EFFECT OF GROWTH RETARDANTS ON GROWTH, FLOWERING, VASE-LIFE AND TUBER FORMATION OF DAHLIA (Dahlia variabilis Desf.) PROPAGATED THROUGH CUTTINGS

By

SUMA B., B.Sc. (Ag.)

THESIS

submitted in partial fulfilment of the
requirement for the Degree of
MASTER OF SCIENCE IN HORTICULT
Faculty of Agriculture
Kerala Agricultural University

DEPARTMENT OF HORTICULTURE
COLLEGE OF AGRICULTURE
VELLAYANI, THIRUVANANTHAPURAM

1993

DECLARATION

I here by declare that this thesis entitled "Effect of growth retardants on growth, flowering, vase-life and tuber formation of dahlia (Dahlia variabilis Desf.) propagated through cuttings" is a bonafide record of research work done by me during the course of research and that 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.

Vellayani,

6.2.1993

SUMA B.

CERTIFICATE

Certified that this thesis entitled "Effect of growth retardants on growth, flowering, vase-life and tuber formation of dahlia (Dahlia variabilis Desf.) propagated through cuttings" is a record of research work done independently by Kum. Suma.B under my guidence and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

Philipose Joshua
Chairman
Advisory Committee
Associate Professor
Department of Horticulture
Vellayani.

Vellayani
6.2.1993

APPROVED BY

CHAIRMAN:

SRI. PHILIPOSE JOSHUA

MEMBERS:

DR.S.RAMACHANDRAN NAIR

DR. K. VASANTHAKUMAR

DR.(Mrs.) P. SARASWATHY

27/2/93

EXTERNAL EXAMINER:

27/2/93

ACKNOWLEDGEMENT

The author wishes to place on record her deep sense of gratitude and indebtedness to:

Dr.Philipose Joshua, Associate Professor, Department of Horticulture, as Major Advisor and Chairman of the Advisory Committee for his valuable guidance, encouragement critical supervision and constructive criticisms during the course of this investigation.

Dr.S.Ramachandran Nair, Professor and Head, Department of Horticulture, as member of the Advisory Committee, for his encouragement, helpful suggestions and advice rendered during the course of the study and also for providing the facilities required for the work.

Dr.K.Vasanthakumar, Associate Professor, Department of Horticulture for critical scrutiny of the manuscript of the thesis.

Dr.(Mrs.) P.Saraswathy, Professor and Head, Department of Agricultural Statistics, College of Agriculture, Vellayani, as member of Advisory Committee for her valuable guidance in connection with the designing of the experiment and interpretation of the experimental data.

Dr.N.Saifudeen, Associate Professor of Agricultural Chemistry, College of Agriculture, Vellayani for his guidance in the biochemical procedures of this investigation.

Dr.K.Rajmohan, Associate Professor, Department of Horticulture for his sincere help and constant encouragement rendered during the endeavour.

Sri.C.E.Ajithkumar, Junior Programmer, Computer Centre, College of Agriculture, Vellayani for analysing the experimental data.

Kum.Sheeba.S and Kum. Rejatha V. for their friendly co-operation and assistence rendered at various stages of work.

The staff members of the Department of Horticulture, College of Agriculture, Vellayani for their sincere support extended throughout the course of this investigation.

And to her parents and brother for their encouragement and help at every stage of her study.

Vellayani,
6.2.1993

SUMA B.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

INTRODUCTION

INTRODUCTION

Dahlia is one of the most flamboyant flowers of winter. Our dahlias are mostly of foreign origin. The Royal Horticultural Society of England has listed 20,000 varieties of this plant. It is a tuberous rooted half hardy herbaceous perennial belonging to the family Asteraceae having its origin in Mexico.

Dahlia is popularly known as the "King of flowers". Dahlias with the gorgeously coloured flowers are very popular in the Indian gardens and are widely used for garden display and indoor decoration. It has a wide range of flower colours and diversity in the form of the flowers and so can cater to the taste of a large number of garden lovers.

Ornamental plants are not only grown in the ground but in pot also. It is desired that a pot plant should be of attractive appearance having dwarf, bushy and compact growth and a flowering plant should produce large number of flowers of normal shape and size. The height of dahlia plants varies from 30 cm to 180 cm depending upon the cultivar. The flower consists of a certain number of outer ray florets in which the male organs are modified into a strap-shaped petal, arranged round a central disc of bisexual florets. Actually the ray florets in dahlia have all the flower colours, whereas the disc florets are generally yellow.

Since dahlia stems are fleshy brittle and liable to break, it needs proper staking. Now-a-days the demand is high for dwarf type of plant so that it looks well massed in beds and makes effective decoration as a pot plant.

Dwarfing of plants by using chemical is now a commercial practice for developing attractive pot plants of azalea, chrysanthemum, poinsettia, dahlia and hydrangea. In recent years a group of chemicals known as growth retarding chemicals or growth retardants which retard stem elongation without causing any malformation of plants has drawn considerable attention of horticulturists and commercial growers of ornamental plants.

Although a number of growth retardants have been synthesised, phosfon-D (2,4 dichlorobenzyl tributyl phosphonium chloride) and B-nine (N-Dimethyl amino succinamic acid) are found effective on larger number of plants. Compared to phosfon-D, much wider plant spectrum is noted with cycocel and Alar.

In addition to dwarf, bushy and compact appearance with dark green colour and thicker foliage, growth retardants also increase the number and size of flower in several species of annual and perennial ornamental plants. The treated plants also show increased resistance to drought, diseases and pests. Cycocel in liquid form is used as foliar spray or soil drench. Phosfon-D and Cycocel in dust form are applied in soil while Alar is used as foliar spray. In case of perennial plants, chemicals are used when new shoots on pruned plants attain five to ten centimeter in length. Annuals are treated 20 to 30 days after tra planting.

This experiment is conducted to study the effect of growth retardants on vegetative, flowering and tuber characters of dahlia.

REVIEW OF LITERATURE

2 REVIEW OF LITERATURE

Synthetic growth - regulating chemicals are becoming extremely important and valuable in commercial floriculture for manipulating growth and flowering of many ornamental plants. A broad range of effects - both morphological and physiological can be observed by the application of growth regulants. The large flowered decorative dahlias are very popular ornamental plants and are widely grown in pots. Effect of plant growth retardants on a number of plants have been studied by different workers and some of their reports are briefly reviewed here under.

2.1 Effect of growth retarding chemicals on plant height

Several studies have shown that the height of the plant was influenced by the application of growth retarding chemicals. Battacharjee *et al*. (1976) studied the interaction of auxin and gibberellin with growth retardants on growth and flowering of *Dahlia variabilis*. CCC and Alar each at 5000 ppm either alone or in various combinations was tried on growth and flowering of Dahlia cv. MasterPiece. Alar when applied alone suppressed the height of dahlia whereas CCC had little effect.

Wilfret (1984) found in poinsettia that plant height was reduced considerably with the multiple application of CCC or a single application of ancymidol or paclobutrazol.

Holcomb (1985) reported that in pelargonium restriction of stem elongation generally increased with the frequency of CCC application at a concentration of 1500 ppm once, twice or three times at weekly intervals.

Reiss-Bubenheim (1986) experimenting with chrysanthemum have shown that Alar 1000-5000 mg/l applied as pre-plant dips to cuttings of the cultivar Garland sequentially reduced the height of both pinched and unpinched plants. Pinching also reduced height and lower concentrations of growth retardants were sufficient to achieve the desired height level. Shedeed et al.(1986) experimenting with some winter annuals like *Antirrhinum majus* and *Delphinium belladona* found that application of Alar at 250-2000 ppm four weeks after planting and again a month later decreased plant height.

Hennig (1986) reported that it is possible to improve the quality of Euphorbias for retail by using substances controlling biological process. He found that plant height of poinsettia cultivars Annette Hegg, Dark Red and Annette HegyDiva were reduced by the application of 0.1% CCC at the rate of 0.3 l/m^2, seven times at 7 days interval.

Reports of Wilfret (1986) showed that chrysanthemum and poinsettia treated thrice with CCC 2000 ppm grew to only 35-45 cm while control plant reached 55-60 cm.

Tayama and Zrebiec (1986) observed that plant height was reduced with the application of Alar in potted chrysanthemum cv. Bright Golden.

Hendriks (1987) studied the effect of CCC on seedling pelargonium cv. Pulsar Red and Pelargonium peltatum hybrid cultivars Cascade Rot and Cascade Rosa. He found that once or twice weekly sprays with 0.15% CCC or watering with 1% CCC reduced shoot growth by 25-29% compared with controls.

According to Shi and Li (1987) Alar at 1500-6000 ppm reduced plant size by 62-67% compared with untreated controls if applied during the vegetative stage and by 3-28% if applied at flowering stage of petunia plants.

Newman and Follett (1987) showed that Alar at 1750, 3500 and 5250 mg/l reduces the plant height without altering the plant quality of _Asclepias tuberosa_.

Shawareb & Qrunfleh (1988) reported that four cultivars of pot Chrysanthemum viz., White popsie, Yellow popsie, Red popsie and Dark Deep popsie when treated with various concentrations of Alar (1250-5000 ppm) as a soil drench or foliar spray, when average lateral shoot length was 5 cm. Foliar or soil applications significantly reduced the length of primary and secondary shoots. The foliar spray in split or single application was more effective in shortening the stem than the soil drench.

Banko and Stefani (1988) studied the growth response of selected container grown bedding plants, _Begonia semperflorens_, _Impatiens sultani_ and _Zinnia elegans_ towards paclobutrazol, uniconazole and Alar. They found that paclobutrazol and uniconazole effectively controlled the height of _B. semperflorens_ and _Impatiens sultani_ at relatively low rates compared with Alar. Alar at the rate of 5000 ppm controlled the height of Zinnia only.

Tayama and Carver (1988) studied the response of poinsettia towards chemical growth regulation. Cycocel alone and in combination with Alar were tried. None of the CCC or Alar mixtures gave significantly better height control than CCC alone (CCC - 1000 ppm).

In an experiment with carnation 'snowmass', pinched plants were sprayed twice with CCC 1500, 2000, 2500, 3000 and 3500 ppm. All the treated plants were significantly shorter than the controls but there were no significant differences in height between treatment (Pobudkiewicz and Goldsberry, 1989).

Strauch (1989) reported that in poinsettias treatment with combinations of Bonzi and CCC gave shorter plants than those treated with CCC alone. Combinations of Bonzi and CCC gave less variation in plant height than other treatments like CCC or Bonzi alone.

Impatiens cultivars Corona, Eva, Pulsar, Red Planet and Twilight treated with Alar (0.3 and 0.6%) and CCC (0.6%) had no effect compared to Alden and Bonzi (Biermann, 1989).

Witt (1989) observed that in Calceolaria rugosa, two doses of 1% Alar reduced plant height by 8%

but did not affect plant diameter. But in the case of *Impatiens walleriana* cv. Fortune Scarlet showed a height reduction of upto 14% and a reduction in diameter upto 19% in response to 3 doses of 0.1-0.15% Alar.

In *Polianthus tuberosa*, CCC at 500-1500 ppm increased the plant height (Choudhary, 1987). Studies were also conducted by Hentig and Hass (1989). They observed that watering plants with 1-2% CCC did not control the plant vigour of some new rose clones.

Gilbertz and Lewis (1986) observed in poinsettia a limited stem elongation when the plants were subjected to pre-plant treatment with CCC but the highest rate caused some phytotoxicity.

Alar applied to dahlias at 2500, 5000 or 10000 ppm retarded plant growth, espsecially at the highest concentration which induced retardation of 17.4 - 64.7% while CCC used as a foliar spray or soil drench at 1000 or 2000 ppm enhanced plant height by 0.6-12%. However, higher concentration of 4000 and 8000 ppm retarded growth by 1.5-12.6% (Bhattacharjee *et al.*, 1974).

2.2 Effect of growth retarding chemicals on production of leaf, branches and Chlorophyll content.

Roivainen (1987) reported that micropropagated Elatior begonias cv. Afrodite Limelight plants treated with 500 or 1000 ppm CCC did not show any difference in the number of branches or in the diameter of the root collar.

Hendriks (1987) found that once or twice weekly sprays with 0.15% CCC or watering with 1% CCC caused a reduction in leaf size and lightening of leaf colour, compared to untreated control in pelargonium.

In Petunia, Alar and CCC applications increased leaf thickness, amount of palisade tissue, leaf weight and chlorophyll content (Shi and Li, 1987).

Plant quality and leaf area were unaffected with the application of Alar (1750, 3500 or 5250 mg/l) in <u>Asclepias</u> <u>tuberosa</u> (Newman and Follett, 1987).

Shawareb (1987) studied the effect of Alar on four cultivars of pot chrysanthemum. Alar (1250-5000 ppm) as foliar and soil application significantly shortened the length of primary and secondary shoots and increased chlorophyll content of the leaves. However diameter and number of the primary lateral shoots were not influenced.

In dwarf carnation 'Snowmass' CCC (3500 ppm, 2 sprays at one month interval) caused some marginal leaf discolouration (Pobudkiewicz and Goldsberry, 1989). El-Shafie and Hassan (1978) observed a reduction in the number of leaves/plant in gerbera with CCC 500 ppm, but at the same time an increase in the number of shoots/plant.

Alar applied to the soil as a drench (2500, 4000 and 5000 ppm) or as a foliar spray at (2 x 1250, 2 x 2000, 2500, 2 x 2500, 4000 and 5000 ppm) to chrysanthemum lessened primary and secondary lateral shoot growth and increased leaf chlorophyll content, but the number and diameter of the primary lateral shoots were unaffected (Shawareb, 1987).

Tezuka <u>et</u> <u>al</u>. (1989) reported that CCC treatment increased leaf thickness and the size of the leaf mesophyll in cv. Summer carnival hollyhock plants.

In *Philodendron scandens* Alar applied as spray increased leaf width, reduced shoot internode length and number of nodes/shoot (Mansous and Poole, 1987).

Novoselova *et al.*(1985) found that *Tagetes patula* grown as a pot plant sprayed or watered with CCC at the start of bud formation had a marked effect and the best results were obtained when 2-5% solutions were watered into the soil thrice. The treated plants were more uniform, freely branching, leafy with more intense green leaves as compared with control plants.

In *Pelargonium zonale*, CCC at the rate of 0.5 and 0.75% produced the best plants with balanced shoot structure and bright green leaves (Selaru, 1985).

Messinger and Holcomb (1986) reported that, CCC causes severe foliage damage when applied to Dianthus cultivars.

According to Bailey *et al.* (1986), when Hydrangeas were treated with CCC the number of expanded leaf pairs/plant was significantly less compared to control plants.

2.3 Effect of growth retarding chemicals on number of days to flower and flowers per plant

Manipulation of crop production process with chemicals may be one of the most important advances to be achieved in agriculture. Several studies have shown that number of flowers per plant are influenced by the application of growth retarding chemicals.

In azalea two applications of CCC at 0.25% as foliar spray causes early initiation of flower buds and increased number of flowers. Treating *Barleria cristata* with CCC and Alar at 0.4 and 0.5% concertrations respectively increased the number of flowers. In hydrangea application of 0.5% Alar solution increased the number and size of flowers (Bose, 1972).

Shedeed *et al* (1986) studied the effect of certain growth regulators on the growth, flowering and seed production of summer annuals like *Zinnia elegans* and *T. erecta*. Alar at 250-2000 ppm at the fourth week after planting and again a month later caused delayed flowering.

Maiko and Yashchenko (1980) reported that Ethrel (100 mg/l) or Alar (200 mg/l) stimulated flowering in dahlia cv. External Fire and Park Princess.

In pelargonium, CCC at the rate of 0.1 or 0.25% advanced flowering by a few days. Those plants which were treated with 0.5 and 0.75% CCC showed high flowering capacity (Selaru, 1985). More and Dohare (1985) reported that highest flower yield was obtained with CCC at 5000 ppm compared to Ethephon, from <u>Jasminum grandiflorum</u>.

Heursel (1985) studied the influence of CCC and Alar on Azalea cv. Hellmut Vogel. Flowering was advanced by five days with Alar compared to untreated control.

Accoı

were treated wi

when applied as

Armitage (1986) reported that application of 1500 ppm CCC to pelargonium cv. Sprinter Scarlet before flower initiation accelerated flowering.

In tuberose (*Polianthes tuberosa*) CCC (500-1500 ppm) increased the number of flowering spikes and flower numbers compared with control (Stephenson, 1985).

Nagarjuna *et al* (1986) reported that treating charysanthemum with Alar at 5000 ppm gave the highest number of flowers per plant (102.9). Spraying was found to be more effective than dipping. In trials with *Jasminum multiflorum*, treatment with CCC at 5000 ppm (4 times at bimonthly intervals commencing from 45 days after pruning) gave the best results with regard to days to flowering (34.5), duration of flowering (275.5 days) and mean flower yield (1118.29 g/bush). The corresponding figures in the untreated control were 56.5 days, 221.5 days and 395.47 g/bush (Murali and Narayana Gowda, 1988).

Shalaby *et al.* (1989) found that maximum flower yield and highest total concrete yield (3027 g/plant) in *Jasminum sambac* was obtained with Alar at 2000 ppm sprayed three times at two weekly intervals, while the control yield was 1448 g/plant. Similar studiees were conducted by Bhattacharjee (1989) in *Jasminum grandiflorum*. In *Antrirrhinum majus* CCC at

500-1000 ppm gave the largest number of flowers (Sarban and El-Sayed, 1983).

In *Tagetes erecta*, highest number of flowers/plant (11.4-11.7) were obtained with CCC at 500 ppm (Parmar and Singh, 1983).

Eldubh *et al*. (1987) compared the effect of Ethrel and CCC on Tulip cv. Apeldoorn CCC at 750 ppm had no effect on the time taken for flowering.

El-Shafie and Assan (1978) studied the effect of gibberellic acid and chlormequat on the growth and flowering of gerbera. CCC at 500 or 750 ppm applied at monthly intervals delayed flowering.

In pelargonium, treatment with CCC at 4.5 ml/l 8 and 10 weeks after sowing advanced the flowering date and increased the uniformity of flowering (Cairol and Hoeau 1979). Studies conducted by Holcomb (1985) revealed that the number of potential flowers was reduced with chlormequat at 1500 or 3000 ppm.

Shedeed *et al*. (1986) found that Alar at 250-2000 ppm applied 4 weeks after planting and again a month later delayed flowering.

Shi and Li (1987) studied the effect of Alar and CCC on dwarfing and flowering of petunia plants. They found that Alar at 1500-3000 ppm increased the number of flowers, but Alar at 6000 ppm and CCC at 2500 - 10,000 ppm slightly reduced the number of flowers. Shawareb and Qrunfleh (1988) reported that foliar spraying of Alar (1250-5000 ppm) on chrysanthemum delayed flowering from two to four days.

Biermann (1989) compared the effect of CCC, Alar and Ancymidol in two Fuchsia cultivars. Spraying Alar (o.5%, twice) increased the number of flower buds.

Bhattacharjee (1984) reported that Alar (1000-5000 ppm), TIBA (500-2000 ppm) and Ethrel (2000 ppm) delayed flower bud appearance by 6-15 days whereas MH (500-1000 ppm), GA_3 (10-100 ppm) and NAA (10-100 ppm) advanced it by 4-5 days, in Dahlia variabilis.

Stahn (1975) have shown that, Camellia japonica watered with 4.8% CCC towards the end of culture periods increased the total number of flower buds/plant by 2.1 and doubled the number of flowering shoots to 1.8/plant.

Adriansen (1976) opined that Alar had no effect on flowering date and flower spike number (425-4250 ppm) on Crossandra infundibuliformis cv. Mona Wallhed. Tayama and Carvar (1990) determined the growth and flowering responses of zonal geranium towards different growth retardants like uniconazole, paclobutrazol, CCC, Alar and ethephon. They found that the chemicals did not affect days to anthesis or inflorescence number. In Jasminum grandiflorum, CCC and Alar at 1000-5000 ppm (2 sprays at one month interval) were tried. The highest flower yield of 3860 g/plant annually was obtained with Alar at 5000 ppm followed by 3696 g/plant with CCC at 1000 ppm compared to control yield (2981 g/plant) (Bhattacharjee, 1989).

Biswas et al. (1983) studied the effect of growth substances on growth and flowering in tuberose. The highest number of flower spikes (6/plant) was obtained with foliar application of CCC at 0.02 ml/l.

Maharana and Pani (1982) conducted an experiment on the effect of post pruning spraying of different growth regulators on hybrid rose. CCC at 5000 or 10,000 ppm advanced flowering whereas MH delayed it.

2.4 Effect of growth retarding chemicals on flower size

Hennig (1986) reported that the quality of Euphorbias was improved for retail by using substances that control biological processes. Bract diameter was significantly increased by watering with CCC i.e., single spray at a concentration of 0.7% but reduced by spraying 5 times at 0.25% concentration.

Hendrics (1987) compared the effect of Bonzi (paclobutrazol) and CCC. He found that inflorescence diameter of pelargonium considerably reduced with the application of CCC 0.15%, once or twice weekly sprays.

Eldubh et al. (1978) found that CCC at 750 ppm lessened the diameter of Tulip cv. Apeldoorn. El-Shafie and Hassan (1978) studied the effect of gibberellic acid and CCC on flowering of gerbera. They found that rewer but heavier flowers were produced with 750 ppm CCC. Both GA and CCC slightly increased the flower diameter.

Heursel (1985) reported that potted plants of Azalea cultivars Memoria Sander and Hellmut Vogel showed a reduction in flower diameter (1.3 cm) with the application of Alar at the rate of 3000 ppm.

The effect of soil drench application of CCC and Alar at 1000, 2500 and 5000 ppm each on growth, flowering, corm and cormel formation of cv. Friendship was studied by Bhattacharjee (1987). Size of flower was increased with the treatment. Zrebiec and Tayama (1986) reported that number of bracts and average bract diameter was reduced with the application of CCC and Alar.

In dahlia, Alar at 2500, 5000 or 10,000 ppm produced larger flowers compared to untreated plants (Bhattacharjee et al. 1974).

2.5 Impact of growth retarding chemicals on tuber characters

Several reports have shown that yield of tuberous roots was significantly affected with chemical treatments.

Mugge and Richter (1980) reported that treating tulip cv. Vander Eerden with CCC at 0.5% immediately after flower removal was most effective in improving bulb.

Preplanting soaking of dahila cuttings in Ethrel 10 mg/l improved early tuber formation and soaking in Alar at 20 mg/l improved subsequent tuber growth. Spraying young plants with Alar at 200 mg/l was a more effective method of stimulating tuber development than soaking the cuttings (Maiko and Yashchenko, 1980). Bhattacharjee (1984) reported that treating Dahlia cv. Kelvin Rose with CCC (2500-5000 ppm), Ethephon (1000-2000 ppm) and Alar (2500 ppm), significantly increased the number and weight of tuberous roots.

Spraying with ABA or Ethephon promoted the tuberization of dahlia plants in long days compared to short days (Biran et al. 1972).

Pappiah and Muthuswamy (1974) observed more number of tubers per plant in dahlia when treated with CCC at 1000 and 2000 ppm.

2.6 Effect of growth retarding chemicals on duration of flowering

Hore and Bose (1972) studied the growth of several species of hibiscus plants regulated by CCC dust. They observed maximum flowering response with the application of 4 and 8 g/plant. It caused a delayed abscission of flowers.

Another study conducted by Bhattacharjee *et al*. (1977) revealed that CCC at 2500-5000 ppm caused enhanced flowering. More over flowers were retained for a longer period on treated plants.

MATERIALS AND METHODS

3 MATERIALS AND METHODS

Investigation was carried out with a view to study the effect of growth retardants on growth, flowering, vase-life and tuber formation of dahlia. The experiment was conducted during 1990-'91 at the Department of Horticulture, College of Agriculture, Vellayani under the Kerala Agricultural University.

3.1 Plant Material

The study was initiated with the planting materials.

1. Dahila variabilis cv. Formal Decorative (Family Asteraceae)

2. **Chemicals**

   i CCC (2-chloro ethyl trimethyl ammonium chloride)

   ii Alar (N-dimethyl amino succinamic acid)

The plant material was collected from a Garden at Thiruvananthapuram. One month old rooted cuttings of Dahlia variabilis cv. Formal Decorative were transplanted to 12" earthenware pots, one in each in a pot mixture of 1 part sand, 1 part soil, one part of well rotted farmyard manure. A handful of bone meal per pot was also added.

3.2.1 Preparation of stock solutions

A stock solution of 4000 ppm Alar was prepared by dissolving 5g of Alar in a small quantity of 50% ethanol and made up the volume to 1000 ml with distilled water. The stock solution was further diluted to the required concentrations and used for the study.

A stock solution of 2000 ppm was prepared by dissolving 2g of Cycocel in a small quantity of distilled water and made up the volume to 1000 ml with distilled water. From the stock solution further dilutions were made to the required concentrations.

Few drops of Lanolin was added to the prepared solutions to serve as wetting agent. Distilled water treatment was run as a control.

3.3 TREATMENTS

Sl.No.	Treatment Code	Mode of treatment
1	T_{10}	Control
2	T_{11}	500 ppm Alar foliar spray
3	T_{12}	1000 ppm "
4	T_{13}	2000 ppm "
5	T_{14}	4000 ppm "
6	T_{20}	Control
7	T_{21}	250 ppm CCC foliar spray

8	T_{22}	500 ppm	"
9	T_{23}	1000 ppm	"
10	T_{24}	2000 ppm	"

3.4 EXPERIMENTAL DESIGN

The experiment was laid out in a completely randomised design, involving ten treatments. Twenty pots were kept for each treatment. For each chemical, five treatments were tried (4 levels of chemical + 1 control). One month after transplanting, growth regulating chemicals viz., Alar (500, 1000, 2000 and 4000 ppm) and CCC (250, 500, 1000 and 2000 ppm) concentrations of each were sprayed thoroughly on each plant treatment wise. Fifteen days after first spray, second spray of CCC and Alar was given treatmentwise on the same plants. Control plants were sprayed with distilled water.

3.5 OBSERVATIONS RECORDED

3.5.1 Plant Characteristics

Observations were taken on vegetative growth at 15 days interval from all plants.

3.5.1.1 Height of plant

Height of the plant was recorded at 15 days intervals, measured in cm and mean height was recorded.

3.5.1.2 **Number of branches/plant**

Number of branches was counted from each plant and the average worked out.

3.5.1.3 **Number of leaves at flowering**

The number of leaves produced by the plant was recorded at 15 days interval till flowering and the average worked out.

3.5.1.4 **Size of leaves**

3rd, 5th and 8th leaf from base on the main stem were collected from each observational plant and measured in cm^2 using leaf area meter.

3.5.1.5 **Length of internodes**

Length of internode of each plant was observed at 15 days interval in cm and the mean taken.

3.5.1.6 **Thickness at nodes and internodes**

Thickness of node and internode was measured and expressed as diameter in cm. The mean values were taken after measuring a minimum of three nodesand internodes at each intervel of 15 days. During the subsequent intervals fresh nodes and internodes above the ones already measured alone were considered for measurement.

3.5.1.7 **Chlorophyll content of the leaf**

Chlorophyll content of the leaf was analysed at the time of flowering. Representative samples were collected from each treatment.

Fresh samples were used for analysis. Leaf samples (5g each) were taken, cut into small pieces and homogenised with 80 percent acetone in a mortar and pestle. The homogenised material was filtered through Buchner funnel using Whatman No.42 filter paper. The extraction was repeated 3 times with acetone. The volume was made upto 100 ml in volumetric flask. Then the OD values were read in Spectronic 2000 spectrophotometer at 645 nm for chlorophyll 'a' and at 663 nm for chlorophyll 'b'.

3.5.2 Flower characteristics

3.5.2.1 **Number of days to flowering**

The number of days taken from the date of transplanting to the date of first flowering was recorded for each plant and the average was taken.

3.5.2.2 **Number of flowers/plant**

Observations were recorc

plants and average was taken.

3.5.2.3 Size of flower, number of florets and size of florets

These observations were recorded for terminal and side flowers separately in cm and average was taken.

3.5.2.4 Longevity of intact flower

The date of opening of the flowers ie., both terminal and side flowers was recorded by tagging the flowers and the tag was removed on the day of senescence ie., the outer whorl of petals started fading and from this the longevity of flower was computed and their average was found out.

3.5.2.5 Longevity of cut flower (vase-life)

At the same day opening four flowers were cut from each treatment and kept in conical flask containing distilled water. The date on which the outer whorl of petals started fading was noticed and thus the vase-life was computed and their average was taken.

3.5.3 Tuber characteristics

The data on tuberous roots were taken by uprooting the tubers carefully after flowering when the plants were completely dried and the stems turned yellow.

3.5.3.1 Fresh weight of tuber

Fresh weight of tuber was recorded on the same day of harvesting in grams and the average was taken.

3.5.3.2 Number of tubers

Number of tubers was counted, recorded and the average was taken.

3.5.3.3. Size of tuber

Length and diameter of tubers from each plant was recorded and average was computed.

3.6 Statistical analysis

The mean values for the different parameters were calculated and the data were analysed using the analysis of variance technique for completely randomised designs. Statistical analysis of data over different intervals was analysed in split plot fashion as the observations are nested over treatments.

RESULTS

4 RESULTS

The experimental data recorded from the present study were statistically analysed to study the effect of growth retardants on growth, flowering, vase-life and tuber formation of dahlia and the results are presented below.

4.1 PLANT CHARACTERISTICS

4.1.1 Plant height

The mean plant height for different periods are presented in Table - 1 and the analysis of variance in Appendix-I.

When Alar and CCC were applied separately as foliar spray on Dahlia variabilis Desf. CV. Formal Decorative, differential response on their effectiveness for inhibiting stem elongation was observed.

At 30th day, the average plant height was 17.09 cm for plants treated with Alar, which was significantly high in comparison with those treated with CCC (14.29 cm). But at 45th day no significant difference in plant height was observed with these treatments. However on 60th and 75th days the average plant height was significantly high for those treated

Table 1. Average height (cm) of plants at different intervals of time

Treatment	30 days	45 days	60 days	75 days
T_{10}	17.35	27.1	46.3	58.75
T_{11}	16.67	24.28	40.1	48.85
T_{12}	17.28	24.83	40.2	45.2
T_{13}	16.78	24.55	37.75	43.48
T_{14}	17.4	24.65	35.15	40.35
Mean (T_1)	17.09	25.08	39.90	47.33
T_{20}	14.0	20.85	50.39	61.30
T_{21}	13.03	20.95	44.83	55.60
T_{22}	14.65	28.40	49.95	55.20
T_{23}	15.25	28.93	48.00	56.23
T_{24}	14.53	31.75	49.90	53.10
Mean (T_2)	14.29	26.04	48.61	56.28
CD: T_1 vs T_2	0.907	-	2.393	1.787
Between levels of T_1/T_2	-	4.139	5.352	3.997

with CCC (48.61 cm, 56.28 cm) in comparison with Alar (39.9 cm, 47.33 cm). In case of Alar, the control plants recorded significant increase in height against the plants treated with various levels of Alar, while their difference was not significant in case of CCC at 60th day. At 75th day also control plants recorded maximum height in both cases, but Alar (500 ppm) recorded a significant increase in height in comparison with Alar 2000 ppm and 4000 ppm. No significant difference in plant height was observed at various levels of CCC.

4.1.2 **Number of leaves/plant.**

The data on mean number of leaves per plant are presented in table - 2 and the analysis of variance in Appendix - II.

The results (Table - 2) reveal that there exist a highly significant difference between the chemicals Alar and CCC. At 30th, 45th and the 60th day after planting, the average number of leaves produced was (17.53, 25.61 and 34.29) for plants treated with Alar which was significantly high in comparision with those treated with CCC (14.8, 22.31 and 31.04). In the case of Alar, the treated plants recorded significant increase in number of leaves against the untreated control while the difference was not significant at 45th day. There was appreciable increase in the number of leaves per plant with the treatment of Alar. Maximum number of leaves resulted with Alar 2000 ppm (35.2) followed by Alar 4000 ppm (35.05), 500 ppm (34.5) and 1000 ppm (34.45) as compared to untreated plants with 32.25. In the case of CCC, there exists a highly significant difference between treated plants and untreated control for number of leaves at 30th, 45th

Table 2. Average number of leaves at different intervals of time.

Treatment	30 days	45 days	60 days	Mean (treatments)
T_{10}	16.05	24.45	32.25	24.25
T_{11}	17.65	25.95	34.50	26.03
T_{12}	17.70	25.80	34.45	25.98
T_{13}	17.95	25.55	35.20	26.23
T_{14}	18.30	26.30	35.05	26.55
Mean (T_1)	17.53	25.61	34.29	25.81
T_{20}	13.90	20.55	31.40	21.95
T_{21}	13.05	19.85	30.15	21.02
T_{22}	14.40	22.00	29.65	22.02
T_{23}	15.50	23.50	31.95	23.65
T_{24}	17.15	25.65	32.05	24.95
Mean (T_2)	14.80	22.31	31.04	22.72
Mean (Period)	16.17	23.96	32.67	24.27
CD: T_1 vs T_2	0.581	0.736	0.845	
Bet. levels of T_1/T_2.	1.30	1.647	1.89	

CD: Between treatments.- 1.428

CD: Between period - 0.304.

and 60th day. CCC at 1000 ppm and 2000 ppm shows an increase in the production of leaves compared to control.

The behaviour of treatment was not consistent over the different intervals of days. Three levels of Alar significantly differ from control, with the highest leaf production at 4000 ppm while in the case of CCC plants treated with 1000 ppm and 2000 ppm gives the maximum value. When the days advances, the treated plants shows an increase in the production of leaves compared to control.

4.1.3 Number of branches/plant

The data on mean number of branches/plant are presented in Table - 3 and the analysis of variance in Appendix - III.

At 30th day,, the average number of branches was 10.95 for plants treated with Alar which was significantly high in comparison with those treated with CCC (10.3). But at 45th day no significant difference in number of branches was observed with these treatments. However on 60th day the average number of branches was significantly high for those treated with CCC (25.96) in comparison with Alar

Table 3. Average number of branches at different intervals of time.

Treatment	30 days	45 days	60 days	Mean (treatments)
T_{10}	7.55	13.90	21.25	14.23
T_{11}	10.95	17.80	24.80	17.85
T_{12}	12.50	19.00	26.40	19.30
T_{13}	11.10	17.60	25.85	18.18
T_{14}	12.65	19.05	26.45	19.38
Mean (T_1)	10.95	17.47	24.95	17.78
T_{20}	8.50	15.15	25.00	16.22
T_{21}	8.50	15.30	25.25	16.35
T_{22}	10.70	18.45	26.00	18.38
T_{23}	11.50	19.50	27.20	19.40
T_{24}	12.30	20.20	26.35	19.62
Mean (T2)	10.30	17.72	25.96	17.99
Mean (Period)	10.63	17.59	25.46	17.89
CD: T1 vs T2	0.616	-	0.899	
Bet. levels of T_1/T_2.	1.378	1.775	2.009	

CD: Between treatments. 1.565

CD: Between period - 0.295.

(24.95). In both cases, the plants treated with various levels of Alar and CCC recorded significant increase in the number of branches, except in the case of CCC at 60th day.

The behaviour of treatment was not consistent over the different intervals of days. For the production of branches plants treated with Alar behaves similarly and significantly differ from control. While in the case of CCC plants treated with higher levels behaves in a similar manner and significantly differ from control. Considering the different period, both the treated and untreated plants showed an increasing tendency in the number of branches as the days advanced but the rate of production was greater for treated plants.

4.1.4 Size of leaves

The data on mean size of leaves are presented in Table - 4 and the analysis of variance of Appendix - V.

The average leaf size was (75.04 cm^2) for plants treated with CCC which was significantly high in comparision with those treated with Alar (58.2 cm^2).

Table 4. Effect of treatment on size of leaves

Treatment	Size of leaves (cm^2)
T_{10}	49.85
T_{11}	51.50
T_{12}	61.85
T_{13}	61.15
T_{14}	66.63
Mean (T_1)	58.20
T_{20}	65.43
T_{21}	71.72
T_{22}	83.10
T_{23}	82.02
T_{24}	72.92
Mean (T_2)	75.04
CD: T_1 vs T_2	3.385
Bet. levels of T_1/T_2.	8.017

The plants treated with various levels of Alar and CCC show highly significant difference in the size of leaves compared to untreated control. CCC 500 ppm and 1000 ppm recorded the maximum size ie. 83.1 cm^2 and 82.02 cm^2 respectively.

4.1.5 **Chlorophyll Content**

The mean chlorophyll contents are presented in the table - 5 and the analysis of variance in Appendix VI.

The results reveal that there was no significant difference between the chemicals Alar and CCC for chlorophyll "a" content. In the case of Alar, those plants treated with 1000, 2000 and 4000 ppm recorded a significant increase in the chlorophyll "a" content compared with 500 ppm.

The average chlorophyll "b" content was 1.83 μ g/0.5g sample for plants treated with CCC, which was significantly high in comparison with those treated with Alar (1.39 μg/0.5 g of sample). There was no significant difference between various level of each chemical against their control.

The average total chlorophyll content was (6.55 μg/-0.5 g of fresh sample) for plants treated with CCC

Table 5. Effect of treatment on chlorophyll content of dahlia.

Treatment	Chlorophyll a	Chlorophyll b	Total Chlorophyll
	μg	μg	μg
T_{10}	4.26	1.42	5.68
T_{11}	3.28	1.08	4.36
T_{12}	4.49	1.41	5.90
T_{13}	5.29	1.55	6.84
T_{14}	4.90	1.47	6.37
Mean (T_1)	4.44	1.39	5.83
T_{20}	4.57	2.05	6.62
T_{21}	4.52	1.77	6.29
T_{22}	5.46	2.02	7.42
T_{23}	4.48	1.66	6.14
T_{24}	4.63	1.63	6.26
Mean (T_2)	4.72	1.83	6.55
CD: T_1 vs T_2	–	0.155	0.640
Between levels of T_1/T_2.	1.12		1.431

which was significantly high in comparison with those treated with Alar (5.83 μg/0.5g of fresh sample while comparing the various levels of Alar and CCC with control, Alar 1000, 2000 and 4000 ppm behaves similarly though significantly different from the control. Among the plants treated with CCC, those treated with 500 ppm alone shows significant difference from the control.

4.1.6 Internodal length

The mean internodal length for different periods are presented in table - 6 and analysis of variance in Appendix VII.

At 30th day no significant difference in internodal length was observed with these treatments. However on 45th, 60th and 75th days the average internodal length was significantly high for those treated with CCC (3.29 cm, 7.76 cm, 9.27 cm) in comparision with Alar (1.82, 4.23 and 6.17 cm). In the case of Alar the control plants recorded significant increase in internodal length against the plants treated with various levels of Alar, while their difference was not significant at 30th and 45th day. However at 75th day Alar 500 ppm recorded a significant increase in internodal length in comparision with Alar

Table 6. Effect of treatment on mean internodal length (cm) of dahlia plants at different intervals

Treatment	30 days	45 days	60 days	75 days
T_{10}	0.90	2.43	5.88	7.25
T_{11}	0.95	2.10	4.50	7.38
T_{12}	0.91	1.62	4.30	6.08
T_{13}	0.85	1.44	3.88	5.65
T_{14}	0.81	1.50	2.60	4.48
Mean (T_1)	0.88	1.82	4.23	6.17
T_{20}	0.79	2.05	7.03	9.80
T_{21}	0.83	2.14	6.38	8.68
T_{22}	0.98	3.98	7.95	9.45
T_{23}	1.07	3.85	8.83	9.78
T_{24}	1.07	4.43	8.76	9.25
Mean (T_2)	0.95	3.29	7.76	9.27
CD:T_1 vs T_2		0.367	0.644	0.553
between levels of T_1/T_2.	0.167	0.821	1.440	1.237

1000, 2000 and 4000 ppm. The results clearly show a highly significant increase in internodal length at the highest doses of CCC against its control, except at 75th day.

4.1.7 **Thickness at node**

The data on mean nodal thickness for different intervals are presented in Table - 7 and analysis of variance in Appendix VIII.

At 30th, 45th, 60th and 75th days the average nodal thickness was 2.29 cm, 3.49 cm and 4.06 cm respectively for plants treated with CCC which was significantly high in comparison with those treated with Alar (2.17 cm, 2.97 cm, 3.27 cm and 3.5 cm respectively). In the case of Alar significant difference between control and various levels of treatments was noted only at 30th day. However with CCC, significant difference between different levels was recorded at 30th and 45th day.

4.1.8. **Thickness at Internode**

The data on mean internodal thickness for different intervals are presented in Table 8 and analysis of variance in Appendix IX.

Table 7. Effect of treatment on nodal thickness (cm) of dahlia plants at different intervals

Treatment	30 days	45 days	60 days	75 days
T_{10}	1.93	2.85	3.48	3.43
T_{11}	2.22	2.88	3.15	3.25
T_{12}	2.13	2.98	3.18	3.65
T_{13}	2.22	3.03	3.30	3.60
T_{14}	2.37	3.10	3.32	3.50
Mean (T_1)	2.17	2.97	3.27	3.49
T_{20}	2.06	3.13	3.85	3.89
T_{21}	2.10	3.30	4.08	3.87
T_{22}	2.28	3.58	3.78	3.99
T_{23}	2.43	3.70	3.78	4.26
T_{24}	2.60	3.73	3.98	4.31
Mean (T2)	2.29	3.49	3.89	4.06
CD:T1 vs T2	0.081	0.101	0.127	0.171
between levels of T_1/T_2.	0.183	0.227	-	-

Table 8. Effect of treatment on internodal thickness (cm) of dahlia plants at different intervals

Treatment	30 days	45 days	60 days	75 days
T_{10}	1.78	2.63	3.00	2.88
T_{11}	1.84	2.70	2.80	2.83
T_{12}	1.81	2.90	2.98	2.90
T_{13}	1.86	3.00	3.05	3.00
T_{14}	1.84	3.00	2.95	2.95
Mean (T_1)	1.82	2.85	2.96	2.91
T_{20}	1.93	2.83	3.55	3.24
T_{21}	1.93	3.05	3.88	3.31
T_{22}	2.08	3.18	3.44	3.44
T_{23}	2.08	3.22	3.26	3.37
T_{24}	2.33	3.43	3.45	3.69
Mean (T_2)	2.07	3.14	3.52	3.41
CD: T_1 vs T_2	0.076	0.104	0.107	0.130
between levels of T_1/T_2.	0.170	0.232	0.240	0.291

At different intervals ie 30th , 45th, 60th and 75th days, the average internodal thickness was significantly high for those treated with CCC (2.07, 3.17, 3.52 and 3.41 cm) in comparison with Alar (1.82, 2.85, 2.96 and 2.91 cm). Plants treated with various levels of CCC shows a highly significant difference compared with control. CCC 2000 ppm consistently recorded maximum internodal thickness in comparison with other treatments.

4.2 FLOWER CHARACTERSTICS

4.2.1 Number of days to flowering

The data on mean number of days to first flower bud appearance from planting, number of days to flower bud opening from first flower bud appreance and total number of days to flowering from planting are presented in Table-9 and the analysis of variance in Appendix-X.

The average number of days to first flower bud appearance from the date of planting was 53 for plants treated with Alar which was significantly high in comparison with CCC (48). In the case of CCC, the control plants recorded significant increase in number of days to first flower bud appearence against the

Table 9. Effect of treatment on mean days to flower

Treatment	Days to first flower bud appearance from date of planting	No. of days to flower bud opening from FFBA	Total No. of days to flowering from day of planting
T_{10}	51.25	18.9	70.15
T_{11}	53.80	22.25	76.05
T_{12}	53.05	21.00	74.05
T_{13}	53.85	21.40	75.75
T_{14}	54.45	20.75	75.20
Mean (T_1)	53.28	20.86	74.24
T_{20}	52.45	21.70	74.15
T_{21}	52.20	22.35	74.55
T_{22}	46.65	19.35	66.00
T_{23}	45.85	20.15	66.00
T_{24}	43.45	20.60	64.05
Mean (T_2)	48.12	20.83	68.95
CD: T_1 vs T_2	1.200	-	1.238
Between levels of T_1/T_2.	2.684	1.409	2.767

plants treated with various levels of CCC, while the difference was not significant in the case of Alar.

There was no significant difference between the two chemicals in number of days to flower bud opening from first flower bud appearance. However there exist a highly significant difference between control and various levels of Alar and CCC.

The average total number of days to flowering was 74 for plants treated with Alar which was significantly high in comparision with CCC (68). In general the treatment of plants with Alar resulted in a significant delay in total number of days to flowering. However treatment of plants with CCC shows a significant earliness in flowering, the only exception being CCC 250 ppm which was on par with control (74 days).

4.2.2 **Number of flowers/plant**

The data on mean number of flowers per paint are presented in Table - 10 and analysis of variance in Appendix XI.

Growth regulator treatments significantly affected the flower production. From the result it was

Table 10. Effect of treatment on mean number of flowers/plant, mean flower longevity and vase-life of dahlia

Treatment	Mean number of flowers/ plant	Mean flower longevity (days)	Mean vaselife (days)
T_{10}	2.7	5.6	7.0
T_{11}	2.7	5.5	6.0
T_{12}	3.95	6.3	8.0
T_{13}	4.05	6.5	7.3
T_{14}	4.05	6.4	7.0
Mean (T_1)	3.49	6.06	7.06
T_{20}	2.85	5.4	5.0
T_{21}	2.20	5.1	5.0
T_{22}	4.30	6.2	5.5
T_{23}	3.60	6.4	5.8
T_{24}	4.60	6.1	5.0
Mean (T_2)	3.51	5.84	5.26
CD: T_1 vs T_2	-	0.221	0.186
Between levels of T_1/T_2.	0.828	0.494	0.417

very clear that there was no significant difference between the chemicals for the number of flowers/plant. In the case of Alar and CCC, the treated plants recorded significant increase in number of flowers against the untreated control, the exceptions being Alar 500 ppm.

4.2.3 Longevity of flowers

The data on mean longevity of flowers are presented in Table - 10 and the analysis of variance in Appendix XI.

The average mean flower longevity was 6.06days for plants treated with Alar which was significantly high in comparision with CCC (5.84 days) . In the case of Alar and CCC, the plants treated with various levels of the chemicals showed a highly significant difference against control, the exceptions being Alar 500 ppm and CCC 250 ppm.

4.2.4 Vase-life

The data on mean vase-life of flower are presented in table-10 and the analysis of variance in Appendix-XI.

The average mean vase-life of flower was (7.06 days) for plants treated with Alar which was significantly high in comparison with CCC (5.26 days). The plants treated with various levels of Alar and CCC show highly significant difference in vase-life of flowers compared to untreated control. Alar 1000 ppm recorded the maximum vase-life 8 days.

4.2.5 Size of terminal flower

The data on mean size of terminal flowers are presented in Table 11 and the analysis of variance in Appendix - XII.

The average diameter of terminal flowers for plants treated with Alar (16.58cm) which was significantly high in comparision with plants treated with CCC (15.72cm) A highly significant difference was observed between various levels of chemicals and the control in the case of both Alar and CCC with the exception of Alar 500 ppm and CCC 250 ppm.

It was also evident from the table that the average number of florets was 132 for plants treated with Alar which was significantly high in comparision

Table 11. Effect of treatment on mean diameter, mean number of florets and mean size of florets of terminal flower of dahlia

Treatment	Mean diameter	Mean No.of florets	Mean length of florets	Mean breadth of florets
T_{10}	16.0	128.90	7.25	2.88
T_{11}	15.6	126.8	7.24	3.06
T_{12}	17.1	136.8	8.16	3.33
T_{13}	17.3	136.3	8.15	3.50
T_{14}	17.0	132.2	8.17	3.56
Mean (T_1)	16.58	132.21	7.79	3.27
T_{20}	15.3	115.3	7.35	3.21
T_{21}	15.0	111.8	7.14	2.95
T_{22}	16.3	121.6	7.89	3.22
T_{23}	15.6	122.8	7.61	3.18
T_{24}	16.4	126.2	7.81	3.18
Mean (T2)	15.72	119.52	7.56	3.15
CD: T1 vs T2	0.325	3.051	0.202	0.091
between levels T_1/T_2.	0.728	6.822	0.451	0.204

with CCC (120). The plants treated with various levels of Alar and CCC show highly significant difference in the number of florets compared to control, except with Alar 500 ppm and CCC 250 ppm.

4.2.5 Size of florets : Terminal flower

The mean size of florets of terminal flowers are presented in Table - 11 and the analysis of variance in Appendix - XII.

It was evident from the table that there was significant difference between the chemicals with respect to the length of florets. The average length of floret of terminal flower was (7.79cm) for plants treated with Alar which was significantly high in comparison with CCC (7.56 cm). The plants treated with various levels of Alar and CCC recorded a highly significant difference compared to control except with Alar 500 ppm and CCC 250 ppm.

The average breadth of floret was 3.27 cm for plants treated with Alar which was significantly high in comparison with CCC (3.15 cm). It was also revealed from the table that breadth of florets was affected significantly with the spray of Alar. Maximum breadth was noticed with Alar at 4000 ppm (3.56 cm) and the treatment with the same at 2000 ppm ranked the next (3.5 cm) while that of control it was 2.80 cm.

4.2.6 Size of lateral flower

The data on mean size of lateral flowers are presented in Table - 12 and the analysis of variance in Appendix - XIII.

There exists a significant difference between the chemicals CCC and Alar with regard to the size of lateral flower. The average diameter of lateral flower was (11.64 cm) for plants treated with Alar which was significantly high in comparison with CCC (10.38 cm). Except with Alar 500 ppm and CCC 250 ppm the plants treated with various levels of both chemicals showed highly significant difference compared to control in this regard.

The average number of florets was 91.61 for plants treated with Alar which was significantly high in comparison with CCC (83.54). There was significant increase in the number of florets with the application of various levels of chemicals except with Alar at 500 ppm and CCC at 250 ppm. Maximum number of florets was

Table 12. Effect of treatment on mean diameter, mean number of florets and mean size of florets of lateral flowers of dahlia

Treatment	Mean diameter	Mean No.of florets	Mean length of florets	Mean breadth of florets
T_{10}	10.2	79.4	5.25	2.1
T_{11}	10.0	78.7	4.48	2.0
T_{12}	12.2	96.05	6.36	2.8
T_{13}	12.9	100.85	6.69	2.9
T_{14}	12.9	103.05	6.75	3.0
Mean (T_1)	11.64	91.61	5.90	2.56
T_{20}	9.7	79.1	5.63	2.3
T_{21}	7.3	56.25	3.98	1.6
T_{22}	12.3	98.15	6.16	2.7
T_{23}	10.3	81.55	5.37	2.2
T_{24}	12.3	102.65	6.72	2.7
Mean (T2)	10.38	100.25	5.57	2.3
CD: T1 vs T2	0.985	7.835	-	0.214
between levels T_1/T_2.	2.203	17.520	1.148	0.479

noticed with Alar at 4000 ppm (103.05) as compared to control (79.4).

4.2.6.1 Size of florets: Lateral flowers

The data on mean size of florets of lateral flowers are presented in Table - 12 and analysis of variance in Appendix - XIII.

It was evident from the table that there was no significant difference between the chemicals for the length of florets. However, a highly significant difference was observed between various levels of Alar and that of CCC against the control. Maximum length of florets was observed with Alar at 4000 ppm (6.75 cm) as compared to the control (5.25 cm).

The average breadth of floret was 2.56cm for plants treated with Alar which was significantly high in comparision with CCC (2.3 cm). The plants treated with various levels of Alar and CCC also showed highly significant difference in the number of florets compared to control. Maximum breadth was noticed with Alar at 4000 ppm (3.0 cm) among all other treatments.

TUBER CHARACTERISTICS

4.3.1 Number of tubers

The data on tuber characters are presented in Table -13 and analysis of variance in appendix-XIV.

There was no significant difference between the chemicals CCC and Alar with regard to the number of tubers. In the case of Alar, plants treated with various levels recorded significant increase in the number of tubers as against the control. There was no significant difference between the various levels of CCC. Maximum number was obtained with Alar at 500 ppm (4.3) among all the treatments.

4.3.2 Fresh weight of tubers

The average fresh weight of tubers was 41.26g for plants treated with Alar which was significantly high in comparison with CCC (30.35g). In the case of Alar, the plants treated with various levels recorded significant increase in weight against the control. However, such a significant difference was not observed between various levels of CCC. Alar at 4000 ppm gave the maximum fresh weight among all the treatments.

Table 13. Effect of treatment on tuber characters

Treatment	No. of tubers	Fresh weight (g)	Length of tuber	Diameter of tuber
T_{10}	2.3	22.75	4.54	0.915
T_{11}	4.3	38.30	6.08	1.36
T_{12}	3.3	48.75	7.93	1.50
T_{13}	2.9	36.00	6.73	1.47
T_{14}	4.0	60.50	7.67	1.88
Mean (T_1)	3.36	41.26	6.59	1.43
T_{20}	2.8	25.9	6.92	1.58
T_{21}	2.9	27.73	6.04	1.48
T_{22}	3.9	35.70	6.54	1.26
T_{23}	4.1	34.25	6.32	1.22
T_{24}	3.2	28.18	6.67	1.30
Mean (T_2)	3.38	30.35	6.50	1.37
CD: T_1 vs T_2	-	6.219	-	-
Between levels of T_1/T_2.	1.259	13.905	1.635	0.482

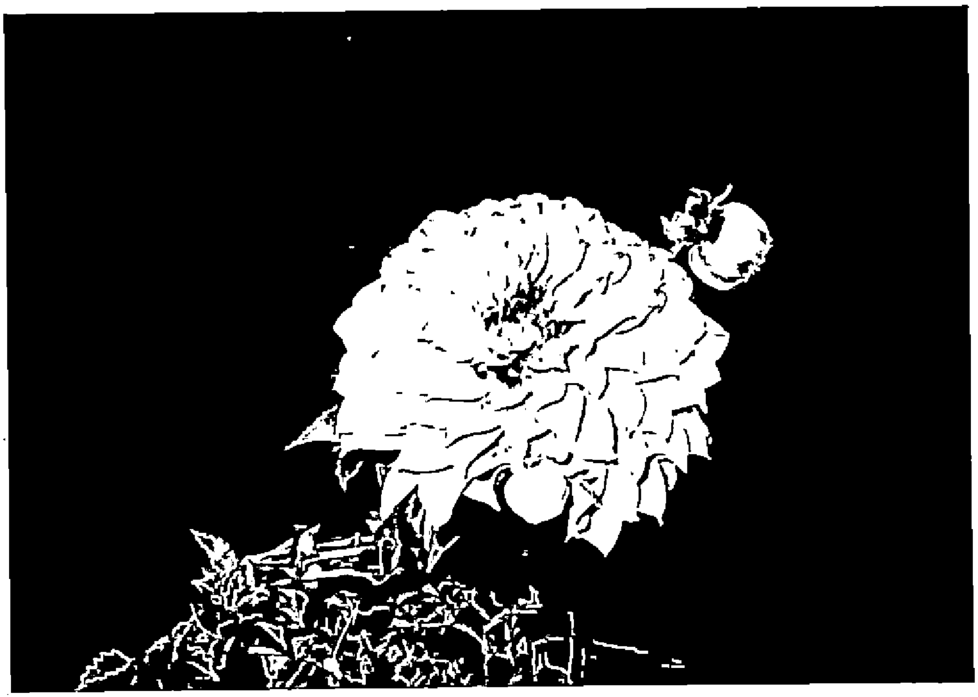
4.3.3 Length and Diameter of tuber

It was evident from the table that there was no significant difference between the chemicals for the length and diameter of tuber.

Various levels of Alar showed significant difference in the length and diameter of tubers. The maximum length of tuber was obtained in the case of Alar 1000 ppm (7.93 cm) followed by Alar 4000 ppm (7.67 cm), where as in the control it was 4.54 cm. In the case of diameter the maximum was obtained with Alar at 4000 ppm (1.88.cm) followed by 1000 ppm (1.5 cm) as against the control (0.915 cm).

There was no significant difference between various levels of CCC with regard to the tuber characteristics.

PLATE - 1



Dahlia var. Formal Decorative

PLATE - 3

EFFECT OF ALAR ON HEIGHT OF DAHLIA PLANT AT BUD FORMATION STAGE

PLATE - 2

GENERAL VIEW OF THE EXPERIMENTAL PLOT

PLATE - 3

EFFECT OF ALAR ON HEIGHT OF DAHLIA PLANT AT BUD FORMATION STAGE

Plate 4 & 5: Effect of CCC on height of dahlia plant at bud formation stage

PLATE - 4

PLATE - 5

Plate 6 & 7: Effect of Alar on dahlia plant at flowering stage

PLATE - 6

PLATE - 7

Plate 8 & 9: Effect of CCC on dahlia at flowering stage

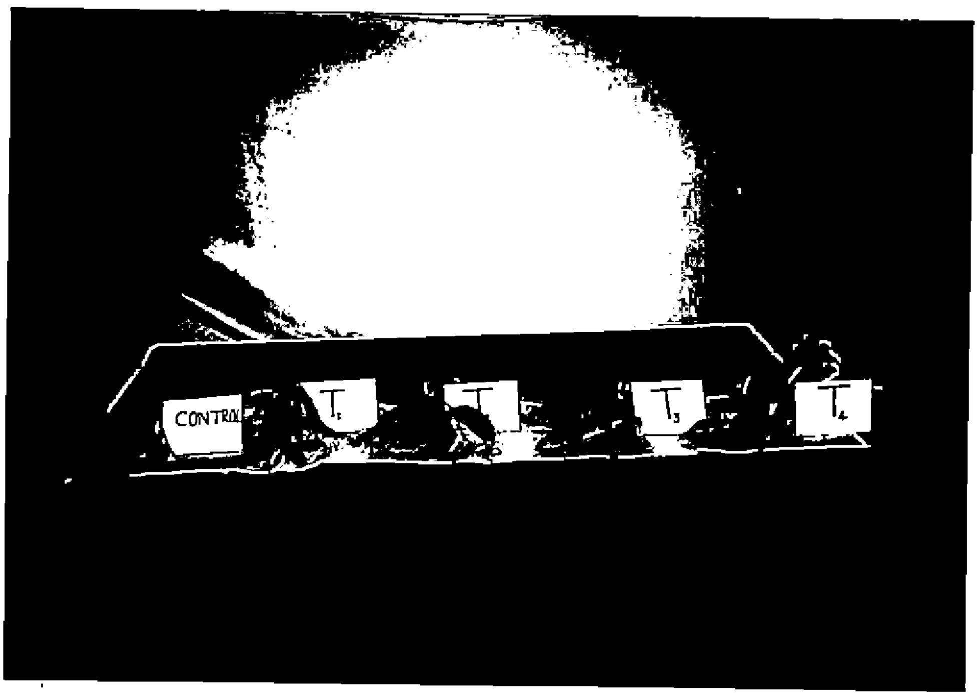
PLATE - 8

PLATE - 9

PLATE - 10

EFFECT OF ALAR ON VASE-LIFE OF DAHLIA

PLATE - 11



EFFECT OF ALAR ON TUBER FORMATION

DISCUSSION

5 DISCUSSION

An experiment was conducted at the College of Agriculture, Vellayani to determine the effect of growth retardants on growth, flowering, vase-life and tuber formation of dahlia (*Dahlia variabilis*) var. Formal Decorative.

Data on biometric characters like height of plant, number of branches, number of leaves, size of leaves, chlorophyll content of leaves, length of internodes, thickness at node and at internode, number of days to flowering number of flowers per plant size of flower, number of florets, size of florets, longevity of intact flower, longevity of cut flower and tuber characteristics like no. of tuber, freshweight, length and diameter were recorded.

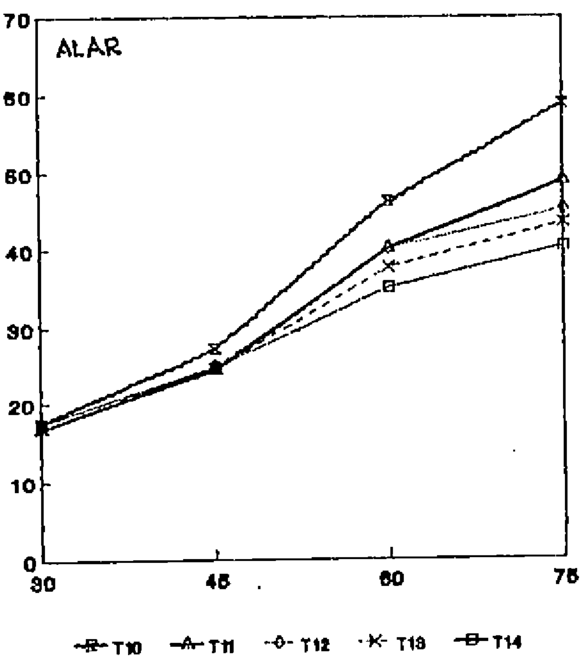
The experimental data were statistically analysed to infer the results.

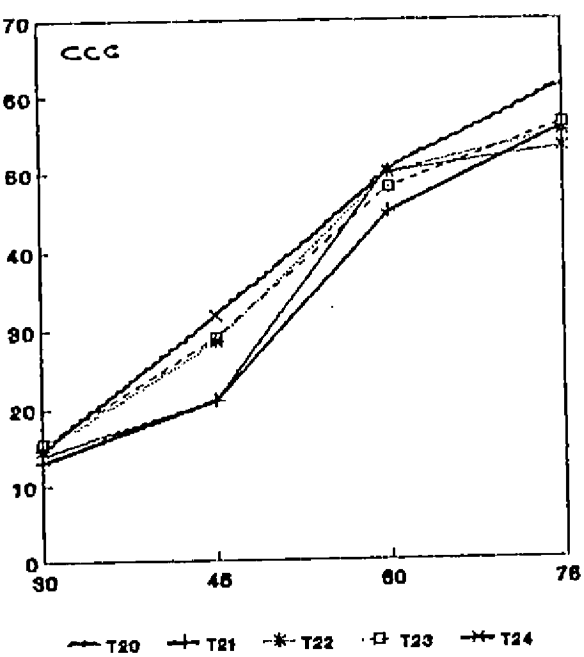
The results obtained on the above mentioned parameters are briefly discussed in this chapter.

5.1 Plant height and number of branches per plant

Alar was very effective in suppressing plant height in all the concentrations. Maximum inhibition

Fig. 1. Average height (cm) of plants at different intervals of time





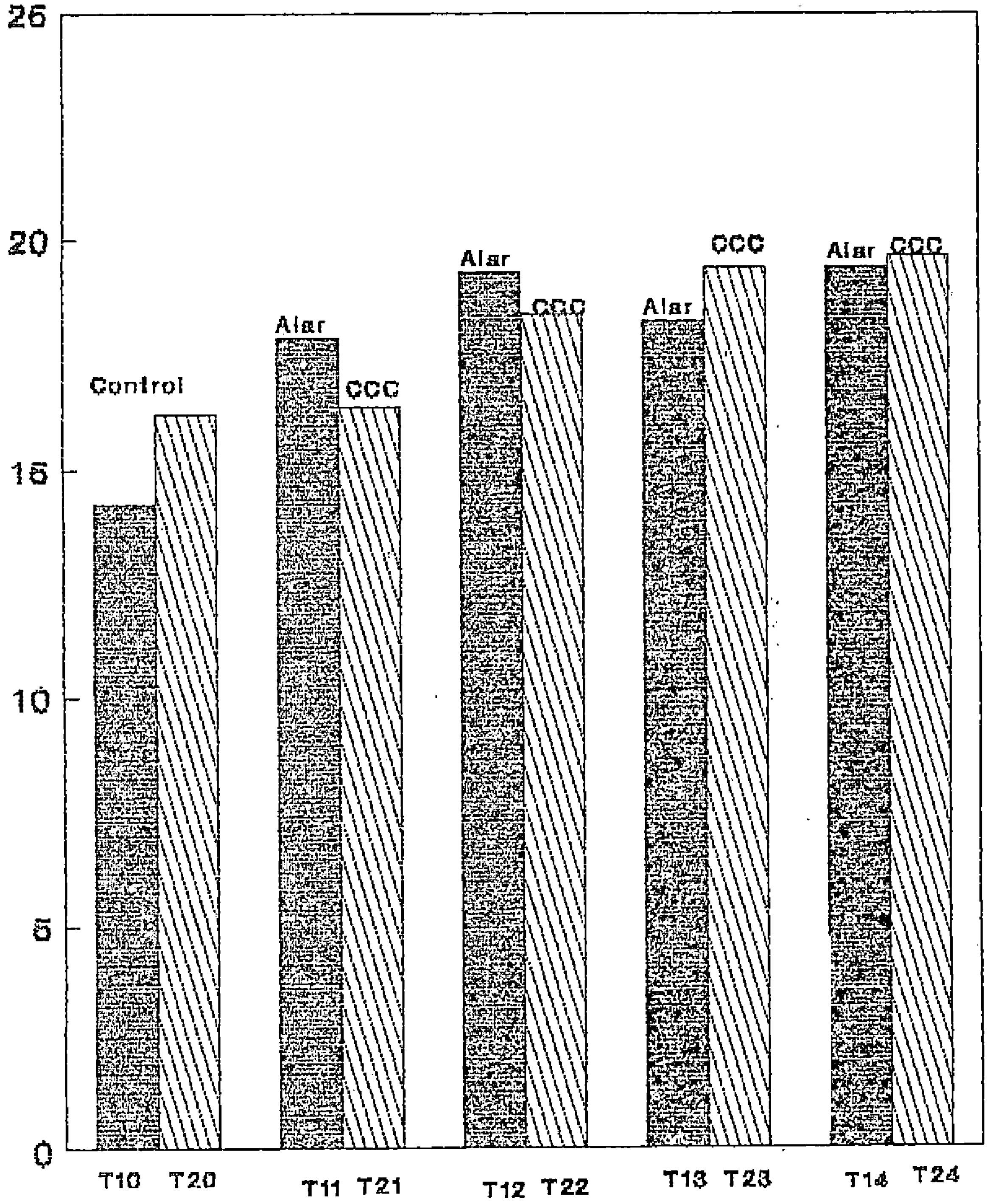
T10 - Control T11 - Alar 500 ppm T12 - Alar 1000 ppm T13 - Alar 2000 ppm

T20 - Control T21 - CCC 250 ppm T22 - CCC 500 ppm T23 - CCC 1000 ppm T24 - CCC 2000 ppm

was resulted with Alar 4000 ppm (40.35 cm) compared to control (58.75 cm). It was observed in general that with the increase in concentration of Alar, percentage of retardation also increased. However, CCC as foliar spray resulted in lesser retardation of plant growth compared to Alar. Bhattacharjee et al. (1971) reported suppression of plant height in different cultivars of Dahlia with the application of Alar and the in-effectiveness of CCC in this regard. CCC and Alar produced shorter stems not through complete suppression of apical dominance but through inhibition of cell division and elongation of sub-apical meristem. These results conform to the findings of cathey and stuart (1961) and Anon (1961) who obtained considerable growth reduction in chrysanthemum with MH and CCC.

There was significant increase over control in the number of branches per plant with the treatment of Alar at 1000 and 4000 ppm. Plants treated with CCC did not show any appreciable variation in the number of branches produced under the various concentration. This is closely similar to the effect noted in Elatior begonias and Afrodite Lime light by Roivainen (1987).

Fig. 2. Effect of treatment on mean number of branches produced



T10 - Control
T11 - Alar 500 ppm
T12 - Alar 1000 ppm

T20 - Control
T21 - CCC 250 ppm
T22 - CCC 500 ppm
T23 - CCC 1000 ppm

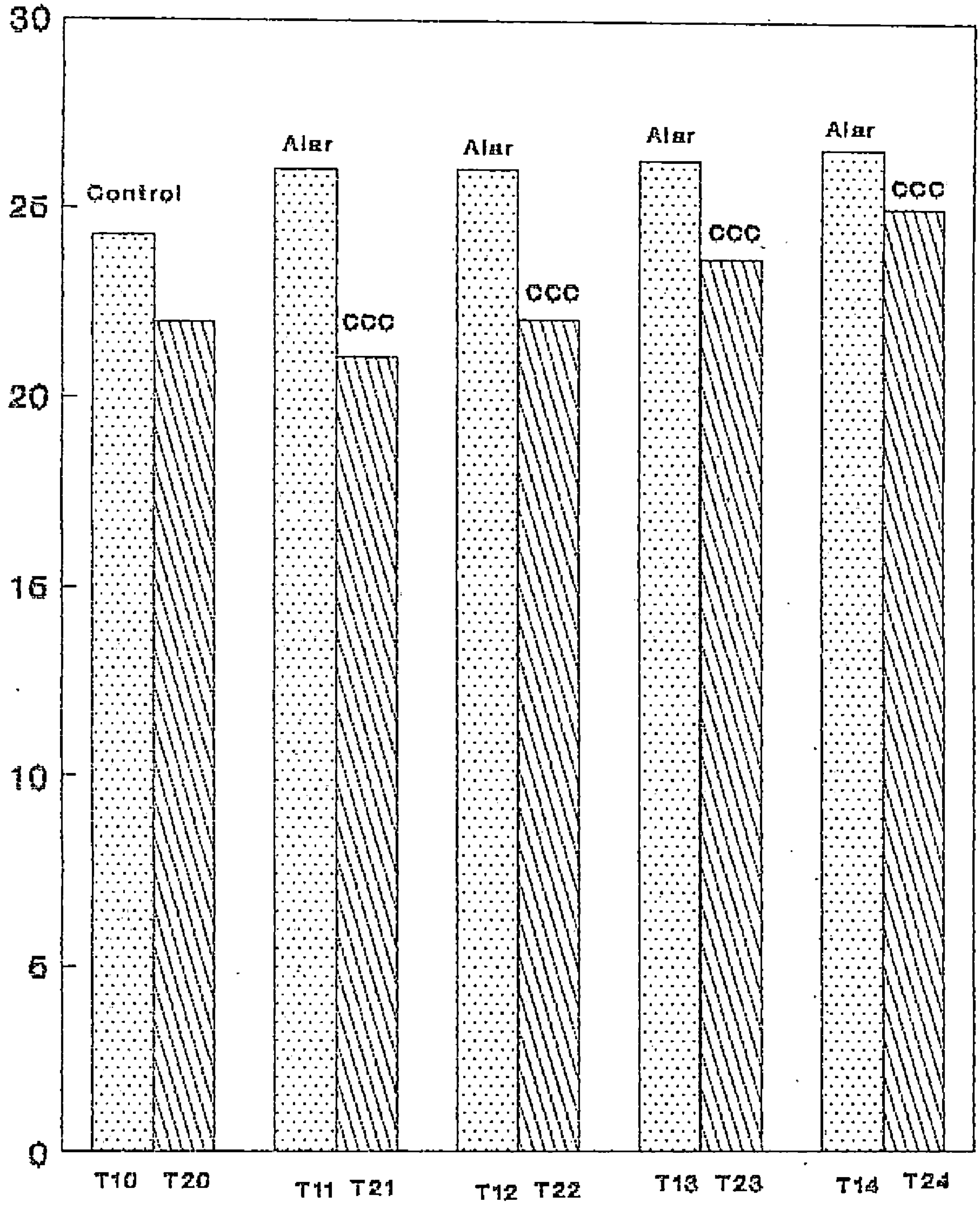
5.2 Number of leaves, size of leaves and chlorophyll content

Treatment with Alar and CCC twice at the vegetative stage as foliar spary at an interval of 15 days showed marked variation in the number of leaves, size of leaves and chlorophyll content under the various treatments.

Though maximum number of leaves was obtained with Alar 2000 ppm (35.2) it was on par with other levels compared to control (32.25). However, CCC as foliar spray in most cases failed to show any appreciable increase in number of leaves; the lower concentrations in effect reduced the number of leaves compared to unreated plants. El-shafie and Hassan (1978) observed a similar reduction in the number of leaves per plant in gerbera with CCC 500 ppm.

There was a trend of improvement in the size of leaves with Alar and CCC. The maximum size with Alar was noticed at 4000 ppm (66.63 cm^2) compared to control (49.85 cm^2) and that with CCC at 500 ppm (83.1 cm^2) followed by CCC at 1000 ppm (82.02 cm^2) compared to control (65.43 cm^2). In <u>Asclepias tuberosa</u>, Newman and Follett (1987) reported that plant quality and leaf area were unaffected with the application of Alar.

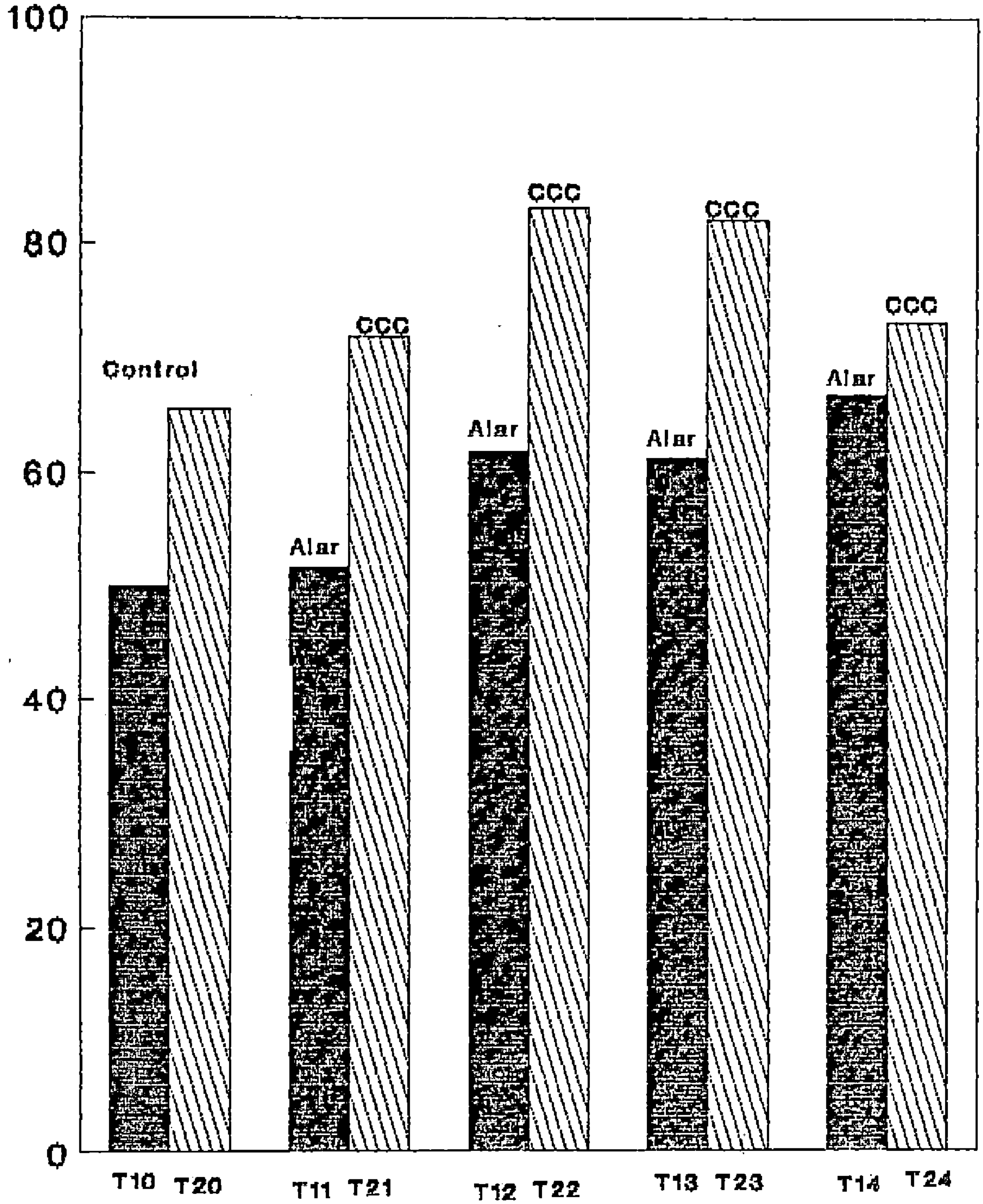
Fig. 3. Effect of treatment on mean number of leaves produced



T10 - Control
T11 - Alar 500 ppm
T12 - Alar 1000 ppm
T13 - Alar 2000 ppm
T14 - Alar 4000 ppm

T20 - Control
T21 - CCC 250 ppm
T22 - CCC 500 ppm
T23 - CCC 1000 ppm
T24 - CCC 2000 ppm

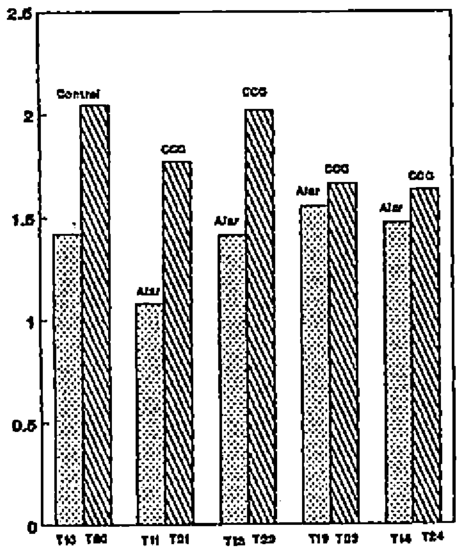
Fig. 4. Effect of treatments on size of leaves



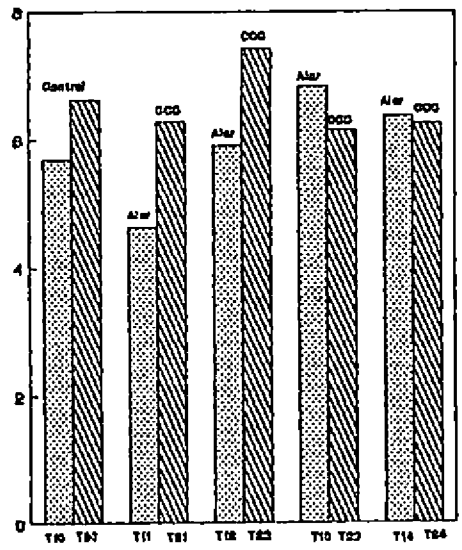
T10 - Control
T11 - Alar 500 ppm
T12 - Alar 1000 ppm
T13 - Alar 2000 ppm
T14 - Alar 4000 ppm

T20 - Control
T21 - CCC 250 ppm
T22 - CCC 500 ppm
T23 - CCC 1000 ppm
T24 - CCC 2000 ppm

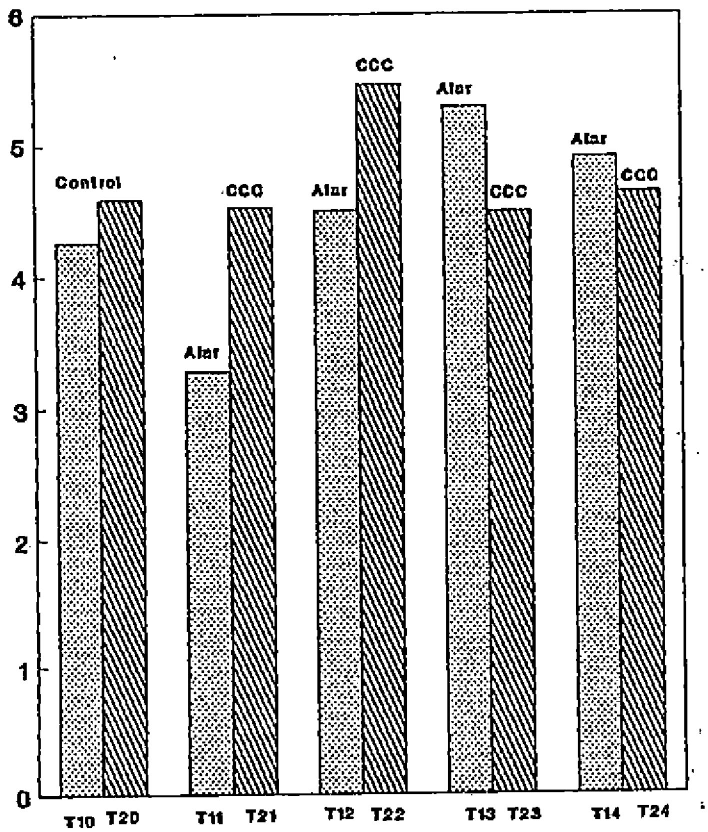
Fig. 5. Effect of treatments on chlorophyll content of dahlia



CHLOROPHYLL 'b'



TOTAL CHLOROPHYLL



CHLOROPHYLL 'a'

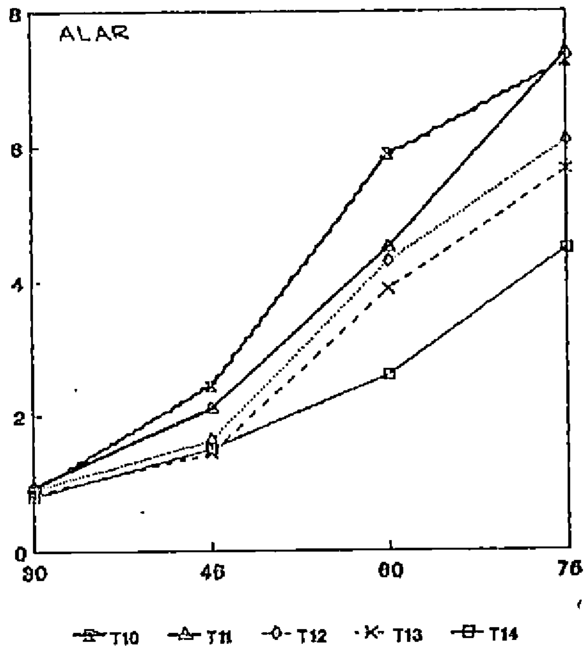
T10 – Control	T20 – Control
T11 – Alar 500 ppm	T21 – CCC 250 ppm
T12 – Alar 1000 ppm	T22 – CCC 500 ppm
	T23 – CCC 1000 ppm

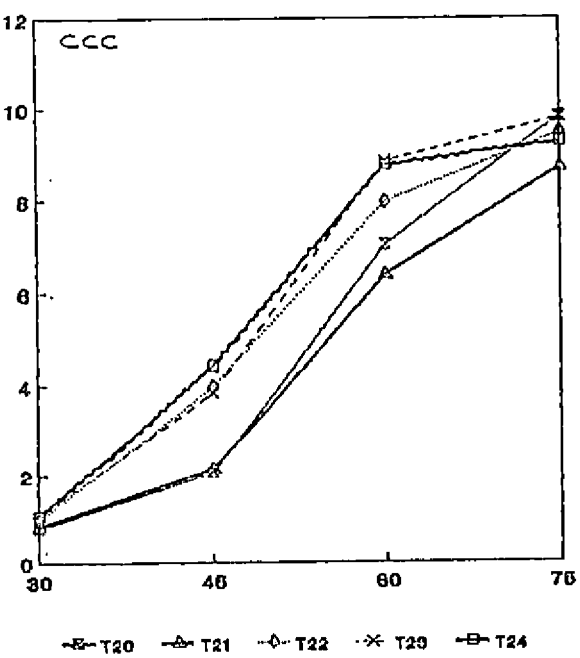
The total chlorophyll content varied significantly with different chemicals. The chemical CCC was superior to Alar with respect to total chlorophyll content. CCC at 500 ppm produced the maximum chlorophyll compared to control. These results find support from the works of shi and Li (1987). They reported that Alar and CCC applications increased leaf thickness, amount of palisade tissue, leaf weight and chlorophyll content. There was also a trend of increase in the chlorophyll content with most of the treatments except with Alar (500 ppm). Increase in the chlorophyll content due to the treatment with Alar was also reported by shawareb (1987) in chrysanthemum.

5.3 Internodal length, Thickness at node and at internode

All concentrations of CCC significantly increased the internodal length. However Alar at various levels reduced the internodal length. The length of internodes was directly related to the height of the plant. It was very clear that the reduction in height obtained with Alar was highly correlated with the reduction in the internodal length. The Alar applied as spray reduced the shoot and internodal

Fig. 8. Effect of treatment on mean internodal length (cm) of dahlia plants at different intervals of time

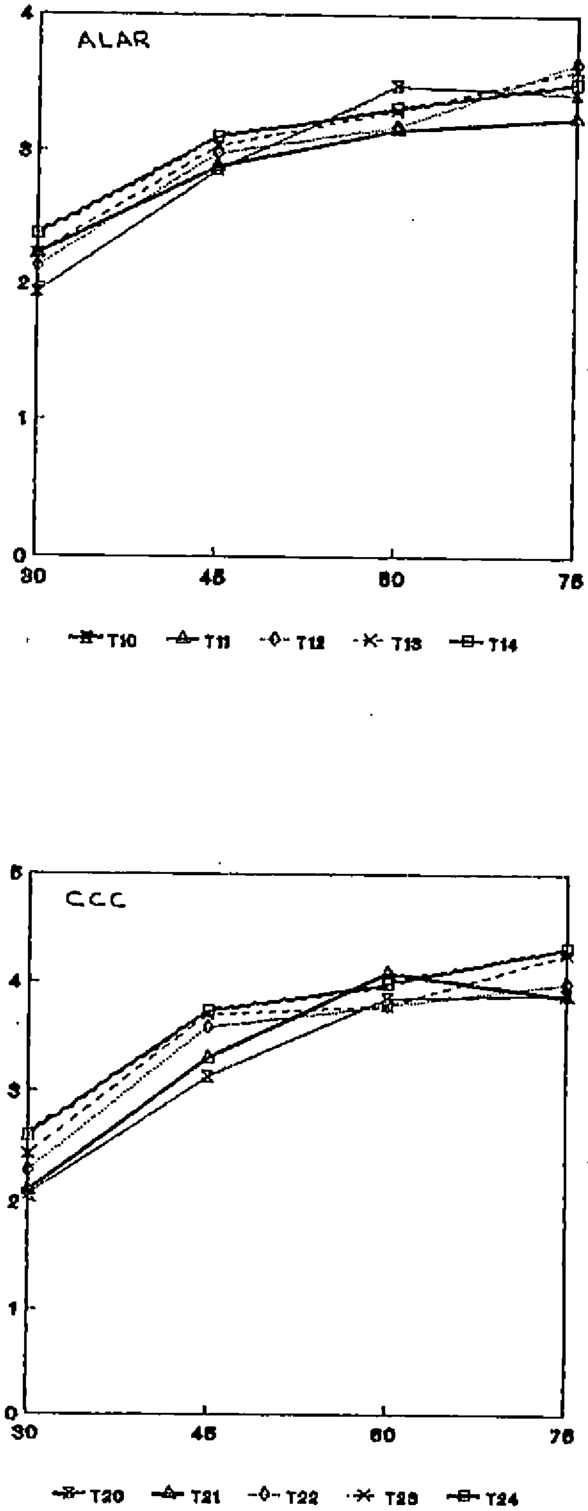




T10 - Control
T11 - Alar 500 ppm
T12 - Alar 1000 ppm
T13 - Alar 2000 ppm
T14 - Alar 4000 ppm

T20 - Control
T21 - CCC 250 ppm
T22 - CCC 500 ppm
T23 - CCC 1000 ppm
T24 - CCC 2000 ppm

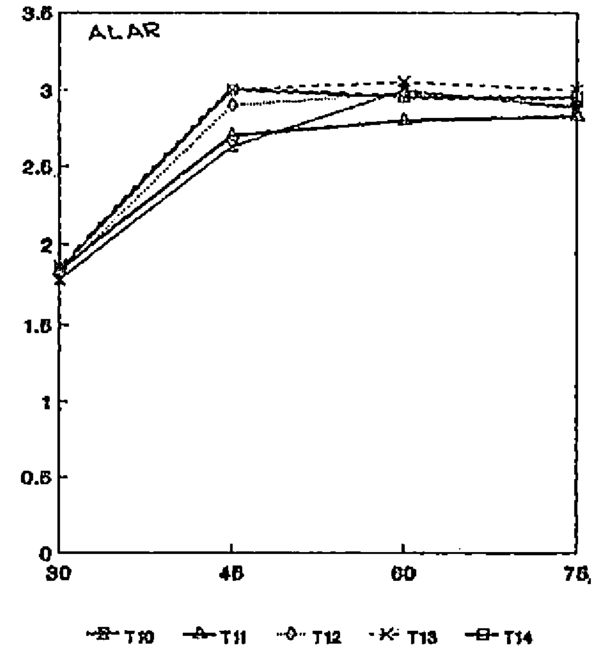
Fig. 7. Effect of treatment on nodal thickness (cm) of dahlia plants at different intervals

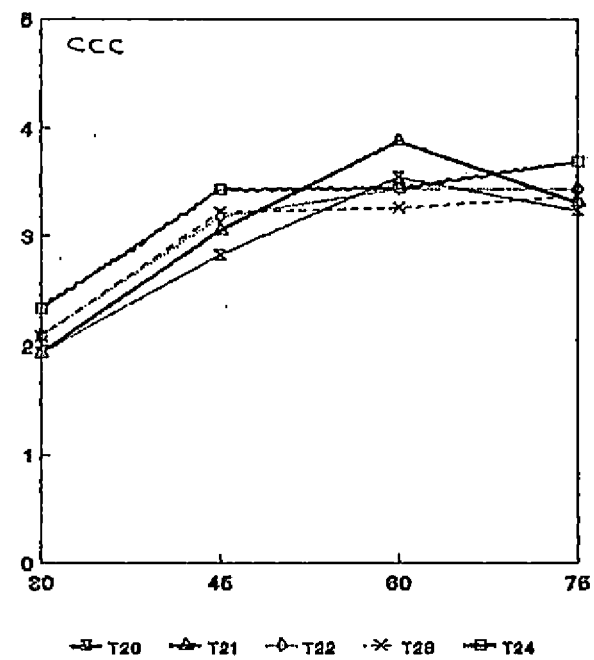


T10 - Control T11 - Alar 500 ppm T12 - Alar 1000 ppm T13 - Alar 2000 ppm T14 - Alar 4000 ppm

T20 - Control T21 - CCC 250 ppm T22 - CCC 500 ppm T23 - CCC 1000 ppm T24 - CCC 2000 ppm

dahlia plants at different intervals





T10 - Control
T11 - Alar 500 ppm
T12 - Alar 1000 ppm
T13 - Alar 2000 ppm

T20 - Control
T21 - CCC 250 ppm
T22 - CCC 500 ppm
T23 - CCC 1000 ppm

length and number of nodes. This is in conformity with the works done in <u>philodendron scandens</u> by Mansous and poole, (1987). Thickness at the node and internode was also increased significantly with the treatment of CCC.

5.4 Number of days to flowering

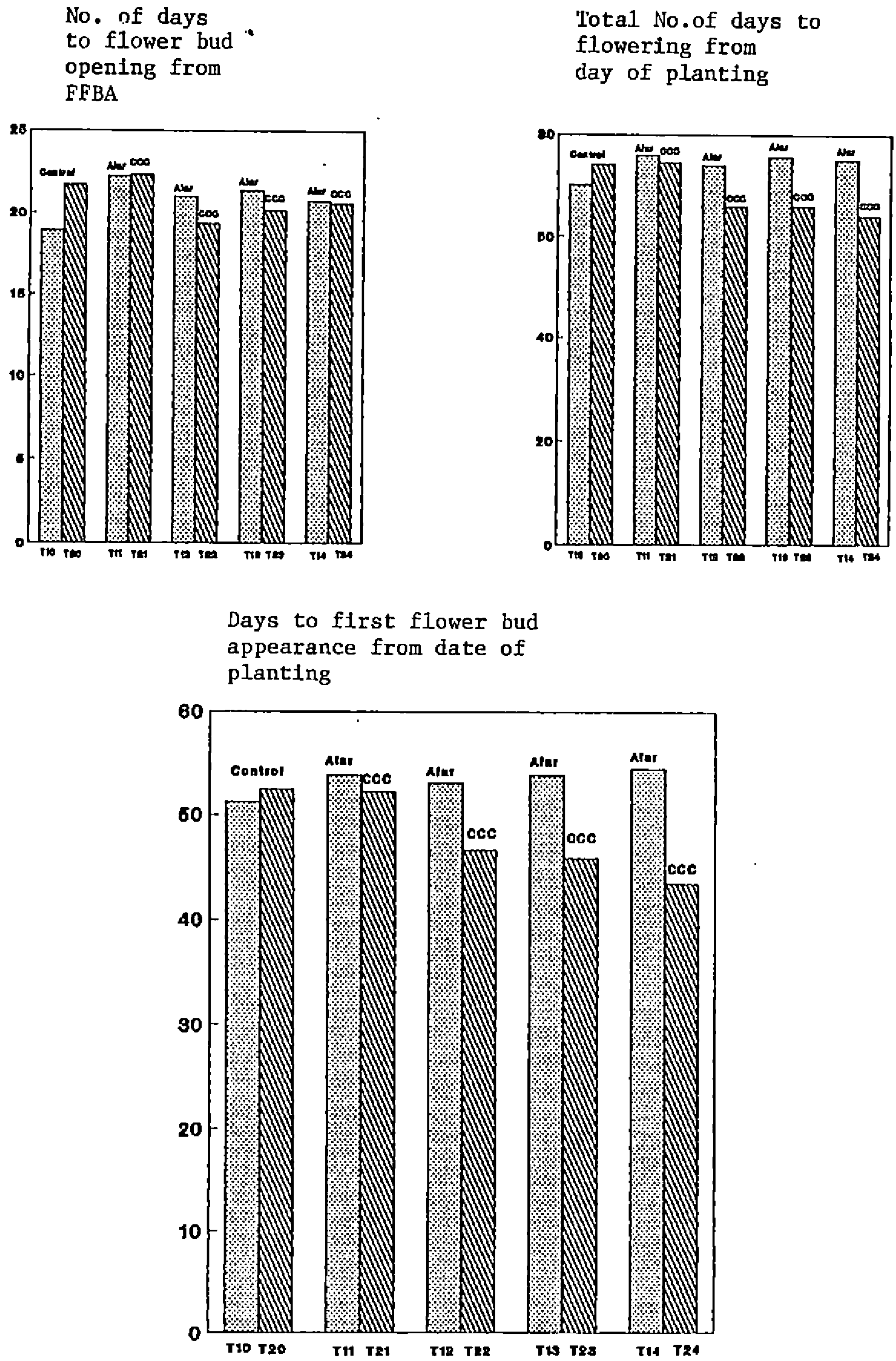
Alar in general delayed the appearance of flower buds. Delay in flower bud appearance by 3.9 days to 5.9 days was recorded with various concentrations of Alar. Maximum delay was obtained with Alar at 500 ppm (5.9 days). In an experiment on some winter annuals Shedeed <u>et al</u>. (1986) also noted delayed flowering.

All the concentrations of CCC except 250 ppm induced earlier flowering than control. The earliness ranged from 8.1 to 10.1 days, with the higher concentrations recording the minimum number of days from planting to flowering. Earlier reports of similar kind are seen on the flowering of geranium with the application of CCC (Carpenter and Carlsen, 1970).

5.5 Number of flowers per plant, flower longevity and vase-life

Treatment of growth retardants significantly

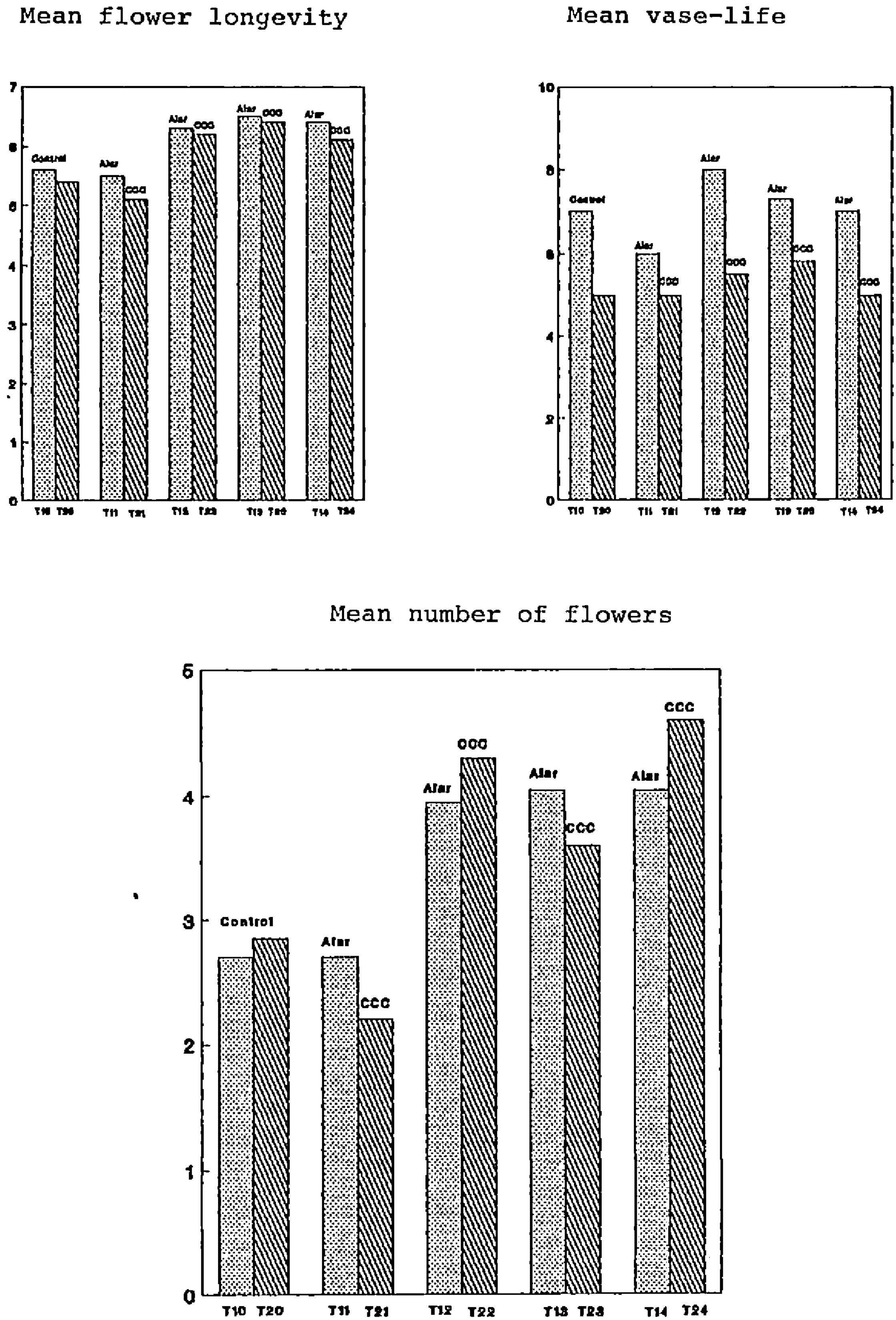
Fig. 9. Effect of treatments on mean days to flower



T10 - Control T11 - Alar 500 ppm T12 - Alar 1000 ppm T13 - Alar 2000 ppm T14 - Alar 4000 ppm

T20 - Control T21 - CCC 250 ppm T22 - CCC 500 ppm T23 - CCC 1000 ppm T24 - CCC 2000 ppm

Fig. 10. Effect of treatment on mean number of flowers/plant, mean flower longevity and vase-life of dahlia



T_{10} - Control T_{11} - Alar 500 ppm T_{12} - Alar 1000 ppm T_{13} - Alar 2000 ppm T_{14} - Alar 4000 ppm

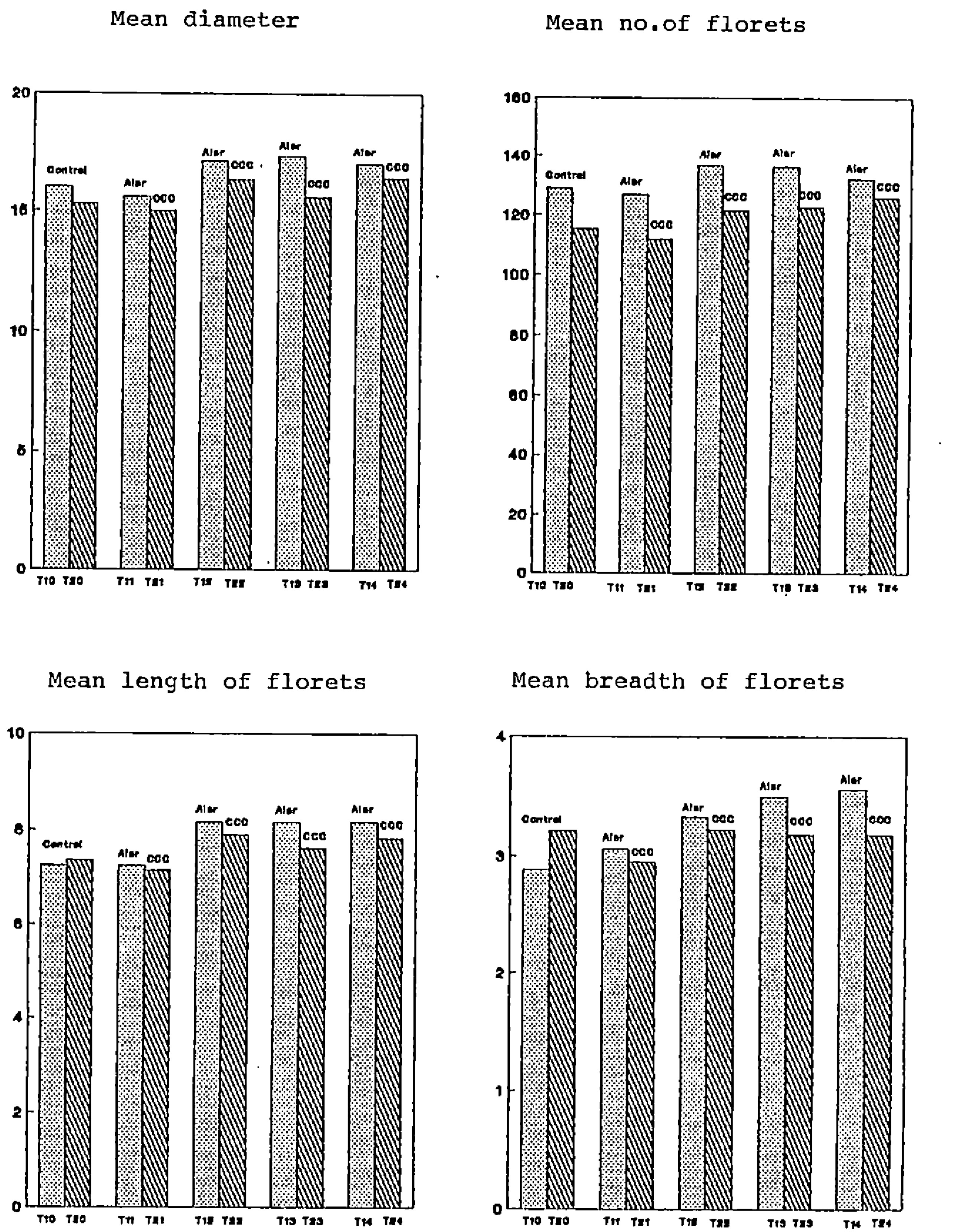
T_{20} - Control T_{21} - CCC 250 ppm T_{22} - CCC 500 ppm T_{23} - CCC 1000 ppm T_{24} - CCC 2000 ppm altered the flower production. Appreciable increase in flower production was observed with Alar at 2000 and 4000 ppm and CCC 2000 ppm. Significant increase in flower production of dahlia was seen by spray of Ethrel at 500 to 1000 ppm and a trend of increase in flower yield by CCC and MH was also recorded by Pappaiah and Muthuswamy (1974). Increased flower number was also reported with the treatment of Alar in chrysanthemum (Nagarjuna _et al_., 1988).

Significant difference in flower longevity and vase-life was noticed with the application of Alar at higher concentrations. Maximum flower longevity and vase-life was obtained with Alar. Improvement in the quality of flower due to the treatment with Alar was also reported by Kohl and Nelson (1966) in hydrangea.

5.6 Size of flowers

There was a trend of improvement in the size of flower with most of the treatments except with Alar 500 ppm and CCC 250 ppm. The maximum size of 17.3 cm was obtained with Alar at 2000 ppm. In an experiment of different cultivars of dahlia, Bhattacharjee _et al_. (1971) also obtained large size of the flowers with sprays of Alar. The size of the flower was determined by the

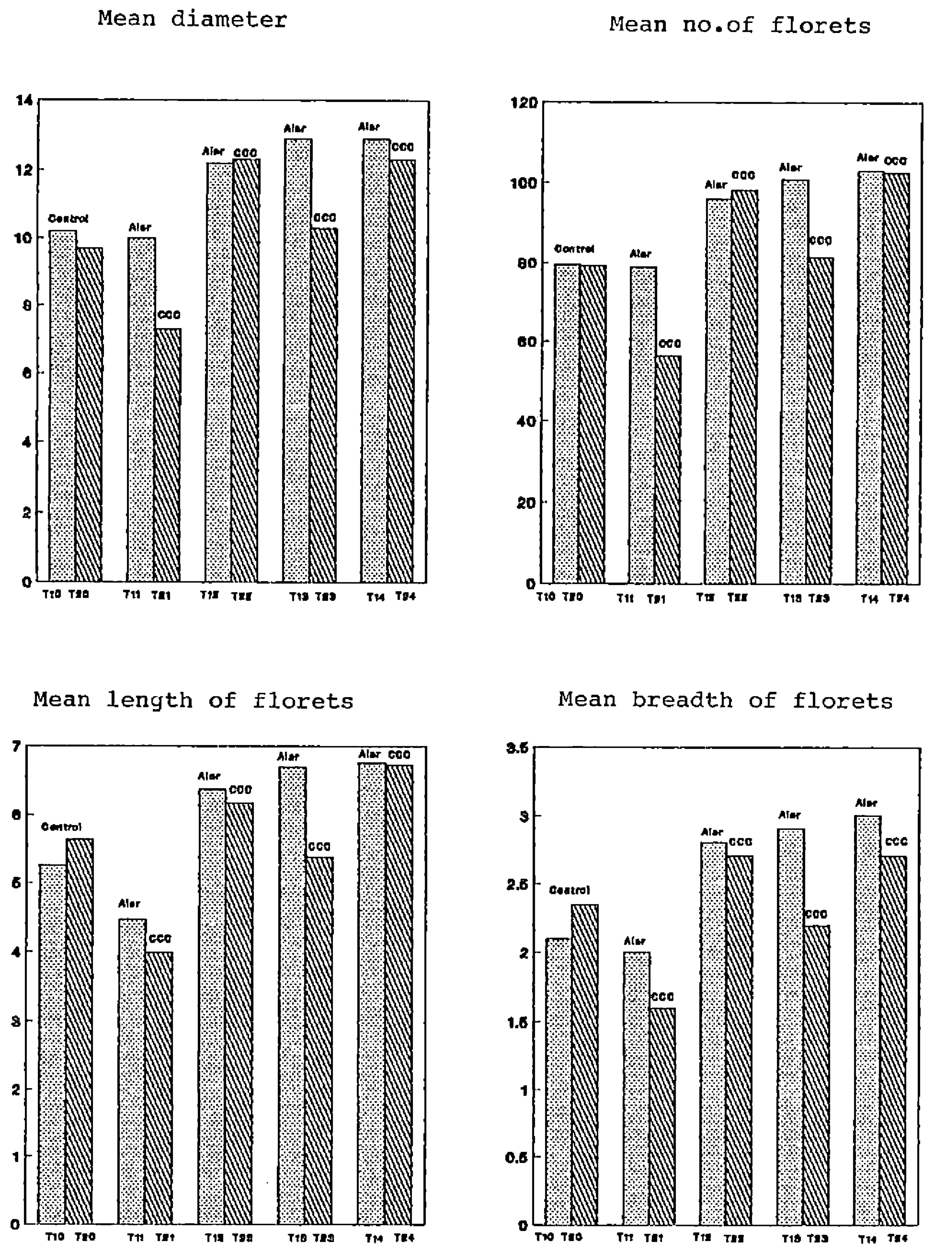
Fig. 11. Effect of treatment on mean diameter, mean number of florets and mean size of florets of terminal flowers of dahlia



T_{10} - Control T_{11} - Alar 500 ppm T_{12} - Alar 1000 ppm T_{13} - Alar 2000 ppm T_{14} - Alar 4000 ppm

T_{20} - Control T_{21} - CCC 250 ppm T_{22} - CCC 500 ppm T_{23} - CCC 1000 ppm T_{24} - CCC 2000 ppm

Fig. 12. Effect of treatment on mean diameter, mean number of florets and mean size of florets of lateral flowers of dahlia



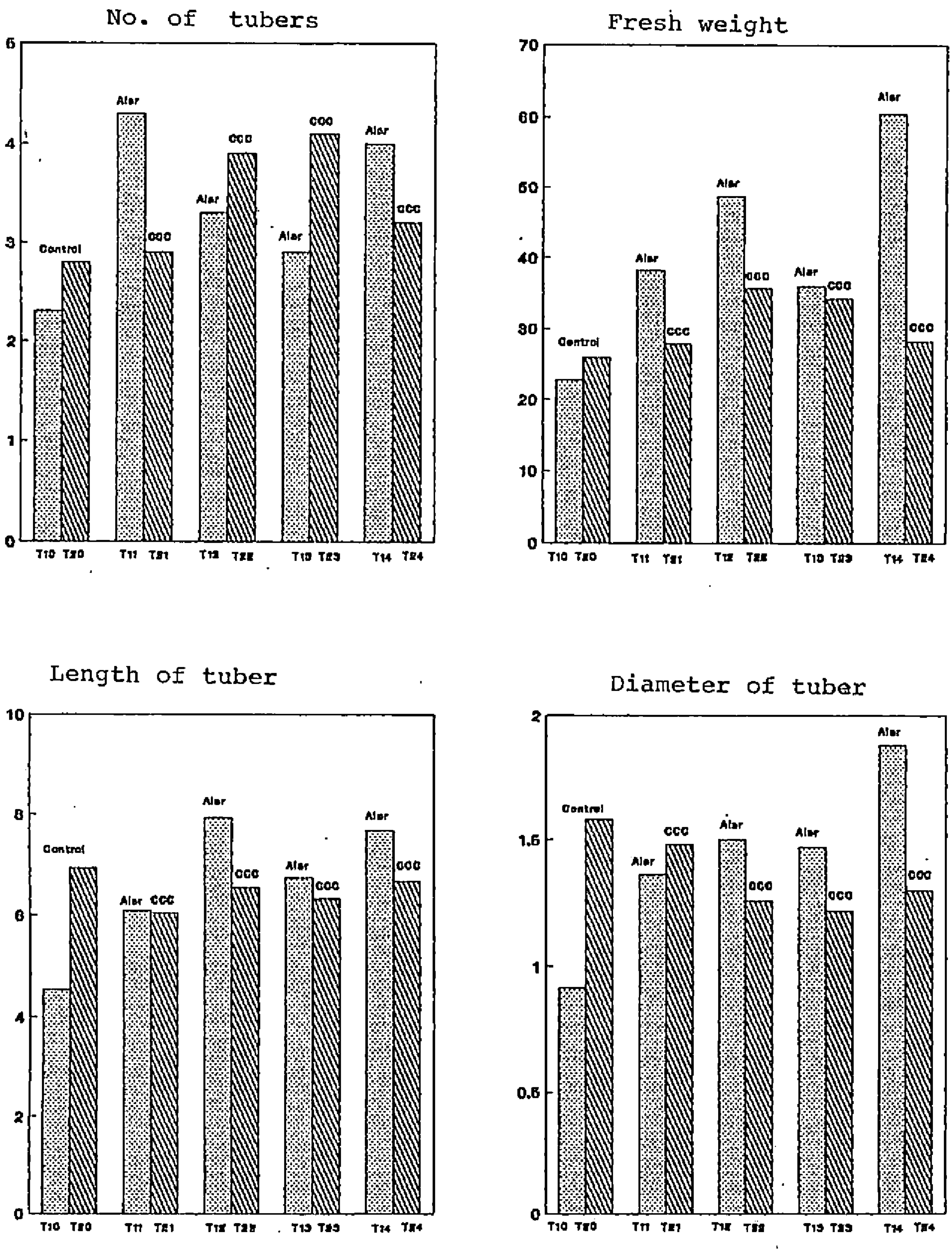
T10 - Control   T11 - Alar 500 ppm   T12 - Alar 1000 ppm   T13 - Alar 2000 ppm   T14 - Alar 4000

T20 - Control   T21 - CCC 250 ppm   T22 - CCC 500 ppm   T23 - CCC 1000 ppm   T24 - CCC 200(

number of florets and size of florets. Alar was found effective in improving the size of the flowers by increasing the number of florets, and size of the florets.

5.7 Tuber characters

The number of tuberous roots/plant, length of tuber and diameter of tuber was not significantly affected with the treatment of Alar and CCC. However the fresh weight of the tuber was significantly high for plants treated with Alar. The highest yield of tuberous roots was found with Alar at 4000 ppm (60.5g). The plants treated with various levels of Alar recorded significant increase in number, fresh weight, length and diameter of tuber against the control, but the difference was not significant in the case of CCC. It has also been noticed by Moses and Hess (1968) that Alar promoted tuberisation in dahlia under long photoperiods.



T10 - Control
T11 - Alar 500 ppm
T12 - Alar 1000 ppm
T13 - Alar 2000 ppm

T20 - Control
T21 - CCC 250 ppm
T22 - CCC 500 ppm
T23 - CCC 1000 ppm

SUMMARY

6 SUMMARY

Investigations were carried out at the Department of Horticulture, College of Agriculture, Vellayani during 1990-91 to gather information on the effect of growth retardants on growth, flowering, vase-life and tuber formation of dahlia (<u>Dahlia variabilis</u> Desf.) propagated through cuttings.

The results of this study are summarised as follows:

6.1 Treatment with Alar markedly retarded the plant height, while CCC did not show appreciable height reduction as compared to the untreatd control.

6.2 There was significant increase over control in the number of branches per plant with the treatment of Alar at 1000 and 4000 ppm.

6.3 Application of Alar showed appreciable increase in number of leaves and the effect of CCC was not much pronounced.

6.4 Treatment with Alar and CCC markedly increased the size of leaves compared to control.

6.5 The total chlorophyll content varied significantly with different chemicals. The chemical CCC was

Superior to Alar with respect to total chlorophyll content.

6.6 The results clearly show a highly significant increase in internodal length at the highest doses of CCC against its control except at 75th day.

6.7 Compared to Alar, the plants treated with CCC show a highly significant increase in thickness at node and internode.

6.8 Treatment with Alar delayed flower bud appearance by 3.9 to 5.9 days while CCC induced earliness in flowering by 8 to 10 days.

6.9 There was no significant difference between the chemicals for the number of flowers.

6.10 Treatment with Alar also improved the size of the flower, increased the number of florets and the flower remained fresh for a longer period on stalk and in vase.

6.11 Significant increase in the weight of tuberousroot also resulted with the treatment of Alar and maximum tuber production was noticed with Alar 4000ppm.

REFERENCE

REFERENCES

*Adriansen, E. (1976). The effects of SADH and Ethephan on Crossandra infundibuliformis cv. Mona Wallhed. Tidsskrift for planteavl, 80 (1):31-40.

Armitage, A.M.(1986). chlormequat-induced early flowering of hybid geranium: the influence of gibberellic acid. Hort. Sci., 21 (1):116-118.

Anon, (1962). Chemicals reduce size of. Ornamental plants. Sci. News. Lett., 82:104.

Bailey, D.A., Weiler, T.C. and Kirk, T.I. (1986). Chemical stimulation of floral initiation in florist's hydrangea. Hort. Sci., 21 (2):256-257.

Banko, T.J. and Stefani, M.A. (1988). Growth response of selected container-grown bedding plants to paclobutrazol, uniconazole and daminozide. J. Env. Hort., 6 (4):124-129.

Bhattacharjee, S.K., Mukhopadhyay.T.and Bose, T.K. (1974). Experiments with growth retardants on dahlia. Indian.J. Hort., 31 (1):86-90.

Bhattacharjee, S.K., Mukhopadhyay, T.P. and Bose, T.K. (1976). Interaction of auxin and gibberellin with growth retardants on growth and flowering of _Dahlia variabilis_ and _Malaviscus conzattii_. _Indian Agriculturist_., 20 (3)" 193-199.

Bhattacharjee, S.K., Mukherjee, T.P. and Bose, T.K. (1977). Dwarfing of _Hibiscus rosasinensis_ L. using CCC as a soil drench. _Punjab. Hort. J._, 17 (3/4):164-167.

Bhatacharjee, S.K. (1984). Effect of growth regulating chemicals on growth flowering and tuberous-root formation of _Dahlia variabilis_ Desf. _Punjab. Hort. J._, 24 (1/4):138-144.

Bhattacharjee, S.K. (1984). The effects of growth regulating chemicals on Gladiolus. _Gartenbauwissenschaft_., 49 (3): 103-106.

Bhattacharjee, S.K., (1989). Influence of growth retarding chemicals on growth and flowering of _Jasminum grandiflorum_.L. _Indian J. Hort._, 46 (2) 240-243.

Bhattacharjee, S.K., Gupta D.K. and Bose, T.K. (1971). B-Nine an effective growth retardant on Dahlia, ineffectiveness of CCC. _Phyton. Agentina_., 28(1):61-65.

Biermann, W. (1989). Chemical growth regulation in fuehsia. Not everything which decrease growth is also sensible. Gb+ GW., 89(35):1708-1710.

Biermann, W. (1989). use of growth retardants in Impatients New Guinea hybrids. Aden and Bonzi reduce extension grwoth markedly Gb + GW., 89 (35): 1698-1699.

Biran, I. Gar, I. and Halevy, A.H. (1972). The relationship between exogenous growth inhibitors and endogenous levels of ethylene and tuberization of dahlias. Physiol. plant., 27(2): 226-230.

Biswas, J., Bose T.K. and Maiti R.G, (1983). Effect of growth substances on growth and flowering of tuberose (polianthus tuberosa L). S. Indian Hort., 31 (2/3): 129-132.

Cairol, D. and Horeau, E. (1979). Pelargonium cultivars from seed: experimental results Hort. Francaise, 103:7-14.

Carpenter, W.J. and Carlson, W.H. (1970). The influence of growth regulators and temperature on flowering of propagated geranium. Hort. Sci., 5:183-4.

Cathey, M.H. and Stuart, N.W. (1961). Comparative growth retarding activity of Amo 1618, Phosfon and cycocel. Bot. Gaz., 123:51-7.

Choudhary, M.L. (1987). Effect of growth regulatants on growth and flowering of tuberose (Polianthes tuberosa L). Ann. Agric. Sci., 32(2):1451-1457.

*Eldubh, R. S., Awad, A.E. and Nabin A. (1978). Effect of growth regulators on tulip (cv. Apeldoorn) Research Bulletin., Faculty of Agriculture, Hin shoms University 958, p.12.

*El-Shafie, S.A. and Assan, H.A. (1978). Effect of gibberellic acid and chlormequent on the growth and flowering of gerbera, Archivfar Gartenbau, 26(7):333-342.

Gilbertz, D.A. and Lewis, A.J. (1986). Poinsettia response to preplant rooting-cube application of ancymidol and chlormequat. Scientia. Hort., 29(1/2) 173-180.

Gowda, V.N., Gowda, J.V.N. and Murthy C.A.S. (1989). Effect of foliar cycocel spray on yield and composition of gundumallige Current Research., University of Agricultural Sciences Bangalore, 18(12):177-179

Hendriks, L. (1987). Produce a new type of Pelargonium with Bonzi. Gb + GW., 87(10):363-364, 366.

Hennig,K (1986). Improving the quality of euphorbias for retail by using substances controlling biological processes. Gartenbau. 33(11):344-345.

Hentig, W.U.Von. and Hass, I. (1985). New pot roses easy to propagate but difficult to retard. Gb + GW, 85 (48):1796-1797.

*Heursel, J (1985). The influence of ancymidol, Chlormequat and daminozide on some azalea cultivars. Mededelingen vande Faculteit Landbouwweten schappen. Rijksuniversitei Gent., 50(20): 363-367.

Holcomb, E.J. (1985). Effect of growth retardants on ivy geranium. Hort.Sci., 20(4):771-772.

Hore, B.K. and Bose, T.K. (1972). Growth of plants regulated by cycocel dust. Punjab. Hort. J., 12(2/3):189-194.

Kohl, H.C. and Nelson, R.L. (1966). Controlling height of hydrangeas with growth retardants. Gartenwelt., 66: 61-63.

Maharana, T. and Pani, A. (1982), Effect of post pruning spraying of different growth regulators on the growth and flowering of hybrid Rose. Bangladesh Hort., 10(1):1-4.

Maiko, T.K. and Yashchenko, N.P. (1980). Effect of retardants on tuber formation and flowering in dahlias. Byulleten Glavnogo Botanicheskogo sada, 118:61-64.

*Mansour H.A. and Poole. R.T. (1987). Trials with growth retardants on ornamental foliage plants. Proceedings of the Florida State Horticultural Society., 100:375-378.

Messinger, N.L. and Holcomb, E.J. (1986). The effect of chlormequat chloride, ancymidol BAS 106 and SD 8339 on selected dianthus cultivars. Hort. Sci., 21 (6): 1397-1400.

More, T.A. and Dohare, S.R. (1985). Note on the effect of different growth retardants on flowering in Jasminum grandiflorum L. Madras Agri. J., 72(5): 293-295.

Mor, Y., Halevy, A.H., Kofranek, A.M. and Kubota, J. (1986). Forcing pot roses from own-root cuttings: effect of growth retardants and light. Acta Hort., 189:201-208.

Moses, B.C, and Hess, C.E. (1968). The physiology of tuberous development in Dahlia. J. Amer. Soc. Hort. Sci., 94: 595-608.

Mugge, A. and Richter, P. (1980). Investigations into the influence of chemical growth regulators on the bulb yield of tulip.II. The influence of CCC. Archiv fur Gartenbau., 28(4) 189-197.

Murali, T.P. and Narayanagowda, J.V. (1988). Studies on the regulation of flowering of jasmine by foliar application of cycocel. Current Research, University of Agricultural Sciences, 17(3):35-37.

Nagarjuna, B., Reddy, V.P., Rao, M.R. and Reddy, E.N. (1988). Effect of growth regulators and potassium nitrate on growth, flowering and yield of chrysanthemum (Chrysunthemum indicum L.) S. Indian Hort.,36(3):136-140.

Newman, S.E. and Follett, M.W. (1987). Effect of four chemical growth retardents on Asclepias tuberosa L. Research Report Mississippi Agricultural and Forestry Experiment Station, 12(8) p.4.

Novoselova, A.N., Sevrover, O.K. and Pyatitskaya, L.I. (1985). Chlorocholine chloride application for improving the ornamental properties of tagetes. Byulleten Glavnogo Botanicheskogo sada, 138:41-44.

Pappiah, C.M. and Muthuswamy, S. (1974). Effect of some plant growth regulants on growth and flowering of dahlia (Dahlia variabilis). S Indian Hort., 22 : 77-80.

Parmar, A.S. and Singh, S.N. (1983). Effect of plant growth regulators on growth and flowering of marigold (Tagetes erecta). S Indian Hort., 31(1):53-54.

Pobudkiewicz, A. and Goldsberry, K.L. (1989). Effect of cycocel on the height of dwarf carnation 'snowmass'. Research Bulletin-colorado Green house Growers Association , 473:4-5.

Reiss - Bubenheim. D. and Lewis, A.J. (1986). Pre-plant application of growth retardants to pinched and unpinched chrysunthemum cuttings. Scientia Hort., 28(1/2):159-164.

Roivainen, P. (1987). The invitro growth and development of micro propagated Elatior begonias (Begonia x Hiemalis) II. Study on the effect of Chlormequat and ancymidol. J. Agric. Sci., Finland 59(5):397-403.

Sarhan, A.Z.and El-Sayed, A.A. (1983). Effect of some growth regulators on growth and flowering of snapdragon plants (Antirrhinum majus L). Ann. Agric. Sci., 19(2):419-426.

Selaru, E. (1985). Studies on the effect of cyocel on *pelargonium zonale* Ait. growth and flowering. *B. Hort.*, 28:101-104.

Shalaby, A.S., Hassan, A.H., Agina E.A. and Hanid, H.A. (1989). Effect of growth substances gibberellic acid and B-nine on the growth, flowering and concrete yields of *Jasminum sambac* Ait. *Indian Perfumer.*,33(4):232-237.

Shawareb, M.N. (1987). Effect of Cultar and Alar on four cultivars of pot Chrysanthenum *Dirsat.*, 14(2):178-179.

Shawareb, M.N. and Qrunfleh, M.M. (1988). Effect of Alar on four cultivars of pot chrysanthemum, *Dirasat.*, 15(11):54-68.

Shedeed, M.R., El-Gamassy, K.M., Hashim, M.E. and Almulla, A.M.N. (1986a). Effect of some growth regulators on the growth, flowering and seed production of some winter annuals. *Ann. Agric. Sci.*, 31(1):691-705.

M.R., El-Gamassy, K.M., Hashim M.E. and Almulla, A.M.N. (1986b). Effect of some growth regulators on the growth flowering and seed production of some summer annuals. *Ann. Agric. Sci.* Ain-shams university., 31(1) 677-689.

Shi, Z.Z. and Li, S.Y. (1987). Effects of the plant growth inhibitors B-Nine and CCC on dwarfing and flowering of petunia plants. Acta Hort., 14(3) 197-202.

Simmonds, J.A., Cumming, B.G.(1977). Bulb dip application of growth-regulating chemicals for inhibiting stem elongation of Enchatment and Harmony lilies. Scientia Hort., 6(1): 71-81.

Stahn, B. (1975). New production methods and enhanced value in *Camellia japonica*. Gartenbau., 22 (7):215-219.

Stephenson J.C. and Shamack, R.L. (1988) Sumagic shows promise as growth regulator for poinsettia production. Research Report Series - Alabana Agricultural Experiment station, Auburn University., No.8, 17, 19.

Strauch, K.H. (1989). Bonzi an alternative to CCC & Low concentrations are active in poinsettias. Gb + GW., 89(35): 1701-1706.

Tayama, H.K. and Zrebiec, V. (1986). A comparison of Bonzi and Bay RSW 0411- used as growth regulators on potted chrysanthemums. Ohio Florists Association Bulletin., 686:5-6.

Tayama, H.K. and Carver, S.A. (1988). Poinsettia research report. Nutrition and chemical growth regulation. Ohio Florists Association Bulletin,709:6-8.

Tayama, H.K. and Carver, S.A. (1990). Zonal geranium growth and flowering responses to six growth regulators. Hort Sci., 25(1): 82-83.

Tezuka, T., Takahara, C. and Yamamoto, Y. (1989). Aspects regarding the action of CCC in hollyhock plants. J. Exp. Bot., 40 (215): 689-692.

*Wilfret, G.J. (1984). Effect of planting date and growth regulators on pcinsettia height. Proceedings of the Florida State Horticultural Society, 97: 289 - 291.

*Wilfret, G.J. (1986). Growth retardation of chrysanthemum and poinsettia with Ortho XE-1019. In Proceedings of the plant Growth. Regulator Society of America 13th annual meeting. p. 65.

Witt, H. (1989). Results with growth regulators in ornamental plants. J Exp. Bot., 29(6):231-262.

Zrebiec, V. and Tayama, H.K. (1986). Effect of Cycocel B-Nine Sp Conbinations spray on the growth and flowering of poinsettia. Ohio Florist's Association Bulletin, 678:15-16

* Original not seen

APPENDICES

APPENDIX I

ABSTRACT OF ANOVA (Plant Height)

Source/Days	df	M.S.S.			
		30	45	60	75
Between chemicals	1	393.40**	59.95ns	3795.84**	4014.06**
Between levels of che. Alar	4	2.350ns	26.30ns	341.380**	1004.22**
Between levels of che. CCC	4	13.96ns	496.25**	106.64ns	184.72**
Error	190	10.72	44.60	74.59	41.60

* Significant at 5% level

** Significant at 1% level

ns not significant

APPENDIX II

ABSTRACT OF ANOVA (Number of leaves)

Source	df	M.S.S. 30 days	M.S.S. 45 days	M.S.S. 60 days
Bet. Chemicals	1	372.64**	544.50**	528.13**
Bet. levels of Che. Alar	4	15.02*	9.88ns	28.18*
Bet. levels of Che. CCC	4	50.23**	109.09**	23.51*
Error	190	4.40	7.06	9.29

* Significnat at 5% level

** Significant at 1% level

ns Not significant.

APPENDIX III

ABSTRACT OF ANOVA (Number of Branches)

Source	df	M.S.S.		
		30 days	45 days	60 days
Bet. Chemicals	1	21.13 *	3.13 ns	51.01 *
Bet. levels of Che. Alar	4	84.38 **	38.54 **	94.38 **
Bet. levels of Che. CCC	4	60.40 **	111.56 **	15.58 ns
Error	190	4.94	8.20	10.51

* Significnat at 5% level

** Significant at 1% level

ns Not significant.

APPENDIX IV

ABSTRACT OF COMBINED ANOVA
(Growth characters over periods)

Source	df	M.S.S.	
		Leaves	Branches
Between Treatments	9	246.59**	189.02**
Error-1	190	15.93	19.13
Between Periods	2	13626.30**	11009.54**
TP	18	9.42**	10.75**
Error-2	380	2.41	2.26

* Significant at 5% level

** Significant at 1% level

APPENDIX V

ABSTRACT OF ANOVA (Mean size of leaves)

Source	df	M.S.S
Between chemicals	1	42537.75**
Between levels of Che. Alar	4	3116.36**
Between levels of Che. ecc	4	3322.16**
Error	590	501.88

* Significant at 5% level

** Significant at 1% level

APPENDIX VI

ABSTRACT OF ANOVA (Chlorophyll content)

		M.S.S.		
Source	df	Chlorophyll a	Chlorophyll b	Total Chlorophyll
Between chemicals	1	0.773 ns	1.94 **	5.162 *
Between levels of Chamical Alar	4	2.303 **	0.128 ns	3.479 *
Between levels of Chemical ecc	4	0.593 ns	0.155 ns	1.082 *
Error	30	0.600	0.058	0.981

* Significant at 5% level

** Significant at 1% level

ns Not Significant

APPENDIX VII

ABSTRACT OF ANOVA (Internodal length)

Source	df	M.S.S.			
		30	45	60	75
Between chemicals	1	0.214 ns	108.41 **	632.61 **	520.03 **
Between levels of Chemical Alar	4	5.935 ns	3.68 ns	27.83 **	28.85 **
Between levels of Chemical CCC	4	0.349 **	24.66 **	23.13 **	4.25 ns
Error	190	0.073	1.76	5.4	3.98

* Significant at 5% level

** Significant at 1% level

ns not significant

APPENDIX VIII

ABSTRACT OF ANOVA (Nodal thickness)

Source	df	M.S.S. 30	45	60	75
Between chemicals	1	0.744**	13.52**	18.362**	16.82**
Between levels of Chemical Alar	4	0.520**	0.216 ns	0.339 ns	0.497 ns
Between levels of Chemical CCC	4	1.029**	1.379**	0.348 ns	0.862 ns
Errors	190	0.087	0.134	0.211	0.380

* Significant at 5% level

** Significant at 1% level

ns not significant

APPENDIX IX

ABSTRACT OF ANOVA (Internodal thickness)

Source	df	30	45	60	75
Between chemicals	1	2.93**	4.35**	15.54**	12.35**
Between levels of Chemical Alar	4	0.018 ns	0.603**	0.180 ns	0.091 ns
Between levels of Chemical ecc	4	0.535**	0.986**	1.05**	0.586*
Errors	190	0.075	0.140	0.149	0.226

* Significant at 5% level

** Significant at 1% level

ns not significant

APPENDIX X

ABSTRACT OF ANOVA (Number of days to flowering)

Source	df	M.S.S. Days to first flower bud appearance from plaing	No.of days to flower bud opening from FFBA	Total number of days to flowering from planting
Between chemicals	1	1331.28**	0.055 ns	1399.19**
Between levels of chemical Alar	4	30.69 ns	30.48**	116.22**
Between levels of chemical CCC	4	322.59**	28.87**	499.08**
Error	190	18.76	5.17	19.94

* Significant at 5% level

** Significant at 1% level

ns Not significant.

APPENDIX XI

ABSTRACT OF ANOVA (No. of flowers & longevity)

Source	df	Mean number of flowers/ plant	Mean flower longevity	Mean vaselife
Between chemicals	1	0.020 ns	2.645 *	32.40 **
Between levels of Chemical Alar	4	10.435 **	4.485 **	2.050 **
Between levels of Chemical CCC	4	19.860 **	6.185 **	0.50 **
Error	190	1.783	0.634	8.33

* Significant at 5% level

** Significant at 1% level

ns Not significant

APPENDIX XII

ABSTRACT OF ANOVA (Terminal flower characteristics)

M.S.S

Source	df	Mean diameter	Mean No. of florets	Mean length of florets	Mean diameter of florets
Between chemicals	1	40.41**	8051.75**	2.736*	0.708*
Between levels of chemical Alar	4	10.62**	389.53*	5.033**	1.703**
Between levels of chemical CCC	4	7.88**	681.19**	1.943**	0.246ns
Error	190	1.38	121.17	0.530	0.107

* Significant at 5% level

** Significant at 1% level

ns Not significant

APPENDIX XIII

ABSTRACT OF ANOVA (Lateral flower characteristics)

M.S.S

Source	df	Mean diameter	Mean No. of florets	Mean length of florets	Mean breadth of florets
Between chemicals	1	81.79*	3256.13*	5.54 ns	2.76*
Between levels of chemical Alar	4	42.20*	2758.61**	19.94**	4.19**
Between levels of chemical CCC	4	86.01**	6735.31**	21.23**	4.18**
Error	190	12.64	799.10	3.43	0.59

* Significant at 5% level

** Significant at 1% level

ns Not significant

APPENDIX XIV

ABSTRACT OF ANOVA (Tuber characteristics)

		M.S.S.			
Source	df	No. of tubers	Fresh weight	Length of tuber	Diameter of tuber
Between chemicals	1	0.0048 ns	5951.41 **	0.488 ns	0.172 ns
Between levels of chemical Alar	4	12.42 *	4026.63 **	37.287 **	2.395 **
Between levels of chemical CCC	4	6.66 ns	376.28 ns	2.450 ns	0.462 ns
Error	190	4.13	503.32	6.956	0.605

* Significant at 5% level

** Significant at 1% level

ns Not significant

EFFECT OF GROWTH RETARDANTS ON GROWTH, FLOWFRING, VASE-LIFE AND TUBER FORMATION OF DAHLIA (*Dahlia variabilis* Desf.) PROPAGATED THROUGH CUTTINGS

By

SUMA B., B. Sc. (Ag.)

ABSTRACT OF A THESIS

submitted in partial fulfilment of the
requirement for the Degree of
MASTER OF SCIENCE IN HORTICULTURE
Faculty of Agriculture
Kerala Agricultural University

DEPARTMENT OF HORTICULTURE
COLLEGE OF AGRICULTURE
VELLAYANI, THIRUVANANTHAPURAM

1993

ABSTRACT

A field experiment was conducted at the College of Agriculture, Vellayani during 1990-91 to study the effect of growth retardants on growth, flowring, vase-life and tuber formation of Dahlia (*Dahlia variabilis* Desf.) propagated through cuttings.

Among the chemicals tried Alar markedly retarded the plant height and at the same time significant increase in the number of branches and leaves compared to control and the effect of CCC was not much pronounced.

Treatment with Alar and CCC markedly increased the size of leaves compared to control.

Chemical CCC was superior to Alar with respect to total chlorophyll content.

There exists a highly significant increase in internodal length at the highest doses of CCC against its control except at 75th day.

Compared to Alar, the plants treated with CCC show a highly significant increase in thickness at node and internode.

Treatment with Alar delayed flower bud appearance by 3.9 to 5.9 days while CCC induced earliness in flowering by 8 to 10 days. However there was no significant difference

between the chemicals for the number of flowers.

Treatment with Alar also improved the size of the flower, increased the number of florets and the flower remained fresh for a longer period on stalk and in vase.

Those plants treated with Alar showed an increase in the weight of tuberousroot and maximum tuber production was noticed with Alar 4000ppm.