal of Botany.* 40(2): 533-545.

Urmila, Singh. and Vikas, kumar. 2016. Studies on Efficacy of Integrated Nutrient Management on Growth and Yield of Marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. *Advances in Life Sciences* 5(20): 9252-9258.

Varu, D. K. and Barad, A. V. 2008. Effect of floral preservatives on quality and vase life of cut flowers tuberose (*Polianthes tuberose* L.) cv. Double. *The Asian Journal of Horticulture.* 3(1): 169-72.

Verma, S.K., Angadi, S.G., Patil, V.S., Mokashi, A.N., Mathad, J.C. and Mummigatti, U.V. 2011. Growth, yield and quality of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Raja as influenced by integrated nutrient management. *Karnataka J. Agric. Sci.* 24 (5): 681-683.

Vijaykumar, N. S., Gopinath, G. and Krishna Manohar, R. 2010. Growth, flowering and post harvest life of China aster as influenced by drip irrigation and fertigation. *Mysore. J. Agri. Sci.* 44 (2): 326-331.

Vishnu, A., Prasad, V. M., Deepthi, B., Srinivas, M. and Rajya laxmi. 2016. Effect of Integrated Nutrient Management on plant growth and flower yield of African marigold (*Tagetes erecta*). Cv. Pusa Basanti. *Environment and Ecology.* 34(3): 841-844.

Waikar, A. U. and Jadhav, S. B. 2012. Response of different potassium fertilizer levels through fertigation on rose (*Rosa hybrida*) Cv. Passion under protected cultivation. *International Journal of Agricultural Engineering.* 5(1): 12-15.

Warade, A. P., Golliwar, V. J., Chopde, N., Lanje, P. W. and Thakre, S. A. 2007. Effect of organic manures and bio fertilizers on growth, flowering and yield of Dahlia. *J. Soils and Crops.* 17(2): 354-357.

Wasim, M., Gupta, N. K., Dubey, S. and Mohanty, A. 2014. Effect of inorganic fertilizers in combination with bio-fertilizers on growth and yield of tuberose (*Polianthes tuberose*). *Indian Hort. J.* 4(1): 37-42.

Yathindra, H. A., Manohar, R.K., Rajesh, A. M. and Harshavardhan, M. 2016. Effect of integrated nutrient management on growth parameters of bird of paradise (*Strelitzia reginae* (L.). *The Bioscan*. 11(1): 565-568.

Zehra, Salma., Pratap, M. and Manohar Rao, A. 2014. Effect of different fertigation levels on growth, quality, yield and vase life of gerbera cultivars grown under polyhouse. *Annals of Biology.* 30(1): 186-188.

* Original not seen.

APPENDIX – I

Meteorological data for the period of experimentation (September 2017 to April 2018) recorded at the meteorological observatory of the Agricultural Research Station, Rajendranagar.

Month	Temperature(^{0}C)			Relative humidity (%)		Rainfall (mm)	No. of rainy days	Sunshine hours	Evaporation (mm)
	Max.	Min.	Mean	Morning	Evening				
September	30.6	21.7	26.15	94	68	4.8	0	5.0	4.0
October	30.9	20.1	25.50	96	56	11.9	0	5.9	3.2
November	30.3	14.6	22.45	89	43	0	0	8.2	3.3
December	28.7	11.1	19.90	89	34.1	0	0	8.5	3.1
January	29.4	10.9	20.15	86	30	0	0	8.7	3.3
February	31.6	13.0	22.30	80	24	0	0	8.8	3.5
March	35.9	17.4	26.65	74	21	0	0	7.8	6.1
April	37.6	21.7	29.65	77	31	0.8	0	8.4	6.7

APPENDIX-II

Cost of Cultivation of China aster CV. Kamini per hectare

Treatments	Cost of WSF Fertilizers	Cost of organic fertilizers	FYM @ Rs 2/kg	Labour Cost		Seed Cost @ 2.5/kg	Fertigation unit Depreciation rate	Repair cost 2500	Insecticides		Total cost of cultivation
				125 Man Days @ 300	107 Women Days 200				Fungicide	Insecticide	
50% WSF	13,390	0	20,000	37,500	21400	7250	22,500	2500	1000	1000	1,26,540
75% WSF	19,796	0	20,000	37,500	21400	7250	22,500	2500	1000	1000	1,32,946
100% WSF	26,620	0	20,000	37,500	21400	7250	22,500	2500	1000	1000	1,39,770
50% WSF +AMC	13,390	175	20,000	37,500	21400	7250	22,500	2500	1000	1000	1,26,715
75% WSF +AMC	19,796	175	20,000	37,500	21400	7250	22,500	2500	1000	1000	1,33,121
50% WSF+VC	13,390	12500	20,000	37,500	21400	7250	22,500	2500	1000	1000	1,39,040
75% WSF+VC	19,796	12500	20,000	37,500	21400	7250	22,500	2500	1000	1000	1,45,446
50% WSF +AMC+VC	13,390	12675	20,000	37,500	21400	7250	22,500	2500	1000	1000	1,39,215
75% WSF +AMC+VC	19,796	12675	20,000	37,500	21400	7250	22,500	2500	1000	1000	1,45,621