REFINEMENT OF MANAGEMENT PRACTICES FOR JASMINE (*Jasminum sambac* L.) IN HUMID TROPICS

By

SMISHA I. S.

THESIS

Submitted in partial fulfilment of the
requirement for the degree of

Master of Science in Horticulture

(POMOLOGY AND FLORICULTURE)

Faculty of Agriculture
Kerala Agricultural University

Department of Pomology and Floriculture

COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR - 680 656
KERALA, INDIA

2007

DECLARATION

I hereby declare that the thesis entitled **"Refinement of management practices for Jasmine (*Jasminum sambac* L.) in humid tropics"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Vellanikkara
29-12-2007

Smisha. I.S.

CERTIFICATE

Certified that this thesis entitled **"Refinement of management practices for Jasmine (*Jasminum sambac* L.) in humid tropics"** is a record of research work done independently by **Ms Smisha .I .S** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, associateship or fellowship to her.

Vellanikkara
29-12-07

Dr. A.Sobhana
(Chairman, Advisory Committee),
Associate Professor, (AICRP),
Dept of Pomology and floriculture,
College of Horticulture,
Vellanikkara.

CERTIFICATE

We, the undersigned members of the Advisory Committee of Ms. **Smisha . I. S,** a candidate for the degree of **Master of Science in Horticulture,** with major field in Pomology and Floriculture, agree that the thesis entitled **"Refinement of management practices for jasmine (*Jasminum sambac* L.) in humid tropics"** may be submitted by Ms. Smisha. I. S, in partial fulfilment of the requirement for the degree.

29/12/07

Dr. A. Sobhana,
(Major Advisor, Advisory Committee)
Associate Professor
Department of Pomology and Floriculture
College of Horticulture
Vellanikkara

29/12/07

Dr. P. K. Rajeevan
(Member, Advisory Committee)
Associate Dean
College of Horticulture
Vellanikkara

29/12/07

Dr. Jyothi Bhaskar
(Member, Advisory Committee)
Associate Professor
Communication Centre
Mannuthy

Dr. P. K. Sushama
(Member, Advisory Committee)
Professor
Dept of Soil Science and
Agricultural Chemistry
College of Horticulture
Vellanikkara.

29/12/07

EXTERNAL EXAMINER

Dr. T. Janakiram,
Principal Scientist,
Division of Ornamental crops,
IIHR Hessaraghatta,
Bangalore - 560089.

Acknowledgement

*I humbly bow my head before the **ALMIGHTY**, who blessed me with will power and courage to complete this endeavour successfully.*

*I have great pleasure to place on record my profound sense of gratitude and indebtedness to **Dr. A. Sobhana,** Assistant Professor in Dept of Pomology and Floriculture and chairperson of my advisory committee for her expert advice, valuable guidance, ever willing help, constructive suggestions, kind concern, unfailing patience, motherly affection and constant encouragement throughout the course of study and preparation of the thesis. I really consider it my greatest fortune in having her guidance for the thesis work.*

*My profound gratitude to **Dr.P.K.Rajeevan** Associate Professor and Head of the Dept of Pomology and Floriculture, member of my advisory committee for his valuable advice, constant encouragement, goodwill and being kind enough to be available for guidance in spite of his busy schedule for the critical scrutiny of the manuscript, suggestions and support rendered throughout the study.*

*I express my sincere thanks to **Dr. Jyothi Bhaskar** Assistant Professor, Department of Pomology and Floriculture member of my advisory committee for her friendly approach, kind concern, whole hearted support and valuable guidance, extended throughout the investigation and various stages of study.*

*I also avail this opportunity to pay my sincere obligations and heartfelt thanks to **Dr. P.K.Sushama,** Associate Professor, Dept of Soil Science and Agricultural Chemistry and member of my advisory committee for her cordial support, ever willing help during the whole chemical analysis.*

It is my pleasant privilege to express my gratitude to ***Dr. P.K Valsalakumari , Dr. C.K.Geetha, Dr. Lila Mathew, Dr.Parameswaran, Dr.Babilatha, Dr. Radha and Dr.Sarah. T. George*** *for their encouragement, kind help and moral support offered at different stages of the study.*

I am genuinely indebted to ***Sri. S. Krishnan,*** *Assistant Professor, Department of Agricultural Statistics, and College of Horticulture for his valuable assistance and guidance during the statistical analysis of the data.*

I express my sincere thanks to ***Dr. Suresh Kumar*** *of Radio Tracer Laboratory, for his valuable guidance and providing facilities for chemical analysis.*

I express my heartfelt gratitude to Jameela chechi, Kuttan chettan, Sakundalachechi and other field workers and without their help I can't complete this venture successfully.

I have no words to express my deep sense of gratitude to my dear friends ***Meghna, Kaveramma and Gayathri*** *for their moral support, encouragement and help throughout the course of my research work.*

I take this opportunity to thank my ever loving friends ***Sreerekha, Jaliya, Blessy, Kukku , Seena , Resmi , Smita , Mable, Remya and Smini,*** *they are always with me not only for the thesis preparation but also during my studies.I also wish my sincere thanks to my juniors Remya.R, Saisree, Kavya, Hima, Hazmin , Archana, Ancy, Prathibha , Nimisha, Deepthi Jose, for their help and concern.*

I am extremely thankful to my seniors ***Mini Sankar, Binisha, Sapheera, Gayathri,*** *Sindhu, Preethi for their kind help and moral support.*

I wish to acknowledge my heartfelt thanks to my friends ***Cinu , Shaneeja , Sini , Lincy , Nisha, Shibi , Suja , Shajna , Veera , Margaratt,***

Grace, Chithra, Lina, Joshy , Renju , Jyothi , Remyamol , Santhosh , Liffy , Premjith, Smitha, and Smitha sara, Dhanya *for all their help.*

I thankfully acknowledge Shri. Santhosh for his valuable help in computer work

Last but not least I also remember my loving friends ***Thasneem, Jismi , Dhanya, Anis, Veena, Ramu, Vinu and Justine*** *for their prayers and concern always with me.*

I am in dearth of words to express my love towards my **parents, sister, in laws and husband** for their boundless affection, moral support, eternal love, deep concern, prayers and personal sacrifices which sustains peace and in my life.

Smisha. I. S

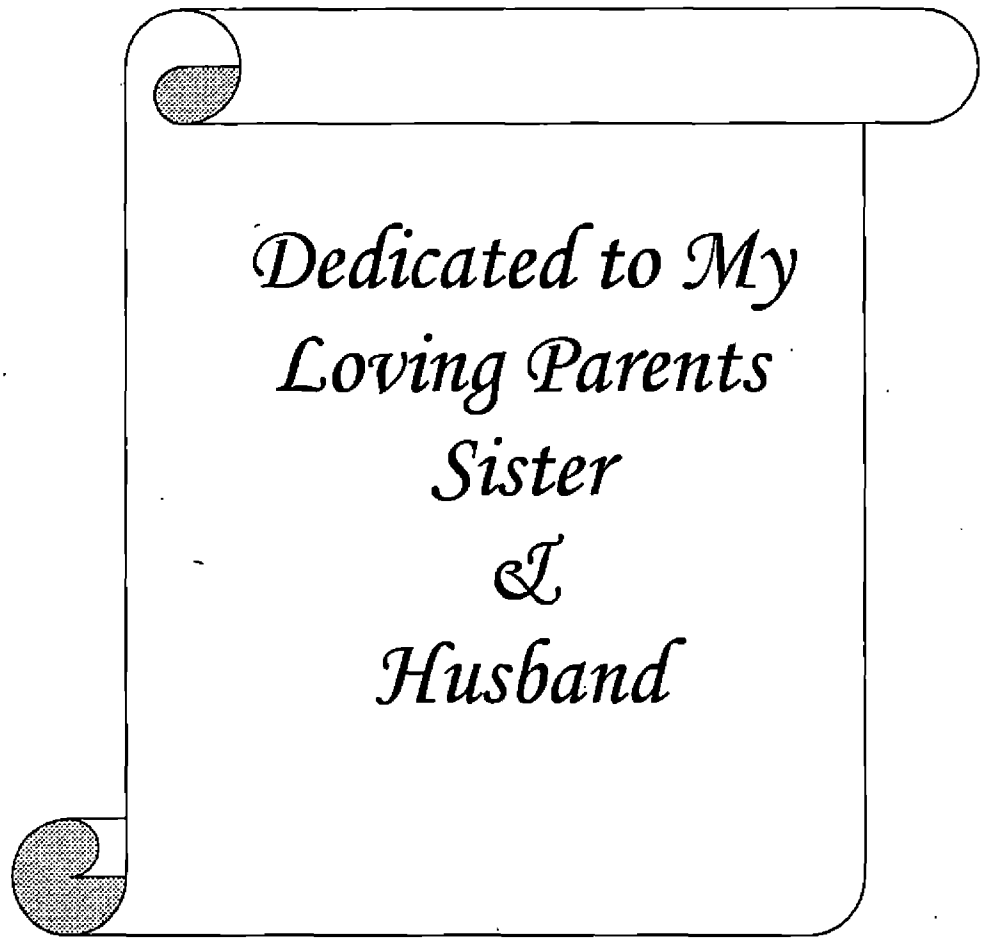

Dedicated to My
Loving Parents
Sister
&
Husband

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

List of plates

Jasmin sambac

India's Moonlight of the Grove

The First Jasmines
by Rabindranath Tagore
(This poem is from 'The Crescent Moon' by Tagore)

AH, these jasmines, these white jasmines!
I seem to remember the first day when I filled my hands
with these jasmines, these white jasmines.
I have loved the sunlight, the sky and the green earth;
I have heard the liquid murmur of the river
through the darkness of midnight;
Autumn sunsets have come to me at the bend of the road
in the lonely waste, like a bride raising her veil
to accept her lover.
Yet my memory is still sweet with the first white jasmines
that I held in my hands when I was a child.
Many a glad day has come in my life,
and I have laughed with merrymakers on festival nights.
On grey mornings of rain
I have crooned many an idle song.
I have worn round my neck the evening wreath of
BAKULAS woven by the hand of love.
Yet my heart is sweet with the memory of the first fresh jasmines
that filled my hands when I was a child.

Introduction

1.INTRODUCTION

Jasmine is one of the important fragrant flowers used even from very ancient days in India. Jasmine flowers have been in use in India for commercial purpose since time immemorial. They are highly esteemed for their attractive and fragrant flowers. It is estimated that at least 20 tonnes of flowers of different kinds of jasmine are sold every day in metropolis of India (Indiresh *et al.* 1992). "Think of fragrance," "Think of jasmine" is a usual saying. Flowers are used for making garlands and for extraction of essential oils. (Randhawa and Mukhopadhyay, 1986). The odour of jasmine is unique and represents a type that cannot be exactly imitated at present by a mixture of any known synthetic aromatic chemicals and natural isolates.

Commercial cultivation is confined to Coimbatore, Madurai, Dindigul, Athoor etc. Apart from internal trade, fresh flowers of jasmine are exported to Malaysia, Singapore and Sri Lanka (Chadha, 2002). There is heavy demand for flowers in kerala state, which is depending on neighbouring states, mainly Tamil Nadu, for meeting the local requirement.

The genuses Jasmine belongs to the family Oleaceae and is native to India and has their origin in the southern foothills of Himalayas (Baily, 1947). Jasmines are cosmopolitan in distribution being found in cultivation under a wide spectrum of climatic conditions ranging from warm humid region of coastal plains up to an elevation of 1300m from sea level. Among the large number of species existing only three species have attained commercial importance. They are *Jasminum sambac*, *J.grandiflorum*, and *J. auriculatum*.

Among the species *Jasminum sambac* is an evergreen twiner. Leaves are simple and opposite. Flowers are white and fragrant. Jasmine prefers well-drained rich sandy loam to clay soils. The ideal conditions for successful cultivation are warm sunshine and mild winter. Jasmine is usually propagated by cutting and layering. Seed propagation though uncommon is necessary for crop improvement through planned hybridization.

Different post harvest management practices like precooling, packaging, chemical treatment and cold storage have been found to be beneficial for extending shelf life of jasmine flowers.

Kerala has a very good potential for jasmine production especially bush jasmine. The main problems are the long spells of rain and high labour charges. However farmers have homestead cultivation of jasmine in small quantities and both pot cultivation and field cultivation are practiced in Kerala. Framers never adopted scientific management and follow their own cultural practices. Jasmine production is very much reduced during the periods of winter months, hence the production during off seasons, will fetch a good price in the market.

Management practices play a key role in regulating the growth and flower production in jasmine. Pruning improves floral yield, quality and plant vigour. Combined effects of pruning along with nutrition management can regulate the flowering time. Jasmine responds to intensive manuring. Indiscriminate use of manure encourages vegetative growth and hampers quality and quantity of blooming. Many commercial growers use only organic manures .Use of bio fertilizers can reduce the quantity of inorganic fertilizers, which in turn may contribute to the quality of flowers.

Hence the present study entitled "Refinement of management practices for jasmine (*Jasminum sambac* L.) in the humid tropics." was carried out with the following objectives:-

1. To enhance the production by adjusting the time of pruning and modifying the manurial practices.

2. To enhance the keeping quality of flower buds by chemical regulation, hilling treatments and different storage methods.

Review of Literature

2. REVIEW OF LITERATURE

Jasmine is one of the leading traditional flowers in India. Bush jasmine is presently being cultivated in Kerala by large number of small and marginal farmers. Maximum yield is obtained when favourable conditions are provided for the crop.

Improper nutrition leading to nutrient imbalance in plants is one of the major factors contributing to low yields of many crops Literature pertaining to pruning trial, nutrient management and post harvest studies are reviewed here.

2.1. PRUNING STUDIES

Pruning is an important practice for the manipulation of growth and flowering, as it influences growth, flower bud initiation, and differentiation and ultimately flower production. The height of pruning depends on the species in a particular environmental condition. Pruning during the month of January in South India led to maximum flower production in jasmine. Later production beyond this time resulted in low yield in jasmine.

2.1.1 Effect of pruning in jasmine

Muthuswami *et al.* (1973) working with *J. sambac* cv Single Mogra, reported that flowering was at peak during March-May and declined there after with less flowering between October to January. By pruning different plants at six-month interval staggered flower production could be achieved in this cultivar.

Pal *et al.* (1980) conducted pruning experiment in *J. sambac* and *Jasminum auriculatum*, in which the plants were pruned at monthly intervals between November and February at a height of 20 or 40 cm above ground level for *J. sambac* and 20-30cm for *J. auriculatum*. Maximum flower production was obtained from plants pruned in

January at a height of 40 cm for *J. sambac* and those pruned in November and February at a height of 30cm in *J. auriculatum*

Nofal and Marwan (1982) conducted pruning trials in *J. grandiflorum* starting from fifth December. Average flower yield, with harvest between June and November, was highest after the earliest pruning in December and declined in the successive pruning dates. A similar trend was noticed with regard to yields of concrete and absolute and their quality.

According to Subramaniam *et al.* (1985) the nitrogen content of leaves was high at the time of flower bud initiation than pruning and the phosphorous content was greater at pruning than at flower bud initiation stage in jathimalli. The level increased during peak flowering stage and decreased during late flowering stage. When the yield declined C/N ratio was slightly higher at pruning than at flower bud initiation stage.

Bhattacharjee (1985a) reported that pruning at 90 cm height resulted in the maximum number of shoots and the highest flower yield/plant in *J. sambac*.

When pruning began between 15th December and 5th January in *J. sambac* flower yield was increased by 13.8 to 28.2% over unpruned controls, with the highest flower yield and shoot number in plants which was first pruned on 15th December. However, the peak flower yield was always in September irrespective of pruning regime (Bhattacharjee, 1985b).

Pruning trial was carried out at fortnightly intervals between 15th December and 30th May in *J. auriculatum* cv parimulli, days to flower bud appearance decreased from 58 days with mid-December pruning to 39.5 days with late May pruning. Flower yield was highest with mid-February and mid-March pruning, *viz.*1134.02 and 1124.22 g/plant, respectively, and it was lowest (105.77 g/plant) with late May pruning. (Gowda *et al.*, 1986)

The studies conducted by Singh and More (1986) revealed that 75 and 30cm pruning heights were found to be beneficial in *J. sambac* and *J. auriculatum* respectively in increasing the flower yield and essential oil content.

Siddagangaiah and Rai (1988) conducted a study in jasmine where the bushes were pruned to 75 cm above ground level at monthly intervals from April 1984 to March 1985 The number of days taken to flowering was significantly lower.. Primary shoot length, internodal length and stem thickness were significantly higher for bushes pruned in March, April and May. Duration of flowering was significantly higher for bushes pruned in October and November pruning. Flower yield was significantly higher for bushes pruned in December (380.10 g/bush/year), January (362.64g/bush/year) and November ((356.90/g/bush/year). Flower production was higher during March to June, due to higher temperature and longer hours of sunshine and declined after June with falling temperature, almost ceasing at the second week of July.

A pruning study conducted by Sharma and Singh (1991) in *J. sambac* by pruning to half their original shoot lengths and by removing all leaves from the branches, indicated that pruning improved floral yield and quality as well as plant vigour.

December last week pruned plants showed significantly lower number of leaves/primary shoot, higher leaf area/plant, flower weight and flower number compared to November and December first week pruning in *J. auriculatum* (Hugar and Nalawadi, 1993)

Field experiment conducted.by Hugar and Nalwadi (1994) showed that pruning in the last week of November along with application of 60 g N+120 g P+120 g K/plant/year resulted in maximum number of sprouts per plant, longer primary shoots, a moderate number of leaves/primary shoots, higher leaf area /plant, maximum number of productive shoots, greater length and diameter of flower bud at peak harvest, maximum number of flowers /plant and flower yield.

A trial with different pruning dates during December and January indicated that pruning on 18th December encouraged better vegetative growth and resulted in highest flower yield in *J. sambac* (4069 kg/ha) (Patel *et al.*, 2002).

The effect of pruning on different dates viz 8, 18 and 28 December, and on 8th January on the growth and yield of *J. sambac* was studied in a field experiment conducted in Dharwad, by Sumangala *et al.* (2003). Pruning on 18th December resulted in the highest number of sprouts (208.7), primary shoot length (153.3 cm), number of laterals (9), number of productive shoots (204.8), number of leaves per primary shoot (250.5), leaf area per shoot (63.6 m2), 100 flower weight (7.62 g), yield per plant (1266.5 g) and yield (4069.4 kg/ha). Pruning had no significant effects on flower initiation, flower bud length and diameter, flower bud index and number of flowers per plant.

2.2. NUTRITION

Management practices play a key role in the growth and flowering of jasmine. Nutritional studies revealed that application of different nutrients markedly improved the growth, flowering and oil yield in jasmine.

2.2.1. Effect of manures and fertilizers on growth and yield of jasmine

Muthuswamy and Pappiah (1976) conducted an experiment in *J. auriculatum* receiving N, P_2O5 and K_2O, each at 0, 120 or 240 g/plant/annually, in all possible combinations and reported that flower yields were highest with nitrogen at 120 or 240 g/plant. Differential effects of P and K alone were slight, but with N at 120 g/plant there was a response to K at 120 g/plant.

In a manurial trial conducted by Muthuswami and Pappiah (1977) in *J. grandiflorum*, FYM at 30 kg/plant, N, P and K at 120, 240 and 240 g/plant respectively, applied alone as well as together in split doses, flower yields, flower bud diameter and weight of 100 flower buds were greatest with FYM and NPK applied together in 6 split doses. In another trial foliar application of N at 30-50 g/plant, P and K each at 240

g/plant/year as application in 2 split doses was compared with soil application of FYM and N, P and K at the above rate applied in split doses. Flower bud yields, weight of 100 flower buds and the percentage recovery of essential oil were highest with FYM + NPK in 12 split doses. Foliar-applied N depressed flower yields, even at the lowest N level.

According to Natarajan and Rao (1980) application of nitrogen at 60 g and P_2O_5 at 120 g per plant applied singly and together in *J. grandiflorum* gave the maximum flower and essential oil yields. The best results, however, were obtained when this was combined with 240 g K_2O and 30 kg FYM.

Kumar and Gill (1983) conducted an experiment in two-year-old plants of *J.sambac* cv JSL-1 and reported that plants receiving nitrogen at 30 g/plant gave the highest yield of flower buds (635.8 g/plant). The control plant yield was 353.7 g/plant.

Earliness in flowering was noticed at low levels of nitrogen and high levels of phosphorous and FYM in jasmine. Flower bud length showed a linear response to the increasing levels of nitrogen. The essential oil content of flowers was higher at high levels of nitrogen and phosphorous (30 kg of FYM, 120g of nitrogen and 240g each of phosphorous and potassium.) (Natarajan and Madhava Rao, 1983).

Bhattacharjee (1985) also supported the fact that increased vegetative growth is as a consequence of nitrogen application in *J. grandiflorum*. Addition of nitrogen (as urea) up to 100 g/plant significantly improved all vegetative characters, flower quality and yield, but no significant differences in flower production was noted between N at 100 and 150 g/plant. P_2O_5 and K_2O application increased flower yield and the number of branches/plant, P_2O_5 alone increased the weight of 100 flowers. Increased flower yield was associated with increased numbers of branches. N at 100 g, P_2O_5 at 150 g and K_2O at 100 g/plant were the yearly rates recommended for improving growth and flowering

The height of *J. sambac* var Khoya increased as a function of applied nitrogen irrespective of the level of phosphorous as reported by Pal *et al* (1985). They also found the beneficial effect of nitrogen on the number of branches produced.

According to Bhattacharjee (1998) nitrogen at 33.3g per plant promoted increased shoot length and stimulated more number of shoots in *J. grandiflorum*. According to Kumar and Gill (1988) jasmine when applied with calcium ammonium nitrate along with FYM at the rate of 4kg and P and K at the rate of 120:60g/plant gave highest flower yield /plant. In a manurial trial in *J. sambac* by Shalaby *et al.* (1989) maximum flower yield and concrete yield were recorded with 450kg N/ha applied as ammonium sulphate.

Srinivasan *et al.* (1989) obtained best results in respect of length, number of primary and secondary shoots as well as length and width of leaves by applying nitrogen at 90g per plant in *J. sambac* cv Gundumalli. Pruning in the last month along with application of 60g N, 120g P, and 120g K/plant resulted in maximum number of sprouts per plant. (Hugar and Nalwadi, 1994)

Studies conducted by Maruthiprasad and Patil (1992) in *Jasminum grandiflorum* showed that application of nitrogen appreciably increased the yield and influenced the growth characters such as length and diameter of primary shoots, number of sprouts, secondary laterals productive shoots, leaves per plant and leaf area index.

Qasim *et al.* (2003) conducted a study on the effects of nitrogen applied at the time of transplanting and 120 days after transplanting on the growth, development and flowering of *J. sambac*. Study revealed that number of leaves per plant, leaf area and plant height were maximum with 30 g N, whereas leaf N content and number and fresh weight of flowers were maximum with 20 g N. Moreover, the number of leaves, leaf area, number and fresh weight of flowers were maximum in June, whereas leaf N content was higher in April than May and June. Nitrogen application at 20 g in June produced the maximum flower yield, whereas vegetative growth was enhanced up to 30 g N.

2.2.2 Effect of manures and inorganic fertilizers on growth and yield of other flower crops:

According to Tsurushima and Date (1971) in salvias and china asters phosphorous raised the fresh weight of leaves, stems and flower buds. In French marigolds extra nitrogen and phosphorus raised the total plant fresh weight. Growth and flowering of zinnias, pansies and coleus were also improved by nitrogen and phosphorous, and coleus leaf colour was intensified by extra nitrogen but dulled by excess potassium. Vegetative growth and flowering in petunia was improved by nitrogen, but celosia plants were more responsive to potassium and the flower heads were smallest in potassium deficient plants.

Chellamuthu (1978) reported that application of nitrogen as FYM at 90 kg/ha registered the highest available nitrogen content as against inorganic nitrogen source in ragi.

Frequency of fertilizing had little effect on the vegetative growth or floral characteristics of *J. grandiflorum* but the maximum flower yield (3.64 kg/plant) and essential oil production (9.69 g/plant) were recorded when 15 kg FYM + 60 g N + 120 g P + 120 g K were applied per plant in 12 monthly applications, followed by the same dose in 6 bimonthly applications (Natarajan *et al* 1980).

Singh *et al.* (1980) and Gupta *et al.* (1983) reported the available nitrogen status by continuous application of FYM in soil. Grewar *et al.* (1981) observed the beneficial effect of organic manure addition and increasing level of available nitrogen content in potato.

Application of NPK at 60:120:120g per plant along with 10kg of FYM applied in two split doses was found to be optimum (Muthuswami and Abdulkhadar, 1986)

Nanjan *et al.* (1980) carried out trials with tuberose cv. Single grown in soil with low N and low available P and high K and the highest flower production and economic returns were obtained with N, P and K at 200:60:0 kg/ha. The effect of N (urea), P(single super phosphate) and K (potassium sulphate) on the performance of *Zinnia elegans* was studied by Javid *et al.*(2005) and reported that the application of 30:20:20g N: P: K/m^2 resulted in greatest plant height, number of lateral shoots, number of leaves, leaf area, number of flowers per plant and flower size.

Yadav *et al.* (1985) obtained good plant growth and the highest flower yield with N and P application at 300:200 kg/ha, with nitrogen applied in two split doses, at planting and 40 days later, in tube rose (*Polianthes tuberosa*) cv Single.

According to Mukhopadhyay and Bankar (1986) only nitrogen, especially at the highest rate, improved plant growth, spike yield, and flower quality in tuberose *[Polianthes tuberosa]* cv. Single. Nitrogen also enhanced the production of daughter bulbs but not of main bulbs.

In an experiment aimed at determining the fertilizer requirements of *Polianthes tuberosa* cv. Single, application of 100 kg N + 75 kg P + 62.5 kg K/ha resulted in the highest number of spikes/plant (1.72), number of flowers/spike (39.67) and the highest flower yield (3578.6 kg/ha) (Waterer and Coltman, 1989).

According to Bankar and Mukhopadhyay, (1990) nitrogen application in *Polianthes tuberosa cv* Single advanced flowering and improved growth. Leaf nitrogen content showed positive correlation where as leaf P and K contents showed negative correlation with number of flowers/spike. The highest number of flower spikes/m^2 (20.09) was obtained with the highest N dose. Fertilization of tuberose with N: P_2O5: K_2O at 20:20:20 g/m^2 is recommended.

Singh *et al* (1990) conducted manurial trial in chrysanthemum when the plants received N and P at 15 to 60 g/m^2 along with K_2O as basal dressing and FYM at 5 kg/m^2. Days taken to visible bud and complete bud formation, as well as days to complete

flowering were studied. All the indices studied were delayed by increasing N rates, with the earliest development occurring in the control plants. Application of P improved earliness.

Parthiban and Khader (1991) reported that in *Polianthes tuberosa cv* Single, application of 100 kg N + 75 kg P + 62.5 kg K/ha resulted in the highest number of spikes/plant (1.72), number of flowers/spike (39.67) and the highest flower yield (3578.6 kg/ha).

Increasing nitrogen significantly increased plant height. Both nitrogen and potassium significantly influenced the number of days required for flower spike emergence. Increasing P and K rates resulted in greater number of flower spikes and number of flowers/spike. The highest yield of flowers (40.20/spike), the longest spikes (81.28 cm) and the longest duration of flowering (29.75 days) were obtained with 200 kg N + 75 kg P+ 125 kg K/ha in tube rose by Gowda *et al.* (1991).

Yadav *et al.* (2000) reported that flower size in African marigold increased progressively up to 120 ppm N. FYM at 0.5% significantly increased flower weight, but higher concentrations of FYM did not affect flower weight significantly. All floral characters like flower yield, flower weight, pedicel length were improved with the application of N at 180 ppm.

When plants were supplied with N and K at 50, 100 and 150mg/kg soil, the number of spikes per plant, length of primary and lateral spikes, and spike yield increased, whereas duration of flowering decreased with increasing rates of nitrogen and potassium (Jayaprabha and Shakila, 2002)

A study conducted by Mohanty *et al.* (2002) to determine the effect of nitrogen and phosphorous on marigold indicate that with increase in application of nitrogen, the days to flowering was prolonged (68.03 days). Application of nitrogen increased the number

of flowers. The interaction effect of nitrogen and phosphorous was significant with respect to flower size and weight of flowers.

The maximum flower size and weight were recorded when *Celosia plumosa* plants were supplied with nitrogen and potassium at 50,100 and 150 mg/kg of soil. The number of spikes per plant, length of primary and lateral spikes and spike yield increased, where as duration of flowering decreased with increasing rate of nitrogen and potassium (Jayaprabha and Arumugham, 2002)

According to Nagaich *et al.* (2003) flower yield, N, P, K uptake rate, net income, and benefit: cost ratio increased with increasing rates of nitrogen and phosphorous. Significant interaction effects between nitrogen and phosphorous were recorded.

Dixit *et al.* (2004) studied the effect of nitrogen and phosphorous on the growth and yield of chrysanthemum cv local White were determined in a field experiment conducted at Raipur. Application of 20 g N/m^2 in combination with 10g P/m^2 resulted in tallest plants (95.8cm), highest number of branches (23.7) and longest life of flower (12.7 days), where as the application of 30g nitrogen in combination with 20gP/m^2 resulted in the highest number of leaves (106.3) and flowers (83.7) and flower yield also increased.

The effects of N and Farmyard manure (FYM) were studied on growth and fresh flower yield of African marigold (Yadav and Singh, 2005). The plant height and spread increased consistently with N upto 120 ppm where as number of branches and fresh flower yield increased with upto 180 ppm N. However at higher rate of nitrogen, both growth parameters and yield were adversely affected. Application of FYM significantly improved the growth parameters and yield of marigold but the effect was more prominent at lower rates of FYM.

The effect of NPK on the performance of *Zinnia elagans* was studied by Javid *et al.* (2005), which revealed that NPK at the rate of 30:20:20g/m^2 resulted in highest the plant

height, number of lateral shoots, number of leaves, leaf area, number of flowers per plant and flower size.

2.2.3. Effect of biofertilisers on flower yield

Biofertilisers are biologically active products containing active stains of specific bacteria, algae and fungi which alone or in combination may help in increasing crop productivity by the way of biological nitrogen fixation, solubilisation of insoluble fertilizer materials and by decomposition of plant residues (Verma and Battacharya, 1972). Microbial inoculants are products containing living cells of different microorganisms, which have ability to mobilize nutritionally important elements from non-usable forms through biological process. They include diazotropic microorganism like *Azospirillum*, phosphate solubilising microorganism and AMF.

Azospirillum brasilense is associative bacteria capable of fixing nitrogen in the presence of diffused levels of atmospheric oxygen. The bacterium develop capsules otherwise being vibriod, which impart adhesive nature and reduced motion by adaptation of rhizospheric life. (Berg *et al* 1980)

Seenapathi *et al* (1987) noticed increased plant height and more number of seeds per pod in cowpea in AMF inoculated plants. Plant height and fruit yield were also more in bell pepper inoculated with AMF grown in low phosphorous content and water stress.

Balasubramanium (1989) reported that *Azospirillum* inoculated plants showed early flowering besides an extended crop period and higher flower yield in French marigold. In crossandra application of nitrogen at 60kg /ha along with *Azospirillum* increase primary and secondary roots (Ravichandran, 1991)

Application of 25% reduced dose of nitrogen and phosphorous with *Azospirillum* and phosphobacteria inoculation increased plant height, number of primary, secondary and tertiary branches in *J. sambac* (Manomani, 1992). Increased plant height, number of

branches per plant and number of lateral roots in chilly was reported when inoculated with *Azospirillum* (Paramaguru and Natarajan, 1993)

Gnanasekhar (1994) reported that there was an increase in growth characters like plant height, number of primary, secondary and tertiary branches, length of primary shoots and internodal length in jathimalli inoculated with *Azospirillum.*

More the number of primary and secondary roots, early flowering and highest number of flowers were obtained in tomato due to the application of *Azospirilum* (Dhanalakshmi and Pappiah, 1995).

Nutritional studies in aswaganda by Rameshbabu (1996) revealed that application of 90 kg N/ha along with 2 kg K/ha each of *Azospirillum* and phosphobacteria recorded highest plant height (111.15cm), number of lateral leaves (37.85) per plant (682.5), leaf area (4988.8cm^2) and the highest fresh and dry weight of shoot.

A study in Tamil Nadu by Swaminathan *et al.* (1999) in tube rose cv Mexican single and showed that treatment with NPK at 30:65:62. + *Azospirillum* resulted in the earliest sprouting (16 days) and treatment with NPK at 120:65:62kg/ha + *Azospirillum*+ phosphobacteria resulted in the highest mean spike length, number of flowers per spike, flower weight, number of tubers, tuber weight per plant; and yield (3.08 and 2.75 t/ha, for the first and second year, respectively).

Bhavanisankar and Vanagamudi (1999) reported the highest flower yield in *J. sambac* by applying 75% of recommended nitrogen and phosphorous along with *Azopspirillum* and phosphobacteria.

The effect of biofertilisers and composited coir pith on the flower yield of crossandra was investigated by Bhavanisangar and Vanangamudi (2000) The study revealed that 100% recommended urea and 10 kg FYM gave highest number of branches

per plant, while combined application of urea + *Azospirillum* and super phosphate + phosphobacteria gave highest flower yield.

Swaminathan and Sambandamurthi (2000) conducted a field experiment to study the effect of *Azospirillum brasilense* along with nitrogen and potassium on the growth and yield of triploid crossandra. The plant height, number of branches, number of leaves, leaf area per plant, number of spikes per plant, spike length, number of flowers per spike and flower yield per plant were the highest in N 120 kg + K 70 kg/ha + *Azospirillum* 2kg/ha + FYM 30 t/ha. *Azospirillum* + N + K proved to be more beneficial than *Azospirillum* or FYM alone.

In a pot culture experiment by Rajadurai and Beaulah (2000) African marigold was inoculated with *Azospirillum* and vesicular arbuscular mycorrhizas (VAM) before sowing and applied 45mg N, 30 or 45 mg P and 37.5mg K_2O/kg soil. N, P and K uptakes were highest in marigolds inoculated with both *Azospirillum* and VAM at the highest N and P level. Soil nutrient status was highest in soils supplied with N and P at 45mg/kg soils. The soil nutrient status was lowest in treatments with out VAM and *Azospirillum* inoculation.

A study was conducted by Raju and Haripriya (2001) on integrated nutrient management in crossandra cv. Dindigul local. The treatment included inorganic form of N, P_2O_5 and K_2O at 75:50:125 kg /ha alone or in combination with biofertilisers, viz *Azospirillum* and phosphobacteria each incorporated at 2kg/ha. Results revealed that application of 100% NPK + *Azospirillum* + phosphobacteria of 41.72g/plant, with maximum returns per rupee invested (1:3.50). Twenty five percent reduced rate of application of inorganic nutrients is sufficient if applied along with *Azospirillum* to get a yield on par with blank recommendation of inorganic fertilizers.

A manurial trial conducted by Seetha and Gowda (2002) in gerbera revealed the beneficial effect of biofertilisers +vermicompost. Maximum plant height, flower stalk length, flower yield and diameter, maximum number of leaves and suckers as well as maximum available P in soil and plant were obtained in plants treated with

vermicompost15t/ha+75% NPK. Minimum days for first flower opening and fifty per cent flowering recorded in plants treated with *Azospirillum*+VAM+50% recommended NPK.

A study conducted by Rathod *et al.* (2002) showed that application of 75% recommended NPK rate in combination with *Azospirillum* + phosphate solubilising bacteria resulted in the highest number of branches (41) and leaves (218.67), number of flowers per plant (70.03), flower diameter (5.03cm) and stalk length (7.37cm) weight of single flowers (2.03g), yield per plant (142.57g) and yield (8911q/ha). The values for plant height, stem girth and days to 50% flowering were the highest with the application of 100% of the recommended NPK.

According to Subramanium *et al.* (2002) inorganic nutrients to a tune of 25% can be saved without any yield reduction if *Azospirillum* +phosphobacteria at the rate of 2kg/ha is incorporated with 75% recommended dose of NPK in crossandra.

Gayathri *et al* (2004) reported that 75% nitrogen, 100% potassium + vermicompost along with *Azotobacter* and phophobacteria significantly increased the growth components like plant height, plant spread, number of leaves and suckers in *Limonium carpia*. The flower components like spike length, spread and number of branches were influenced by the application 50%N; P and 100%K+vermicompost +*Azotobacter* and phosphobacteria. .

A field investigation was carried.out by Yadav *et al.* (2005) in sandy loam soil was to evaluate the effect of nitrogen (0,10,20,30g/m^2) and biofertilisers (*Azotoacter*, phosphorous solubilising bacteria and *Azospirillum*) on growth parameters of tuberose cv Double .The growth parameters like plant height, number of leaves per plant, leaf length and area of leaf increased significantly with increasing levels of nitrogen and bio fertilizers.

In a study conducted at College of Horticulture Vellanikkara with NPK at the rate of 30:10:10 (0.2%)+GA_3 200ppm+ phosphobacteria +VAM as well as NPK at 15:0:10 (0.2%)+GA_3 200ppm+*Azospirillum*+phosphobacteria+VAM were found significantly superior to all other treatments in producing maximum vegetative growth and better flowering in anthurium var Tropical (AICFIP,2005).

2.2.4 Effect of vermicompost

Vermicompost reduced the requirements of chemical fertilizers in cowpea and bitter gourd (Jiji *et al.*, 1996)

Kulkarni *et al* (1996) reported the effect of vermicompost and *in situ* vermiculture on growth and yield of China aster cv Ostrich Plume Mixed. Flower yields of 11t/ha could be obtained by applying 15t FYM/ha with the recommended rate of fertilizer, 2.5 t vermicompost/ha with 75% recommended dose of fertilizer, 5t vermicompost/ha with 50% recommended dose of fertilizer or with *in situ* vermiculture with 200 earthworms/ha.

Arunkumar (1997) reported that number of leaves were higher in chilly plants which received vermicompost. A field experiment conducted by Chauhan *et al* (2005) to see the response of vermicompost and time of pinching on growth and flower production of marigold Pusa Narangi Gainda. Maximum number of flower buds per plant, individual flower weight and flower yield /m^2 were recorded with the application of vermicompost @1000g/m^2

2.3 Post harvest studies in jasmine

The post harvest loss due to the spoilage of flowers is estimated to be worth several lakhs of rupees a year (Roy, 1990). Due to short life span of harvested flowers, the growers often face the problem of storage in the peak season of flowering. It is an established fact that preservative chemicals regulate the shelf or vase life of flowers.

Jasmine flowers are empirical in nature. Under normal conditions, the flowers show the sign of browning either at the end of the day or on the second day, thus bringing down the value of the flowers. This becomes one of the major constraints in the marketing of jasmine flowers.

2.3.1. Effect of packaging treatments

The effect of packing and post harvest life quality of *J. sambac* flowers were investigated in Coimbatore .The packing material used as polythene bags of varied thickness .100, 200, 300, 400, 500 gauges without ventilation. Physiological weight loss in the treatments were recorded at 48 and 78 hours of storage. The most effective treatment of storage was 300 gauge thick bags (Mohanalakshmi *et al*, 2002)

2.3.2. Effect of chilling treatments

When jasmine (*J. grandiflorum*) flowers were packed in polyethylene bags and kept at frozen -15^{0}C for 24 h. It was seen that freezing the flowers had no significant effect on odour and quality of the concrete and absolute as assessed by a sensory panel. The freezing procedure is recommended for use on an industrial scale, both to increase essential oil yield and as a method of storing the flowers. (Atawia *et al*, 1988.)

Flower buds of jasmine cv. Motia, of three different sizes, with stalks, were kept in water at room temperature for 30 min, after which they were wrapped in tissue paper and kept at 1.6^0, 7.2^{0}or 35^{0}C. The smallest buds were greenish white and did not develop fragrance, whereas the other size groups were white and highly scented. The optimum storage temperature for small, medium and large buds was 7.2^{0}C, at which they remained fresh for 10, 12 and 8 days, respectively, the larger sized buds retaining their fragrance for 6 days. At the highest temperature none of the buds remained fresh for longer than one or two days (Bose and Raghava, 1975)

2.3.3. Effect of chemicals on vase life of jasmine flowers

In an experiment conducted on fully developed flower buds of *J. sambac* var Khoya flower buds were soaked in different concentrations of sugar, sodium chloride, boric acid and citric acid, copper sulphate, aluminium sulphate, maleic hydrazide, sodium benzoate, potassium meta bisulphate, cycocel and silver nitrate. Flower buds treated with sucrose, boric acid, copper suphate, aluminium sulphate and silver nitrate remained fresh upto 75 hours with out affecting fragrance. (Mukhopadhyay *et al.*, 1988).

Trials were conducted by Salvi *et al.* (1996) at College of Horticulture, Kerala Agricultural University, Thrissur, to study the effect of chemicals on keeping quality of *J. sambac* flowers. Physiological weight loss was reduced in flowers and buds by pre harvest application of chemicals. Keeping quality of open flowers were the same for all the treatments including control (as water spray). However in unopened buds the chemicals at higher concentrations gave a shelf life of 4 days compared with the three days in control. For unopened buds dipping in water reduced the physiological weight loss to 67.5%.

Fully matured *J. sambac* flower buds were treated with solutions of 0.5% sucrose, 10ppm benzyl adenine, 15% potassium permanganate and 5% kaoline. It was found that 0.5% sucrose extended shelf life to the maximum of 29.33hrs, 10ppm BA to 27 hrs, 15% potassium permanganate 67h and 5% kaoline 38h. The combination of 0.5% sucrose+10ppm BA +15% potassium permanganate +5% kaoline extended shelf life upto 42 hrs (Sudha, 1998)

2.3.4 Post harvest studies in other flower crops

The longest vase life was obtained (12 days) in solutions containing 1% sucrose + 200 ppm. aluminium sulphate, and 2% sucrose + 400 ppm. aluminium sulphate in tuberose(Gowda, 1990)

The shelf life of tuberose (*Polianthes tuberosa*), gaillardia (*Gaillardia pulchella*), golden rod (*Solidago virgaurea*) and jasmine (*Jasminum sambac*) were tested in filtered water containing either 1% sucrose or 1% NaCl. The vase life of tuberose was best with 1% NaCl, which gave a significantly better flower colour and freshness together with stem colour and firmness. With gaillardia and golden rod, 1% sucrose increased the vase life and the flowers also had a better colour and freshness. The shelf life of jasmine was not improved by the treatments (Harode *et al.*, 1993)

Chrysanthemum flowers (cultivars Co.1 and Co.2) harvested at the 3/4-developed stage and were placed in 100 ml of water (control), 4% silver thiosulphate (STS), 2% sucrose, 4% STS + 2% sucrose, 0.5% boric acid, 0.5% citric acid and 0.1 % aluminium sulphate for 24 h and then transferred to water. The water was changed every 3 days and approximately 0.5 cm of stalk removed. The highest percentage flower weight increase (6.4 and 7.0% for Co.1 and Co.2, respectively), longest vase life (10 and 11 days for Co.1 and Co.2, respectively) and least flower damage were obtained with the 0.1% aluminium sulphate treatment (Rajagopalan and Khader, 1993)

CCC (5-10ppm) kinetin (5-25ppm) and triadimefon (5-25ppm) increased longevity by at least one day compared with controls (from 4 to 6 days) in Chyrsanthemum cv Delhi. Of the post harvest sprays, 5 and 10 ppm CCC, 15ppm kinetin and 15 ppm triadimefon increased longevity by one to two days, Flowers given post harvest sprays tended to dry out more quickly than those given pre harvest sprays. (Salvi *et al.*, 1998)

A study was conducted by Nagaraja *et al.* (1999) in tuberose to investigate the response of loose tuberose (*Polianthes tuberosa*) flowers stored at ambient conditions to different packing materials like polyethylene (PE) bags of different gauges (200, 300 and 400 gauge) and with 0.5 or 1.0% ventilation. Physiological loss in weight (PLW), wilting, rotting, moisture content and shelf life were recorded daily. The rate of PLW and cumulative PLW were least in the polyethylene-bagged flowers compared to the unpacked spikes. After 5 days PLW in the control was 38.56% compared to a range of

0.68 to 4.12 in the packed flowers. Flowers packed in 200-gauge polyethylene had the least PLW. Packing flowers in unventilated PE bags significantly decreased wilting but produced off odours.

According to Desai *et al.* (2002) maximum vase life of four to five days was recorded in 35ppm silver nitrate+3% sucrose treated flowers, followed by 0.1% aluminium sulphate+3%sucrose in chrysanthemum cv Local white.

Rakesh *et al.* (2004) conducted an experiment to determine the effect of different chemicals on vase life of chrysanthemum (*Chrysanthemum morifolium*, cultivars Flirt and Gauri) flowers. The treatments with sucrose +aluminum sulphate +cobalt sulphate enhanced the vase life in both cultivars.

Mukhopadhyay *et al.* (1988) conducted an experiment in crossandra with fresh opened flowers soaked for 2 hrs in solutions of different chemicals. The effect of treatments on flower freshness was studied for up to 144 hrs. About 50% of the flowers remained fresh for up to 120 hrs after treatment with boric acid (0.5-2.0%), aluminium sulphate (0.1%) and silver nitrate (0.001-0.05%). Other treatments gave inferior results.

Shelf life of crossandra can be extended by soaking them in a solution of 1% sucrose and 1% $Al_2 (SO)_4$ for two hours .Pre cooled flowers packed in polythene bags enhance freshness, colour and longivity, Loose flowers can be stored at 3-5 ^{0} C for two weeks at high humidity and proper ventilation. (Bhattacharjee and De, 2003)

Keeping quality of crossandra can be increased by soaking them in 0.55 boric acid, 0.001% $AgNO_3$ or 0.1% $Al_2 (SO_4)_3$ for 3h (Bhattacharjee and De, 2003)

Packing of crossandra flowers in 200 guage polythene bags without ventilation and storing in cool chamber retains freshness and colour and increase their longevity. (Bhattacharjee and De, 2003)

Materials and Methods

3 MATERIALS AND METHODS

The present study entitled "Refinement of management practices for jasmine *(Jasminum sambac* L.) in the humid tropics" was carried at the department of Pomology and Floriculture, College Of Horticulture, Vellanikkara, Thrissur, during 2004-2006.

Vellanikkara is situated at an altitude of 22.25m above MSL and $10^{0}32^{1}$N latitude and $76^{0}10$ longitude.

The climate enjoys a humid tropical climate with maximum temperature varying from 28.5^{0}C to 34.8^{0}C and minimum temperature from 23^{0}C to 24.8^{0}C during the period of investigation. The mean relative humidity varied from 31to 94%. The total rainfall recorded maximum in July (727.5mm).

The weather parameters during the experimental period are presented in the appendix.

The details of the experiments conducted and the methods followed for the analysis of the data are presented in this chapter.

The study comprised of three experiments

1. Pruning studies
2. Manurial studies
3. Post harvest studies

3.1. PRUNING STUDIES

This experiment was carried out in two-year-old jasmine plants in the field of department of Pomology and Floriculture, College Of Horticulture (Plate1 and 2). Pruning treatment was conducted in the following months.

T_1 January

T_2 April

T_3 July

T_4 October

Plate 1. General view of the field (pruning trial)

Plate 2. General view of the field (Pruning trial)

Ten sets of plants were selected in each month and were pruned at a height of 30cm from the ground level (Plate 3).

3.1.1. Main items of observations made

3.1.1.1. Growth characters

a. Plant height

The height of the plant was measured from the base of the tallest shoot to the last node at monthly intervals and expressed in cm.

b. Plant spread

Plant spread was taken in north south and east west direction and expressed in cm

c. Number of primary and secondary branches

Number of primary and secondary branches were taken at monthly intervals and tabulated

d. Number of productive shoots

Number of flowering or productive shoots were taken at monthly intervals and tabulated

3.1.1.2. Floral characters

a. Time taken for first flower bud appearance after pruning.

Time taken for first flower bud to appear in each plant after each set of pruning was taken and expressed in days.

b. Days to flower opening from bud appearance

Flower opening after bud appearance was also taken after each set of pruning.

c. Corolla tube length

Length of corolla tube was taken and expressed in cm

d. Flowers bud diameter (cm)

Diameter of flower bud was taken and expressed in cm.

e. Weight of 100 flower buds (g)

Plate 3. Pruned plant

Weight of flower buds harvested in each day was measured and hundred flowers weight was calculated and expressed in g.

f. Yield of flower buds/plant/day (g)

Flower buds were harvested every day and weight was taken and expressed in g.

g. Peak season of flowering.

Flowering was recorded daily and from that peak season of flowering was recorded.

h. Yield of flower bud per plant per year. (g/plant/year)

Yield of flower buds per plant per year was calculated from the flower bud weight recorded daily and expressed in g.

3.1.1.3. Incidence of pest and diseases

Certain pests were observed and controlled by spraying insecticides

3.2. MANURIAL TRIAL

This experiment was carried out in pot culture. Rooted cuttings of bush jasmine (*Jasminum sambac* L*)* were planted in mud pots of size 25x30cm, filled with potting media @1:2:1-soil: sand: FYM.(Plate 4.)

3.2.1. DESIGN OF THE EXPERIMENT

Design of the experiment was completely randomized block design .The main plot treatment consists of two methods of planting *viz*, single plant per pot and double plant per pot. (Plate 5 and 6)

3.2.2. Treatment details (Plate 7)

T_1. Full dose of KAU recommendation (NPK-120: 240:240g/plant/year) along with 50g neemcake+50g groundnut cake at fortnightly intervals. nitrogen was applied in the form of urea, phosphorous in the form of rajphos and potassium in the form muriate of potash.

T_2. Half the dose of treatment 1, given at fortnightly intervals.

Plate 4. General view of the plot (Manurial trial)

Plate 5. Single plant per pot

Plate 6. Double plant per pot

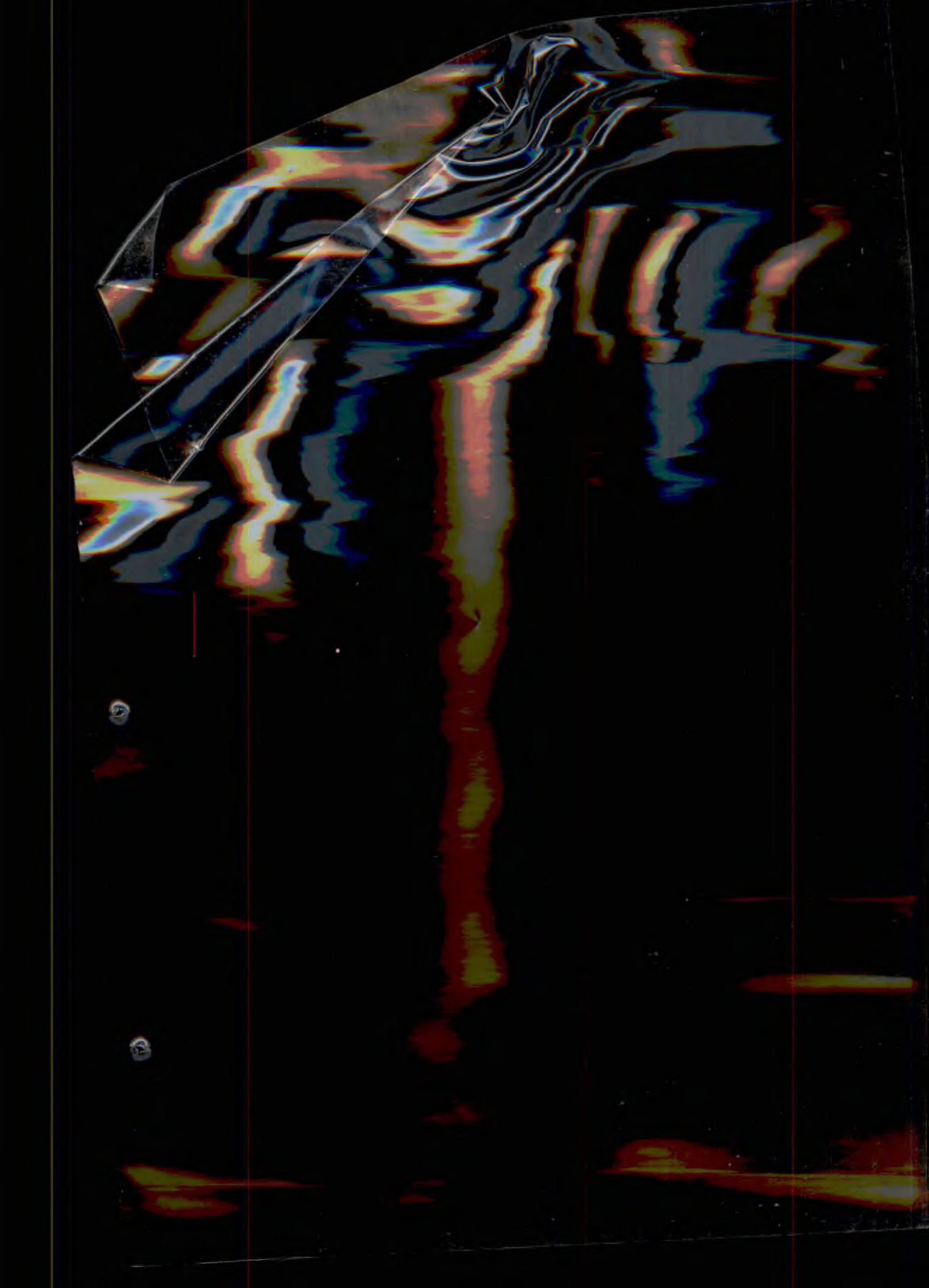


Plate 7. Single treatment

T_3. A combination of *Azospirillum* and phosphobacteria +AMF along with the treatments

T_4. A combination of *Azospirillum* + phosphobacteria +AMF along with three fourth dose of treatment1

(*Azospirillum* and phosphobacteria slurry were prepared and the rooted cuttings were dipped in the slurry for 20 minutes before planting. AMF was mixed with the media and filled in the pots. (10g AMF/1kg media).

T_5 NPK 45:45:65g /plant/year along with 100g-neem cake+100g groundnut cake was given at monthly intervals. (Based on the results obtained at College of Agriculture Vellayani)

T_6 Upto 4 months 70g groundnut cake + 30g neem cake was applied. After 4 months 70g sterameal (7:10:5) + 50g neemcake also applied at monthly intervals. It is based on farmers practice at Paravur.

T_7 17:17:17 NPK mixture 50g + neemcake 100g+ FYM 100 + ground nut cake 100g given at monthly intervals. It is based on farmers practice at Thrissur.

T_8 Neemcake100g + vermicompost 100g +ground nut cake 100g was given at monthly intervals.

T_9 Neemcake100g+FYM100g+ground nut cake 100g given at monthly intervals.

T_{10} Neemcake100g +Poultry manure 100g +ground nut cake 100g applied at monthly intervals.

3.2.3. Observations

3.2.3.1. Growth characters

a. Plant height (cm)

b. Plant spread (cm)

c. No of primary branches

d. No of productive shoots

These observations were recorded after imposing same treatments of the first experiment at monthly intervals and observations were tabulated.

3.2.3.2. Floral characters

a. Time taken for flower appearance after the application of fertilizers was noted and expressed in days

b. Time taken for flower opening from bud appearance was noted and expressed in days

c. Corolla tube length (cm)

d .Flower bud diameter (cm)

e. Weight of 100 flower buds (g)

f. Yield of flower buds/plant/day (g)

g. Peak flowering season

h. Yield of flower bud per plant per year(g)

i. Duration of flowering

3.2.4. Nutrient analysis

3.2.4.1. Soil analysis of NPK before planting and at peak flowering season

Soil samples were collected before planting and at peak flowering season. Samples were dried under shade and sieved through 2mm sieve for P and K analysis and through 0.5mm sieve for organic carbon estimation.

3.2.4.1.1 Estimation of nitrogen

Organic carbon of the soil was estimated by wet digestion method (Walkely and Black, 1934). The values for nitrogen content was computed based on C: N ratio 10:1.

3.2.4.1.2. Estimation of phosphorous

Available phosphorous in the soil samples was extracted using Bray No 1 reagent (Bray and Kurtz, 1945) and estimated calorimetrically by reduced molybdate ascorbic acid blue colour method using spectrophotometer. (Watanabe and Olsen, 1965)

3.2.4.1.3. Estimation of potassium

Available potassium in the soil sample was extracted using neutral normal ammonium acetate and its content in the extract was estimated using flame photometry (Jackson, 1958)

3.2.4.2. Leaf analysis for NPK at vegetative stage and at peak flowering stage.

Leaf samples were collected at vegetative stage and at peak flowering stage. Samples were dried under shade for two week and then dried in oven at a temperature of 60°C for two days. It is then ground well and used for the subsequent analytical work.

3.2.4.2.1 Estimation of nitrogen

Microkjeldhal digestion and distillation method (Jackson, 1958) was used. The plant sample (0.1g) was digested using concentrated sulphuric acid in presence of catalysts. The digested material was made alkaline and then distilled to release ammonia, which was quantified.

3.2.4.2.*2* Estimation of phosphorous

The plant sample (1g) was taken and digested using diacid mixture of nitric acid and per chloric acid taken in the ratio of 9:4 (Johnson and Ulrich, 1959). Finally phosphorous was estimated using Vanadomolybdo phosphoric yellow colour method (Jackson, 1958). The intensity of yellow colour was read in spectronic 20 at 470nm.

3.2.4.2.3. Estimation of potassium

From the digested sample as mentioned above an aliquot was prepared and available potassium in the sample was estimated using normal ammonium acetate solution. Contents of respective element were determined by flame photometry (Jackson, 1958).

3.3. POST HARVEST STUDIES

Harvested buds of the controlled plots were taken early morning and the following treatments were imposed. This was repeated in two seasons, viz., rainy season and summer.

3.3.1. Chemical treatments (as spray)

T_1. Aluminium sulphate 25, 50 ppm
T_2. Silver nitrate 25, 50 ppm
T_3. Benzyl adenine 25, 50 ppm
T_4. Kinetin 25, 50 ppm
T_5. Sodium benzoate 25, 50 ppm
T_6. Triadimefon 25, 50 ppm
T_7. Water
T_8. Control

The harvested flower buds were kept in paper plates (20 numbers per plate) The required concentration of above chemicals were prepared and sprayed to the flower buds.

3.3.2. Storage methods

T_0 Storage at ambient temperature
T_1 Storage at $25^\circ C \pm 1$
T_2 Storage at $20^\circ C \pm 1$
T_3 Storage at $15^\circ C \pm 1$

Flower buds were taken at early morning and stored at above following temperatures.

3.3.3. Covering and packing materials

T_1. Polythene covers (200 guage)
T_2. Polythene covers with 2% perforation

T_4. Polythene covers with 6% perforation

T_5. Newspaper

T_6. Brown paper

Flower buds were harvested in early morning and kept in the above mentioned packing materials. Observations were taken at every six hours interval.

3.3.4. Observations

a. Weight of flower buds before and after treatment and expressed in g

b. Physiological weight loss after harvest and expressed in g

c. Keeping quality

d. Visual observations like change in colour, quality and time taken for buds to open.

3.4 Statistical analysis

The data pertaining to the growth parameters and floral characters and post harvest studies were subjected to statistical analysis by applying the technique of analysis of variance (ANOVA) for completely randomised block design (Panse and Sukhatme, 1985).MStat and MS excel software were used.

4. RESULTS

The results of the experiment entitled "Refinement of management practices of jasmine (*Jasminum sambac* L.) in humid tropics" are presented in this chapter.

Study conducted during the year 2004-2006 consisted of three experiments. The results of these three experiments are presented under the following headings.

1. Pruning experiment
2. Manurial trial
3. Post harvest studies

4.1. PRUNING EXPERIMENT

4.1.1. Growth parameters

The data pertaining to the vegetative and floral characters as influenced by different pruning months are presented as Table (1-5). From the tables it is clear that there was an increasing trend for all the vegetative characters, irrespective of the month of pruning.

4.1.1.1 Plant height

There was an increasing trend in heights in all the months of pruning and maximum height of 43.84 cm was noticed in October pruned plants (Table1) followed by July pruned plants (42.35 cm) (Table 2). The increment in plant height was maximum in plants pruned in the month of October (1.56) and it was significantly superior to all other treatments, followed by plants pruned in January (1.24) and it was significantly superior to the April and July pruned plants. There was no significant difference between the April and July pruned plants (Table 5)

4.1.1.2 Plant spread

As growth proceeded the plant spread increased in all the plants pruned in different months and maximum plant spread was noticed in October pruned plants with 37.7 cm (Table 3) followed by January pruned plants having a plant spread of 36.8 cm (Table 4). When the mean spread was taken into account it was observed that there was no significant difference in the plant spread between the treatments.

Table 1. Monthly variation in vegetative characters and yield in April pruned plants

	Plant height (cm)	Plant spread (cm)	No of primary branches	No of Secondary branches	No of productive shoots	Yield (g)
April	30.00	32.40	5.00	14	20.30	10.96
May	32.50	31.90	6.00	15	21.40	17.19
June	32.60	30.80	6.00	17	22.30	23.08
July	33.10	33.30	7.00	17	23.10	24.84
August	32.05	32.10	8.00	16	24.20	19.02
September	32.05	32.10	8.00	16	25.60	19.02
October	32.46	32.00	9.00	16	26.10	20.63
November	35.10	34.20	9.00	19	27.50	20.99
December	36.30	33.40	9.00	20	27.80	17.83
January	37.20	33.30	9.00	21	28.30	13.42
February	35.40	34.70	10.00	20	28.90	12.65
March	36.50	34.00	10.00	21	30.10	12.03
April	36.20	33.50	10.20	27	30.20	12.03
May	35.10	32.80	10.30	28	30.50	10.64
June	38.60	34.60	10.30	29	30.80	25.23
July	38.70	34.30	10.30	30	31.20	27.03

Table 2. Monthly variation in vegetative characters and yield in July pruned plants

	Plant height (cm)	Plant spread (cm)	No of primary branches	No of secondary branches	No of productive shoots	Yield (g)
July	30.00	32.18	4.00	19.40	21.20	15.18
August	32.50	30.54	4.80	16.80	22.50	23.04
September	33.90	31.24	5.00	21.90	22.90	31.8
October	34.30	32.22	5.60	20.90	23.10	17.56
November	35.40	32.58	5.80	22.20	23.50	18.04
December	36.14	33.54	6.00	19.37	24.10	18.04
January	36.60	33.88	6.10	19.26	24.30	17.28
February	37.15	35.06	6.20	19.98	25.30	16.48
March	38.05	35.60	6.20	20.64	26.10	15.98
April	39.15	35.38	7.00	24.34	26.80	16.6
May	40.40	34.50	7.00	24.34	27.10	15.08
June	41.30	32.52	7.20	25.18	27.80	30.24
July	42.35	33.32	7.20	25.94	28.20	27.64

Table 3. Monthly variation in vegetative characters and yield in October pruned plants

	Plant height (cm)	Plant spread (cm)	No of primary branches	No of Secondary branches	No of productive shoots	Yield (g)
October	30.00	33.10	4.80	6.70	8.00	13.70
November	32.34	34.20	5.30	7.50	8.90	17.40
December	33.06	35.20	5.35	8.20	9.60	22.90
January	34.08	35.20	5.48	8.70	10.00	25.90
February	35.72	35.20	6.00	9.30	10.00	19.90
March	37.14	34.90	6.23	9.90	10.20	15.40
April	38.66	35.50	6.23	10.20	10.60	12.50
May	40.58	36.20	6.40	10.70	11.20	15.70
June	42.44	36.80	6.40	11.60	11.90	27.20
July	43.84	37.70	6.80	12.10	12.10	32.40

Table 4. Monthly variation in vegetative characters and yield in January pruned plants

	Plant height (cm)	Plant spread (cm)	No of primary branches	No of Secondary branches	No of productive branches	Yield (g)
January	30.00	31.40	5.00	6.70	8.00	22.60
February	31.86	32.30	5.20	7.54	9.00	28.50
March	32.58	32.90	5.30	8.12	9.72	35.20
April	33.40	34.10	6.00	8.62	10.62	34.50
May	34.44	34.30	6.00	9.50	10.62	34.70
June	35.40	35.30	6.10	9.94	10.62	37.00
July	36.64	36.80	6.20	10.70	11.02	38.00

Table 5 **Effect of different months of pruning on vegetative and floral characters of *Jasminum sambac***

Character / Treatments	Plant Height (cm)	Plant Spread cm	No of primary branches	No of secondary branches	No of productive shoots	Yield(g)
April	*1.00 (1.17)	33.36	1.05 (1.21)	1.28 (1.28)	1.35 (1.33)	19.53
July	*1.06 (1.23)	33.20	1.08 (1.20)	1.19 (1.28)	0.85 (1.15)	20.23
October	*1.56 (1.43)	35.41	0.45 (0.97)	0.60 (1.05)	0.48 (0.98)	20.30
January	*1.24 (1.32)	33.85	0.92 (1.89)	0.77 (1.12)	0.61 (1.02)	32.94
CD (at 5% level)	0.22	2.63	0.41	0.31	0.19	5.81

* Increment in plant height
Original values are in the bracket

4.1.1.3 Number of primary branches

An increasing trend was noticed in all months of pruning and maximum number of primary branches was noticed in plants pruned in April (10.33), followed by the plants pruned in July (7.20) as evidenced from (Table 1 and 2). January pruned plants showed lowest number of primary branches (6.20). Increment in number of primary branches was taken and from the Table 5 it is clear that number of primary branches was maximum in July (1.08) which was on par with April pruned plants (1.05) and January pruned plants (0.92) and significantly superior to the plants pruned in the month of October (0.45).

4.1.1.4. Number of secondary branches

Even though there was increase in number of secondary branches as growth proceeded a reduction was noticed in certain months. Number of secondary branches was highest in plants pruned in the month of April with value 30 (Table1) followed by July pruned plants with (25.94). In October pruned plants maximum number of secondary branches was 12.1 (Table3) and in January pruned plants 10.7(Table 4) after six months. When the increment in number of primary branches was taken and highest value noticed in April pruned plants (1.28), which was on par with July pruned plants (1.19) and significantly superior to October pruned (0.60) and January pruned plants (0.76). There was no significant difference between October and January pruned plants.

4.1.1.5 Number of productive shoots.

From the tables it was observed that number of productive shoots showed an increasing trend irrespective of the months of pruning. Number of productive shoots was highest in plants pruned in the month of April with value 31.3 (Table 1) followed by July pruned plants 28.2 (Table 2). January pruned plants showed minimum value in number of productive shoots 11.02 (Table 4) followed by October pruned plants (12.1,Table 3). When the increment in number of productive shoots was taken and maximum number of productive shoots was noticed in the month of April 1.35 (Table 5) and it was significantly superior to all other treatments, followed by July pruned plants (0.85). Lowest number of productive shoots was noticed in the month of January (0.48).

Table 6. **Floral characters as influenced by pruning**

Treatments (Periods of pruning)	Wt of 100 flower buds in (g)	Time taken for flower bud appearance (days)	Corolla tube length (cm)	Flower bud diameter (cm)	Flower bud length (cm)
April pruning	12.34	35-40	1.60	0.60	3.20
July pruning	13.26	36-40	1.80	0.58	3.30
October pruning	11.20	40-45	2.10	0.61	3.60
January pruning	14.23	40-45	1.80	0.59	3.70

4.1.2 Floral characters

4.1.2.1Flower Yield:

Data on flower yield as influenced by the month of pruning are presented in tables (1-5). Monthly variations were observed in the yield data after the commencement of pruning in all the treatments. The plants pruned in April, October and January showed the maximum yield in July (27.03g, 32.4g, and 38g respectively), where as those pruned in July showed maximum yield during the month of June (30.24). Minimum yield was noticed in March, April and May in all the treatments except January pruning. From the table 5 it was observed that maximum yield was observed in the plants pruned in the month of January (32.94g). Plants pruned in the month of April showed minimum yield (19.52g). There was no significant difference in the yield between the plants pruned in the month of July and October.

4.1.2.2 Other floral characters

From the table (6), it was observed that weight of 100 flower buds were maximum for flowers taken from January pruned plants (14.23g) followed by flowers taken from plants pruned in July (13.26g). Minimum weight of 100 flower buds was observed for flowers taken from October pruned plants (11.20). January and October pruned plants took 40-45 days for first flower bud appearance and was minimum in April and July pruned plants (35-40, 36-40 respectively). Corolla tube length was maximum for October pruned plants (2.1cm) and minimum for April pruned plants (1.6cm). July and January pruned plants had a corolla tube length of 1.8 cm. Not much difference in flower bud diameter was noticed in different months of pruning and it was maximum in October pruned plants (0.61cm) and minimum in July pruned plants (0.58cm). Flower bud length was maximum for January pruned plants (3.7cm) and minimum for plants pruned in April (3.2cm).

4.1.3 Correlation studies:

4.1.3.1 Correlation between plant height and climatic factors with respect to pruning

Data obtained in correlation between the plant height and climatic factors in different months of pruning are presented in tables. In April pruned plants there was no significant correlation between plant height and climatic factors (Table7). Jasmine plants pruned in July showed positive correlation at 1% significant level to the maximum temperature and negative correlation to rainfall at 5% level, also showed negative

correlation with minimum temperature, relative humidity and mean sunshine hours and positive correlation with rainy days. Plant height showed positive correlation to all the climatic factors except mean sunshine hours in October pruning and negative correlation to all climatic factors except mean sunshine hours in January pruning.

4.1.3.1. April pruning

From table 8 it was observed that in the case of April pruned plants, plant spread showed significant negative correlation to maximum temperature (at 5% level) and minimum temperature (at 1% level). But it showed significant positive correlation with mean sunshine hours at 1% level. Number of primary and secondary branches showed significant positive correlation to mean sunshine hours (at 1% level). Yield showed significant negative correlation to maximum temperature (at 5% level) and mean sunshine hours (at1% level). It showed significant positive correlation to relative humidity, rainfall and rainy days (at 1% level).

4.1.3.2. July pruning

Plant spread showed significant negative correlation (at 5% level) with relative humidity and positive correlation with rainy days (at 1% level). Number of primary branches showed significant negative correlation with maximum temperature (at 5% level) and relative humidity and rainfall (at 1% level). Number of productive shoots showed negative correlation with rainy days (at 5% level). Yield also showed significant negative correlation with maximum temperature (at 5% level)(Table 9)

4.1.3.3. October pruning

Number of primary branches had shown significant positive correlation to maximum temperature (at 1% level) and minimum temperature (at 5% level). Number of secondary branches also showed significant positive correlation to maximum temperature (at 5% level), minimum temperature (at 1% level) and rainfall (at 5% level). Significant positive correlation had shown by number of productive shoots to minimum temperature

Table 7. Coefficient of correlation between Plant height and Climatic factors in different months of pruning

Climatic factors / Plant ht	Temp max	Temp Min	RH% Morning	RH% Evening	Rain fall	Mean sunshine hours	Rainy days
April	0.056	0.149	0.065	0.025	0.193	-0.099	0.084
July	0.554**	-0.207	-0.230	-0.250	-0.270*	-0.082	0.087
October	0.065	0.273	0.239	0.116	0.147	-0.026	0.202
January	-0.234	-0.262	-0.187	-0.054	-0.055	0.060	-0.051

Table 8. Coefficient of correlation between vegetative characters, yield and climatic factors in the month of April

Climatic Factors / Plant characters	Temp Max	Temp Min	RH% Morning	RH% Evening	Rain fall	Mean sunshine hours	Rainy days
Plant spread	-0.250*	-0.372**	-0.039	0.057	0.175	0.374**	0.091
No of primary branches	-0.015	0.118	0.204	0.099	0.199	0.389**	0.031
No of secondary branches	-0.013	0.020	0.095	0.021	0.168	0.489**	-0.031
No of productive shoots	0.155	0.186	0.088	-0.057	0.110	0.212	-0.032
Yield	-0.779*	0.024	0.684**	0.846**	0.780**	-0.404**	0.809**

Fig 1.Variation in yield in different months of pruning

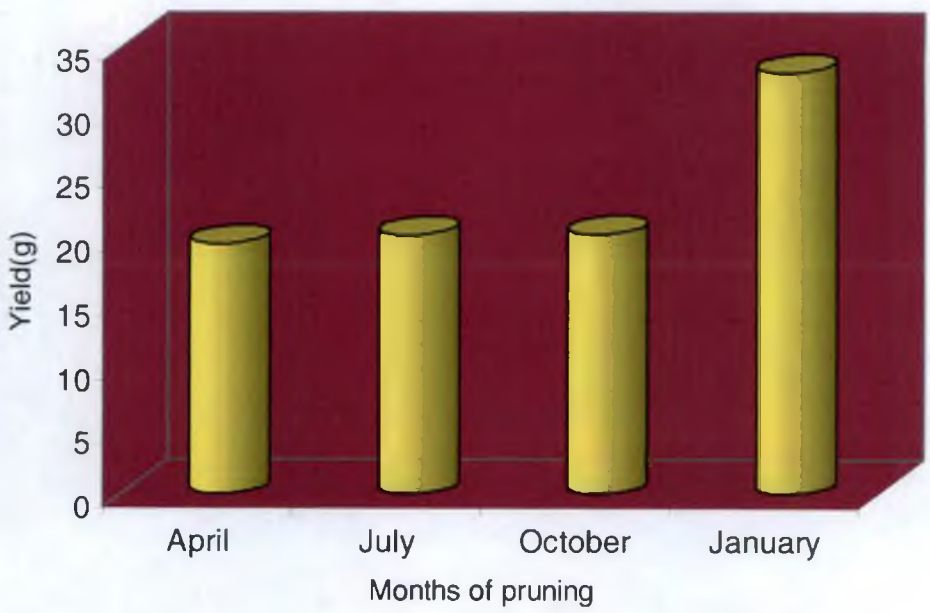


Fig 2 Effect of different time of pruning on 100 flower bud weight

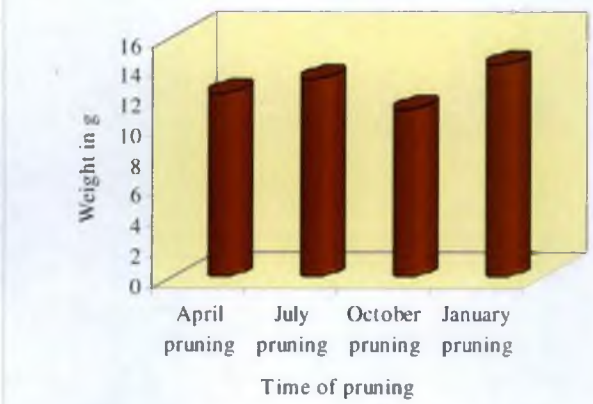


Fig 3 Effect of time of pruning on corolla tube length, flower bud length and flower bud diameter

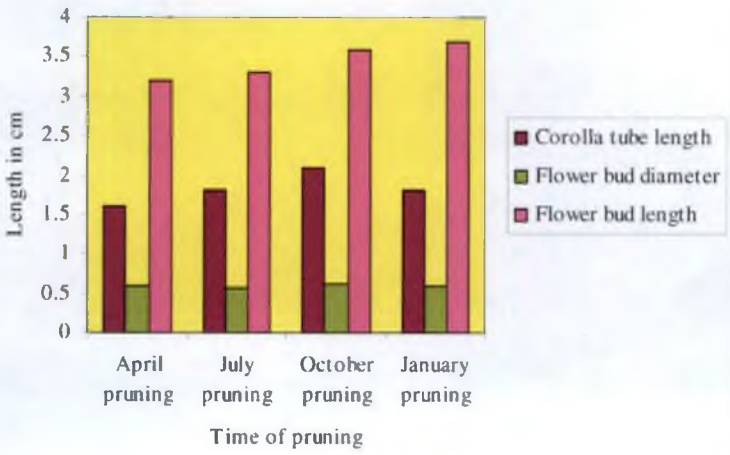


Table 9. Coefficient of correlation between vegetative characters, yield and climatic factors in the month of July

Climatic factors / Plant characters	Temp Max	Temp Min	RH% Morning	RH% Evening	Rain fall	Mean sunshine hours	Rainy days
Plant spread	-0.140	-0.224	-0.280*	-0.198	-0.190	-0.28	0.324**
No of primary branches	-0.262*	-0.188	-0.374**	-0.243	-0.338**	-0.114	0.035
No of secondary branches	0.153	0.097	0.461	0.080	0103	0.073	0.715
No of productive shoots	0.058	0.182	-0.223	-0.062	-0.168	-0.178	-0.247*
Yield	-0.300*	0.058	0.120	-0.118	-0.158	-0.090	-0.123

Table 10. Coefficient of correlation between Vegetative characters, yield and climatic factors in the month of October

Climatic factors / Plant characters	Temp Max	Temp Min	RH% Morning	RH% Evening	Rain fall	Mean sunshine hours	Rainy days
Plant spread	0.047	0.161	0.069	0.016	0.149	-0.222	0.058
No of primary branches	0.444**	0.333*	-0.061	-0.274	0.193	0.256	0.036
No of secondary branches	0.305*	0.416**	0.095	-0.105	0.350*	0.099	0.131
No of productive shoots	0.262	0.432**	0.130	0.063	0.352*	0.064	0.113
Yield	-0.473	-0.042	0.171	0.300*	0.474**	-0.358	0.297*

Table 11. Coefficient of correlation between vegetative characters and Climatic Factors in the month of January

Climatic factors / Plant characters	Temp Max	Temp Min	RH% Morning	RH% Evening	Rain fall	Mean sunshine hours	Rainy days
Plant spread	-0.301	0.571**	0.630**	0.631**	0.681**	-0.673**	0.733**
No of primary branches	-0.343	0.674**	0.730**	0.727**	0.787**	-0.767**	0.831**
No of secondary branches	-0.292	0.725**	0.711**	0.698**	0.751**	-0.731**	0.798**
No of productive shoots	0.030	0.636**	0.518**	0.425*	0.484**	-0.448**	0.538**
Yield	0.059	0.620**	0.445**	0.371*	0.585**	-0.462**	0.623**

(at 1% level) and rainfall at (5% level). Yield showed positive correlation to relative humidity (at 5% level), rainfall (1% level) and rainy days (at 5% level)(Table10)

4.1.3.4. January pruning

From table 11, it was observed that plant height showed significant positive correlation to all the weather parameters (at 1% level) except maximum temperature. Number of primary and secondary branches also showed positive correlation (at 1% level) to all the weather parameters and negative correlation to minimum temperature. Yield and number of productive shoots showed significant positive correlation to minimum temperature, maximum temperature, RH (Morning), rainfall and rainy days(at 1% level) and RH (Evening) at 5% level. Both showed negative correlation to mean sunshine hours.

4.2. MANURIAL TRIAL

Data obtained on the effect of different treatments on vegetative and floral characters of *J. sambac* in monthly intervals from July 2005 to June 2006 are tabulated and statistically analyzed and results of the experiment are presented below.

4.2.1. Effect of different treatments on plant height:

Plant height showed an increasing trend from the month of July to next June irrespective of the treatment (Table 12). In the month of July T_3 was significantly superior to all other treatment and showed maximum plant height (16.17cm) in single plant condition, which was significantly superior to all other treatments, followed by T_9 (16.00 cm) which was on par with T_{10}, T_2, T_7 and T_6. T_8 (15.33 cm) showed lowest height. In August also T_3 showed maximum height (17.23 cm), which was on par with T_7 (17.00 cm) followed by T_9 (16.83 cm), which was on par with all other treatments except T_4 (16.03 cm). T_2 showed maximum height (17.83 cm) in September, which was on par with T_9 (17.30 cm) and T_3 (17.28 cm), followed by T_{10} (17.17 cm), which was significantly on par with all other treatments except T_1 (16.50 cm). In October also T_2 showed maximum height (18.83 cm) followed by T_6 (18.73 cm), which was on par with T_3, T_4, T_5, T6 and T_7.

Minimum height was showed by T_8. In November also showed the same trend. In December T_9 showed the maximum height (19.73 cm) which was on par with T_3, T_{10} and significantly superior to all other treatments. In January T_9 showed maximum height (25.23 cm) which was on par with T_{10} (24.70 cm) and significantly superior to other treatments, followed by T_5 (22.53 cm) which was on par with (22.

Table 12. Effect of manures and fertilizers on height in *J. sambac* from July to December

Plant height from July to December in cm												
	July		August		September		October		November		December	
Treatments	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP
T1	15.50^{b}	15.83^{ab}	16.83^{ab}	16.83^{ab}	16.50^{b}	17.37^{ab}	17.60^{ab}	17.37^{b}	17.60^{ab}	17.37^{b}	17.48^{b}	17.37^{b}
T2	16.00^{ab}	15.83^{ab}	16.67^{ab}	16.67^{ab}	17.83^{a}	17.20^{ab}	18.03^{a}	17.80^{ab}	18.30^{a}	18.80^{ab}	18.35^{ab}	18.80^{ab}
T3	16.17^{a}	17.00^{a}	17.23^{a}	17.33^{a}	17.28^{a}	17.87^{a}	18.17^{a}	18.07^{ab}	18.37^{a}	18.47^{ab}	18.52^{a}	18.87^{ab}
T4	15.77^{ab}	16.00^{ab}	16.03^{b}	16.33^{ab}	17.10^{ab}	17.50^{ab}	18.17^{a}	17.90^{ab}	18.17^{a}	18.10^{ab}	17.63^{b}	18.90^{ab}
T5	15.67^{ab}	16.00^{ab}	16.33^{ab}	16.33^{ab}	17.00^{ab}	16.60^{b}	18.07^{a}	17.60^{b}	18.67^{a}	18.00^{ab}	18.83^{ab}	18.60^{ab}
T6	15.83^{ab}	15.83^{ab}	16.20^{ab}	16.00^{b}	17.00^{ab}	17.17^{ab}	18.73^{a}	18.17^{ab}	18.73^{a}	18.17^{ab}	18.45^{ab}	19.07^{ab}
T7	16.00^{ab}	15.97^{ab}	17.00^{a}	17.00^{a}	17.03^{ab}	17.50^{ab}	18.20^{a}	18.50^{ab}	18.20^{a}	19.20^{a}	18.85^{ab}	19.50^{ab}
T8	15.33^{b}	15.83^{ab}	16.50^{ab}	16.50^{ab}	16.87^{ab}	17.00^{ab}	17.37^{ab}	18.30^{ab}	17.97^{a}	19.50^{a}	18.93^{ab}	20.50^{a}
T9	16.00^{ab}	16.03^{ab}	16.83^{ab}	17.83^{a}	17.30^{a}	18.07^{a}	17.80^{ab}	19.27^{a}	18.20^{a}	20.27^{a}	19.73^{a}	21.27^{a}
T10	15.83^{ab}	15.17^{b}	16.50^{ab}	17.50^{a}	17.17^{ab}	18.20^{a}	17.50^{ab}	18.80^{a}	18.00^{a}	19.20^{a}	19.00^{a}	21.00^{a}

T_1- NPK-120: 240:240g/plant/year+ 50g neemcake+50g groundnut cake given at fortnightly intervals.

T_2 - Half the dose of treatment 1, given at fortnightly intervals.

T_3- A combination of *Azospirillum* and phosphobacteria +AMF along with the treatment 1

T_4- A Combination of *Azospirillum* + phosphobacteria +AMF along with three fourth dose of treatment1

T_5 - NPK 45:45:65g/plant/year along with 100g-neem cake+100g groundnut cake was given at monthly intervals

T_6 Upto 4 month's 70g groundnut cake +30g neem cake was applied. After 4 months 70g sterameal (7:10:5)+50g neemcake applied at monthly intervals

T_7 17:17:17 NPK complex fertilizer 50g+ neemcake 100g +FYM 100+ground nut cake 100g given at monthly intervals

T_8 Neemcake100g+Vermicompost 100g+ground nut cake 100g was given at monthly intervals.

T_9 Neemcake100g+FYM100g+ground nut cake 100g given at monthly intervals.

T_{10} Neemcake100g +Poultry manure 100g +ground nut cake 100g applied at monthly intervals

*SP: Single plant per pot

*DP: Double plant per pot

Table 12 Contd Effect of manures and fertilizers on height in *J. sambac* from January to June

Height of the plants from in cm												
	January		February		March		April		May		June	
Treatments	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP
T1	22.20^{ab}	22.03^{ab}	24.63^{ab}	23.00^{ab}	24.97^{ab}	24.05^{ab}	25.07^{ab}	24.80^{bc}	25.80^{b}	25.00^{b}	26.93^{b}	26.00^{b}
T2	21.23^{b}	22.57^{ab}	22.5^{ab}	23.30^{ab}	23.37^{b}	24.30^{ab}	24.36^{b}	26.30^{ab}	25.30^{b}	26.30^{ab}	26.30^{b}	26.30^{b}
T3	22.13^{ab}	21.67^{ab}	22.93^{ab}	22.63^{b}	23.97^{b}	23.63^{b}	25.40^{ab}	24.63^{bc}	26.63^{ab}	25.63^{ab}	27.63^{ab}	26.03^{b}
T4	21.30^{b}	22.13^{b}	23.63^{ab}	23.30^{ab}	24.63^{ab}	24.80^{ab}	25.63^{ab}	25.50^{b}	26.63^{ab}	26.30^{ab}	28.63^{ab}	26.80^{b}
T5	22.53^{ab}	23.73^{ab}	23.63^{ab}	24.63^{ab}	25.30^{ab}	25.93^{ab}	26.30^{ab}	26.03^{ab}	27.32^{ab}	26.93^{ab}	28.30^{ab}	27.60^{ab}
T6	22.53^{ab}	21.30	23.63^{ab}	22.30^{b}	24.30^{ab}	23.30^{b}	25.37^{ab}	24.30^{bc}	26.96^{ab}	25.30^{b}	27.30^{ab}	26.30^{ab}
T7	21.63^{b}	22.97^{b}	23.30^{ab}	23.30^{ab}	24.30^{ab}	24.80^{ab}	25.37^{ab}	25.30^{b}	26.30^{ab}	26.30^{ab}	28.86^{ab}	27.30^{ab}
T8	21.63^{b}	24.97^{ab}	27.30^{a}	25.97^{a}	28.50^{a}	26.47^{a}	29.30^{a}	26.97^{a}	30.20^{a}	27.96^{a}	31.20^{a}	28.96^{ab}
T9	25.23^{a}	26.37^{a}	26.97^{a}	27.63^{a}	28.07^{a}	28.03^{a}	29.30^{a}	28.83^{a}	30.26^{a}	29.63^{a}	31.10^{a}	30.63^{a}
T10	24.70^{a}	26.63^{a}	25.63^{a}	27.63^{a}	26.93^{a}	28.53^{a}	29.30^{a}	29.43^{a}	30.03^{a}	30.73^{a}	31.33^{a}	30.53^{a}

*SP: Single plant per pot

*DP: Double plant per pot

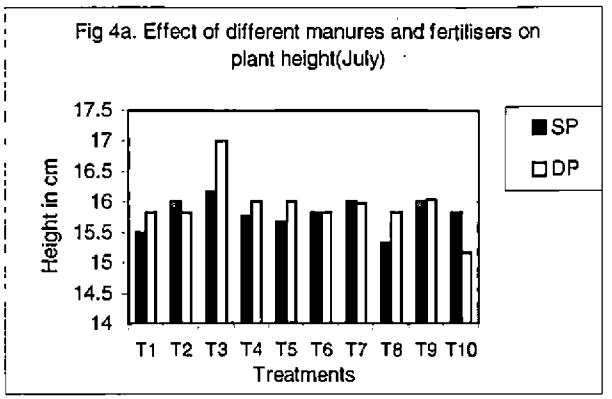


Fig 4a. Effect of different manures and fertilisers on plant height(July)
Height in cm
17.5
17
16.5
16
15.5
15
14.5
14
T1 T2 T3 T4 T5 T6 T7 T8 T9 T10
Treatments
SP
DP

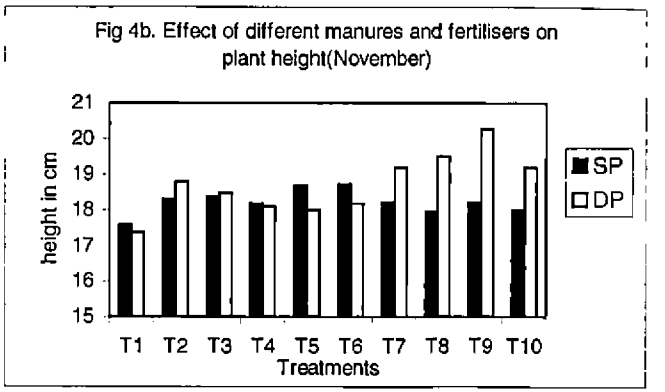


Fig 4b. Effect of different manures and fertilisers on plant height(November)
height in cm
21
20
19
18
17
16
15
T1 T2 T3 T4 T5 T6 T7 T8 T9 T10
Treatments
SP
DP

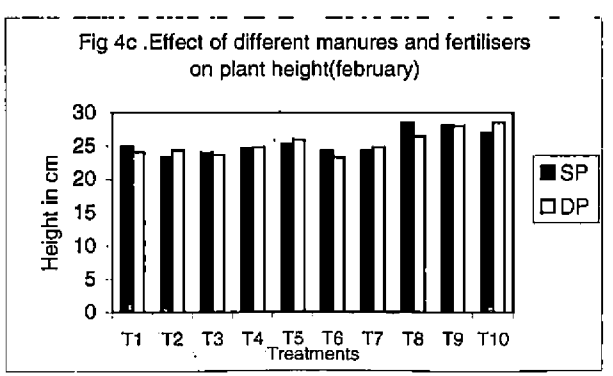


Fig 4c .Effect of different manures and fertilisers on plant height(february)
Height in cm
30
25
20
15
10
5
0
T1 T2 T3 T4 T5 T6 T7 T8 T9 T10
Treatments
SP
DP

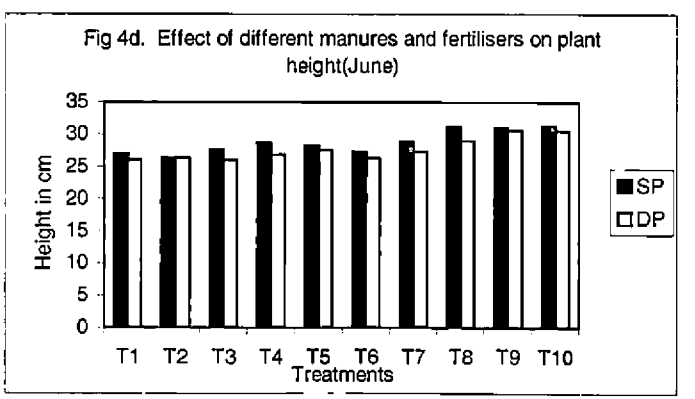


Fig 4d. Effect of different manures and fertilisers on plant height(June)
Height in cm
35
30
25
20
15
10
5
0
T1 T2 T3 T4 T5 T6 T7 T8 T9 T10
Treatments
SP
DP

respectively in single plant and double plant condition). August and September months also showed the same trend. In October in single plant condition T_5 showed maximum plant spread (19.10) which was on par with T_9 (18.50), T_4 (18.30), T_2 (18.13) in single plant condition. In November and December, there was no significant variation between the treatments in plant spread. An increasing trend was shown by the treatments in plant spread from December to January. In March, April a decreasing trend was observed in plant spread. In April month T_3 showed maximum plant spread which is significantly on par with T_4 in the first condition and in the second condition with T_7 showed maximum value. In May June again an increasing trend observed in plant spread and in June T_{10} showed maximum value (28.34, 29.10) in both conditions.

4.2.3. Effect of different fertilizer trials on Number of Primary branches

From the (table 14) it was observed that, in number of primary branches there was no significant difference between the treatments depending upon the type of fertilizers applied. An increasing trend in number of primary branches in the initial months was noticed and there was no significant difference between the treatments from July to June. How ever a slight difference was observed in May in single plant condition and June in double plant condition.

4.2.4. Effect of different fertilizer trials on number of secondary branches

In number of secondary branches also there was an increasing trend from July to December and January to June (Table 15). It was shown in the table. There was no significant difference between the treatments when statistically analyzed.

4.2.5. Effect of different fertilizer trials on number of productive shoots

From (Table16), it was observed that number of productive shoots showed both increasing and decreasing trend from July to June. In July T_{10} containing organic manures showed maximum number of productive shoots (5.18), which was on par with T_8 (5.06)

Table 13.Effect of manures and fertilizers on plants spread in *J. sambac* from July to December

	Plant spread in cm											
	July		August		September		October		November		December	
Treatments	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP
T1	15.16^{ab}	15.83^{a}	16.36^{abc}	16.00^{ab}	16.5^{ab}	17.93^{ab}	17.11^{ab}	17.93^{ab}	18.10^{a}	17.93^{a}	18.51^{a}	18.21^{a}
T2	14.66^{ab}	15.83^{a}	15.66^{abc}	16.80^{ab}	17.83^{ab}	18.10^{a}	18.13^{a}	18.10^{a}	18.15^{a}	18.10^{a}	17.97^{a}	18.50^{a}
T3	17.00^{a}	17.00^{a}	17.50^{a}	17.00^{a}	19.00^{a}	18.26^{a}	17.30^{ab}	18.26^{a}	17.50^{b}	18.27^{a}	18.63^{a}	18.37^{a}
T4	16.00^{ab}	16.00^{ab}	17.16^{ab}	15.00^{ab}	17.5^{ab}	17.5^{ab}	18.30^{a}	17.5^{ab}	18.30^{a}	17.50^{a}	17.50^{a}	18.10^{a}
T5	13.66^{b}	14.00^{b}	15.16^{bc}	15.00^{ab}	18.00^{a}	17.53^{ab}	19.10^{a}	17.53^{ab}	18.00^{a}	17.53^{a}	17.77^{a}	17.30^{ab}
T6	16.00^{ab}	15.83^{ab}	16.66^{abc}	15.00^{ab}	16.00^{ab}	17.53^{a}	17.10^{b}	17.53^{ab}	18.53^{a}	17.53^{a}	16.77^{a}	18.10^{a}
T7	13.66^{ab}	15.97^{ab}	15.16^{bc}	15.33^{ab}	14.70^{b}	17.50^{ab}	15.10^{bc}	17.50^{ab}	17.50^{b}	17.50^{a}	16.10^{a}	18.30^{a}
T8	15.66^{ab}	15.83^{ab}	16.5^{abc}	14.63^{b}	16.80^{ab}	17.26^{b}	17.10^{ab}	17.26^{ab}	17.30^{b}	17.27^{a}	17.07^{a}	17.60^{ab}
T9	14.00^{b}	16.03^{ab}	15.5^{abc}	15.83^{ab}	17.30^{ab}	$17.13a^{b}$	18.50^{a}	17.13^{ab}	17.15^{b}	17.13^{a}	17.22^{a}	18.10^{a}
T10	15.16^{ab}	15.17^{ab}	15.93^{c}	16.00^{ab}	17.16^{ab}	17.18^{ab}	17.50^{ab}	17.23^{ab}	18.13^{a}	17.30^{a}	18.18^{a}	18.18^{a}

*SP: Single plant per pot

*DP: Double plant per pot

Table 13 contd **Effect of manures and fertilizers on plant spread in *J. sambac* from January to June**

Plant spread from January to July(cm)												
	January		February		March		April		May		June	
Treatment	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP
T1	24.43^{a}	24.43^{ab}	25.36^{ab}	25.30^{ab}	26.30^{abc}	25.30^{bc}	27.30^{abc}	25.30^{bc}	27.30^{abc}	25.30^{ab}	27.30^{abc}	25.30^{b}
T2	24.27^{a}	24.27^{ab}	26.30^{a}	24.96^{b}	27.40^{ab}	24.97^{c}	28.30^{ab}	24.97^{c}	28.30^{ab}	24.96^{b}	28.30^{ab}	24.96^{b}
T3	25.33^{a}	25.33^{a}	26.63^{a}	25.96^{ab}	27.73^{a}	25.97^{abc}	28.63^{a}	25.97^{abc}	28.63^{a}	25.96^{b}	28.63^{a}	25.96^{b}
T4	24.93^{a}	24.93^{ab}	26.56^{a}	26.30^{ab}	27.73^{a}	26.30^{abc}	28.63^{a}	26.30^{abc}	28.63^{a}	26.30^{b}	28.63^{a}	26.30^{ab}
T5	26.10^{a}	26.10^{a}	26.40^{a}	26.96^{a}	27.30^{ab}	26.97^{ab}	28.30^{ab}	26.97^{ab}	28.30^{ab}	26.96^{ab}	28.30^{ab}	26.96^{ab}
T6	24.87^{a}	24.87^{ab}	25.56^{ab}	25.96^{ab}	27.07^{ab}	25.97^{abc}	28.30^{ab}	25.97^{abc}	28.30^{ab}	25.97^{b}	28.30^{ab}	25.96^{b}
T7	26.53^{a}	26.53^{a}	26.63^{a}	27.30^{a}	25.63^{bc}	27.30^{a}	28.30^{ab}	27.30^{a}	26.63^{c}	27.30^{ab}	26.63^{bc}	27.30^{ab}
T8	25.77^{a}	25.77^{a}	25.60^{ab}	26.30^{ab}	25.80^{bc}	26.30^{abc}	26.30^{c}	26.30^{abc}	26.63^{c}	26.30^{b}	26.30^{c}	26.30^{ab}
T9	26.60^{a}	26.60^{a}	24.40^{ab}	27.63^{a}	26.63^{abc}	27.63^{a}	27.30^{abc}	27.63^{a}	27.30^{abc}	27.63^{ab}	27.30^{abc}	27.63^{a}
T10	24.60^{a}	24.60^{ab}	26.30^{a}	25.30^{ab}	26.17^{abc}	26.80^{bc}	26.20^{abc}	27.00^{bc}	27.20^{bc}	28.32^{a}	28.34^{abc}	29.10^{a}

*SP: Single plant per pot
*DP: Double plant per pot

Table 14 Effect of manures and fertilizers on primary branches *J. sambac* plants from July to December

July			August		September		October		November		December	
Treatments	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP
T1	2.23[a]	2.29[a]	2.51[a]	2.76[a]	2.70[a]	2.76[a]	2.70[a]	2.76[a]	2.70[a]	2.76[a]	2.73[a]	2.76[a]
T2	2.62[a]	2.44[a]	2.81[a]	2.82[a]	2.64[a]	2.75[a]	2.70[a]	2.75[a]	2.64[a]	2.75[a]	2.70[a]	2.75[a]
T3	2.21[a]	2.37[a]	2.64[a]	2.76[a]	2.82[a]	2.94[a]	2.82[a]	2.94[a]	2.82[a]	2.94[a]	2.88[a]	2.94[a]
T4	2.44[a]	2.29[a]	2.78[a]	2.70[a]	2.75[a]	2.82[a]	2.75[a]	2.82[a]	2.75[a]	2.82[a]	2.79[a]	2.82[a]
T5	2.37[a]	2.30[a]	2.81[a]	2.88[a]	2.82[a]	2.94[a]	2.82[a]	2.94[a]	2.82[a]	2.94[a]	2.88[a]	2.94[a]
T6	2.30[a]	2.43[a]	2.64[a]	2.69[a]	2.82[a]	2.99[a]	2.82[a]	2.99[a]	2.82[a]	2.99[a]	2.91[a]	2.99[a]
T7	2.15[a]	2.23[a]	2.64[a]	2.94[a]	2.64[a]	2.82[a]	2.64[a]	2.82[a]	2.64[a]	2.82[a]	2.73[a]	2.82[a]
T8	2.30[a]	2.43[a]	2.42[a]	2.82[a]	2.69[a]	2.88[a]	2.69[a]	2.88[a]	2.69[a]	2.88[a]	2.79[a]	2.88[a]
T9	2.22[a]	2.15[a]	2.64[a]	2.64[a]	2.70[a]	2.87[a]	2.70[a]	2.87[a]	2.70[a]	2.87[a]	2.79[a]	2.87[a]
T10	2.37[a]	2.37[a]	2.58[a]	2.70[a]	2.64[a]	2.81[a]	2.64[a]	2.81[a]	2.64[a]	2.81[a]	2.73[a]	2.81[a]

*SP: Single plant per pot
*DP: Double plant per pot

Table 14 Contd. Effect of manures and fertilizers on primary branches of *J. sambac* plants from January to June

January			February		March		April		May		June	
Treatments	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP
T1	2.64[a]	2.57[a]	2.70[a]	2.57[a]	2.70[a]	2.57[a]	2.11[a]	1.95[a]	2.70[a]	2.57[a]	2.70[a]	2.57[a]
T2	2.50[a]	2.43[a]	2.56[a]	2.43[a]	2.56[a]	2.43[a]	1.93[ab]	1.85[a]	2.56[a]	2.43[a]	2.56[a]	2.43[a]
T3	2.76[a]	2.57[a]	2.51[a]	2.57[a]	2.51[a]	2.57[a]	1.67[b]	1.95[a]	2.51[a]	2.57[a]	2.51[a]	2.57[a]
T4	2.58[a]	2.64[a]	2.58[a]	2.64[a]	2.58[a]	2.64[a]	1.95[ab]	2.03[a]	2.58[a]	2.63[a]	2.58[a]	2.64[a]
T5	2.57[a]	2.63[a]	2.76[a]	2.63[a]	2.76[a]	2.63[a]	2.27[a]	1.85[a]	2.76[a]	2.64[a]	2.76[a]	2.63[a]
T6	2.64[a]	2.57[a]	2.76[a]	2.56[a]	2.76[a]	2.57[a]	2.12[a]	1.95[a]	2.76[a]	2.57[a]	2.76[a]	2.57[a]
T7	2.76[a]	2.64[a]	2.76[a]	2.64[a]	2.76[a]	2.64[a]	2.12[a]	2.03[a]	2.76[a]	2.64[a]	2.76[a]	2.64[a]
T8	2.64[a]	2.64[a]	2.64[a]	2.64[a]	2.64[a]	2.64[a]	2.03[a]	1.95[a]	2.64[a]	2.64[a]	2.64[a]	2.64[a]
T9	2.51[a]	2.64[a]	2.51[a]	2.64[a]	2.51[a]	2.64[a]	1.95[ab]	2.03[a]	2.51[a]	2.64[a]	2.51[a]	2.64[a]
T10	2.50[a]	2.58[a]	2.50[a]	2.58[a]	2.50[a]	2.58[a]	1.95[ab]	1.95[a]	2.50[a]	2.58[a]	2.50[a]	2.58[a]

*SP: Single plant per pot
*DP: Double plant per pot

Table 15 Effect of manures and fertilizers on secondary branches of *J. sambac* from July to December

July			August		September		October		November		December	
Treatments	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP
T1	2.23[a]	2.33[a]	2.50[a]	2.35[a]	2.70[a]	2.76[a]	2.72[a]	2.76[a]	2.70[a]	2.76[a]	2.73[a]	2.76[a]
T2	2.50[a]	2.23[a]	2.83[a]	2.82[a]	2.64[a]	2.75[a]	2.64[a]	2.75[a]	2.64[a]	2.75[a]	2.70[a]	2.75[a]
T3	2.23[a]	2.30[a]	2.64[a]	2.78[a]	2.82[a]	2.92[a]	2.82[a]	2.90[a]	2.82[a]	2.94[a]	2.88[a]	2.82[a]
T4	2.44[a]	2.15[a]	2.76[a]	2.77[a]	2.75[a]	2.82[a]	2.75[a]	2.82[a]	2.75[a]	2.82[a]	2.79[a]	2.94[a]
T5	2.15[a]	2.30[a]	2.80[a]	2.86[a]	2.82[a]	2.94[a]	2.82[a]	2.91[a]	2.82[a]	2.93[a]	2.88[a]	2.94[a]
T6	2.36[a]	2.36[a]	2.64[a]	2.68[a]	2..82[a]	2.93[a]	2.83[a]	2.99[a]	2.83[a]	2.91[a]	2.91[a]	2.99[a]
T7	2.30[a]	2.37[a]	2.64[a]	2.94[a]	2.64[a]	2.82[a]	2.64[a]	2.82[a]	2.64[a]	2.82[a]	2.73[a]	2.82[a]
T8	2.36[a]	2.36[a]	2.42[a]	2.82[a]	2.69[a]	2.88[a]	2.68[a]	2.88[a]	2.69[a]	2.88[a]	2.79[a]	2.88[a]
T9	2.30[a]	2.22[a]	2.63[a]	2.64[a]	2.70[a]	2.87[a]	2.70[a]	2.87[a]	2.70[a]	2.85[a]	2.78[a]	2.87[a]
T10	2.36[a]	2.30[a]	2.58[a]	2.70[a]	2.64[a]	2.81[a]	2.64[a]	2.81[a]	2.64[a]	2.78[a]	2.73[a]	2.81[a]

* SP Single plant per pot
* DP Double plant per pot

Table 15 Contd Effect of manures and fertilizers on secondary branches of *J. sambac* from July to December

January			February		March		April		May		June	
Treatments	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP
T1	2.58[a]	2.57[a]	2.58[a]	2.67[a]	2.68[a]	2.57[a]	2.59[a]	2.50[a]	2.70[a]	2.63[a]	2.81[a]	2.71[a]
T2	2.58[a]	2.42[a]	2.68[a]	2.52[a]	2.78[a]	2.42[a]	2.60[a]	2.51[a]	2.71[a]	2.61[a]	2.78[a]	2.70[a]
T3	2.76[a]	2.57[a]	2.86[a]	2.67[a]	2.96[a]	2.57[a]	2.83[a]	2.62[a]	2.90[a]	2.68[a]	2.95[a]	2.72[a]
T4	2.64[a]	2.70[a]	2.74[a]	2.80[a]	2.84[a]	2.70[a]	2.70[a]	2.81[a]	2.81[a]	2.82[a]	2.91[a]	2.83[a]
T5	2.51[a]	2.51[a]	2.61[a]	2.51[a]	2.71[a]	2.51[a]	2.60[a]	2.63[a]	2.70[a]	2.73[a]	2.80[a]	2.75[a]
T6	2.64[a]	2.50[a]	2.64[a]	2.60[a]	2.74[a]	2.50[a]	2.71[a]	2.60[a]	2.80[a]	2.70[a]	2.90[a]	2.80[a]
T7	2.51[a]	2.50[a]	2.58[a]	2.50[a]	2.61[a]	2.50[a]	2.60[a]	2.60[a]	2.70[a]	2.70[a]	2.80[a]	2.80[a]
T8	2.44[a]	2.37[a]	2.54[a]	2.47[a]	2.64[a]	2.37[a]	2.50[a]	2.48[a]	2.60[a]	2.50[a]	2.71[a]	2.60[a]
T9	2.44[a]	2.50[a]	2.64[a]	2.55[a]	2.74[a]	2.50[a]	2.53[a]	2.61[a]	2.61[a]	2.68[a]	2.63[a]	2.70[a]
T10	2.50[a]	2.54[a]	2.56[a]	2.60[a]	2.72[a]	2.74[a]	2.80[a]	2.82[a]	2.85[a]	2..87[a]	2.89[a]	2.90[a]

* SP Single plant per pot
* DP Double plant per pot

Table 16 Effect manures and fertilizers on productive shoots in *J. sambac* from July to December

July			August		September		October		November		December	
Treatments	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP
T1	3.99^{b}	4.35^{ab}	4.23^{ab}	4.15^{ab}	4.37^{ab}	4.28^{b}	4.37^{cd}	4.38^{b}	4.38^{ab}	4.50^{b}	4.50^{b}	4.52^{b}
T2	4.43^{ab}	4.19^{ab}	4.21^{ab}	4.12^{ab}	4.51^{ab}	4.34^{b}	4.51^{c}	4.39^{b}	4.51^{ab}	4.80^{b}	4.52^{b}	4.90^{b}
T3	4.36^{ab}	4.27^{ab}	4.46^{ab}	4.29^{ab}	4.14^{ab}	4.43^{b}	4.14^{d}	4.33^{b}	4.14^{ab}	4.56^{b}	4.29^{b}	4.93^{b}
T4	4.18^{ab}	4.23^{ab}	4.19^{ab}	4.26^{ab}	4.32^{ab}	4.29^{b}	$4.32c^{d}$	4.29^{b}	4.32^{ab}	4.32^{b}	4.36^{b}	4.50^{b}
T5	4.26^{ab}	4.23^{ab}	4.35^{ab}	4.36^{ab}	4.19^{ab}	4.37^{b}	4.19^{d}	4.37^{b}	4.19^{ab}	4.50^{b}	4.47^{b}	4.60^{b}
T6	4.45^{ab}	4.23^{ab}	4.19^{ab}	4.60^{ab}	4.39^{ab}	4.54^{b}	4.39^{cd}	4.54^{b}	4.39^{ab}	4.90^{b}	4.51^{b}	4.90^{b}
T7	4.39^{ab}	4.78^{ab}	4.03^{ab}	4.19^{ab}	4.24^{ab}	4.37^{b}	4.24^{d}	4.37^{b}	4.24^{ab}	4.50^{b}	4.53^{b}	5.10^{ab}
T8	5.06^{a}	4.96^{a}	4.89^{a}	5.09^{a}	4.93^{a}	5.28^{a}	4.93^{b}	5.28^{a}	4.93^{a}	5.50^{a}	5.10^{a}	5.28^{a}
T9	5.15^{a}	5.16^{a}	5.33^{a}	5.56^{a}	5.38^{a}	5.48^{a}	5.38^{a}	5.48^{a}	5.38^{a}	5.51^{a}	5.43^{a}	5.70^{a}
T10	5.18^{a}	5.25^{a}	5.59^{a}	5.56^{a}	5.35^{a}	5.44^{a}	5.36^{a}	5.44^{a}	5.35^{a}	5.51^{a}	5.45^{a}	5.60^{a}

*SP: Single plant per pot
*DP: Double plant per pot

and T_9 (5.15) in single plant condition. There was no significant difference between the other treatments except T_1 (3.99) with lowest number of productive shoots. In double plant condition also T_{10} showed maximum number of productive shoots (5.25), which was significantly on par with T_8 (4.96) and T_9 (5.16). There was no significant difference between the other treatments. Similar trend was shown from August to June in both conditions. From December to January a decreasing trend was noticed.

4.2.6. Effect of different fertilizer trials on flower yield of *Jasminum sambac*

Flower yield showed both increasing and decreasing trend from July to January.In the month of July flower yield was maximum in T_3 (17.00g) in single plant condition, which was significantly superior to other treatments, followed by T_6, which was significantly on par with other treatments except with T_5 and T_7. In Double plant condition T_{10} showed maximum yield value (25.33g) followed by T_9 (23.97g). Minimum yield was observed in T_2 (15.30g) and T_5 (15.30g). In August T_{10} showed maximum yield in both condition (28.03g, 28.27g respectively), which was significantly superior to all other treatments. In September T_9 and T_{10} showed higher yield (25.30g, 26.37g) which was significantly superior to all other treatments in single plant condition and T_1 Showed minimum value. In double plant condition also T_{10} showed maximum value and which were significantly on par with T_8 and T_9. Rest of the months also T_8, T_9 and T_{10} showed maximum yield than the other treatments. In January T_{10} Showed maximum value (27.70g). There was no significant difference between T_1 to T_7.

4.2.7 Floral characters

From the table (18) weight of 100 flower bud was same for T_9, T_3 and T_6 with value 12.1g and it was minimum for T_9 10.4). There was not much difference in time taken for first flower bud appearance and it was maximum for T_4 (40-45 days). Corolla tube length was maximum for T_{10} (2.7cm) and minimum for T_1 (1.5). Flower bud diameter was high for T_9 (0.67) followed by T_7 (0.64) and T_4 (0.63). Flower bud diameter was high for T_8 (4.10). There was not much difference between the other treatments.

Table 17 **Effect of manures and fertilizers on yield in *J. sambac* from July to December**

Yield of Jasmine flowers expressed in gram from July to December (g)												
July			August		September		October		November		December	
Treatments	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP
T1	15.17^{ab}	16.30^{d}	14.23^{e}	14.60^{e}	14.80^{c}	15.13^{b}	14.80^{cd}	15.13^{b}	14.80^{c}	15.13^{b}	14.97^{b}	15.13^{b}
T2	14.67^{ab}	15.30^{d}	14.80^{de}	14.67^{e}	16.40^{c}	15.53^{b}	16.40^{c}	15.53^{b}	16.40^{c}	15.53^{b}	15.97^{b}	15.53^{b}
T3	17.00^{a}	15.63^{d}	16.27^{d}	15.80^{e}	13.87^{c}	15.00b	13.87^{d}	15.00^{b}	13.87^{c}	15.00^{b}	14.43^{b}	15.00^{b}
T4	16.00^{ab}	15.63^{d}	14.97^{de}	15.90^{e}	15.07^{c}	14.77^{b}	15.07^{cd}	14.77^{b}	15.07^{c}	15.00^{b}	14.92^{b}	14.77^{b}
T5	13.67^{b}	15.30^{d}	15.27^{de}	16.40^{e}	14.30^{c}	14.83^{b}	14.30^{cd}	14.83^{b}	14.30^{c}	14.83^{b}	14.57^{b}	14.83^{b}
T6	16.00^{ab}	15.63d	14.27^{e}	18.87^{d}	14.30^{c}	16.37^{b}	15.67^{cd}	16.37^{b}	15.67^{c}	16.37^{b}	16.02^{b}	16.37^{b}
T7	13.67^{b}	19.97^{c}	13.27^{e}	14.93^{c}	14.33^{c}	14.80^{b}	14.33^{cd}	14.80^{b}	14.33^{c}	14.80^{b}	14.57^{b}	14.80^{b}
T8	15.67^{ab}	22.30^{b}	20.67^{c}	22.63^{c}	21.03^{b}	23.63^{a}	21.03^{b}	23.63^{a}	21.03^{b}	23.63^{a}	22.33^{a}	23.63^{a}
T9	14.00^{b}	23.97^{ab}	24.83^{b}	24.97^{b}	25.30^{a}	25.40^{a}	25.30^{a}	25.40^{a}	25.30^{a}	25.40^{a}	25.35^{a}	25.40^{a}
T10	15.17^{ab}	25.33^{a}	28.03^{a}	28.27^{a}	26.37^{a}	26.01^{a}	26.00^{a}	25.80^{a}	25.32^{a}	24.90^{a}	26.23^{a}	26.80^{a}

Table 17 contd Effect of manures and fertilizers on yield in *J. sambac* from January to June

Flower yield per plant (g)												
January			February		March		April		May		June	
Treatments	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP	SP	DP
T1	14.43^{c}	14.97^{c}	14.43^{b}	14.97^{c}	15.30^{b}	14.97^{b}	15.33^{c}	14.90^{e}	15.33^{ef}	14.90^{c}	15.33^{c}	14.90^{bc}
T2	15.37^{c}	14.37^{c}	15.37^{b}	14.37^{c}	17.30^{b}	14.37^{b}	15.60^{c}	16.30^{de}	15.60^{d}	16.30^{bc}	15.60^{c}	16.30^{bc}
T3	14.97^{c}	15.07^{c}	15.30^{b}	15.07^{c}	16.30^{b}	15.07^{b}	15.20^{c}	15.90^{de}	15.20^{f}	15.90^{bc}	15.20^{c}	15.90^{bc}
T4	15.10^{c}	15.37^{c}	15.70^{b}	15.37^{c}	15.97^{b}	15.37^{b}	15.57^{c}	17.30^{cd}	15.57^{de}	17.30^{b}	15.20^{c}	17.30^{b}
T5	15.33^{c}	15.37^{c}	15.33^{b}	15.37^{c}	16.30^{b}	15.37^{b}	15.60^{c}	17.62^{cd}	15.57^{de}	17.62^{b}	15.57^{c}	17.62^{b}
T6	14.97^{c}	14.97^{c}	15.33^{b}	14.97^{c}	16.30^{b}	14.97^{b}	15.30^{c}	18.59^{c}	15.57^{de}	18.5^{ab}	15.30^{c}	18.58^{ab}
T7	14.90^{c}	13.60^{c}	14.90^{b}	13.60^{c}	16.63^{b}	13.60^{b}	15.67^{c}	17.63cd	15.57^{de}	18.58^{ab}	15.67^{c}	17.63^{b}
T8	25.30^{b}	24.77^{b}	25.30^{a}	24.77^{b}	25.63^{a}	24.77^{a}	24.30^{b}	20.63^{b}	15.57^{de}	20.63^{a}	24.30^{b}	20.63^{a}
T9	27.30^{ab}	27.37^{a}	27.30^{a}	27.37^{a}	24.97^{a}	27.37^{a}	25.30^{b}	23.90^{a}	25.30^{b}	23.90^{a}	25.30^{b}	23.90^{a}
T10	27.60^{a}	26.80^{a}	28.00^{a}	26.30^{ab}	26.30^{a}	27.30^{a}	27.47^{a}	26.10^{a}	27.47^{a}	26.36^{a}	27.47^{a}	24.36^{a}

*SP Single plant per pot
*DP Double plant per pot

Fig 5a.Effect of different manures and fertilisers on flower yield(July)

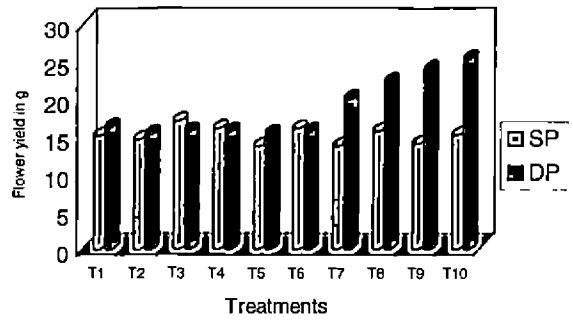


Fig 5b .Effect of different manures and fertilisers on flower yield(November)

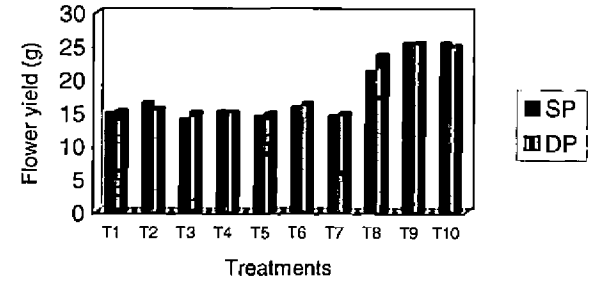


Fig 5c.Effect of different manures and fertilisers on flower yield(February)

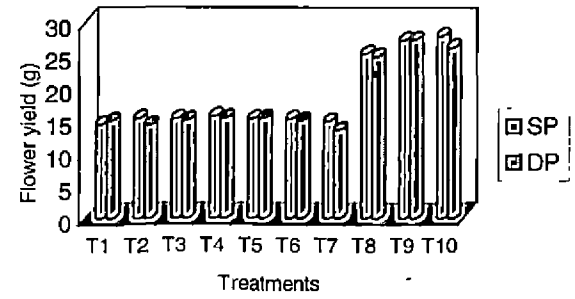


Fig 5d. Effect of different manures and fertilisers on flower yield(June)

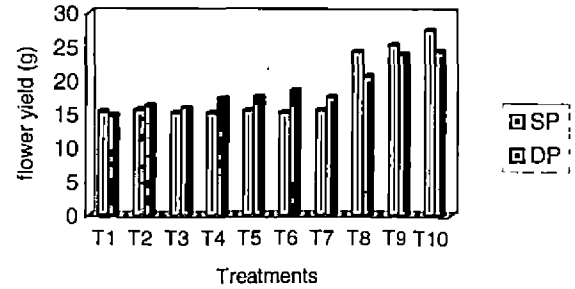


Table 18 **Floral characters as influenced by the treatments**

Treatments	Wt of 100 flower buds (g)	Time taken for flower bud appearance (days)	Corolla tube length (cm)	Flower bud diameter (cm)	Flower bud length (cm)
T_1	10.4	35-40	1.5	0.56	3.06
T_2	11.5	38-41	2.1	0.65	3.32
T_3	12.1	35-40	2.2	0.54	3.35
T_4	11.3	40-45	2.3	0.63	3.70
T_5	10.9	36-40	2.2	0.58	3.53
T_6	12.1	35-41	2.4	0.56	3.34
T_7	11.3	33-40	2.5	0.64	3.90
T_8	11.2	34-41	2.4	0.60	4.10
T_9	12.1	30-35	2.2	0.67	3.80
T_{10}	10.8	35-40	2.7	0.59	3.30

Fig 6. Effect of manures and fertilisers on 100 flower bud weight

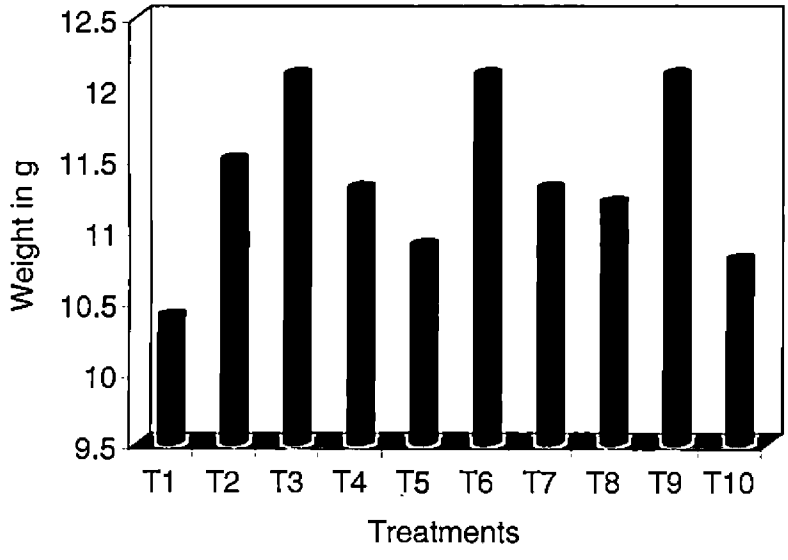
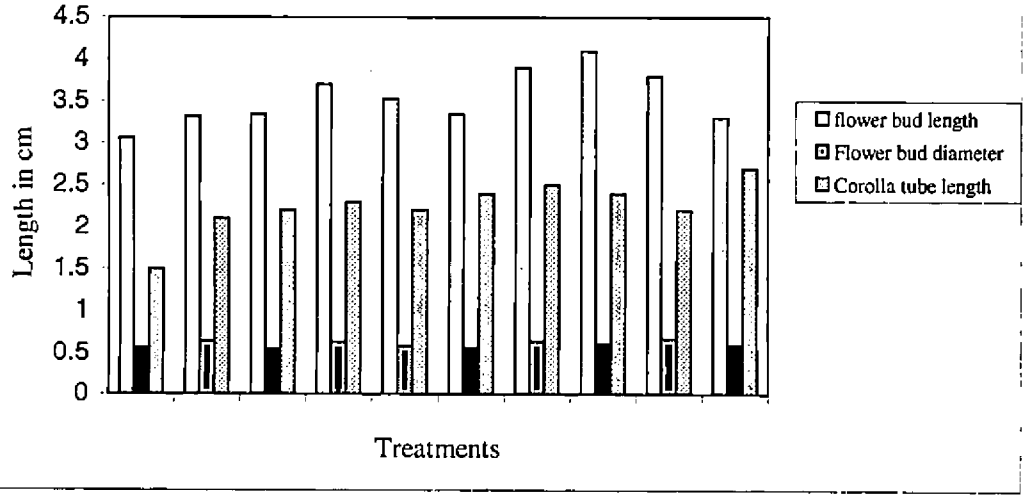


Fig 7. Effect of treatments on flowerbud length, Corolla tube length and Flower bud diameter



4.2.8. Nutrient analysis:

4.2.8.1.Available nitrogen,phosphorous and potassium in soil samples before planting and peak flowering stage(fig. 8)

4.2.8.1.1. Available nitrogen

From the Table 13, it is observed that soil samples taken before planting showed maximum value of nitrogen (0.15 kg/ha) followed by the soil samples collected from T_7 containing chemical fertilizers (0.078 kg/ha). T_9 containing organic manures showed minimum value of nitrogen (0.062 kg/ha). There was no significant difference between the other treatments.

4.2.8.1.2 Available phosphorous

In the case of phosphorous soil samples taken from the treatments containing organic manures showed maximum value (1.568 kg/ha) followed by treatments containing phosphobacteria and *Azospirillum* (1.545 kg/ha). There was no significant difference between the treatments

4.2.8.1.3. Available potassium

Potassium content was maximum in T_4 containing *Azospirillum* and phosphobacteria (0.454 kg/ha) followed by T_6 (0.470 kg/ha), There was no significant difference between the other treatments and the soils taken before planting.

4.2.8.2. Available nitrogen, phosphorous and potassium in leaf samples at vegetative and flowering stage:

4.2.8.2.1. Available nitrogen in vegetative stage

nutrient analysis was done in leaf samples collected from the jasmine plant at vegetative and flowering stage and the data obtained in percentage were tabulated and statistically analyzed. From the tabulated data samples collected from T_{10} containing neem cake (100g), groundnut cake (100g) and poultry manure (100g) showed maximum value (2.83%) followed by T_9 containing neem cake, FYM and ground nut cake each 100g with value (2.73%). The other treatments there was no significant difference.

Fig 8. NPK present in soil samples taken from different treatments at peak flowering stage(kg/ha)

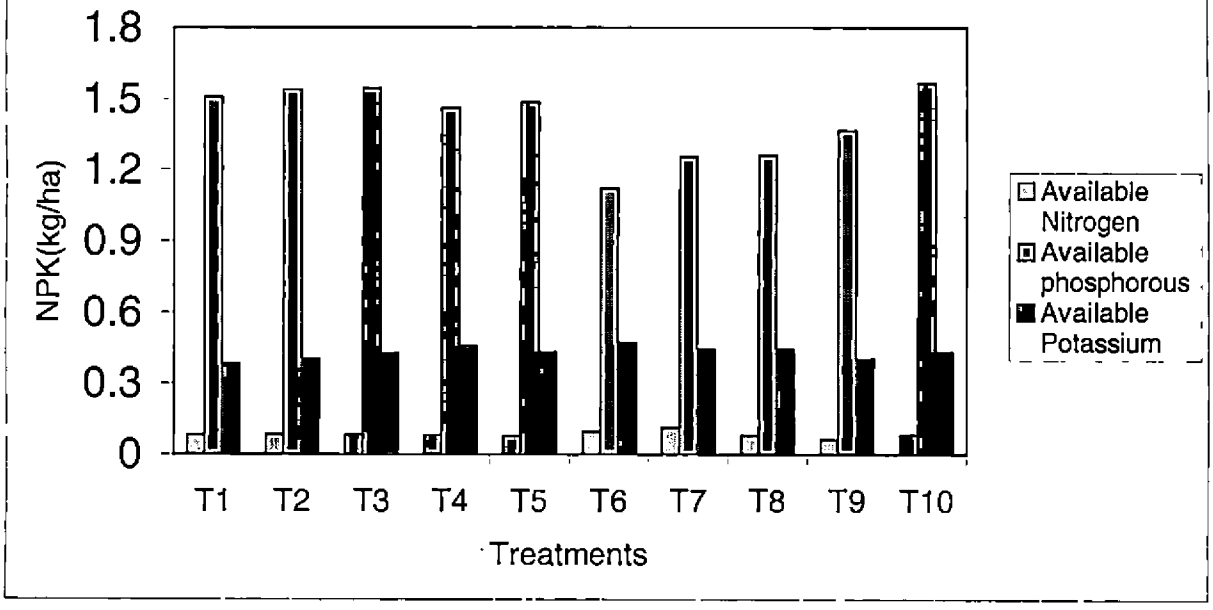


Table 19 **Available N, P and K present in different soil samples**

Treatments	Available nitrogen (kg/ha)	Available phosphorous (kg/ha)	Available potassium (kg/ha)
T1	0.082	1.507	0.380
T2	0.085	1.538	0.403
T3	0.082	1.545	0.425
T4	0.080	1.462	0.454
T5	0.078	1.485	0.432
T6	0.096	1.120	0.470
T7	0.112	1.254	0.441
T8	0.080	1.261	0.441
T9	0.062	1.366	0.403
T10	0.082	1.568	0.432
Soil sample before planting	0.150	1.260	0.441
CD	0.014	0.530	0.170

Table 20. **Total N, P and K in Leaf samples at vegetative and flowering stage (%)**

Treatments	At vegetative stage			At flowering stage		
	Nitrogen	Phosphorous	Potassium	Nitrogen	Phosphorous	Potassium
	% on oven dry basis			% on oven dry basis		
T1	2.38^{a}	0.40^{b}	1.06^{d}	2.26^{a}	0.27^{d}	0.69^{c}
T2	2.40^{a}	0.40^{b}	1.07^{d}	2.26^{a}	0.36^{c}	0.75^{c}
T3	2.47^{a}	0.40^{b}	1.23^{c}	2.30^{a}	0.37^{c}	0.76^{c}
T4	2.50^{a}	0.42^{b}	1.33^{b}	2.40^{a}	0.39^{c}	0.91^{b}
T5	2.51^{a}	0.42^{ab}	1.34^{b}	2.40^{a}	0.48^{b}	0.93^{ab}
T6	2.54^{a}	0.42^{ab}	1.35^{b}	2.43^{a}	0.48^{b}	0.98^{ab}
T7	2.61^{a}	0.43^{ab}	1.35^{b}	2.46^{a}	0.50^{b}	0.99^{ab}
T8	2.66^{a}	0.43^{ab}	1.37^{ab}	2.50^{a}	0.52^{b}	1.01^{ab}
T9	2.73^{a}	0.44^{ab}	1.37^{ab}	2.50^{a}	0.56^{ab}	1.02^{ab}
T10	2.83^{a}	0.47^{a}	1.44^{a}	2.56^{a}	0.61^{a}	1.05^{a}

4.2.8.2.2. Available phosphorous in vegetative stage

From Table 7 it was observed that T_{10} was significantly superior over the other treatment with value (0.47%). There was no significant difference between the leaf samples of other treatments in the amount of available phosphorous.

4.2.8.2.3. Available potassium in vegetative stage

From the table 7 it was observed that treatments containing organic manures are significantly superior over the other treatments. Treatment containing T_{10} showed maximum value (44%) followed by T_8 (1.37%) and T_9 (1.37%). The other treatments there were no significant difference.

4.2.8.2.4. Available nitrogen at flowering stage

In flowering stage there was no significant difference between the treatments in available nitrogen content (Table 7)

4.2.8.2.5. Available phosphorous at flowering stage

From the Table 7 it was clear that, in the amount of phosphorus T_{10} was superior over the other treatment (0.61%) followed by T_9 (0.56%) and there was no significant difference between the other treatments.

4.2.8.2.6. Available potassium at flowering stage:

T_{10} containing organic manures are significantly superior over the other treatments with 1.05% potassium content. Treatments T_5 to T_9 were significantly on par. There was not much significant variation between the other treatments (Table 7).

4.4. POST HARVEST STUDIES

4.4.1 Effect of packaging materials

Packaging of flowers in polythene bags without ventilation retained the characteristic white colour for a long time and reduced the development of brown colour compared to the flowers packed in ventilated bags and compared to non packed control flowers.

4.4.1.1 Physiological loss of weight

From the Table (20) it was observed that all the treatments showed significant variation. Physiological loss of weight was low for flowers packaged with polythene bags

Fig 8. NPK present in soil samples taken from different treatments at peak flowering stage(kg/ha)

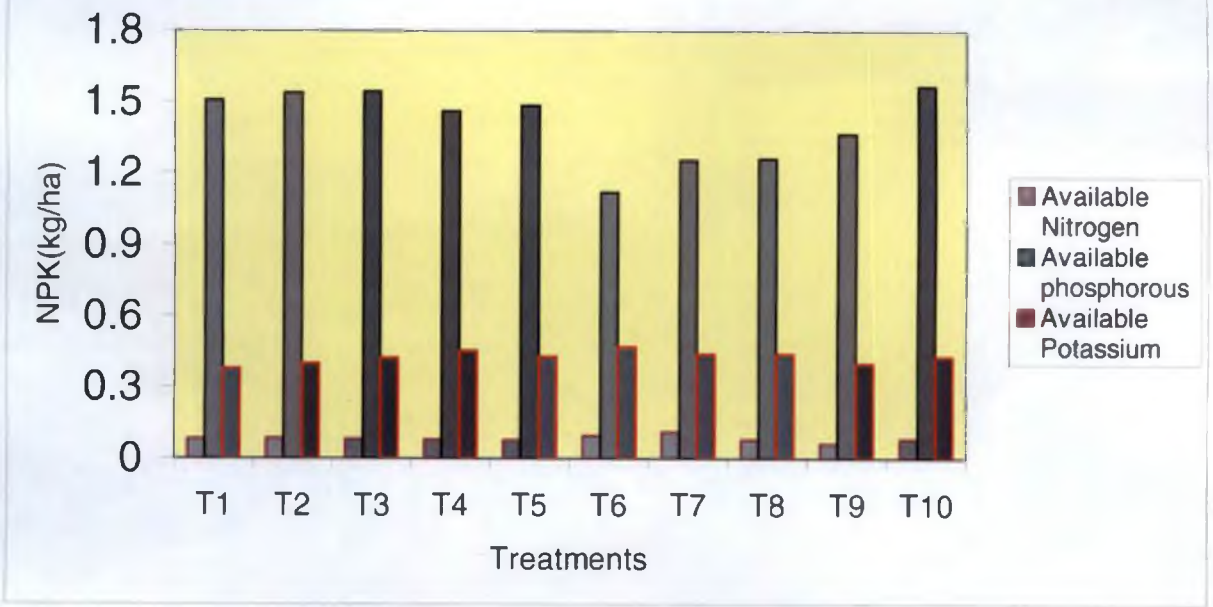


Fig 9a. Total N P K in leaf sample at vegetative a stage (%)

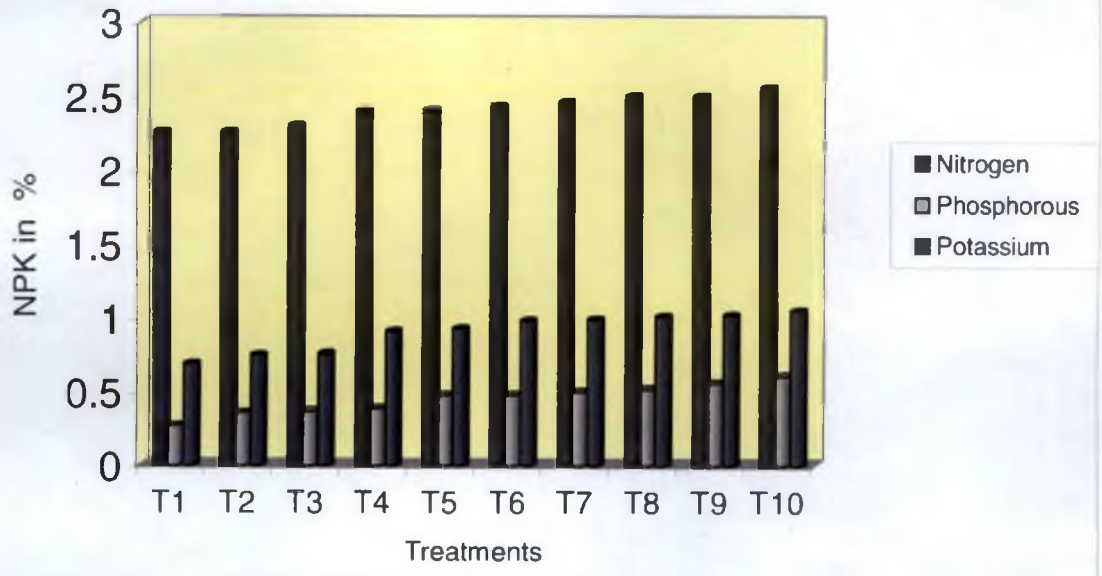


Fig 9b .Total N P K in leaf sample at peak flowering stage (%)

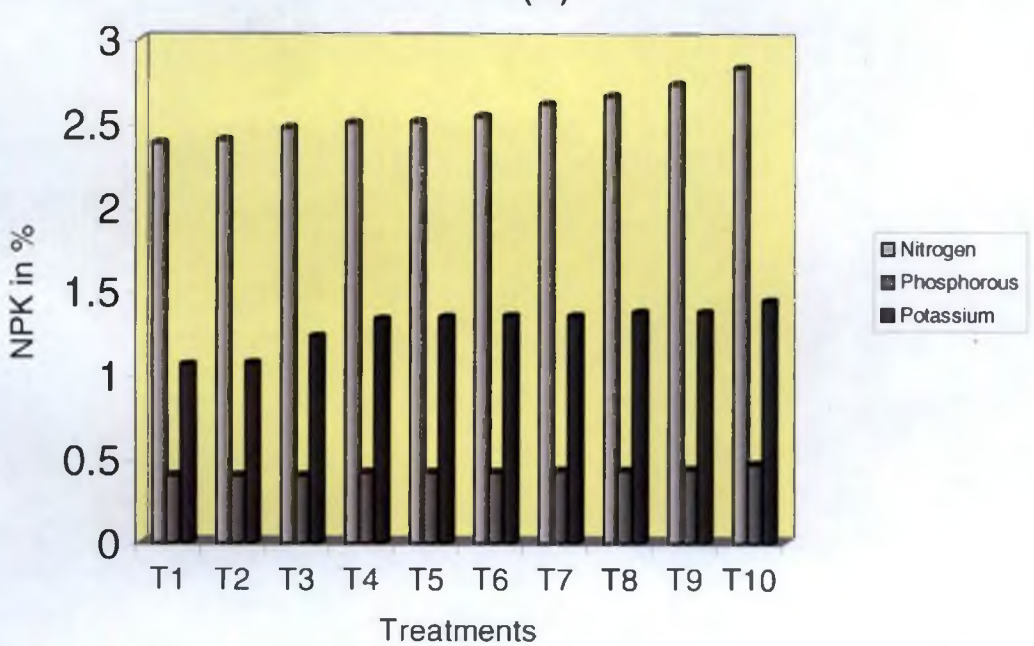


Table 21 Effect of different packaging treatments on keeping quality of jasmine flowers in two seasons

Seasons / Treatments	Physiological loss of weight (Winter season)(g)	Physiological loss of weight (summer season)(g)	Time taken to wilt in hrs (Summer season)	Time taken to wilt in hrs (Winter season)
Polyethylene cover (200G)	0.18	0.19	35.67	35.67
2%perforation	0.23	0.23	33.67	34.33
4%perforation	0.13	0.18	34.33	34.33
6% perforation	0.21	0.23	31.67	33.00
News paper	0.18	0.24	31.67	34.00
Brown paper	0.26	0.26	33.67	31.67
Control	0.33	0.34	11.67	12.00
CD	0.02	0.06	1.38	1.67

with 4% perforation with value (0.13g) followed by flowers packed with polythene cover without perforation (0.18g) which is significantly on par with the flowers packed in newspaper bag. Control treatment without packaging showed maximum value for cumulative physiological loss of weight (0.33g).

In summer season Flowers packed in polythene bag with four per cent perforation showed minimum physiological loss of weight (0.18g) and which was significantly on par with Polythene cover with four percent perforation (0.19g). In other treatments there was no significant difference in physiological loss of weight.

4.4.1.1. Keeping quality of flowers in hours

Flowers packed in polythene cover with out perforation showed maximum keeping quality of 35.66 h (Table 21) than all other treatments, which was significantly on par with the treatment containing polythene bag with 4% perforation and 2% perforation (34.33h). All the treatments were superior to control. Least value shown by flowers packed in brown paper cover (31.66h). In winter also polythene cover without perforation showed maximum keeping quality than all the other treatments. All the treatments were superior to the control in this season also.

4.4.2. Sensory evaluation of jasmine flowers

4.4.2.1 Fresh flower percentage

A sudden decline in fresh flower percentage was observed in non-packaged flowers. While in packaged flowers a slump in the same was observed in two days after packaging. Flowers packed in polythene bags are superior over the other treatments. There was

Table 22 **Effect of chemical treatments on keeping quality of jasmine flowers**

Treatments	Physiological Loss of weight (Summer season) (g)	Physiological Loss of Weight (Winter season) (g)	Time taken to wilt in hrs (Summer season)(g)	Time taken to wilt in hrs (Winter season)(g)
Aluminium sulphate 25ppm	0.52	0.45	36	36
Aluminium sulphate 50ppm	0.53	0.57	36	36
Silver nitrate 25ppm	0.60	0.69	32	32
Silver nitrate 50ppm	0.51	0.56	32	34
Benzyl Adenine 25ppm	0.62	0.69	42	42
Benzyl Adenine 50ppm	0.74	0.77	38	40
Kinetin 25 ppm	0.72	0.62	34	34
Kinetin 50 ppm	0.50	0.47	36	36
Sodium benzoate 25ppm	0.60	0.57	32	34
Sodium benzoate 50ppm	0.61	0.60	36	36
Boric acid 25ppm	0.54	0.55	32	34
Boric acid 50ppm	0.60	0.51	32	34
Triademefon 25ppm	0.53	0.56	30	30
Triademefon 50ppm	0.58	0.55	30	30
Water	0.58	0.52	24	24
Control	0.70	0.77	18	18
CD	0.06	0.08	1.63	1.82

Table 23 Effect of chilling treatments on vase life of jasmine flowers

Storage methods	Time taken to wilt in hrs(summer season)	Time taken to wilt in hrs (Winter season)	Physiological loss of weight (Summer season) (g)	Physiological loss of weight (Winter season) (g)
Storage at ambient temperature	24	30	0.14	0.16
Storage at 25±1°C	60	60	0.14	0.12
Storage at 20±1°C	72	74	0.10	0.12
Storage at 15±1°C	72	72	0.10	0.10

no significant difference between other treatments. Flowers packed with packaging materials like polythene cover, newspaper and brown paper extended the shelf life than that of control.

4.4.2.2. Retention of colour

In non-packaged flowers pinkish discoloration was observed after harvest. Flowers packed in polythene cover, newspaper and brown paper cover retained the colour up to 2-3 days. Flowers packed in polythene cover retained the white colour up to 36hrs.

4.4.2.3. Fragrance

Flowers treated with packaging materials retained the fragrance more time than unpackaged flowers.

4.4.2. Effect of chemicals on keeping quality of flowers

4.4.2.1. Physiological loss* of *weight.

Data generated on the physiological loss of weight of flower buds sprayed on different chemicals are presented in tables. From the table (22) it was observed that in both seasons there were significant variation between the flowers sprayed with different chemicals and the control treatments. Aluminium sulphate at 25ppm had minimum physiological loss of weight 0.45g in winter season and 0.52g in summer season. Kinetin at 50ppm showed a physiological loss of weight of 0.47g in winter season and 0.50g in summer season. Benzyl adenine showed maximum physiological loss of weight with values 0.74 (25 ppm), 0.72 (50 ppm) in summer season and 0.77 (25 ppm), 0.62 (50 ppm) in winter season respectively.

4.4.2.2. Time taken to wilt

From the table 22 it was observed that benzyl adenine at 25 ppm showed maximum time taken for wilting with value 42hrs in both the seasons and which was significantly superior to all other treatments, followed by aluminium sulphate 25 and 50 ppm with value 36h in both the seasons. All the flowers sprayed with different chemicals expressed more vase life than control.

4.4.3 Effect of chilling treatments

Plate 8. Comparison between chemical treatments and control

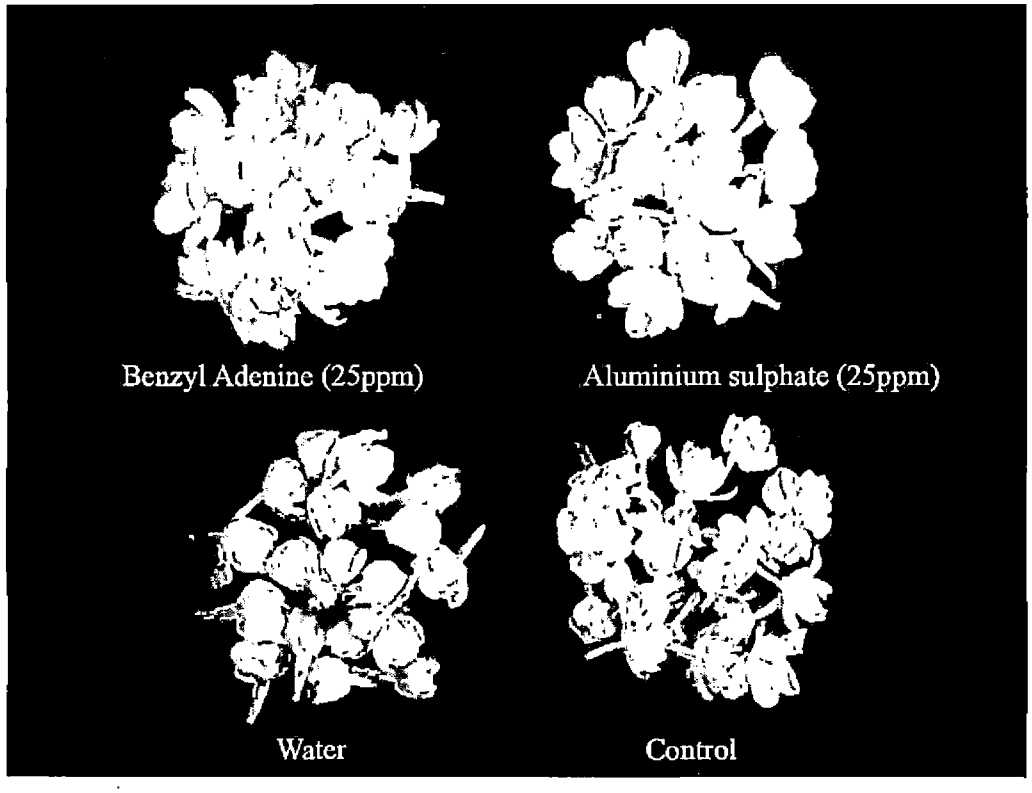


Plate 9. Comparison between packaging treatments and control

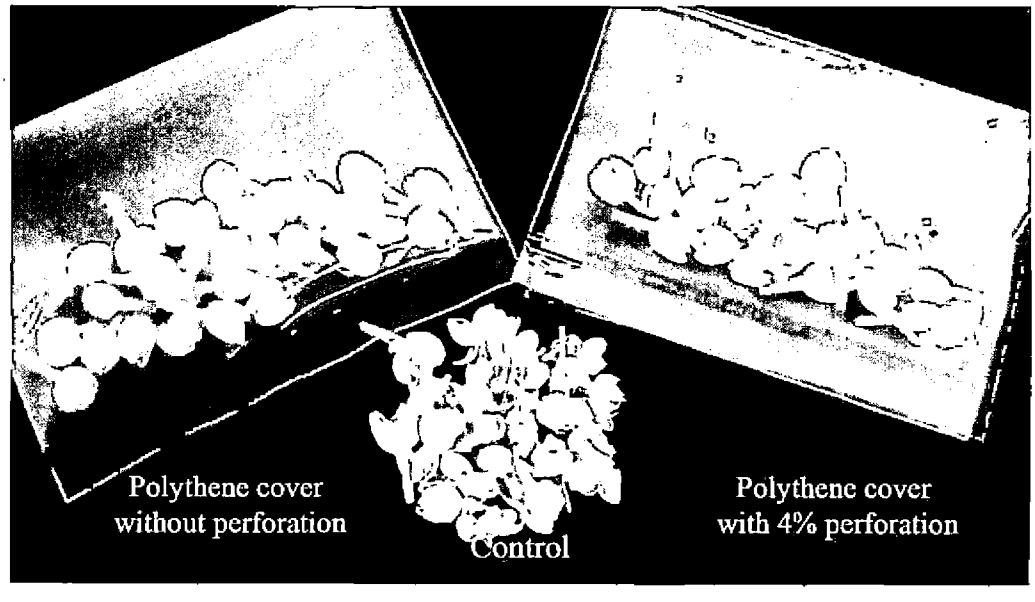
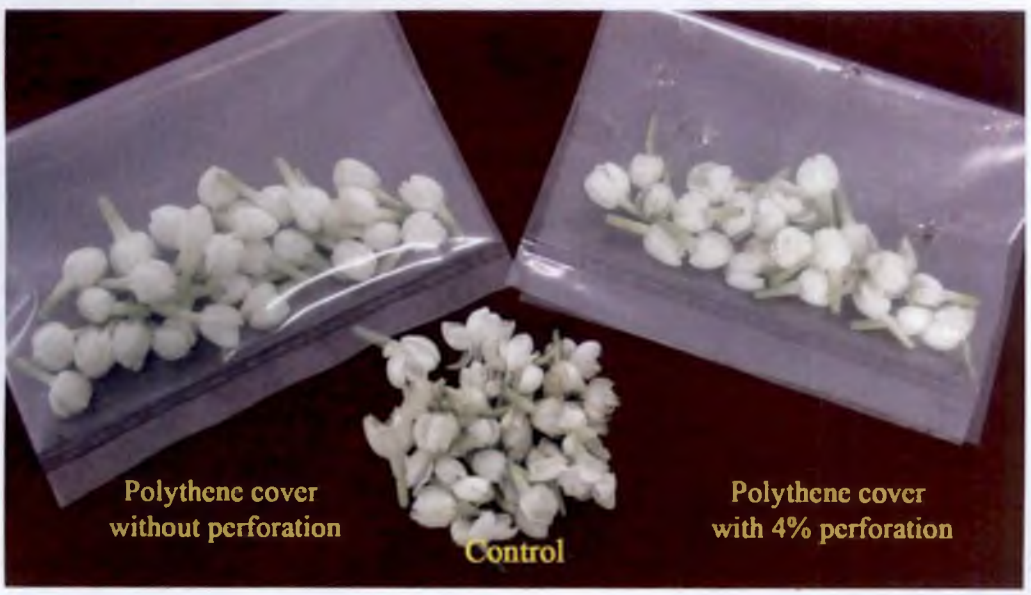


Plate 8. Comparison between chemical treatments and control

Plate 9. Comparison between packaging treatments and control



Fig(I)Effect of Packaging treatments on keeping quality of Jasmine

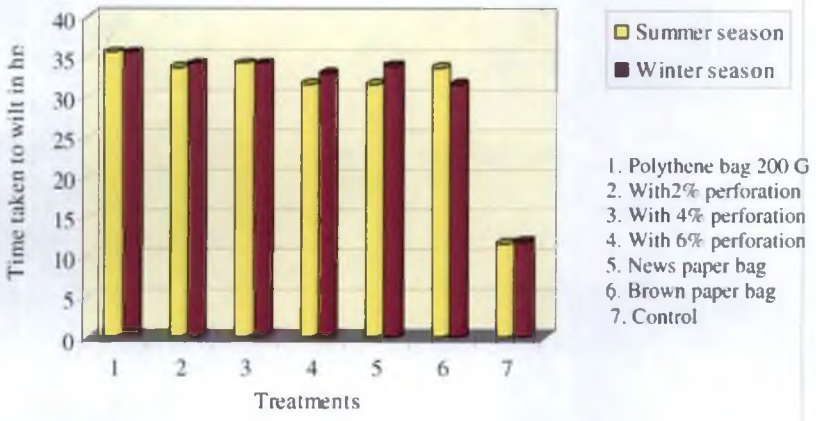
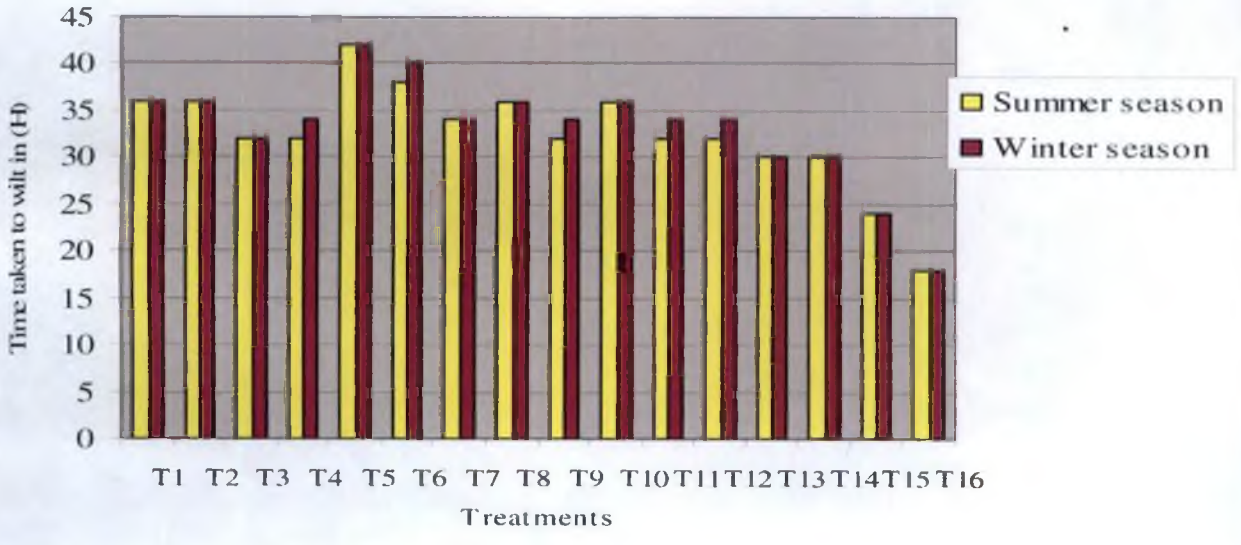


Fig II.Effect of chemicals on keeping quality of Jasmine



4.4.3 Effect of chilling treatments

Data generated on the effect of chilling treatments in keeping quality of jasmine are presented in Table 23

4.4.3.1. Time taken to wilt in h

From the Table 22, it was observed that flower buds kept in cool chamber at 20^0C had the maximum keeping quality and remained fresh up to 74h in winter season and 72 h in summer season and flower buds kept in 15^0C remained fresh up to 72h both in summer and winter seasons. Flowers kept in ambient temperature had the minimum keeping quality and wilted in 30 h in winter season and 24 h in summer season.

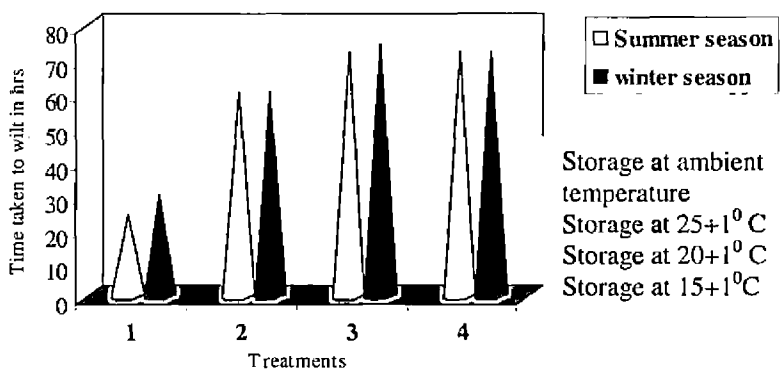
4.4.3.2 Physiological loss of weight

Physiological loss of weight was maximum for flowers kept at ambient temperature and minimum for flowers kept at temperature 15^0C with value 0.10(Table 22) followed by flower buds kept at temperature 20^0C with physiological loss of weight 0.10g in summer season and 0.12g in winter season. Flower buds kept at ambient temperature showed maximum physiological loss of weight 0.14g in summer season and of 0.16g in winter season.

4.5. Incidence of pests and diseases

Main pests observed generally in the jasmine plants planted in the pots were mites, thrips and budworm. Pest attack was more during rainy days and due to budworm, flower bud showed pinkish discoloration and it was hand picked and destroyed. Thrips attack was more during April, May season and it was less in plants applied with organic fertilizers containing neem cake. Neem suspensions was applied as preventive measure and Imidachlorpid against thrips and mites.

Fig. Effect of chilling treatments on keeping quality of Jasmine



Discussion

5. DISCUSSION

The results generated from the studies on the effect of time of pruning and nutrition on vegetative and floral characters of *Jasminum sambac* and post harvest studies to increase the vase life of jasmine flowers are discussed in this chapter.

Jasmine is one of the leading traditional flowers in India. Jasmine is primarily grown for fresh flower production. Its flowers are used for making garlands, adorning hairs of women in religious and ceremonial function. It is a promising crop and used as a starting material in the perfume and cosmetic industries and for trade, the factors responsible for economic yield in a plant are genotype, climate, soil, and cultural manipulations and their interactions. Maximum yield is obtained when favourable conditions are provided for the crop. Among these factors pruning time and nutrition also play a prime role in deciding the growth and ultimately yield in Jasmine crop.

In order to meet our increasing demand for fresh flowers, judicious application of manures and fertilizers are in evitable for getting higher yield. Pruning in case of jasmine is one to force out potentially productive growth.

The present study especially conducted to know the best time of pruning and optimum nutrient requirement for getting maximum flower yield in Jasmine. The results of these investigations are discussed in this chapter in three main headings.

5.1. Pruning studies

Pruning is one of the oldest cultural practices and it is the least understood horticultural practice. (Gardener, 1951). Pruning was also important in deciding the flower yield in jasmine. Battacharjee (1984) reported that pruning was found to be beneficial for improving flower yield and quality as well as vigour of the plant.

5.1.1. Growth parameters

An increasing trend was noticed for all vegetative characters irrespective of the month of pruning. This can be attributed due to general physiological phenomena.

5.1.1.1. Plant height

Irrespective of the time of pruning an increasing trend in plant height is a general physiological trend. Plants pruned in October showed the maximum plant height. This may be due to the climatic factors. April and July pruning did not show any significant influence in plant height, this may be due to climatic influence. January pruning showed less plant height. Plant height showed negative correlation to all climatic factors except mean sunshine hours in January pruned plants. The increment in height was also more in October pruned plants compared to other months of pruning.

5.1.1.2. Plant spread

Plant spread was high in October pruning (37.7 cm in the month of July) and it is on par with the plants pruned in the month of July. Least plant spread was recorded in the month of April pruned plants.

5.1.1.3 Number of primary branches

There is an increasing trend in the number of primary branches in July, October and January pruned plants but reduction was noticed during certain months, in the April pruned plants. The increase was maximum pronounced in January pruned plants. Number of primary branches at later stages of plant growth is important which will in turn determine the number of secondary branches and the number of productive shoots.

5.1.1.4 Number of *secondary* branches

April and July pruned plants showed both increasing and decreasing trends in the number of secondary branches in all periods of the year. But October and January pruned plants did not show any reduction in the number even though the monthly increment in the number of secondary branches was very little. The number of secondary branches

indirectly influences the number of productive shoots which in turn influence the flower yield.

5.1.1.5 Number of productive shoots

In the case of number of productive shoots the number was more at the beginning of the treatment in April and July pruned plants. However a decrease in the number was noticed in certain months as growth advanced. But in October and January pruned plants always an increasing trend was noticed in the number of productive shoots even though initially the number was less. The number of productive shoots showed significant positive correlation to temperature, relative humidity, rainfall and rainy days.

5.1.2. Flower yield

Maximum yield was noticed in the plants pruned in January (starting from January to July) compared to the other months of pruning. This may be due high temperature, long hours of sunshine along with water stress prevailed during this period. This impact has resulted in the maximum flower yield. This is in conformity with the findings of Pal *et al.* (1980) that maximum flower production was reported in January pruned plants in *J. sambac.* Similar results were coined by Muthuswami (1975), working with *J. auriculatum* and found that temperature played a major role in the production of flowers. Early pruned plants recorded high yield and longer duration of flowering as they received optimum heat units.

Maximum weight of 100 flower buds as well as the maximum flower bud length obtained in January pruned plants might have contributed highest yield in these plants. Yield was minimum for April pruned plants. This may be due to the low weight of 100 flower buds and minimum flower bud length. Another reason for yield reduction may be due to the negative correlation with maximum temperature and sunshine hours.

5.2. Manurial trial

Influence of different level of manures and fertilizers for growth and flower yield of Jasmine were studied by recording the data on vegetative characters like plant height, plant spread, and number of primary and secondary branches and yield of the plant.

Importance of balanced nutrition and nutrient requirement in jasmine, has been recognized by many workers (Muthuswamy and Pappiah, 1976).

5.2.1. Effect of manures and fertilisers on plant height and spread

From the results it was observed that T_9 with organic manures neem cake 100g, FYM100g and groundnut cake 100g given at monthly intervals and T_{10} with organic manures, neemcake (100g), poultry manure (100) and groundnut cake (100g) showed maximum height in single as well as double plant conditions.

In the first three to four months organic manures did not show much influence on plant height and this may be because of the slow release of nutrients from organic manures. In these months inorganic fertilisers showed much influence on plant height and plants treated with biofertilisers like *Azospirillum* and phosphobacteria along with recommended dose of fertilizers showed maximum height in initial months and which was significantly superior to other treatments in single plant condition. In the case of double plant condition, in the first month this trend was noticed and for the remaining period, organic manures showed superiority over the other treatments in enhancing the height of the plants. From these observations, it may be concluded that sustained growth may be promoted by well-balanced nutrient conditions by organics.

Plant spread was also high for the treatment containing *Azospirillum* and phosphobacteria. Increase in growth characters due to *Azospirillum* inoculation, was due to the amount of nitrogen added to crop growth through associative symbiosis and increase of the production of the growth hormone like NAA, GA and cytokinin. These phytohormones might have caused morphological changes in roots thereby causing an increase in uptake of nutrients resulting in better growth. The possible reason for such effect could be that *Azospirillum* fixes appreciable quantity of atmospheric nitrogen, which leads to increase in cell division and cell elongation in the region of axilary buds (Torrey, 1950). Similar findings were reported by Subramaniam *et al.* (1989) in French marigold, Preethi *et al.* (1990) in Edward rose.

This is in confirmity with the findings of Manomani(1992) who observed that phosphobacteria as treated with rooted cuttings of *J. sambac* have given an increased plant height and Nagesh and Reddy(1999) reported that the use of AMF and oil cake in pot experiments promoted better plant growth.

Nitrogen being the essential constituent of the proteins it might have resulted in better growth leading to increase in production of leaves as reported by Mayanard *et al.* (1962). Similar results were reported by Swaminathan and Sambandamurthi (2000).

From the study it could be concluded that even though the rate of reaction of organic fertilisers was slow, it had significant influence in the long run. The increased plant height and plant spread with the application of FYM was reported in centella by Chavan *et al.* (2005). The influence of organic manures is found to be more in double plant per pot compared to single plant per pot.

The utility of biofertilisers to mobilize the nutritionally important elements from non usable form to usable form, the application of biological form might be the reason for the increased spread in jasmine. The incorporation of biologically active organisms might have resulted in the better uptake of nutrients especially nitrogen and phosphorous.

Gupta (1999) also reported that treatments with 100% nitrogen along with *Azotobacter* and phosphobacteria have given increased growth and highest flower yield in marigold. Bhagyaraj and Powell (1985) reported that AMF have a positive influence on the growth and yield of marigold.

5.2.2. Effect of manures and fertilizers on number of primary branches

Regarding the number of primary branches, there was no significant difference between the treatments. In the initial six months T_4 showed high value.

5.2.3. Effect of manures and fertilizers on number of secondary branches

In number of secondary branches also there was no significant difference. However T_3 is found to be having maximum value in the case of single plant per pot during entire period of study except initial two months. In double plant condition, even

though there was no significant difference among the treatments maximum number of secondary branches was obtained in treatments containing neemcake and groundnutcake without inorganic fertilizers. During the last four months of observation T_{10} with neemcake, poultrymanure and groundnut cake showed maximum value. Number of secondary branches influenced the production of productive shoots which in turn influence the yield during the later period.

5.2.4. Effect of manures and fertilizers on number of productive shoots

From the results it was clear that number of productive shoots were maximum in T_{10} in all the months in single plant condition and it was on par with T_9 and T_8 in a few months in double plant per pot. All these treatments received organic manures neemcake and groundnut cake along with poultry manure or FYM or vermicompost. Application of organic manures to soil apart from improving soil physical properties, improve the availability of nutrients, organic carbon content, CEC of the soil and increases the yield.

Ketkar (1993) reported the contribution of nitrogen in the improvement of soil properties from different organic manures like FYM, goat manure, poultry manure and vermicompost. Application of FYM, neemcake, leaf compost and vermicompost resulted the increased availability of NPK and micronutrients. (Sadanandan *et al.* 1998). In fresh poultry excreta uric acid or urate was the most abundant N compound (40-70%) of total Nitrogen while urea and ammonium were present in small quantities(Krogdahl and Dalisgard,1981).Vermicompost enhances beneficial soil micrflora thereby increasing plant growth.Vermicompost is rich in micro and macronutrients besides having many plant growth promoting substances, humus forming substances and nitrogen fixers(Bano *et al.* 1987).Jasmine plants planted in pots containing organic fertilizers showed maximum value and number of productive shoots in later period significantly influenced the plant yield.

5.2.5. Effect of manures and fertilizers on flower yield

In the first month of the trial flower yield was significantly superior in T_3 in single plant condition. Rest of the period yield was significantly superior in T_{10} which was on par with T_9 and T_8 under double plant condition. All these treatments received organic manures like neemcake, FYM,

vermicompost and poultry manure. The increased yield by the application of FYM in soyabean was reported by Dev *et al.* (1976) in turmeric, Krishnamurthy *et al.* (1999) in chillies and Hari *et al.* in coleus.

Flower bud length was high in T_8 followed by T_9. Hundred flower bud weight was also high in T_3 followed T_9.Hundred flower bud weight was also high in T_3 followed by T_9, T_8.This was also the reason for the increased yield in the treatments containing organic fertilizers. In nutshell, more biomass production in terms of increased plant height and more number of productive shoots, must result in more flower production. As compared to in organics, the organic manure applications forward the soil fertility and plant productivity.

5.2.6. POST HARVEST STUDIES

Jasmine flowers are empirical in nature. Under normal conditions, the flowers show the sign of browning either at the end of the day or on the second day, thus bringing down the value of flowers. The post harvest loss due to spoilage of flowers is estimated to be worth several lakhs of rupees a year. (Roy, 1990). The results obtained in different post harvest treatments are discussed in the following headings.

5.2.6.1. Effect of different packaging materials on vase life

From the results it was observed that vase life of flowers was high for flowers packed in polythene cover without perforation and polythene cover with 4% perforation. This is in consonance with the findings of Nirmalatha and Reddy (1994), they reported that 200guage PE bags without ventilation maintained freshness, retained colour and extended shelf life up to 3.33 days in ambient temperature. Polythene bag without ventillation associated with a reduction in the permeability of the bag to moisture and air and thereby reducing of physiological loss of weight which may be due to reduced oxygen and increased carbon dioxide levels. CO_2 has been shown to antagonise ethylene action, decrease respiration and delay senescence (Halevy and Mayak, 1981) Packaging of flower in polythene bags retained the characteristic colour for a longer time and reduced the development of brown colour compared to non packed flower buds.

Semi permeability property of polyethene bags to gases and non permeable to moisture and also the maintenance of water balance have resulted in the low physiological loss of weight of flowers packed in polythene bag .In packaged flowers irrespective of the packaging retention of colour observed at a slower pace after packaging. Enhanced vase life of flower buds in polythene bags may be due to the maintenance of high relative humidity as reported by Bhat *et al.* (1999).

5.2.6.2. Effect of chemicals on keeping quality of jasmine flowers

From the results it was observed that flowers treated with chemicals of different concentrations remained fresh for longer hours than the control and it also reduced the physiological loss of weight.

Benzyl adenine at 25ppm remained fresh upto 42hrs in both the seasons and at 50ppm remained fresh upto 40hrs in winter season. Aluminium sulphate at 25ppm and 50ppm also remained fresh upto 36hrs and Physiological loss of weight was also minimum for flower buds treated with this chemical. This was in line with the findings of Patil and Nalwadi(1994) who reported that aluminium sulphate, silver nitrate and Sodium benzoate were found to be effective in extention of shelf life upto 42hrs.

Alumium sulphate reduces pH and very effectively reduces bacterial growth and there by increasing vase life.

5.2.6.3 Effect of chilling treatments

From the results it was clear that flower buds kept at cool chamber at 20^0C has maximum keeping quality up to 74hrs in winter season and 72hours in summer season and flower buds kept at cool chamber at 15^0C remain fresh upto 72 hrs in both the seasons. Physiological loss of weight was also minimum for flowers kept at 15^0C and 20^0C.

Low temperature storage besides less respiration also reduce excessive opening of the buds, water loss, ethylene production and growth of pathogens. Thus it increases the vase life of flower buds

Summary

6. SUMMARY

An experim ent was conducted during April 2005 to July 2006 in the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara, Thrissur to standardize the management practices like time of pruning and fertilizer requirement as well as post harvest studies in *Jasminum sambac*(bush jasmine) and the results are summerised below.

The pruning study was undertaken in the existing two-year-old Jasmine plants of *J. sambac.* Pruning was conducted in four months April, July, October and January.

In pruning studies it was observed that increment in plant height was maximum for the plants pruned in October(1.56cm),which was significantly superior to all other treatments, followed by plants pruned in January(1.24cm) and which was significantly superior to the April and July pruned plants. The number of primary branches was maximum for plants pruned in July (1.08) which was on par with April pruned plants(1.05).Number of secondary branches was highest in April pruned plants(1.28)which was on par with July pruned plants(1.19) and significantly superior to October and January pruned plants. Maximum number of productive shoots was noticed in the month of April (1.35) this was significantly superior to all other treatments.

Yield and weight of hundred flower buds were maximum for the plants pruned in the month of January (32.94g, 14.23g respectively). Corolla tube length and flower bud diameter was high for October pruned plants (2.1cm, 0.61cm) but flower bud length was maximum for January pruned plants (3.7cm).

Correlation between the climatic factors and vegetative characters indicated that all vegetative characters of January pruned plants showed some positive correlation to all climatic factors studied but yield showed negative correlation to mean sunshine hours.

Manurial trial was conducted in pot plants of *J. sambac*. Fertilizer trial included ten treatments with organics like Farm yard manure, poultry manure, neem cake and groundnut cake and vermicompost and biofertilisers like *Azospirillum* and phosphobacteria and chemical fertilizers of NPK were applied at monthly and fortnightly intervals according to the treatment schedule.

In manurial trial jasmine plants showed an increasing trend in plant height during the whole period of study. In the initial months treatments containing biofertilisers showed maximum plant height but later months T_{10} containing neem cake, ground nut cake and poultry manure showed maximum height (31.33cm) which was on par with treatments containing neem cake, groundnut cake and farmyard manure(31.10cm) and treatment containing neem cake, groundnut cake and vermicompost(31.20cm) in both single plant and double plant conditions. Treatment containing organic manures showed maximum plant spread. In number of primary and secondary branches there was no significant difference. Productive shoots was maximum in the plants which received organic manures in both conditions. Flower yield, 100 flower bud weight and corolla tube length were also maximum in treatment containing organic manures like neem cake groundnut cake and poultry manure.

Nutrient analysis was also done in soil samples taken before planting and peak flowering stage and leaf samples taken at vegetative and peak flowering stage. The treatments containing chemical fertilizers showed maximum amount of available nitrogen in soil treatments containing organic manures showed maximum amount of phosphorus. Potassium content was maximum for treatments containing *Azospirillum* and phosphobacteria. Leaf nutrient analysis was also done and nitrogen content was maximum for samples containing neemcake, groundnut cake and farm yard manure (0.70%). Phosphorous content was high for treatment containing neem cake, groundnut cake and poultry manure (0.47%). In the case of potassium also treatment containing organic manures showed maximum value.

Post harvest studies were also conducted by taking flower buds from control plots. Three separate experiments were carried out as chemical treatments, packaging treatments in perforated polythene bags, newspaper bags and brown paper bags and chilling treatments by keeping flower buds in cool chamber to find out effect on keeping quality.

Under post harvest studies in packaging treatments, polythene cover with 4% perforation showed minimum physiological loss of weight (0.13g) followed by the flowers packed in polythene bag without perforation (0.18g) in summer season. In winter season polythene cover without perforation showed minimum physiological loss of weight (0.18g) and which was on par with flowers in Polythene cover with four percent perforation (0.19). Flowers packed in polythene bag remained fresh upto 35.66 hrs, which was on par with flowers packed in polythene bag with four percent perforation. All the treatments were superior to control

In chemical treatments aluminium sulphate at 25ppm had minimum physiological loss of weight (0.45g) in winter season and (0.52g) in summer season. Benzyl adenine at 25 ppm took 42 hrs for wilting in both seasons, which was significantly superior to all other treatments followed by aluminum sulphate 25 ppm took 36 hrs to wilt. All the treatments were superior to control.

In chilling treatments time taken to wilt was maximum for flower buds kept at a temperature 20^0C followed by flower buds kept at temperature of 15°C, which remained fresh up to 72hours.

References

References

Acharya, M.M. and Dashora, L.K.2004. Response of graded levels of nitrogen and phosphorous on vegetative growth and flowering in African marigold. *J. Ornamental. Hort.* 7(2): 179-183

AICFIP. 2006. Biennial report, College Of Horticulture, Vellanikkara. Kerala Agricultural University, Trissur, Kerala. India.58p.

Arunkumar, S. 1997. Azotobacter and Azospirillum inoculate for nitrogen economy in vegetable cultivation. M.Sc. (Ag.) thesis, Kerala Agricultural University, Thrissur, 105p.

Atawia, B.A., Hallabo, S.A.S. and Morsi, M.K. 1988. Effect of freezing of jasmine flowers on their jasmine concrete and absolute qualities. Egyptian J. Fd. Sci. *16(1-2): 237-247*

Bagyaraj, D. J. and Powell, C. L.1985. Effect of VAM inoculation and fertiliser application on growth of marigold. N. Z. J. agric. Res. *28:169-173*

Baily, L.H. 1947. *The standard Enzyclopedia of Horticulture.* (2) The Macmillian Company. New York 1782p

Balasubramanium, J. 1989. Studies on the combined effect of Azospirillum, Vascular Arbascular Mycorrrhiza and inorganic fungi on growth and performance of French marigold (*Tagetes patula*). M.Sc. (Hort) thesis, Tamil Nadu Agricultural University, Coimbatore, 102p.

Banker, G. J. and Mukhopadhay, A. 1990. Effect of N P K on growth characters of *P. tuberose. S. Indian. Hort.* 35(4):165-167

Bano, K., Kalg, D and Gajanan, G., 1987.Cutting of earthworm, *Eudrillus euginae* for cast production and assessment of worm cast as biofertiliser. *J Soil Biol and Ecol*: 2(1) 98-104

Berg, R. H., Tyler, M., Novick, V. and Vasil, I.K. 1980. Biology of Azospirillum sugar cane association and enhancement of nitrogen activity. *Appl. Environ. Microbiol.* 39 (3): 642-649

Bhattacharjee, S.K. 1984. Studies on the effect of sequential pruning and environmental factors on *Jasminum grandiflorum. Pefai. J.* 6(1): 25-27

Bhattacharjee, S.K. 1985a. Effect of different levels of pruning on *J. grandiflorum* L. Flower yield. *Indian Perfumer* 29(3-4): 181-185

Bhattacharjee, S.K. 1985b. The response of *Jasminum grandiflorum* L. to N, P_2O_5 and K_2O fertilization (2nd trial). *Singapore. J. Primary Ind.* 13 (2): 102-111

Bhattacharjee, S.K. 1998. Studies on the effect of split doses of nitrogen on *Jasminum sambac. Indian Perfumer* 32(4): 321-326

Bhattacharjee, S.K. and De, L.C. 2003. *Post harvest technology of flowers and ornamental plants*. Pointer publishers, Jaipur, 340p

Bhattacharjee, S.K. and Kumar, P.N. 2002. Agrotechniques for flower crop production. AICRP on floriculture, *tech. Bull.* 16, ICAR, New Delhi, 67p.

Bhavanisankar, K. and Vanagamudi, K. 2000. Studies on the integrated nutrient management of crossandra (*C. infundibuliformis* L). *S. Indian Hort.* 47(1-6): 125-129

Bhavanisankar, K. and Vanangamudi, K. 1999. Integrated nutrient Management in Gundumalli (*J. sambac* L). *S. Indian. Hort.* 47: 1-6

Bose, T. K. and Raghava, S. P. S.1975. Low temperature prolongs the storage life of jasmine flower. *Sci. Cult.* 41(3): 115-116

Bray, R. H. and Kurtz, L. T.1945. Determining total organic and available forms of phosphate in soils. *Soil sci.* 59: 39-40

Chadha, K.L. 2002. *Handbook of Horticulture*. Indian Council of Agricultural Research, New Delhi, 1031p.

Chauhan, S., Singh, C.N. and Singh, A.K. 2005. Effect of vermicompost on growth and flowering in marigold cv Pusa Narangi Gainda. *Progressive Hort.* 87(2): 419- 422

Chavan, S., Tuse , B. P. , Mahatale , P.V. , Madhurishirole and Mahatale,Y.V.2005 effect of organic manures and spacing on growth and yield of *Centella asiatica J. plant. physiol* 19(2) 243-244

Chellamuthu. 1978. Studies on the yield and quality of ragi as influenced by organic and inorganic form of nitrogen. M.Sc. (Ag.) thesis, TNAU, Coimbatore, 104p.

Desai, J. R., Pansuria, P. P. and Patel, B.N.2002.Extension of vase life of Chrysanthemum. *National Symposium on Indian floriculture in the new millennium feb 25-27*, Bangalore. pp 24-25

Dev, S.P., Thilak, K. V. B. K and Kumar, S. 1976. Effect of nitrogen amendments in the nodulation and nitrogen fixation by soyabean. *Indian. J. Agric sci* 46:252-256

Dhanalakshmi, P. and Pappiah, C.M. 1995. *National symposium on organic farming 27- 28 Oct*. Tamil Nadu Agricultural University, Coimbatore, pp 25-29

Dixit, A., Trivedi, J. and Varma, S. 2004. Effect of nitrogen and phosphorous on growth, flowering and yield of Chrysanthemum cv Local White under Chattisgarh region. *Plant Arch.* 4(1): 171-173

Gardener. 1951. *Basic Horticulture.* The Macmillian Copmpany, New York.206p.

Gayathri, H.N., Jayaprasad. and Narayanaswami, P. 2004. Response of biofertilisers and their combined application with different levels of inorganic fertilizer in Statice (*Limonium carpia*) *J. Ornamental Hort.* 6(2): 124-126

Gnanasekhar, V.1994. Studies on the effect of graded levels of nitrogen and phosphorous with *Azospirillum* and phosphobacteria on growth and yield of Jathimalli *(J. grandiflorum. L)* M.Sc. (Ag.) thesis, TNAU, Coimbatore, 103p.

Gowda, J.V.N. 1990. Effect of sucrose and aluminium sulphate on the post harvest life of tuberose cv Double. *Curr. Res.* 19(1): 14-16

Gowda, J.V.N., Jacob, S. and Hudda, A.G. 1991. Effect of N, P and K on growth and flowering of tuberose (*Polianthes tuberosa* Linn.) cv. Double. *Indian Perfumer* 35 (2): 100-101

Gowda, J.V.N., Sulladmath, U.V. and Jayanthi, R. 1986. Studies on the effect of staggered pruning in Jasminum. *Curr. Res.* 15(10): 106-107

Grewal, J.S., Sharma, R.C. and Sud, K.C. 1981. Effect of continous application of P and K fertilizer and FYM on potato yield and some soil properties. *J. Indian. Soc. Soil Sci.* 29: 129-131

Gupta, J.P., Agarwal, R.K., Gupta, G.N. and Kaul, P. 1983. Effect of continuous application of FYM and urea on soil properties of Western Rajastan. *Indian .J. Agric. Sci.* 53(1): 53-56

Gupta, J.P. 1999. Effect of Azotobacter and phosphobacteria on growth and flower yield of marigold. *S. Indian Hort.* 23(3): 123-124

Halevy, J. and Mayak, S.1981. Effect of packaging on shelf life of jasmine. *Indian perfumer.* 23 (2): 24-25

Hari, G.S., Rao, P.V and Reddy, M.S.2006.Effect of organic manures in combination with nitrogenous fertilisers on the yield and nutrient uptake in paprika (*C. annum* L) under improved condition of Northern Telungana zone of Andra Pradesh *Crop Res.*, 31(2): 230-233

Harode, S. M., Kotake, V .G. and Zend, J.P. 1993. Effect of selected treatments on longevity and freshness of selected flowers in home decoration. *J. Maharashtra. agric. Univ.* 18(3): 448-450

Hugar, A.H. and Nalawadi, U.G. 1993. Influence of time of pruning on vegetative growth and flower yield of jasmine. *Curr. Sci.* 22(3-5): 65-66

Hugar, A.H. and Nalawadi, U.G. 1994. Studies on the effect of pruning and nutrition on growth and flower yield of Jasmine (*J. auriculatum* Vahl.). *Karnataka J. agric. Sci.* 7(4): 406-409

Indiresh, K.M., Mohan, E. and Lingaiah, H.B. 1992. Performance of various *Jasminum sp* in the coastal region of Karnataka. *Proceedings of National Seminar on Commercial Floriculture in India*, pp148-151.

Jackson, M.L.1958. *Soil Chemical Analysis.* Prentice Hall of Indian Pvt. Limited, New Delhi, 498p

Javid, Q.A., Abbasi, N.A., Saleem, N.I.A. and Mughal, A.L. 2005. Effect of NPK fertilizer on performance of Zinnia (*Zinnia elgans*) cv. Wirlyging shade. *Int. J. agric. Biol.* 7(3): 471-473

Jayaprabha, P. and Arumugham,T.2002. Effect of nitrogen and phosphorous on growth and yield of celosia. *S. Indian Hort.* 9(4) 456-457

Jayaprabha, P.and Shakila, A. 2002. Effect of nitrogen and potassium on growth and yield of celosia (*celosia plumose*). *S. Indian Hort.* 50(4/6): 649-652

Jiji, T., Dale, D. and Padmaja, P. 1996. Vermicompost reduces the requirement of chemical fertilizers of cowpea and bitter gourd. *National seminar on organic farming and sustainable agriculture, October 9-11 1996*, University of Agricultural Science, Bangalore. India. 332p

Kelkar, C.M.C. 1993. *Biogasslurry utilisation.* Rural technology, New Delhi. 23-26

Krishnamurthy, V.V. and Rajkannan, B. K.1999.Effect of organics on yield of turmeric. *Spice India* 2(7) :21-22

* Krogdahl, A and Dahlesgard, B. 1981. Estimation of N digestibility in poultry content and distribution of major urinary nitrogen compounds and excreta, *Poultry Sci.* 2480-2485.

Kulkarni, B. S. Nalwadi, U .G. and Giraddi, S.1996.Effect of vermicmpost and vermiculture on growth and yield of china aster(*Callistephes chinensis*) Ostrich plume mixed. *S. Indian Hort.* 44(1-2): 33-35

Kumar, R. and Gill, A.P.S. 1983. Effect of nitrogen application on the flower yield of young plants of *J. sambac* Ait. *S. Indian Hort.* 31(1): 20-21

Kumar, R and Gill, A. P. S. 1988. Effect of calcium ammonium nitrate on flower yield of *J. sambac* Ait. *S. Indian Hort.* 34(2): 23-24

Manomani, R. 1992. Effect of soil inoculation of *Azospirillum and* phosphobacteria and graded doses of nitrogen and phosphorous on growth and yield of *J. sambac* cv Gundumalli. M.Sc. (Ag.) thesis, Tamil Nadu Agricultural University, Coimbatore, 105p.

Maruthiprasad, S.M.V. and Patil, A.A. 1992. Effect of nitrogen and plant population on growth and flower production in *J.auriculatum* vahl. under transitional tract conditions of Karnataka I Growth attributes. *Indian Perfumer* 36(1):1-5

Mayanard, D. N., Check, W. W. and Vernall, H. F. 1962. The influence of nitrogen levels on flowering and fruit set of peppers. *Proc. Am. Soc. Hort. Sci.* 81:385-389

Mohanalakshmi, M., Vijayakumar, M. and Thangaraj, T. 2002. Packaging studies in gundumalli (*J. sambac* Ait) *S. Indian Hort.* 50(4/6): 620-623

Mohanthy, C.R., Mishra, N.K. and Padnraja, P. 2002. Effect of nitrogen and phosphorous on flower production in marigold. *J. Ornamental Hort. New Ser.* 5(1): 67-68

Mukhopadhyay, A. and Bankar, G.J. 1986. Studies on nutritional requirement of tuberose. *S. Indian Hort.* 34(3): 167-172

Mukhopadhyay, T.P., Bose, T.K., Maity, R.G., Mitra, S.K. and Biswas, J. 1980. Effect of chemicals on the post harvest life of *C. undulaefolia. National Seminar on Production Technology for Commercial Flower Crops.* Tamil Nadu Agricultural University,Coimbatore pp 97-99

Mukhopadhyay, T.P., Bose, T.K., Mitaj, R.G., Mitra, S.K. and Biswas, T. 1988. Effect of chemicals and temperature on post harvest life of jasmine flowers. *National*

Seminar on Production Technology for Commercial Flower Crops, Tamil Nadu Agricultural University, Coimbatore, pp 47-50.

Muthuswami, S. and Abdulkhadar, J.B.M. 1986. *Ornamental Hort.India.* Indian Council Of Agricultural Research, 230p.

Muthuswami, S., Pappiah, C.M. and Sayed, S. 1973. A note on the effect of pruning in *Jasminum sambac* Ait. Var. Single Mohra. *S. Indian Hort.* 21: 70-72

Muthuswami, S.1975. Effect of different dates of pruning in *J. sambac.* PhD thesis, Tamil Nadu Agricultural University, Coimbatore,180p.

Muthuswamy, S. and Pappiah, C.M. 1976. Studies on the response of *jasminum auriculatum*.Vahl. to NPK fertilisation. *S. Indian Hort.* 24(3): 88-93

Muthuswamy, S. and Pappiah, C.M. 1977. Nutritional studies on *jasminum grandiflorum* L. *Indian J. Hort.* 34(30): 289-293

Nagaich, K.N., Trivedi, S.K. and Rajulekhi. 2003. Effect of nitrogen and phosphorous on growth, flowering, yield and quality of marigold. *scient. Hort.* 8: 203-209

Nagaraja, G.S., Gowda, J.V.N. and Farooqi, A.A. 1999. Shelf life of tuberose flowers as influenced by packaging and ventilation. *Karnataka J. agric. Sci.* 12(1-4): 239-242

Nagesh, C. J. Reddy, J. 1999. EfFect of AMF on plant growth. S.Indian Hort. 23(2):123-124

Nanjan, K., Nambisan, K.M.P., Veeraragavathatham, D. and Krishnan, B.M. 1980. The effect of nitrogen, phosphorus and potash on the yield of tuberose (*Polianthes*

tuberosa L.). *National Seminar on Production Technology for Commercial Flower Crops*. Tamil Nadu Agricultural University, Coimbatore. 76-78 pp.

Natarajan, S. and Rao, V.N.M. 1983a. Effect of frequency of fertilizer application in jathimalli (*Jasminum grandiflorum* L.). *Madras agric .J.* 67(3): 207-210

Natarajan, S. and Rao, V.N.M. 1983b. Flowering and floral characters in *J. grandiflorum* L. as affected by graded and split doses of fertilizers. *Indian Perfumer* 27(1): 1-4

Natarajan, S., Nambisan, K. M. P., Krishnan, B.M. and Shanmugavelu, K. C. 1980. Effect of application of N, P and K on flower yield of *J. sambac* Ait. cv. Gundumalli. *Indian Perfumer* 25(3-4): 89-92

Natarajan, S.and Rao, V.N.M. 1980. Response of jathimalli (*J. grandiflorum* L.) to nitrogen and phosphorus. *Madras agric. J.* 67(4): 252-254

Nirmalatha, S. and Reddy, T. V.1994. Effect of polythene bags on shelf life of jasmine. Mysore J. agric. Sci. 27(3) 272-276

*Nofal, M.A. and Marwan, A.E. 1982. Jasmine quality as affected by pruning. *Res. Bull.* Faculty of Agriculture Ain Shams University, 17pp

Pal, P., Maity, R. G. and Bose, T.K. 1980. Effect of different time and height of pruning on growth and yield of flowers in *J. auriculatum* vars. Single and Double. *National seminar on Production Technology for commercial Flower crops.* Tamil Nadu Agricultural University, Coimbatore .27-28 pp

Pal, P., Maity, R. G. and Bose, T.K. 1985. Effect of nitrogen, phosphorus and plant density on growth and yield of flowers in Sol. var. Khoya. *S. Indian Hort.* 33(2): 118-121

Panse, V. G. and Sukhatme, P. V. 1985. *Statistical methods for Agricultural workers.* 4th Ed. Indian Council of Agricultural Resarch. New Delhi. 381p

Paramaguru, P. and Natarajan, S. 1993. Effect of Azospirillum on the growth and yield of chilli grown in semidry conditions. *S. Indian Hort.* 41(2): 80-83

Parikh, S. and Mankad, A. 2003. Effect of certain chemicals on gaillardia and dianthus loose flowers. *J. Ornamental Hort* 6(2): 151-152

Parthiban, S. and Khader, M.A. 1991. Effect of N, P and K on yield components and yield in tuberose. *S. Indian Hort.* 39(6): 363-367

Patel, V.S. Sumangala, S.P and Rao, M. M.2002. Effect of plant population and time of pruning on *Jasminum sambac. National symbosium on Indian floriculture in the new millennium Feb* 25-27, Bangalore. 42p.

*Petrov, A. and Tsanev, T. 1972. Studies on pruning peach trees to encourage fruiting. III. The variety Marigold - second year of investigations. *Gradinarska-i-Lozarska-Nauka* 9(2): 7-11

Prabhakaran, J., Suresh, S., Selvaraj, K. V. S., Jyothi, V. and Janaga Rathinaz, T. 2006. Influence of organics on the yield parameters, tuberous root yield and essential oil of medicinal coleus in ultisols of Tamil Nadu. *International conference on globalization of traditional complementary and alternate system of medicine*, Tamil Nadu Agricultural University,Coimbatore.

Preethi, T. L., Pappiah, C. M. and Anbu, S. 1998. Studies on the effect of *Azospirillum* sp nitrogen and ascorbic acid on the growth and flowering of Edward rose(*R. bourboriana*) *S. Indian Hort.* 48: 83-87

Qasim, M., Ahmad, I. and Nadeem, A. 2003. Influence of various nitrogen levels on growth and biomass of *J. sambac. Pakist. J. agric. Sci.* 40(3/4): 144-150

Raj, A.K. and Kumari, V.L.G. 2001. Effect of organic manures and Azospirillum inoculation on yield and quality of okra(*A. esculentus* L. Moench). *Vegetable. Sci.* 28(2): 179-181

Rajadurai, K.R. and Bealah, A. 2000. Effect of Azospirillum and VAM on nutrient uptake in African marigold *J. Ecotoxicology. Environ. Monitoring* 10(3-4): 173-176

Rajagopalan, A. and Khadar, M.A.1993.Effect of pulsing treatments on the vase life of chrysanthemum cut flowers. *S. Indian Hort.* 41(1): 61-63

Raju, S.N. and Haripriya, K. 2002. Integrated nutrient management in crossandra cv Dindigul local. *S. Indian Hort.* 49: 181-182

Rakesh, Singhrot, R. S., Gupta, A .K. and Moond, S.K.2004.Studies on the vase life of cut flowers in chrysanthemum. *Haryana. J. Hort. Sci.* 33(2): 78-80

Rameshbabu, T.I. 1996. Nutritional studies in Aswaganda. M.Sc. (Hort.) thesis, HC&RI Periyakulam.

Randhava, G.S. and Mukhopadhyaay. 1986. *Floriculture in India.* Allied publishers Pvt Ltd, New Delhi, 385p.

Rathod, N.G., Nrawadakar, P.R., Sajindranath, A.K. and Prabhu, T. Effect of nitrogen and phosphorous on growth, flowering, yield and quality of marigold. *Scient.Hort.* 8: 203-209

Ravichandran, M. 1991. Chemical and biochemical regulation of growth and flowering in crossandra. M.Sc. (Hort.) thesis. Tamil Nadu Agricultural University, Coimbatore, AC and RI Madurai.

Roy, S.K. 1990. Packaging and storage of Horticultural crops of India. *Proceeding of 11th International Congress on Plastics Agriculture, 25 feb, 1990*, Oxford and IBH Publishing Co.Ltd. India,

Sadanandan, A. K., Srinivasan, V., Hamsa, S., Sajna, A. M. and Rukma, M.R.1998. Effect of organic fertilizers on soil quality productivity and productivity of black pepper and Cardomom. Indian Institute of spices Research, Calicut.49-50

Salvi, B.R., Rajeevan, P.K., Valsalakumari, P.K. and Geetha, C.K. 1999. Chemical regulation of post harvest life of *Jasminum sambac*. *J. Ornamental Hort. New ser* (2): 141-143

Seenapathi, H.K., Pail, A.K. and Swain, S.K. 1987. Effect of mycorrhiza on the growth characteristics of okra in laterite soils. *Indian J. Hort. Sci.* 44(1-2): 93-95.

Seetha and Gowda, J. V. N. 2002. Effect of vermicompost and biofertilisers on gerbera. *National Symposium on Indian Floriculture in the new Millennium feb 25-27 Bangalore*,2002. pp24-25

Shalaby, A.S., Hassan, A.H., Agina, E.A. and Hamid, H.A.2000. Effect of nitrogen fertilization on growth, flower and concrete oil yield of *Jasminum sambac*. *Indian Perfumer* 33(4): 268-273

Sharma, C.K. and Singh, I.P. 1991. Response of amount of pruning of the growth and flowering of *Jasminum sambac* in cv Gundumalli. *Haryana. J. Hort. Sci.* 20(3-4): 176-182

Shalaby, A.S., Hassan, A.H., Agina, E.A. and Hamid, H.A.2000. Effect of nitrogen fertilization on growth, flower and concrete oil yield of *Jasminum sambac*. *Indian Perfumer* 33(4): 268-273

Sharma, C.K. and Singh, I.P. 1991. Response of amount of pruning of the growth and flowering of *Jasminum sambac* in cv Gundumalli. *Haryana. J. Hort. Sci.* 20(3-4): 176-182

Siddagangaiah. and Rai, B.G.M. 1988. The effect of seasonal factors on the growth and yield of Gundumalli. *Mysore .J. agric. Sci.* 22(4): 493-497

Singh , Lodhi , A.K., Tewari, G.N. and Pathak, R.K. 1990. Effect of various levels of nitrogen and phosphorus on flowering of chrysanthemum (*Chrysanthemum morifolium* Ram). *Hort .J.* 3(1-2): 56-58

Singh, K.D. Veema, R.N.S. and Lohia, S.S. 1980. Effect of continous application of FYM and chemical fertilizers on some soil properties. *J. Indian Soc. Soil Sci.* 28: 170-172

Singh, R.P. and More, T.A. 1986. Effect of different heights of pruning on flowering and essential oil content and its quality in *Jasminum sp. Indian Perfumer* 30(1): 251-253

Srinivasan, K., Balakrishnan, R. and Pappiah, C.M. 1989. Studies on the effect of graded doses and split application of nitrogen and Phosphorous on vegetative and floral characters in *Jasminum sambac* cv Gundumalli. *Indian. J. Hort.* 46:530-534

Srivasthava, R., Kandpal, K. and Jacehari, S. 2005. Effect of packaging material and pulsing solution on post harvest life of gladiolus. *J. Ornamental. Hort.* 8(2): 115-118

Subramaniam, R., Shanmughavelu, K.G. and Rajasekharan, L. R. 1985. Effect of different dates of pruning on the nutritional changes of Jathimalli (*J. grandiflorum*). *Indian perfumer* 29(1-2): 111-116

Subramaniam, R., Shanmughavelu, K.G. and Rajasekharan, L. R.1989. Integrated nutrient management in French marigold. *S. Indian. Hort.* 27(3): 122-123

Subramaniam, S., Jawaharlal, M., Arumugham, T. and Vijayakumar, M.2002. Integrated nutrient management in crossandra. *National symposium on Indian floriculture in the new millennium , feb 25-27*,2002. Bangalore pp39-40

Sudha, P. 1998. *Mathematical modeling for modified atmospheric packaging of Gundumalli (J. sambac) flowers* M.Sc. (Ag.) thesis, Tamil Nadu Agricultural University, Coimbatore.158p.

Sumangala, H.P., Patil, V.S. and Rao, M.M. 2003. Effect of time of pruning in *Jasminum sambac. J. Ornamental. Hort. New Ser.* 6(2) :137-138

Swaminathan, V. and Sambandamurthi, S. 2000. Studies on integrated nutrient management on growth and yield of triploid crossandra *(Crossandra infundibuliformis* L.). *Crop Res.* 20(2): 334-337

Swaminathan, V., Ramaswamy, N. and Pillai, O.A.A. 1999. Effect of Azospirillum, phosphobacteria and inorganic nutrients on the growth and yield of tuberose. *S. Indian Hort.* 47(1-6): 331-334

Tsurushima, H. and Dale, N. 1971. The effects of nitrogen, phosphorus and potassium on the growth and flowering of bedding plants. *J. Japanese Soc. Hort. Sci.* 40(4): 407- 415

Torrey, 1950. Effect of *Azpospirillum* on plant growth. *S. Indian Hort.* 34(2):123-124

Verma, L. N and Battacharya, P. 1972. Production, promotion and distribution of biofertilisers. *Fertilizers, organic manures, recyclable wastes and biofertilisers* (ed. H. L. S Tandon) FDO, New Delhi,22-27pp

Wakley, A.J and Black, I .A. 1934. Estimation of soil organic carbon by Chromic acid titration method. *Soil Sci.*3(1) 29-38

Watanabe, F.S. and Olsen, S.R.1965. Test of an ascorbic acid for determining phosphorous in water and sodium bicarbonate extracts from soil. *Soil Sci .Soc. Am. Proc.*39-45.

Waterer, D.R. and Coltmann, R.1989. Response of mycorrhizal bell pepper to inoculation timing and water stress. *Hort. Sci.* 24(4): 688-690

Yadav, B.S., Gupta, A.K. and Singh, S. 2005. Studies on the effect of nitrogen, plant spacing and biofertilisers on growth parameters in tuberose cv. Double. *Haryana. J. Hort. Sci.* 34(1-2): 78-80

Yadav, L.P., Bose, T.K. and Maiti, R.G. 1985. Response of tuberose (*P. tuberosa* L.) to nitrogen and phosphorus fertilization. *Progressive Hort.* 17(2): 83-86

Yadav, P.K., Singh, S., Dhindwal, A.S. and Yadav, M.K. 2000. Effect of nitrogen and FYM application on floral characters and yield of African marigold (*Tagetes erecta* L.) *S. Indian Hort* 28(4): 232-233

Yassin, G.M.D and Pappiah, C.M. 1990. Effect of pinching and manuring on growth and flowering of chrysanthemum cv MDU. *S. Indian Hort.* 38(4): 232-233

* originals not seen

Appendix

Appendix 1

Mateorological data during experimental period

Month	Temperature Maximum	Temperature Minimum	Relative Humidity Morning	Relative Humidity evening	Rainfall mm	Mean Sunshine H	Rainy days
April	33.7	24.8	88	60	171.4	6.9	10
May	33.6	25	86	58	89.2	7	5
June	30	23.5	94	78	711.4	3.1	23
July	28.7	23	94	82	727.5	51.9	28
August	29.9	23.3	92	72	346.5	160.5	16
September	29.4	23.3	92	78	416.1	127.7	16
October	31	23.2	91	68	178.4	159.4	9
November	30.7	22.9	81	63	11.6	156.3	1
December	31.5	22.1	81	51	3.2	226.1	0
January	32.5	22.6	74	41	0	277.7	0
February	34.3	22.3	71	31	0	267.8	0
March	34.8	23.8	86	49	95.2	236.5	4
April	33.4	24.7	90	59	86.2	211.3	3
May	31.8	24.3	91	66	675.5	179.9	14
June	29.9	23.6	93	75	608.6	113.1	17

REFINEMENT OF MANAGEMENT PRACTICES FOR JASMINE (*Jasminum sambac* L.) IN HUMID TROPICS

By

SMISHA I. S.

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the
requirement for the degree of

Master of Science in Horticulture

(POMOLOGY AND FLORICULTURE)

Faculty of Agriculture
Kerala Agricultural University

Department of Pomology and Floriculture

COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR - 680 656
KERALA, INDIA

2007

ABSTRACT

Studies were conducted at the Department of Pomology and Floriculture, College of Horticulture Vellanikkara, to find out the effect of month of pruning and fertilisers on vegetative and floral characters of *J. sambac* as well as post harvest trials on extending the keeping quality of flowers.

Out of different months of pruning, plants pruned in October showed maximum plant height while those pruned in July showed maximum plant spread. Number of primary and secondary branches were highest in April pruned plants which was on par with July pruned plants. There was no significant difference in the number of productive shoots. Yield was highest for January pruned plants. Hundred flower bud weight and flower bud length were also maximum for these plants.

The manurial trial included organic manures, inorganic fertilizers and biofertilisers. Plant height was maximum for treatment containing *Azospirillum*, phosphobacteria and AMF along with NPK 120:240:240.g/plant per year in the initial months but in later months treatments containing neem cake, groundnut cake and poultry manure showed maximum plant height.

Plant spread was highest in treatment containing neem cake 100g, FYM 100g and ground nut cake 100g given at monthly intervals. Productive shoots were also maximum in treatments containing neem cake, groundnut cake and poultry manure. Flower yield was also maximum in treatment containing neem cake, groundnut cake and poultry manure. This was significantly superior to all other treatments.

Nutrient analysis revealed that the treatment containing chemical fertilizers had maximum amount of available nitrogen and the treatment containing organic manures had maximum amount of phosphorous in soil. Potassium content was maximum for treatment containing *Azospirillum* and phosphobacteria.

In vegetative stage leaf nitrogen, phosphorous and potassium contents were maximum in treatment containing neem cake, ground nut cake and poultry manure. In flowering stage there was no significant difference among the treatments in the case of nitrogen. Treatment containing neem cake, ground nut cake and poultry manure showed maximum value in the case of phosphorous and potassium.

Under post harvest studies packaging treatments containing polythene cover with four per cent perforation showed minimum physiological loss of weight followed by the flowers packed in polythene bag without perforation. Flower buds packed in polythene bag remained fresh up to 36 hours.

In chemical treatments aluminium sulphate 25ppm delayed wilting by 42hours in both seasons. This was significantly superior to all other treatments.

In chilling treatments time taken to wilt was maximum for flower buds kept at temperature of 20^0C followed by flower buds kept at temperature of 15^0C.