# STUDIES ON THE EFFECT OF CONTAINERS, POTTING MIXTURES AND GROWTH REGULATORS ON GROWTH AND SURVIVAL OF CLOVE SEEDLINGS

BY

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THESIS

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requirement for the degree of

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DECLARATION

I hereby declare that this thesis entitled "Studies on the effect of containers, potting mixtures and growth regulators on growth and survival of clove seedlings" 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.

(K. [illegible]).

Vellanikkara,
15 --6--1981.

CERTIFICATE

Certified that this thesis, entitled "Studies on the effect of containers, potting mixtures and growth regulators on growth and survival of clove seedlings" is a record of research work done independently by Mst. [illegible], under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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## CERTIFICATE

We, the undersigned members of the Advisory Committee of Smt. S. Prasannakumari Amma, a candidate for the degree of Master of Science in Horticulture with major in Horticulture, agree that the thesis entitled "Studies on the effect of containers, potting mixtures and growth regulators on growth and survival of clove seedlings" may be submitted by Smt. S. Prasannakumari Amma, in partial fulfilment of the requirements for the degree.

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# INTRODUCTION

# INTRODUCTION

Clove (*Syzygium aromaticum*, L), is one of the three important tree spices of Kerala. The long juvenile phase, difficulty in vegetative propagation, lack of scientific information on nursery practices, methods of culture etc. are the problems faced by the clove growers. The average annual yield, after fifteenth year, is only two kg of dry cloves per tree (Anon., 1979). However, individual tree yields as high as 15 kgs of dried cloves have been recorded (Wit, 1969). Exploitation of such high yielding trees has not been possible mainly due to difficulties in vegetative methods of propagation. Francois (1936) asserted that young branches of clove can be marcotted fairly easily. However, according to Tidbury (1949), this method failed in Zanzibar. One of the later reports (Maistre, 1964) also suggest possibility of success through marcottage. Rooting of cuttings has also been reported to be very difficult in cloves. Tidbury (1949) mentioned about one single cutting made from the softwood portion which took several months to strike roots. Graftings on related species (May, 1949) or on clove seedlings (Nutman and Roberts, 1953) have also been attempted, though not with much success. Until some successful methods of vegetative propagation are standardised, the clove propagator has to necessarily depend on seed propagation.

The germination of clove seeds is fairly low and the viability is very short. In the early stages, the clove seedlings

grow very slowly and they need much care (Shanmugavelu and Rao, 1977). The seedlings are usually transplanted when they are between 1 - 1½ years old. The seedlings often fail to establish in the main field, because of the disturbance, during transplanting, to the very tender and deep root system. Added to this, the clove has a long juvenile period of six or seven years. All these create considerable problems to the growers.

So far, no systematic attempt seems to have been made to study the above problems in cloves. Sporadic attempts were made by some workers to evolve suitable solution to some of the above problems. Deinum and Wit (1949) reported that the long juvenile period of clove could be shortened to four years by selecting good planting material and by good management and fertilization. Kannan (1972), Sriram (1977) and Nair et al.(1979) studied the effect of peeling the seeds on the germination and growth of the seedlings. Peeling gave encouraging results. Their studies also indicated beneficial effects on using heavier seeds.

The present investigations were carried out during 1979-80 in the College of Horticulture, with the following objectives:

1. to study the effect of period of seed collection, weight of seeds and removal of the pericarp on germination and growth of the seedlings

ii. to study the effect of GA treatment on the germination of clove seeds

iii. to study the effect of different containers, potting mixtures and chemical booster sprays (GA and urea) on the rate of growth of the seedlings, and

iv. to study the effect of different containers on the survival and establishment of the seedlings after transplanting to the mainfield.

# REVIEW OF LITERATURE

## REVIEW OF LITERATURE

Clove (*Syzygium aromaticum*, L.) which is mainly propagated through seeds poses many problems in the nursery. The percentage of germination is low and the growth of the seedlings in the nursery is considerably slow. Infestation by pests, diseases, etc., also pose serious problems. Further, the seedlings often fail to establish in the main field causing loss to the growers. These aspects have caught the attention of the researchers for quite sometime. Attempts have been made to improve the germination as well as to provide optimum conditions for the growth of the seedlings, effective plant protection, better conditions for the field establishment, etc. Research work done on the above aspects in cloves and other perennials, with similar problems have been briefly reviewed in this chapter.

### 1. Germination and vigour of seedlings as influenced by period of collection of seeds, weight of seeds and removal of pericarp

#### i. Period of collection of seeds

The clove fruits take about 3 - 4 months to develop. The ripe fruit is reddish green to purple in colour. Ripe seeds of clove have been reported to be available for sowing from August to October (Anon., 1974). According to another report (Anon., 1979), the seeds of clove will be available from

June to October. In cloves, the effect of time of collection of seeds and sowing has not been investigated upon. However, the review of literature available on this aspect in some of the perennial crops are presented below:.

Atanda and Jacob (1970) obtained highest germination in cocoa during the months of June, July and November. Keshavachandran (1979), however, suggested February and March as the best months for sowing cocoa. In trials with tea, Sanikidze (1977) found that April was the best month. Mathew (1979) observed June as the best month for sowing nutmeg. She found that the germination percentage was high during the month of June and the seedlings produced were healthier.

ii. Weight of seeds

Use of heavier and bigger seeds has resulted in faster germination and better growth of the seedlings in many crops. Purseglove (1974) recommended sowing of clove seeds, weighing less than 500 seeds per pound to obtain better germination and growth of the seedlings. Sriram (1977) reported that big (dehusked) clove seeds gave 88 per cent germination, as against 43 per cent in the case of small (dehusked) ones.

The influence of seed size upon germination, field emergence and subsequent growth of agricultural crops has been

studied in a number of species of economic importance ever since 1893 (Boss, 1893). Beach (1903) observed that in grapes, the rate of germination increased uniformly with increase in size of seeds. He also observed a corresponding increase in the vigour of the seedlings, as the size of the seeds were increased. Tubbs (1932) obtained increased germination of seeds in tea by using large seeds. Ali (1963) and Ali and Chakraborty (1968) found that the seedlings of tea raised from larger seeds were significantly taller than those from medium or small seeds. Turner (1956) observed increased speed of germination, when cashewnuts of greater density were used. According to Gergenyi and Brunner (1968), the vigour of stone fruit trees in early stages was associated with 1000 - seed weight. On the contrary, Gangwar and Kumar (1975) while studying the germination of walnut seeds observed that medium sized seeds gave the highest germination, followed by large and small seeds.

iii. Removal of pericarp

Wit (1969) stated that the ripe fleshy fruits, which normally contain one seed, if carefully hulled and planted quickly, gave a germination of about 90 per cent within a period of ten days. On the contrary, unhulled seeds gave lower percentages (70 - 80 per cent) of germination and the

germination period extended to four or six weeks. Further, hulled seeds, when packed in a moist mixture of powdered charcoal and coir dust, gave good results during transportation. Kannan (1972) and Sriram (1977) also reported beneficial effects of dehusking in accelerating the germination and in obtaining higher percentage of germination. Anon. (1974) reported that the seeds could be sown with or without the fruit coat. It was further stated that the seeds sown after the removal of the fruit coat recorded higher percentage of germination. Sriram (1977) while studying the effect of size of seeds reported that dehusked (big) seeds gave as much as 88 per cent germination. Sharmugavelu and Madhava Rao (1977) however, reported the difference in germination of seeds sown with or without fruitcoat to be insignificant. Nair et al.(1979) obtained 94 per cent germination by sowing clove seeds after removal of the pulp, as against 68 per cent in the control.

The effect of removal of seedcoat/pericarp on the germination has been investigated upon in several other crops.

Said (1969) reported that the citrus seeds germinated best when the exocarp was removed. Mosquedavazquez (1969) obtained rapid and complete germination by washing and removing the sarcotesta in papaya. Atanda and Jacob (1970) observed more rapid and higher germination in cocoa when the beans were peeled. Katsuo et al. (1970) and Sanikidze (1975) recommended

removal of seedcoats of tea seeds for accelerating germination and producing vigorous seedlings. Gopal and Ramaiah (1971) obtained early germination of seeds of coffee by parchment removal.

2. Effect of GA on germination of seeds and growth of the seedlings

i. Effect of GA on germination of seeds and growth of the seedlings

Growth regulators have been used in several crops to obtain higher percentage of germination. Work on these lines have not been attempted in cloves. However, several useful findings have been reported in other crops.

Reddy (1963) sprayed guava seedlings with GA at 50, 100 and 150 ppm and found that maximum growth increase occurred at 100 ppm level. Farooqui et al. (1971) while working in sapota, obtained hastened germination with GA at 50 ppm. In jack seedlings, Shanmugavelu (1971) found that shoot length, fresh weights and dry weights of shoots and roots were increased by 25 - 100 ppm GA. Bhujbal (1975) obtained 92.5 per cent germination in Phyllanthus emblica, when the stones were soaked in 500 ppm GA of or 24 hours. Mathew (1979) found that there was significant increase in germination when nutmeg seeds were soaked for 24 hours in GA at 200 p.m.

Nichols (1959) and Are (1964) reported that the rate of elongation of stem of cocoa seedlings increased by GA treatment, at 25, 500 and 1,000 ppm.

Randhawa and Singh (1959) obtained increase in height, fresh weight and leaf size in Citrus limon by applying GA in various concentrations ranging from 10 - 100 ppm, and the maximum response was obtained in height (71.4 per cent) with 100 ppm. In sweet orange, Burns and Coggins (1969) observed that germination was hastened by treating with GA at 0.1 per cent. Shant and Rao (1973) applied GA to 4½ month-old-lime seedlings and found that 300 ppm treatment produced 183 per cent increase in height and 104.2 per cent increase in girth over unsprayed controls. Achituv and Mendel (1976) observed that GA at 200 or 500 ppm stimulated germination of sweet lime seeds.

Motilal and Gilkar (1967) recorded increased rate of germination in peaches, when the seeds were treated with GA at 500 ppm for 24 hours. Carlone (1959) obtained accelerated growth of shoots in peach seedlings, as a result of GA spray with a 100 ppm solution. Hull and Lewis (1959) found that the linear growth and trunk diameter were increased significantly by applying GA at 100, 500 and 1000 ppm in cherry, peach and apple seedlings. Powell et al. (1959) studied the effect of GA on young apple seedlings and found that, when GA was applied at twice weekly intervals, more linear growth was produced with

more growing points and greater number of leaves.

Ram and Kamini (1965) working with Withania somnifera recorded a delay in the onset of germination in the GA treated plots. Shreve and Campbell (1967) found increase in stem diameter following the application of GA at 500 ppm to pecan seedlings. In chicory seeds, germination was improved to 90 per cent by the application of GA at 200 ppm (Srivastava, et al., 1974). Ballington et al. (1976) reported negative response of GA on germination of Rabbit Eye blue berry seeds. Valio (1976) also obtained negative response of coffee seeds to GA treatment on germination

ii. Effect of GA and urea on growth of the seedlings

Foliar application of urea and combined application of GA and urea have also been reported to be beneficial in many perennial crops. Blasberg (1953) reported phenomenal response in apple to urea sprays in increasing the plant growth and leaf size. Sukumaran and Nair (1964) obtained increased height, number of leaves, girth and leaf area in chewing tobacco seedlings, following foliar spray of urea. Vaz (1965) observed that the foliar sprays of urea did not show any significant effect on the growth of coffee seedlings. Chhonkar and Tiwari (1966) reported increased stem girth, length, leaf number and leaf size, when kagzi lime seedlings were sprayed with urea at 1.5 per cent. Gilliam and Wright (1977) obtained

decrease in shoot number (18 per cent) and increase in root length (12 per cent) in Ilex crenata, when GA was applied in combination with different levels of Nitrogen.

3. Effect of containers and potting mixtures on growth of clove seedlings

Even after obtaining satisfactory germination, the resulting clove seedlings grow very slowly not only in the nursery, but also in the field after transplanting. As such, the juvenile period is considerably long. In poor soils, eight to ten years usually elapse before the first flower appears. In an experimental garden, this period could be shortened to four years by the application of good planting material, good management and fertilisation (Deinum and Wit, 1949).

i. Containers

Use of appropriate containers and suitable potting mixtures has given encouraging results with regard to the growth of seedlings/grafts/layers in several crops. Work on these lines is also lacking with regard to cloves.

Eastoe and Pollard (1959), who studied the different types of pots in relation to seedling growth recorded that (permeability and aeration of) the pot wall influenced the growth of the seedlings markedly. Figueiredo and others (1964)

obtained taller and heavier coffee seedlings when grown in polythene bags. Reyes and Armas (1965) recommended raising of cocoa seedlings in plastic pots holding six kg. potting mixture, as the seedlings made more growth in these containers. Freeman (1965) observed the growth of cocoa seedlings in polythene pots and whalehide pots to be good. Kozma and Polyak et al. (1968) found the clay pots (30 cm x 30 cm) sunk in the ground to be suitable for growing grape vines for one to three years. Appaiah (1970) observed that the growth of arecanut seedlings in polythene bags were better. According to Funk (1971) the growth of Juglans nigra seedlings was dependent on pot volume. Tanaka et al. (1977) reported that clay pots contain $K_2O$, $Na_2O$, CaO and MgO, which could be absorbed by plant roots. Rajeevan (1978) studied the growth of cashew air layers in pots made of clay, straw and coconut husk. He found that the growth of the air layers were significantly better in the coconut husk pots.

ii. Potting mixtures

Various types of potting mixtures have been tried for enhancing the early growth of seedlings and other potted plants. Vine and Mitchell (1969) compared sixteen compost mixtures for raising coffee seedlings in the nursery. Best results were obtained with a mixture of 32 per cent alluvial soil, 32 per cent top soil, 16 per cent coarse sand and 20 per cent farmyard

manure by volume. Where sisal waste was readily available, a mixture of 16 parts top soil, 4 parts coarse sand, 4 parts chopped sisal waste and 5 parts farmyard manure (by volume) was recommended. Waters et al. (1970) compared twenty seven media consisting of combinations of builder's sand, wood shavings, perlite, German peat and Florida peat. Detailed studies showed that the important factors to be considered in formulating the media include appearance, shrinkage loss, ignition loss, bulk density, water holding capacity, non-capillary air space, $p^H$, salinity and soil test values. Hauert (1978) reported that liquid feeding and slow release fertilizers were important in the nurseries for container grown plants. Rajeevan (1978) found that addition of sterameal or coir dust in the potting mixture had no effect on the growth of cashew air layers. Keshavachandran (1979) used a mixture of soil, sand and farmyard manure in the proportion of 1:1:2 for growing cocoa seedlings for 3-5 months.

4. Survival, establishment and after growth of clove seedlings

In crops where the survival on transplanting to the main field has been poor, or where the initial growth has been very slow, attempts have been made to improve the establishment and also to push up initial growth by several means. Benstead (1950) advocated the use of baskets, woven from palm fronds, for raising cocoa seedlings which would result in better

establishment of seedlings in the main field. However, Freeman (1965) did not get any significant difference in the establishment of the seedlings of cocoa raised in polythene pots and whalehide pots.

Harer (1962) described the use of a perishable type of container prepared from banana fibre for raising coffee seedlings, which helped to minimise root injury during transplanting. Snock (1965) advocated wrapping of balled roots of robusta coffee in pandanus leaves to aid in successful transplanting of coffee seedlings.

Albuquerque et al. (1958) recommended containers made of hill grass, popularly known as 'coffee baskets' for raising cashew seedlings, which rendered transplanting more easy and successful. Shetty and Bhaktal (1965) observed that raising of cashew seedlings in individual baskets or receptacles made of hill grass or small bamboo baskets and planting them intact with the container in the early monsoon gave better establishment in the main field.

Serier (1966) recommended the raising of oilpalm seedlings in plastic bags for ease in carrying them to the main field which avoided disturbance of the roots. Appaiah (1970) advocated the practice of growing arecanut seedlings in polythene bags rather than raising them in the nursery beds for obtaining better growth and 15 per cent reduction in field mortality.

Singhrot et al. (1970) observed that plastic bags (which gave the least mortality after transplanting) were the best type of containers for raising Ziziphus mauritiana seedlings. Varslavans (1974) recommended the use of peat blocks for increasing the survival of scot pine seedlings. Froland (1975) advocated the use of peat briquette for increasing the survival of most of the plants. Rajeevan (1978) obtained 86% success when cashew air layers were planted first to coconut husk pots and later planted intact to the main field.

5. Vegetative propagation

Vegetative propagation in cloves was attempted in Indonesia shortly before World War II (Wit, 1969). All cuttings failed, but some grafts on root stocks of wild clove tree met at least with a temporary success. After the war, rooted cuttings were produced from leaf stalks; but these did not develop any further. Tidbury (1949) mentioned about one single cutting made from soft wood which took several months to strike roots and graftings on to related species which resulted in temporary unions. According to May (1949) one of the grafts of clove on guava made in 1942 was still surviving in 1949. He also succeeded in approach grafting the branch tips of mature clove trees on to young clove seedlings. Several of these were still alive and healthy in 1953 (Nutman and Roberts, 1953). It is reported that young clove branches can be marcotted fairly easily (Francois, 1938; Maistre, 1964).

# MATERIALS AND METHODS

## MATERIALS AND METHODS

The present studies were carried out during 1979-80 at the Instructional Farm, attached to the College of Horticulture, Vellanikkara. Experiments were designed to elucidate information on

(i) germination and growth of clove as influenced by the period of collection, the average weight of seeds and the removal of the seedcoat.

(ii) the effect of GA treatment on germination of clove seeds.

(iii) the effect of different containers, potting mixtures and chemical boosters on the rate of growth of seedlings and

(iv) the effect of growing clove seedlings in different containers and transplanting them to the main field with or without the containers on the field establishment.

### 1. The germination and growth of clove, as influenced by the period of seed collection, the average weight of seeds and the removal of the seed coat

The propagating material in cloves, is the one-seeded fleshy fruit which is morphologically a drupe. This is popularly known as "the mother of cloves". In this dissertation, the term seed is used for denoting this one-seeded fruit.

The clove seeds mature during May, June and continue to be available upto July. Twenty-year-old clove trees grown at

Velimalai Estate, Kanyakumari District, were used for the collection of seeds. Trees were marked and seeds were collected during the months of May, June and July 1979. Only ripe, dark purple seeds were collected. The seeds collected during the month of May were designated as 'early season seeds', the seeds of June as 'mid season seeds' and those collected during July as 'late season seeds'.

The seeds collected during each month were classified into the following three categories based on their weight.

Heavy seeds - weighing more than 2 g each

Medium seeds - weighing between 1.5 g and 2 g

Light seeds - weighing less than 1.5 g

The seeds after one day of collection, were then divided into two equal lots. They were then soaked in water for 24 hours. One lot from each category (three collection periods and three weight groups) was mixed with sand, rubbed and peeled carefully. The other lot was sown as such, with the seedcoat intact, to serve as control.

Nursery was laid out under the shade of large trees. Raised beds (150 cm. x 90 cm. x 25 cm.) were taken. River sand was spread on the top of the beds to a depth of 15 cm. The seeds were sown flat at a depth of 2.5 cm. and with a spacing of 15 cm. either way. The nursery was irrigated twice daily.

The experiment was laid out as 3 x 3 x 2 factorial,

Randomised Block Design. The treatments were combinations of three factors, A, B and C at 3, 3 and 2 levels respectively, as described below.

Period of sowing - Factor A

Early season seeds - $a_1$

Mid season seeds - $a_2$

Late season seeds - $a_3$

Average weight of seeds - Factor B

Heavy seeds - $b_1$

Medium seeds - $b_2$

Light seeds - $b_3$

Removal of pericarp - Factor C

With pericarp - $c_1$

Without pericarp - $c_2$

Number of replications - three

Number of seeds/treatment/replication - 100

The germination counts were recorded daily in all the treatments and this was continued upto two months. When the cotyledons of seeds rose above the soil level, the seeds were reckoned as germinated. From the data so obtained, the percentage of germination, number of days taken for commencement of germination, number of days for 50 per cent germination and number of days for completion of germination were worked out.

In order to study the effect of different treatments on the growth of the seedlings in the nursery, the seedlings were taken at random (two months after sowing) from all the eighteen treatments and from three replications. The seedlings were transplanted in polythene bags (size 20 cm. x 15 cm., 200 gauge) filled with potting mixture containing one part soil, one part sand and one part powdered cowdung.

The following growth characters of the seedlings were recorded at monthly intervals, upto the 4th month of transplanting.

i. Height of the seedlings: The height of the seedlings was measured from the soil level to the apex and expressed in cm. From the data the mean increments in height of the seedlings during the four months of observation, were worked out.

ii. Girth of the seedlings: The girth of the seedlings was measured at the collar level using a twine and scale and expressed in cm. The mean increments in girth during every month of observation were worked out.

iii. Number of leaves: Number of fully opened leaves in the seedlings were counted every month. The mean increments in the number of leaves during the four months were calculated.

2. <u>Effect of GA treatment on germination of clove seeds</u>

The medium seeds collected during June 1979 were used for this study. The seeds after one day of collection were

soaked for 24 hours in GA at four concentrations namely, 100 ppm, 200 ppm, 300 ppm and 400 ppm. The seeds were then sown flat in the nursery beds with a spacing of 15 cm x 15 cm and at a depth of 2.5 cm. The experiment was laid out in Randomised Block Design with three replications with 100 seeds/ treatment/replication.

Germination count was recorded upto two months of sowing, as described before and the number of days for first germination, number of days for 50% germination and number of days for the completion of germination were worked out.

3. Effect of different containers, potting mixtures and chemical boosters on the rate of growth of clove seedlings

Medium seeds collected during June 1979 were used for this study. The seedlings, after two months of sowing were transplanted to the following three types of containers.

Three types of containers namely, clay pots (unused clay pots of size 15 cm x 15 cm), polythene bags (size 20 cm x 15 cm, 200 gauge) and coconut husk pots *(a decomposing type of container made from retted coconut husk) were used for transplanting the seedlings.

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* The coconut husk pots were made as follows:

A frame like structure was made on an inverted clay pot (15 cm x 15 cm) using pieces of rachii of coconut leaves. This frame was tied firmly by country twine, covered all around with a 5 cm layer of coconut husk and again tied firmly. The centrally placed pot was then removed and the coconut husk pot thus obtained was trimmed to shape. This pot could then hold potting mixture equivalent to a 15 cm x 15 cm clay pot.

Three types of potting mixtures namely, Mixture 1 one part sand, one part soil and one part powdered cowdung. Mixture 2 (Mixture 1 & bonemeal @ 2 teaspoons/pot) and Mixture 3 (mixture 1 + bonemal @ 2 teaspoons/pot + powdered groundnut cake @ 2 teaspoons/pot). Two kg. of potting mixtures were filled in each pot. The chemical treatments included foliar sprays of GA (100 ppm and 200 ppm), urea (0.5 per cent) and their combinations. There was also a control with distilled water spray. The experiment was laid out as a 3 x 3 x 6 factorial in Randomised Block Design with three replications and 5 seedlings/ treatment.

The treatments were combinations of three factors A, B and C at 3, 3 and 6 levels respectively, as described below:

Containers - Factor A

Clay pot - $a_1$

Polythene bag - $a_2$

Coconut husk pot - $a_3$

Potting mixtures - Factor B

Mixture 1 - $b_1$

Mixture 2 - $b_2$

Mixture 3 - $b_3$

Foliar sprays - Factor C

| | |
|---|---|
| GA 100 ppm | $C_1$ |
| GA 200 ppm | $C_2$ |
| Urea 0.5 per cent | $C_3$ |
| GA 100 ppm + urea 0.5 per cent | $C_4$ |
| GA 200 ppm + urea 0.5 per cent | $C_5$ |
| Control | $C_6$ |

The following observations were recorded.

i. Physical characteristics of containers: The total porosity and relative evaporating capacity of the pots were determined before use, as enumerated by Eastoe and Pollard (1959).

ii. Physico-Chemical characteristics of the potting mixtures: Samples were air dried, pounded, sieved through 1 mm sieve and the following were estimated.

1. Moisture content: A sample of each mixture (5.0 g) was weighed and kept in an air oven at 105°C. to constant weight. Moisture per cent was calculated from the loss in weight.

2. Physical constants: The apparent density, water holding capacity and specific gravity were determined by the keen Raczkowski box method (Wright 1934).

3. $p^H$: The $p^H$ of the mixtures was determined with an Elico $p^H$ meter at 1:2.5 soil: water ratio.

4. Total Nitrogen: Total Nitrogen was estimated by the modified microkjeldahl method (Jackson 1973) using sulphuric salicylic acid mixture.

5. Available phosphorus: The phosphorus was extracted by 0.1 N Hcl and 0.03 N $NH_4F$ solution and determined by the method of Dickman and Bray (1940).

6. Available Potassium: Available potassium was estimated by 1 N neutral ammonium acetate extract - flame photometric method (Jackson 1973).

7. Electrical conductivity: Electrical conductivity was determined with a mixture solution ratio of 1:2.5 using Elico 'Conductivity bridge' and the results expressed in mmhos/$cm^2$.

8. Organic carbon: Organic carbon in the mixtures was determined by Walkly and Black's rapid titration method, as described by Jackson (1973). Percentage of organic matter was obtained by multiplying the percentage of carbon by the factor 1.72.

iii. Growth characters of seedlings: Growth parameters were recorded upto the seventh month of transplanting in the pots. The height, number of leaves and girth were recorded upto this period at monthly intervals and the mean increments calculated as described earlier. After the seven months of growth the seedlings were uprooted and fresh weight, length of roots, leaf area, length of internodes and dry weight were recorded as described below:

1. Fresh weight of the seedlings: The seedlings were washed free of soil and weight expressed in g.

2. Length of tap root: The length of tap root was recorded before transplanting the seedlings to the pots. The seedlings were

handled with great care to avoid injury. After seven months' growth, the seedlings were uprooted, washed free of soil and length of the tap roots was measured again. The increments in the length of roots after seven months growth was calculated.

3. Leaf area: The leaves were plucked from individual seedlings and the total leaf area was worked out graphically and expressed in $cm^2$.

4. Length of internodes: The mean length of internodes was found out by dividing the height of the seedlings by the number of nodes and expressed in cm.

5. Dry weight of the seedlings: After recording the fresh weight, the plants were kept in an air oven at 70°C to constant weight and dry weight was recorded in g

14. <u>The effect of growing clove seedlings in different containers and transplanting them to the mainfield with or without the containers on the field establishment</u>

Seedlings were obtained from the June sowing of medium sized seeds. Twenty seedlings each were transplanted in the three types of containers, namely clay pot, polythene bags and coconut husk pots filled with ordinary potting mixture (Mixture I). The seedlings were maintained in the nursery upto seven months. The mainfield was prepared and pits (60 $cm^3$) were dug at 2.0 m x 2.0 m spacing. The seedlings raised in clay pots were

extracted with the soil ball after breaking the pots, (to avoid any injury to the roots) and were transplanted. The polythene bags were torn carefully and the seedlings were transplanted with the ball of earth. The seedlings growing in the coconut husk pots were transplanted as such. The seedlings were shaded using coconut leaves and watered twice daily.

Observations on survival and growth characters namely height, girth and number of leaves were recorded upto six months as described previously.

Since the percentage of survival of the seedlings in the three types of containers were different, the experimental design used for analysis of the data was Completely Randomised Design with unequal number of replications.

9. Statistical Analysis

The statistical analysis of the data in the different experiments was carried out as per Snedecor and Cochran (1967).

For evaluating the vigour of the seedlings a scoring technique was adopted as follows:

The total increments in all growth parameters were classified after seven months of observation. The median was then found out. The first 30 per cent of the observations were given a score of 1, 31 to 70 per cent - 2 and the remaining 71 to 100 per cent - 3. The scores for each treatment were tabulated

and the total score worked out. The treatment which secured the highest score was considered as the one which produced the most vigorous seedlings.

# RESULTS

# RESULTS

Studies were conducted with the main objectives of increasing the germination percentage of clove seeds, accelerating the rate of growth and vigour of seedlings in the nursery and increasing the survival of the seedlings in the mainfield. The results are presented in the following pages.

## 1. Germination as influenced by the period of collection of seeds, average weight of seeds and the removal of the pericarp

The experiment consisted of three periods of collection of seeds (May, June and July 1979), three weight groups (Heavy, Medium and Light) and two treatments for studying the effect of the pericarp (sowing after removal of the pericarp and sowing with the pericarp).

The mean values of observation on percentage of first germination, number of days for 50 per cent germination, number of days for 50 per cent germination and number of days for the completion of germination are presented in Table 1 and the analysis of variance in Appendix I. The data have been presented in Fig. 1 and 2 also.

The data showed that the percentage of germination was markedly influenced by the period of seed collection, weight of seeds and removal of pericarp. The seeds collected and sown during the month of June 1979, recorded the highest germination (51.5 per cent), followed by those of May 1979 (49.2 per cent)

Table 1. Effect of period of collection of seeds, weight of seeds and removal of the pericarp on percentage of germination, number of days for first germination, number of days for 50 per cent germination and number of days for the completion of germination.

Transformed values (Actual values in parenthesis)

| Treatments | Percentage of germination | Number of days for first germination | Number of days for 50 per cent germination | Number of days for the completion of germination |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| $a_1$ | 44.52(49.20) | 3.55(12.60) | 4.54(20.61) | 5.38(28.94) |
| $a_2$ | 45.83(51.50) | 3.54(12.53) | 4.35(18.92) | 5.07(25.70) |
| $a_3$ | 40.71(42.50) | 3.07( 9.42) | 4.07(16.56) | 4.91(24.10) |
| $SE_m$ | 0.31 | 0.04 | 0.08 | 0.07 |
| C.D. (0.05) | 0.88 | 0.13 | 0.24 | — |
| $b_1$ | 46.07(51.90) | 3.36(11.28) | 4.34(18.83) | 5.01(25.10) |
| $b_2$ | 43.67(47.70) | 3.44(11.83) | 4.28(18.31) | 5.06(25.60) |
| $b_3$ | 41.32(43.67) | 3.36(11.28) | 4.35(18.92) | 5.29(27.98) |
| $SE_m$ | 0.31 | 0.04 | 0.08 | 0.07 |
| C.D. (0.05) | 0.88 | — | — | — |
| $c_1$ | 49.72(58.20) | 3.07( 9.42) | 4.04(16.32) | 4.83(23.32) |
| $c_2$ | 37.80(37.50) | 3.71(13.76) | 4.61(21.25) | 5.41(29.26) |
| $SE_m$ | 0.25 | 0.03 | 0.03 | 0.06 |
| C.D. (0.05) | 0.72 | — | — | — |

$a_1$ Early season seeds
$a_2$ Mid season seeds
$a_3$ Late season seeds
$b_1$ Heavy seeds
$b_2$ Medium seeds
$b_3$ Light seeds
$c_1$ Pericarp removed
$c_2$ Pericarp intact

Table 1 contd.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| $a_1b_1$ | 43.34(47.10) | 3.54(12.53) | 4.58(20.97) | 5.35(28.62) |
| $a_1b_2$ | 44.51(49.20) | 3.62(13.10) | 4.48(20.07) | 5.37(28.83) |
| $a_1b_3$ | 45.69(51.20) | 3.49(12.18) | 4.56(20.79) | 5.41(29.26) |
| $a_2b_1$ | 43.23(46.90) | 3.54(12.53) | 4.45(19.80) | 5.05(25.50) |
| $a_2b_2$ | 45.39(50.70) | 3.59(12.88) | 4.24(17.94) | 4.78(22.84) |
| $a_2b_3$ | 48.86(56.30) | 3.50(12.25) | 4.38(19.18) | 5.38(28.94) |
| $a_3b_1$ | 37.39(36.90) | 3.03( 9.18) | 3.98(15.84) | 4.61(21.25) |
| $a_3b_2$ | 41.11(43.20) | 3.10( 9.61) | 4.12(16.97) | 5.02(25.20) |
| $a_3b_3$ | 43.64(47.60) | 3.09( 9.54) | 4.11(18.69) | 5.10(26.01) |
| $SE_m$ | 0.53 | 0.08 | 0.07 | 0.13 |
| C.D. (0.05) | — | — | — | — |
| $a_1c_1$ | 38.51(38.80) | 3.87(14.97) | 4.84(23.42) | 5.78(33.40) |
| $a_1c_2$ | 50.52(59.60) | 3.22(10.36) | 4.24(17.97) | 4.97(24.70) |
| $a_2c_1$ | 38.95(39.50) | 3.76(14.13) | 4.62(21.34) | 5.25(27.56) |
| $a_2c_2$ | 52.70(63.30) | 3.32(11.02) | 4.09(16.72) | 4.88(23.81) |
| $a_3c_1$ | 35.46(33.60) | 3.47(12.04) | 4.37(19.09) | 5.18(28.83) |
| $a_3c_1$ | 45.96(51.70) | 2.67( 7.12) | 3.77(13.76) | 4.63(21.43) |
| $SE_m$ | 0.44 | 0.06 | 0.06 | 0.11 |
| C.D. (0.05) | — | — | — | — |
| $b_1c_1$ | 35.40(33.60) | 3.68(13.54) | 4.63(21.43) | 5.32(28.30) |
| $b_1c_2$ | 47.24(53.90) | 3.05( 9.30) | 4.04(16.32) | 4.69(21.99) |
| $b_2c_1$ | 37.72(37.41) | 3.79(14.36) | 4.54(20.61) | 5.30(28.09) |
| $b_2c_2$ | 49.62(58.00) | 3.09( 9.54) | 4.01(16.08) | 4.82(23.23) |
| $b_3c_1$ | 39.80(41.00) | 3.64(13.24) | 4.65(21.62) | 5.61(31.47) |
| $b_3c_2$ | 52.32(62.60) | 3.07( 9.41) | 4.05(16.40) | 4.97(24.70) |
| $SE_m$ | 0.44 | 0.06 | 0.06 | 0.11 |
| C.D. (0.05) | — | — | — | — |

$a_1$. MAY SEEDS. $b_1$. HEAVY SEEDS.
$a_2$. JUNE SEEDS. $b_2$. MEDIUM SEEDS.
$a_3$. JULY SEEDS. $b_3$. LIGHT SEEDS.

$C_1$. PERICARP REMOVED.
$C_2$. PERICARP INTACT.

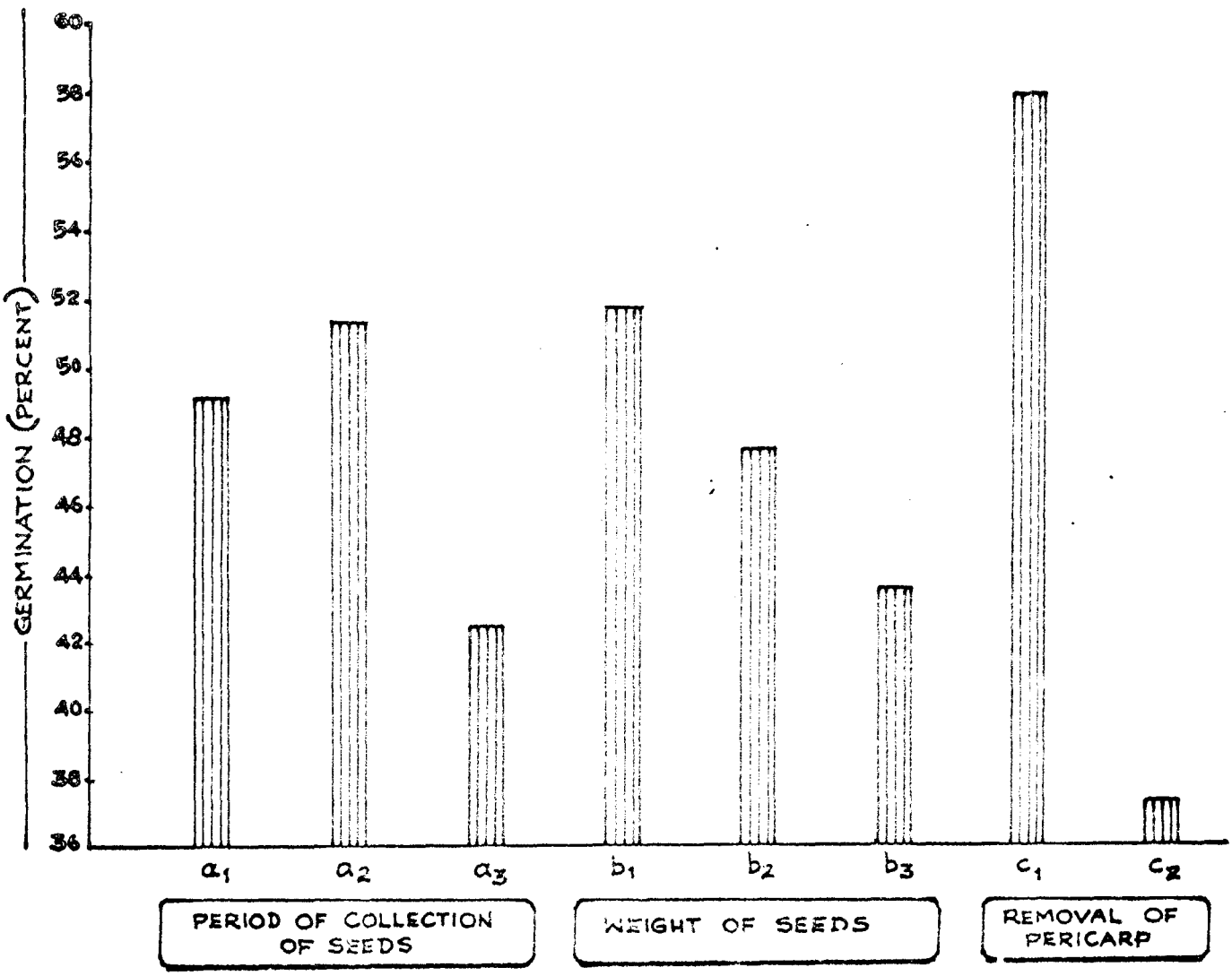


FIG.1.-EFFECT OF PERIOD OF COLLECTION OF SEEDS, WEIGHT OF SEEDS AND REMOVAL OF PERICARP ON GERMINATION OF CLOVE SEEDS.

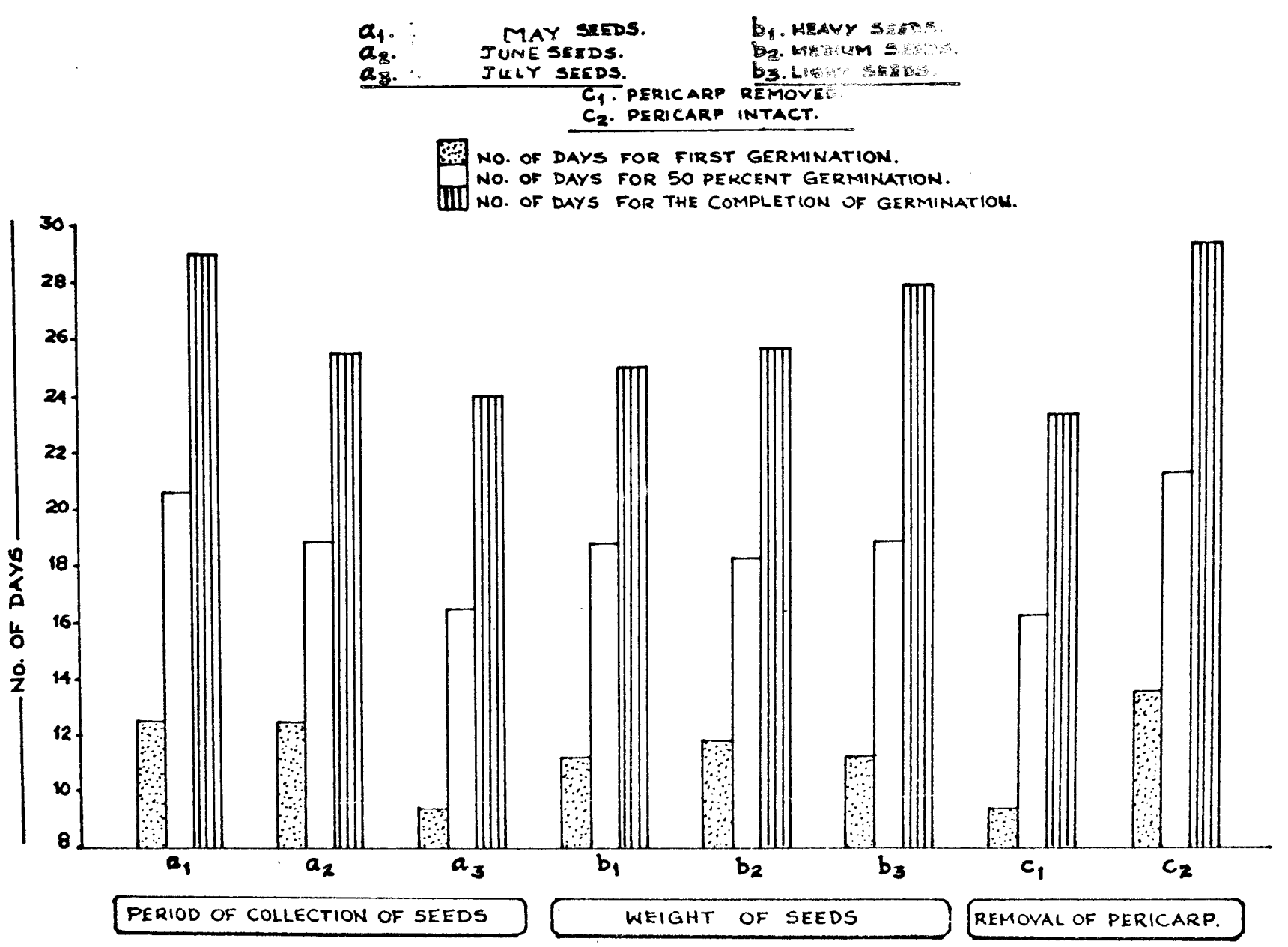


FIG. 2.-EFFECT OF PERIOD OF COLLECTION OF SEEDS, WEIGHT OF SEEDS AND REMOVAL OF PERICARP ON NUMBER OF DAYS FOR FIRST GERMINATION, NUMBER OF DAYS FOR 50 PER-CENT GERMINATION AND NUMBER OF DAYS FOR THE COMPLETION OF GERMINATION.

and those of July 1979 (42.5 per cent). The heavier seeds gave highest germination (51.90 per cent) followed by medium (47.70 per cent) and light seeds (43.67 per cent). The removal of pericarp helped to increase the germination from 37.3 to 58.2 per cent. The data revealed that number of days for first germination varied significantly, only in the case of different collection periods. The seeds of July started germination in 9.42 days as against 12.53 days taken by the seeds collected and sown in June and 12.60 days by those of May. The effect of period of collection of seeds was significant for the number of days for 50 per cent germination. The seeds collected during July recorded 50 per cent germination in the shortest time (16.56 days) while the seeds of June and May took 18.92 days and 20.61 days respectively. The data revealed that there was no significant difference among the treatments for the completion of germination. The different factors among themselves were not statistically significant in the case of percentage of germination, number of days for first germination, number of days for 50 per cent germination and number of days for the completion of germination.

2. Effect of GA treatment on germination of clove seeds

The effect of GA treatment on percentage of germination, number of days for first germination, number of days for 50 per cent germination and number of days for the completion of germination are presented in Table 2 and the analysis of

Table 2. Effect of GA on percentage of germination, number of days for first germination, number of days for 50 per cent germination and number of days for the completion of germination.

| Treatments | Transformed values (Actual values in parenthesis) | | | |
|---|---|---|---|---|
| | Percentage of germination | Number of days for first germination | Number of days for 50 per cent germination | Number of days for the completion of germination |
| GA 100 ppm | 29.76(24.6) | 3.46(12.0) | 4.69(22.0) | 5.72(32.7) |
| GA 200 ppm | 27.87(21.9) | 3.63(13.2) | 4.78(22.9) | 5.99(35.9) |
| GA 300 ppm | 21.65(13.6) | 3.54(12.5) | 4.78(22.9) | 5.66(32.1) |
| GA 400 ppm | 19.66(11.3) | 3.63(13.2) | 4.69(22.0) | 5.83(34.0) |
| Control | 43.85(48.0) | 3.63(13.2) | 4.54(20.6) | 4.80(23.1) |
| $SE_m$ | 0.107 | 0.19 | 0.11 | 2.04 |
| | NS | NS | C.D.(0.05) = 0.27 | C.D.(0.05) = 5.81 |

variance in Appendix II. It can be seen that GA inhibited the germination of clove seeds, as the control gave 48.0 per cent germination, against 24.6 per cent, 21.9 per cent, 13.6 per cent and 11.3 per cent, when the seeds were soaked in GA at 100, 200, 300 and 400 ppm respectively. GA 100 and 200 ppm were on par with regard to the percentage of germination. Similarly, the two higher concentrations of GA namely, 300 and 400 ppm were also on par. All the GA treatments significantly inhibited the percentage of germination as against the control. With regard to the number of days for first germination and number of days for 50 per cent germination, the treatments did not show any significant difference. However, with regard to the days taken for the completion of germination, the GA treatment exhibited significant effects. The control gave significant reduction in number of days for the completion of germination, when compared to the other treatments. GA 200 ppm, 400 ppm and 100 ppm were on par. The effect of GA 200 ppm, 100 ppm and 300 ppm were also on par.

3. <u>Growth parameters of the seedlings as influenced by the period of collection of seeds, weight of seeds and removal of the pericarp</u>

The second part of the experiment was aimed at studying the effect of seed collection periods, average weight of seeds, and the presence or absence of the pericarp, on the growth of the clove seedlings. The growth parameters studied were the

height of the seedlings, the girth of the seedlings and the number of leaves.

1. Height of the seedlings

The effect of the different treatments on the mean increments in height during the first four months and the total increase in height after four months of growth are presented in Table 3 and the analysis of variance in Appendix III. The height increment during the first and second months were not significantly influenced by the period of collection and sowing. During the third and fourth months, the seeds of May produced the tallest seedlings. The seedlings obtained from the June sowing were taller than those from the July sowing. The total increments in height also showed similar trend. During the first month, the average weight of seeds did not produce any significant effect in increasing the height of the seedlings. During the second month, the medium seeds produced the tallest seedlings followed by heavy and light seeds. The mean increments in height produced by the seedlings of heavy and medium seeds were on par, during the third month. The lighter seeds produced significantly shorter seedlings. During the fourth month, the tallest seedlings were produced by the heavy seeds, followed by medium and light seeds. The total height increment during the four months of observation, indicated no significant difference between the seedlings from heavy and medium seeds. However, they were superior to the seedlings from light seeds. The removal

Table 3. Effect of period of collection of seeds, weight of seeds and removal of the pericarp on mean monthly increments in height upto the fourth month and total increments in height after four months of growth.

| Treatments | Initial height | Increments in height (cm) during the | | | | Total increments in height (cm) after four months of growth |
|---|---|---|---|---|---|---|
| | | First month | Second month | Third month | Fourth month | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| $a_1$ | 5.58 | 0.175 | 0.542 | 0.827 | 1.067 | 2.60 |
| $a_2$ | 6.63 | 0.202 | 0.495 | 0.671 | 0.895 | 2.26 |
| $a_3$ | 6.63 | 0.172 | 0.517 | 0.648 | 0.774 | 2.10 |
| $SE_m$ | — | 0.007 | 0.012 | 0.012 | 0.009 | 0.027 |
| C.D. (0.05) | — | — | — | 0.035 | 0.026 | 0.079 |
| $b_1$ | 6.53 | 0.180 | 0.512 | 0.774 | 0.985 | 2.46 |
| $b_2$ | 6.71 | 0.200 | 0.586 | 0.749 | 0.909 | 2.44 |
| $b_3$ | 6.60 | 0.166 | 0.455 | 0.622 | 0.840 | 2.07 |
| $SE_m$ | — | 0.007 | 0.012 | 0.012 | 0.009 | 0.027 |
| C.D. (0.05) | — | — | 0.037 | 0.035 | 0.026 | 0.079 |
| $c_1$ | 6.72 | 0.201 | 0.487 | 0.671 | 0.873 | 2.22 |
| $c_2$ | 6.51 | 0.166 | 0.548 | 0.759 | 0.951 | 2.42 |
| $SE_m$ | — | 0.006 | 0.010 | 0.009 | 0.007 | 0.002 |
| C.D. (0.05) | — | — | 0.030 | — | 0.021 | — |

$a_1$ Early season seeds
$a_2$ Mid season seeds
$a_3$ Late season seeds
$b_1$ Heavy seeds
$b_2$ Medium seeds
$b_3$ Light seeds
$c_1$ Pericarp removed
$c_2$ Pericarp intact

Table 3 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| $a_1b_1$ | 6.40 | 0.158 | 0.456 | 0.915 | 1.303 | 2.83 |
| $a_1b_2$ | 6.96 | 0.200 | 0.653 | 0.860 | 1.048 | 2.76 |
| $a_1b_3$ | 6.39 | 0.166 | 0.515 | 0.707 | 0.852 | 2.20 |
| $a_2b_1$ | 6.76 | 0.228 | 0.575 | 0.758 | 0.940 | 2.50 |
| $a_2b_2$ | 6.79 | 0.213 | 0.543 | 0.678 | 0.873 | 2.31 |
| $a_2b_3$ | 6.34 | 0.165 | 0.366 | 0.575 | 0.871 | 1.97 |
| $a_3b_1$ | 6.44 | 0.157 | 0.508 | 0.650 | 0.713 | 2.03 |
| $a_3b_1$ | 6.39 | 0.187 | 0.561 | 0.710 | 0.805 | 2.26 |
| $a_3b_2$ | 7.06 | 0.173 | 0.483 | 0.583 | 0.805 | 2.03 |
| $SE_m$ | — | 0.013 | 0.022 | 0.020 | 0.015 | 0.047 |
| C.D. (0.05) | — | — | 0.064 | — | 0.045 | 0.138 |
| $a_1c_1$ | 6.50 | 0.206 | 0.494 | 0.807 | 1.080 | 2.57 |
| $a_1c_2$ | 6.66 | 0.043 | 0.589 | 0.847 | 1.050 | 2.63 |
| $a_2c_2$ | 6.97 | 0.213 | 0.510 | 0.641 | 0.849 | 2.21 |
| $a_2c_1$ | 6.29 | 0.191 | 0.48 | 0.700 | 0.941 | 2.31 |
| $a_3c_1$ | 6.69 | 0.182 | 0.456 | 0.564 | 0.691 | 1.88 |
| $a_3c_2$ | 6.57 | 0.162 | 0.578 | 0.731 | 0.858 | 2.33 |
| $SE_m$ | — | 0.011 | 0.018 | 0.017 | 0.012 | 0.039 |
| C.D. (0.05) | — | — | — | — | 0.372 | — |
| $b_1c_1$ | 6.51 | 0.206 | 0.447 | 0.756 | 0.998 | 2.41 |
| $b_1c_2$ | 6.56 | 0.155 | 0.578 | 0.793 | 0.972 | 2.5 |
| $b_2c_1$ | 6.89 | 0.208 | 0.563 | 0.692 | 0.839 | 2.30 |
| $b_2c_2$ | 6.54 | 0.191 | 0.609 | 0.806 | 0.979 | 2.58 |
| $b_3c_1$ | 6.77 | 0.186 | 0.450 | 0.566 | 0.782 | 1.98 |
| $b_3c_2$ | 6.43 | 0.150 | 0.450 | 0.678 | 0.903 | 2.19 |
| $SE_m$ | — | 0.011 | 0.018 | 0.017 | 0.012 | 0.039 |
| C.D. (0.05) | — | — | — | — | 0.017 | — |

of pericarp did not show any significant effect in the increments in height of seedlings during the first and third month. In the second and fourth months, the peeled seeds produced significantly taller seedlings. The total increments in height upto the fourth month did not show any significant difference.

The interaction of the period of collection of seeds and weight of seeds indicated no significant difference during the first and third month. During the second month, May - sown medium seeds were superior to the other treatments. During the fourth month, the seedlings from May - sown heavy seeds produced maximum height, followed by May - sown medium seeds. With regard to the increments in height after four months of growth, the May - sown heavy, and medium seeds were superior to those of the other treatment combinations. The interaction of the period of seed collection, and the removal of pericarp showed no significant difference upto the third month. During the fourth month, the July sown peeled seeds were significantly shorter than those of May - sown peeled seeds. The former was on par with unpeeled seeds sown in May, June and July and peeled seeds sown in June. The May - sown peeled seeds were on par with those sown with the pericarp, in May, June and July as well as with the peeled seeds sown in June. The total height increments at the end of four months of operation, showed no significant difference between the treatments. The interaction of weight of seeds and removal

of pericarp showed no significant difference upto the third month. During the fourth month, the heavy seeds (unpeeled and peeled) as well as medium unpeeled seeds produced significantly taller seedlings than the other treatment combinations. The total increments in height after four months of observation did not show any significant difference.

ii. Number of leaves

The effect of different treatments on increments in leaf number during the first four months and the total increments after four months of growth are presented in Table 3 and analysis of variance in Appendix III.

The data showed that during the first month, the seedlings from May and June sowings produced higher increments in leaf number than those of July. During the second, third and fourth months, no significant difference in the increments of leaf number was observed. However, the total increments in leaves after four months of growth showed the seedlings from May-sowings to be significantly superior to those of June and July sowings. The poorest seedlings with regard to the number of leaves were from July - sowings. It can be seen from data presented in Table 3 that the increments in number of leaves is not influenced by the weight of seeds, removal of the pericarp and the interaction of the three treatments.

iii. Girth of the seedlings

The effect of different treatments on monthly mean

Table 4. Effect of period of collection of seeds, weight of seeds and the removal of the pericarp on mean monthly increments in number of leaves upto the fourth month and total increments in number of leaves after four months of growth.

| Treatments | Initial number of leaves | Increments in number of leaves during the | | | | Total increments in number of leaves after four months of growth |
|---|---|---|---|---|---|---|
| | | first month | Second month | Third month | Fourth month | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| $a_1$ | 2.18 | 0.94 | 1.86 | 2.41 | 2.48 | 7.78 |
| $a_2$ | 2.31 | 1.01 | 1.95 | 2.08 | 2.48 | 7.47 |
| $a_3$ | 2.16 | 0.49 | 1.65 | 2.20 | 2.42 | 6.79 |
| $SE_m$ | — | 0.05 | 0.09 | 0.08 | 0.08 | 0.09 |
| C.D. (0.05) | — | 0.16 | — | — | — | 0.08 |
| $b_1$ | 2.08 | 0.85 | 2.13 | 2.12 | 2.51 | 7.66 |
| $b_2$ | 2.32 | 0.84 | 1.51 | 2.11 | 2.52 | 6.92 |
| $b_3$ | 2.25 | 0.76 | 1.85 | 2.49 | 2.35 | 7.46 |
| $SE_m$ | — | 0.05 | 0.09 | 0.08 | 0.08 | 0.09 |
| C.D. (0.05) | — | — | — | — | — | — |
| $c_1$ | 2.03 | 0.84 | 1.66 | 2.20 | 2.33 | 7.03 |
| $c_2$ | 2.41 | 0.79 | 1.99 | 2.28 | 2.63 | 7.69 |
| $SE_m$ | — | 0.05 | 0.07 | 0.07 | 0.06 | 0.08 |
| C.D. (0.05) | — | — | — | — | — | — |

$a_1$ Early season seeds
$a_2$ Mid season seeds
$a_3$ Late season seeds

$b_1$ Heavy seeds
$b_2$ Medium seeds
$b_3$ Light seeds

$c_1$ Pericarp removed
$c_2$ Pericarp intact

Table 4 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| $a_1b_1$ | 2.00 | 1.08 | 2.25 | 2.03 | 2.25 | 7.78 |
| $a_1b_2$ | 2.36 | 0.85 | 1.38 | 2.53 | 2.62 | 7.38 |
| $a_1b_3$ | 2.22 | 0.90 | 2.03 | 2.66 | 2.58 | 8.18 |
| $a_2b_1$ | 2.18 | 1.00 | 2.30 | 2.03 | 2.86 | 8.20 |
| $a_2b_2$ | 2.40 | 1.22 | 1.66 | 1.57 | 2.46 | 6.75 |
| $a_2b_3$ | 2.36 | 0.81 | 1.88 | 2.65 | 2.12 | 7.46 |
| $a_3b_1$ | 2.08 | 0.46 | 1.85 | 2.28 | 2.41 | 7.02 |
| $a_3b_2$ | 2.20 | 0.45 | 1.48 | 2.22 | 2.48 | 6.63 |
| $a_3b_3$ | 2.20 | 0.56 | 1.63 | 2.26 | 2.36 | 6.73 |
| $SE_m$ | — | 0.09 | 0.16 | 0.15 | 0.11 | 0.15 |
| C.D. (0.05) | — | — | — | — | — | — |
| $a_1c_1$ | 2.00 | 1.00 | 1.91 | 2.31 | 2.27 | 7.50 |
| $a_1c_2$ | 2.37 | 0.88 | 1.86 | 2.51 | 2.68 | 8.07 |
| $a_2c_1$ | 2.07 | 0.91 | 1.71 | 2.28 | 2.53 | 7.43 |
| $a_2c_2$ | 2.55 | 1.11 | 2.18 | 1.88 | 2.43 | 7.51 |
| $a_3c_1$ | 2.01 | 0.80 | 1.37 | 2.01 | 2.08 | 6.09 |
| $a_3c_2$ | 2.31 | 0.39 | 1.93 | 2.43 | 2.75 | 7.51 |
| $SE_m$ | — | 0.08 | 0.13 | 0.12 | 0.11 | 0.14 |
| C.D. (0.05) | — | — | — | — | — | — |
| $b_1c_1$ | 2.01 | 0.84 | 1.98 | 2.24 | 2.39 | 7.46 |
| $b_1c_2$ | 2.17 | 0.85 | 2.28 | 1.99 | 2.63 | 7.87 |
| $b_2c_1$ | 2.06 | 1.00 | 1.43 | 1.87 | 2.36 | 6.66 |
| $b_2c_2$ | 2.57 | 0.67 | 1.58 | 2.34 | 2.67 | 7.18 |
| $b_3c_1$ | 2.01 | 0.66 | 0.150 | 2.48 | 2.14 | 6.89 |
| $b_3c_2$ | 2.50 | 0.85 | 2.11 | 2.50 | 2.56 | 8.03 |
| $SE_m$ | — | 0.08 | 0.13 | 0.12 | 0.11 | 0.14 |
| C.D. (0.05) | — | — | — | — | — | — |

Table 5. Effect of period of collection of seeds, weight of seeds and the removal of pericarp on mean monthly increments in girth of the seedlings upto the fourth month and total increments in girth of the seedlings after four months of growth.

| Treatments | Initial girth (cm) | Increments in girth (cm) during the | | | | Total increments in girth (cm) after four months of growth |
|---|---|---|---|---|---|---|
| | | First month | Second month | Third month | Fourth month | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| $a_1$ | 0.331 | 0.024 | 0.067 | 0.054 | 0.081 | 0.217 |
| $a_2$ | 0.328 | 0.022 | 0.070 | 0.050 | 0.079 | 0.224 |
| $a_3$ | 0.310 | 0.024 | 0.066 | 0.055 | 0.091 | 0.232 |
| $SE_m$ | — | 0.003 | 0.004 | 0.005 | 0.004 | 0.004 |
| C.D. (0.05) | — | — | — | — | — | — |
| $b_1$ | 0.317 | 0.017 | 0.062 | 0.053 | 0.078 | 0.213 |
| $b_2$ | 0.327 | 0.022 | 0.073 | 0.047 | 0.089 | 0.233 |
| $b_3$ | 0.324 | 0.031 | 0.068 | 0.053 | 0.083 | 0.227 |
| $SE_m$ | — | 0.003 | 0.004 | 0.005 | 0.004 | 0.004 |
| C.D. (0.05) | — | — | — | — | — | 0.012 |
| $c_1$ | 0.320 | 0.023 | 0.062 | 0.052 | 0.080 | 0.217 |
| $c_2$ | 0.336 | 0.024 | 0.073 | 0.051 | 0.087 | 0.232 |
| $SE_m$ | — | 0.002 | 0.003 | 0.004 | 0.003 | 0.003 |
| C.D. (0.05) | — | — | — | — | — | — |

$a_1$ Early season seeds
$a_2$ Mid season seeds
$a_3$ Late season seeds
$b_1$ Heavy seeds
$b_2$ Medium seeds
$b_3$ Light seeds
$c_1$ Pericarp removed
$c_2$ Pericarp intact

Table 5 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| $a_1b_1$ | 0.333 | 0.016 | 0.053 | 0.046 | 0.070 | 0.187 |
| $a_1b_2$ | 0.343 | 0.026 | 0.070 | 0.041 | 0.096 | 0.235 |
| $a_1b_3$ | 0.316 | 0.030 | 0.078 | 0.075 | 0.076 | 0.230 |
| $a_2b_1$ | 0.320 | 0.016 | 0.072 | 0.071 | 0.066 | 0.231 |
| $a_2b_2$ | 0.336 | 0.013 | 0.080 | 0.046 | 0.083 | 0.225 |
| $a_2b_3$ | 0.328 | 0.036 | 0.058 | 0.032 | 0.088 | 0.215 |
| $a_3b_1$ | 0.310 | 0.018 | 0.061 | 0.041 | 0.098 | 0.220 |
| $a_3b_2$ | 0.301 | 0.028 | 0.068 | 0.050 | 0.088 | 0.240 |
| $a_3b_3$ | 0.328 | 0.025 | 0.068 | 0.055 | 0.086 | 0.023 |
| $SE_m$ | — | 0.005 | 0.007 | 0.008 | 0.007 | 0.007 |
| C.D. (0.05) | — | — | — | — | — | — |
| $a_1c_1$ | 0.328 | 0.025 | 0.064 | 0.066 | 0.073 | 0.217 |
| $a_1c_2$ | 0.333 | 0.023 | 0.070 | 0.042 | 0.088 | 0.216 |
| $a_2c_1$ | 0.322 | 0.022 | 0.067 | 0.053 | 0.081 | 0.322 |
| $a_2c_2$ | 0.334 | 0.022 | 0.072 | 0.046 | 0.077 | 0.215 |
| $a_3c_1$ | 0.308 | 0.022 | 0.054 | 0.036 | 0.086 | 0.200 |
| $a_3c_2$ | 0.311 | 0.025 | 0.077 | 0.084 | 0.095 | 0.263 |
| $SE_m$ | — | 0.004 | 0.006 | 0.006 | 0.005 | 0.006 |
| C.D. (0.05) | — | — | — | — | — | — |
| $b_1c_1$ | 0.314 | 0.013 | 0.066 | 0.052 | 0.066 | 0.197 |
| $b_1c_2$ | 0.321 | 0.021 | 0.062 | 0.054 | 0.090 | 0.227 |
| $b_2c_1$ | 0.324 | 0.022 | 0.080 | 0.050 | 0.093 | 0.231 |
| $b_2c_2$ | 0.330 | 0.023 | 0.073 | 0.045 | 0.085 | 0.236 |
| $b_3c_1$ | 0.321 | 0.034 | 0.073 | 0.084 | 0.081 | 0.221 |
| $b_3c_2$ | 0.327 | 0.026 | 0.068 | 0.053 | 0.086 | 0.230 |
| $SE_m$ | — | 0.004 | 0.006 | 0.006 | 0.006 | 0.006 |
| C.D. (0.05) | — | — | — | — | — | — |

increments in girth and the total increment in girth after four months of growth are presented in Table 4 and the analysis of variance in Appendix IV. It could be observed from the data that the increments in girth was not influenced by any of the treatments except seed weight. The total increments in girth after four months of growth was higher in the seedlings from medium and light seeds, and they were on par. The seedlings from heavier seeds recorded the lowest girth increments.

iv. Evaluation of vigour of seedlings by scoring technique

In order to have an overall assessment of seedling vigour as a result of the different treatments, a scoring technique was adopted. The scores obtained for the different treatments are presented in Table 5. The seedlings which obtained scores of 7, 8 or 9 were considered as vigorous, those with 4, 5 or 6 as medium vigrous and the remaining as weak. None of the treatments produced seedlings with a score of 9. The May - sown seeds, May - sown heavy, medium or light seeds and May- sown peeled or unpeeled seeds produced seedlings with scores of 7 or 8 and as such considered more vigorous. Vigorous seedlings were also produced by medium seeds, unpeeled seeds, June heavy seeds, June peeled seeds, July peeled seeds, Heavy unpeeled seeds and light unpeeled seeds. July sown peeled seeds produced the weakest seedlings (score 3 out of 9).

Table 6. Effect of period of collection of seeds, weight of seeds and removal of the pericarp on the vigour of the seedlings after four months of growth.

| Treatments | Increments in height | Increments in number of leaves | Increments in girth | Total score out of a possible maximum of 9 |
|---|---|---|---|---|
| $a_1$ | 3 | 3 | 2 | 8 |
| $a_2$ | 2 | 2 | 2 | 6 |
| $a_3$ | 1 | 1 | 2 | 4 |
| $b_1$ | 2 | 2 | 1 | 5 |
| $b_2$ | 2 | 2 | 3 | 7 |
| $b_3$ | 1 | 2 | 2 | 5 |
| $c_1$ | 2 | 2 | 2 | 6 |
| $c_2$ | 2 | 3 | 2 | 7 |
| $a_1b_1$ | 3 | 3 | 1 | 7 |
| $a_1b_2$ | 3 | 2 | 3 | 8 |
| $a_1b_3$ | 2 | 3 | 2 | 7 |
| $a_2b_1$ | 3 | 3 | 2 | 8 |
| $a_2b_2$ | 2 | 1 | 2 | 5 |
| $a_2b_3$ | 1 | 2 | 1 | 4 |
| $a_3b_1$ | 1 | 2 | 2 | 5 |
| $a_3b_2$ | 2 | 1 | 3 | 6 |
| $a_3b_3$ | 1 | 1 | 3 | 5 |
| $a_1c_1$ | 3 | 2 | 2 | 7 |
| $a_1c_2$ | 3 | 3 | 1 | 7 |
| $a_2c_1$ | 2 | 2 | 3 | 7 |
| $a_2c_2$ | 2 | 2 | 1 | 5 |
| $a_3c_1$ | 1 | 1 | 1 | 3 |
| $a_3c_2$ | 2 | 2 | 3 | 7 |
| $b_1c_1$ | 2 | 2 | 1 | 5 |
| $b_1c_2$ | 3 | 3 | 2 | 8 |
| $b_2c_1$ | 2 | 1 | 2 | 5 |
| $b_2c_2$ | 3 | 2 | 3 | 8 |
| $b_3c_1$ | 1 | 1 | 2 | 4 |
| $b_3c_2$ | 2 | 3 | 2 | 7 |

## 4. Effect of containers, potting mixtures and chemical boosters on the growth and vigour of the seedlings

The results of the experiment conducted to evaluate the three types of containers (clay pots, polythene bags and coconut husk pots), three types of potting mixtures (Mixture 1, Mixture 2 and Mixture 3) and two chemical boosters (GA and urea) on the growth and vigour of clove seedlings are described as follows:

### i. Physical characteristics of containers

The different physical constants for the three types of containers used in this study are presented in Table 7. The different containers were so selected to have uniform internal capacity. The total porosity and the relative evaporating capacity of the three types of containers were markedly different with the mean values ranging from 20.0 to 48.2 per cent and 21.2 to 27.2 g respectively.

### ii. Physico-chemical characteristics of potting mixtures

The data relating to different physico-chemical characteristics of the potting mixtures used for the study are presented in Table 8. The specific gravity and apparant density were not affected by the addition of bonemeal and groundnut cake, while the pore space and water holding capacity were increased slightly by adding groundnut cake in the mixture. It can also be seen from the table that there was not much

Table 7. Physical characteristics of the different containers.

| Containers | Total porosity (per cent) | Relative evaporating capacity (g) |
|---|---|---|
| Clay pots | 30.8 | 21.2 |
| Polythene bags | 20.0 | 22.8 |
| Coconut husk pots | 48.2 | 27.2 |

Table 8. Physico-chemical characteristics of the different potting mixtures.

| Potting mixtures | Physical characteristics | | | | Chemical characteristics | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Specific gravity | Apparent density | Pore space (per cent) | Water holding capacity (per cent) | Moisture (per cent) | Soil reaction | Electrical conductivity (mmhos/cm$^2$) | Organic matter (per cent) | Total nitrogen (per cent) | Available phosphorus (per cent) | Available potassium (per cent) |
| Mixture 1 | 3.05 | 1.13 | 41.22 | 40.83 | 2.4 | 6.6 | 4.1 | 6.5 | 0.225 | 0.060 | 0.033 |
| Mixture 2 | 3.08 | 1.21 | 42.11 | 41.35 | 2.2 | 6.9 | 4.3 | 6.0 | 0.223 | 0.058 | 0.035 |
| Mixture 3 | 3.12 | 1.24 | 45.52 | 44.45 | 2.5 | 6.2 | 4.7 | 6.8 | 0.227 | 0.059 | 0.038 |

change in the chemical properties of the mixtures by the addition of bonemeal and groundnut cake.

iii. Height of the seedlings

The mean increments in the height of the seedlings during every month upto the seventh month and the total increment in the height after seven months of growth in the nursery are presented in Table 9 and the analysis of variance in Appendix VI. The data have been presented in Fig. 3 also.

The mean increments in height of the seedlings were not influenced by the type of the container upto the fourth month. During the fifth month, polythene bags were found to be superior. Coconut husk pots produced significantly taller seedlings than clay pots. During the sixth and seventh months, the coconut husk pots and polythene bags were on par, but superior to clay pots. The total increments in height after seven months of growth indicated that the most effective container was the coconut husk pot. The potting mixtures did not show any significant effect on height increments during the first and second months. During the third month, Mixture 2 was on par with Mixture 3, both being superior to Mixture 1. The height increment during the fourth to seventh months, as well as the total height increment after seven months of growth showed Mixture 3 to be the most effective, followed by Mixture 2. The effect of foliar sprays on the growth of the seedlings revealed no significant difference during the first and second months. The analysis

Table 9. Effect of containers, potting mixtures and foliar sprays on mean increments in height upto the seventh month and total increments in height after seven months of growth.

| Treatments | Increments in height (cm) during the | | | | | | | Total increments in height after seven months of growth |
|---|---|---|---|---|---|---|---|---|
| | First month | Second month | Third month | Fourth month | Fifth month | Sixth month | Seventh month | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| $a_1$ | 0.199 | 0.458 | 0.848 | 1.056 | 1.053 | 1.071 | 1.156 | 5.877 |
| $a_2$ | 0.230 | 0.413 | 0.919 | 1.185 | 1.844 | 1.334 | 1.396 | 6.743 |
| $a_3$ | 0.233 | 0.448 | 0.899 | 1.255 | 1.240 | 1.370 | 1.384 | 6.849 |
| $SE_m$ | 0.006 | 0.009 | 0.017 | 0.028 | 0.011 | 0.013 | 0.025 | 0.029 |
| C.D. (0.05) | — | — | — | — | 0.031 | 0.037 | 0.069 | 0.081 |
| $b_1$ | 0.227 | 0.439 | 0.771 | 0.960 | 0.996 | 1.093 | 1.202 | 5.775 |
| $b_2$ | 0.214 | 0.438 | 0.945 | 1.202 | 1.198 | 1.327 | 1.301 | 6.659 |
| $b_3$ | 0.221 | 0.442 | 0.949 | 1.298 | 1.316 | 1.357 | 1.432 | 7.035 |
| $SE_m$ | 0.006 | 0.009 | 0.017 | 0.028 | 0.011 | 0.013 | 0.025 | 0.029 |
| C.D. (0.05) | — | — | 0.049 | 0.079 | 0.031 | 0.037 | 0.069 | 0.081 |
| $c_1$ | 0.216 | 0.444 | 0.885 | 1.152 | 1.145 | 1.156 | 1.326 | 6.314 |
| $c_2$ | 0.221 | 0.443 | 0.927 | 1.162 | 1.210 | 1.390 | 1.407 | 6.888 |
| $c_3$ | 0.201 | 0.439 | 0.875 | 1.108 | 1.066 | 1.190 | 1.210 | 6.083 |
| $c_4$ | 0.231 | 0.466 | 0.947 | 1.354 | 1.182 | 1.320 | 1.266 | 6.707 |
| $c_5$ | 0.237 | 0.437 | 0.965 | 1.166 | 1.443 | 1.434 | 1.517 | 7.433 |
| $c_6$ | 0.220 | 0.407 | 0.732 | 1.052 | 1.623 | 1.060 | 1.444 | 5.515 |
| $SE_m$ | 0.008 | 0.012 | 0.025 | 0.040 | 0.015 | 0.018 | 0.035 | 0.041 |
| C.D. (0.05) | — | — | 0.070 | 0.112 | 0.442 | 0.053 | 0.098 | 0.114 |

Table 9 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| $a_1b_1$ | 0.254 | 0.468 | 0.746 | 0.882 | 0.876 | 0.917 | 0.958 | 5.100 |
| $a_1b_2$ | 0.176 | 0.442 | 0.845 | 1.098 | 1.088 | 1.159 | 1.257 | 6.143 |
| $a_1b_3$ | 0.166 | 0.463 | 0.953 | 1.187 | 1.195 | 1.135 | 1.252 | 6.390 |
| $a_2b_1$ | 0.209 | 0.375 | 0.760 | 1.032 | 0.985 | 1.138 | 1.338 | 5.938 |
| $a_2b_2$ | 0.232 | 0.425 | 0.957 | 1.231 | 1.240 | 1.413 | 1.324 | 6.910 |
| $a_2b_3$ | 0.247 | 0.436 | 1.040 | 1.294 | 1.320 | 1.452 | 1.524 | 7.381 |
| $a_3b_1$ | 0.217 | 0.473 | 0.808 | 1.075 | 1.038 | 1.221 | 1.308 | 6.287 |
| $a_3b_2$ | 0.233 | 0.445 | 1.033 | 1.277 | 1.260 | 1.407 | 1.321 | 6.925 |
| $a_3b_3$ | 0.248 | 0.425 | 0.855 | 1.413 | 1.433 | 1.485 | 1.521 | 7.335 |
| $SE_m$ | 0.111 | 0.016 | 0.031 | 0.041 | 0.019 | 0.023 | 0.043 | 0.058 |
| C.D. (0.05) | 0.029 | — | 0.086 | — | — | — | — | 0.140 |

| | | | |
|---|---|---|---|
| $a_1$ | Clay pot | $b_1$ | Mixture 1 |
| $a_2$ | Polythene bag | $b_2$ | Mixture 2 |
| $a_3$ | Coconut husk pot | $b_3$ | Mixture 3 |
| $c_1$ | GA 100 ppm | $c_4$ | GA 100 ppm + urea 0.5 per cent |
| $c_2$ | GA 200 ppm | $c_5$ | GA 200 ppm + urea 0.5 per cent |
| $c_3$ | Urea 0.5 per cent | $c_6$ | control |

Table 9 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| $a_1c_1$ | 0.222 | 0.433 | 0.742 | 1.075 | 1.000 | 1.091 | 1.244 | 5.731 |
| $a_1c_2$ | 0.171 | 0.467 | 0.945 | 1.148 | 1.228 | 1.138 | 1.283 | 6.442 |
| $a_1c_3$ | 0.157 | 0.475 | 0.814 | 1.035 | 0.977 | 0.995 | 1.108 | 5.510 |
| $a_1c_4$ | 0.228 | 0.486 | 0.927 | 1.153 | 1.330 | 1.144 | 1.157 | 6.280 |
| $a_1c_5$ | 0.188 | 0.462 | 1.035 | 1.042 | 1.168 | 1.262 | 1.275 | 6.633 |
| $a_1c_6$ | 0.226 | 0.424 | 0.624 | 0.882 | 0.813 | 0.793 | 0.866 | 4.671 |
| $a_2c_1$ | 0.187 | 0.408 | 0.877 | 1.148 | 1.186 | 1.168 | 1.388 | 6.490 |
| $a_2c_2$ | 0.235 | 0.393 | 0.931 | 1.117 | 1.142 | 1.604 | 1.320 | 6.920 |
| $a_2c_3$ | 0.224 | 0.402 | 0.873 | 1.120 | 1.037 | 1.268 | 1.304 | 6.220 |
| $a_2c_4$ | 0.256 | 0.451 | 0.920 | 1.420 | 1.237 | 1.335 | 1.424 | 6.910 |
| $a_2c_5$ | 0.226 | 0.408 | 1.068 | 1.191 | 1.157 | 1.491 | 1.633 | 7.850 |
| $a_2c_6$ | 0.208 | 0.411 | 0.844 | 1.117 | 0.984 | 1.140 | 1.304 | 6.060 |
| $a_3c_1$ | 0.237 | 0.491 | 1.035 | 2.232 | 1.251 | 1.208 | 1.344 | 6.722 |
| $a_3c_2$ | 0.255 | 0.468 | 0.906 | 1.222 | 1.261 | 1.426 | 1.620 | 7.305 |
| $a_3c_3$ | 0.220 | 0.440 | 0.937 | 1.168 | 1.182 | 1.315 | 1.217 | 6.520 |
| $a_3c_4$ | 0.206 | 0.462 | 0.995 | 1.488 | 1.175 | 1.480 | 1.216 | 6.928 |
| $a_3c_5$ | 0.255 | 0.440 | 0.791 | 1.264 | 1.642 | 1.551 | 1.644 | 7.806 |
| $a_3c_6$ | 0.244 | 0.386 | 0.728 | 1.155 | 0.951 | 1.246 | 1.260 | 5.813 |
| $SE_m$ | 0.015 | 0.023 | 0.043 | 0.068 | 0.027 | 0.033 | 0.061 | 0.071 |
| C.D. (0.05) | — | — | 0.122 | — | 0.076 | 0.092 | 0.169 | 0.198 |

Table 9 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| $b_1c_1$ | 0.218 | 0.444 | 0.777 | 0.934 | 0.908 | 1.011 | 1.197 | 5.525 |
| $b_1c_2$ | 0.204 | 0.468 | 0.853 | 0.911 | 0.998 | 1.115 | 1.282 | 6.067 |
| $b_1c_3$ | 0.217 | 0.411 | 0.727 | 0.946 | 0.862 | 0.971 | 1.057 | 5.158 |
| $b_1c_4$ | 0.237 | 0.480 | 0.792 | 1.162 | 0.988 | 1.082 | 1.215 | 5.924 |
| $b_1c_5$ | 0.225 | 0.442 | 0.844 | 1.015 | 1.262 | 1.276 | 1.380 | 6.784 |
| $b_1c_6$ | 0.288 | 0.388 | 0.635 | 1.008 | 0.880 | 1.100 | 1.080 | 5.191 |
| $b_2c_1$ | 0.211 | 0.431 | 0.924 | 1.231 | 1.226 | 1.180 | 1.302 | 6.500 |
| $b_2c_1$ | 0.217 | 0.427 | 0.950 | 1.264 | 1.300 | 1.601 | 1.250 | 7.064 |
| $b_2c_2$ | 0.180 | 0.422 | 1.006 | 1.142 | 1.115 | 1.180 | 1.302 | 6.313 |
| $b_2c_3$ | 0.238 | 0.468 | 0.020 | 1.328 | 1.240 | 1.488 | 1.293 | 7.027 |
| $b_2c_4$ | 0.222 | 0.457 | 1.051 | 1.124 | 1.390 | 1.540 | 1.602 | 7.706 |
| $b_2c_5$ | 0.215 | 0.420 | 0.720 | 1.124 | 0.913 | 0.968 | 1.055 | 6.346 |
| $b_2c_6$ | 0.217 | 0.457 | 0.953 | 1.291 | 1.302 | 1.277 | 1.477 | 6.917 |
| $b_3c_1$ | 0.240 | 0.433 | 0.980 | 1.313 | 1.333 | 1.458 | 1.691 | 7.533 |
| $b_3c_2$ | 0.204 | 0.484 | 0.891 | 1.235 | 1.220 | 1.428 | 1.271 | 6.777 |
| $b_3c_3$ | 0.215 | 0.451 | 1.030 | 1.571 | 1.317 | 1.388 | 1.290 | 7.171 |
| $b_3c_4$ | 0.233 | 0.411 | 1.000 | 1.357 | 1.668 | 1.496 | 1.570 | 7.806 |
| $b_3c_5$ | 0.215 | 0.413 | 0.842 | 1.022 | 1.055 | 1.110 | 1.295 | 6.006 |
| $b_3c_6$ | | | | | | | | |
| $SE_m$ | 0.015 | 0.022 | 0.043 | 0.068 | 0.027 | 0.033 | 0.061 | 0.071 |
| C.D. (0.05) | — | — | — | — | 0.076 | 0.092 | 0.169 | 0.198 |

$a_1$. CLAY POTS.
$a_2$. POLYTHENE BAGS.
$a_3$. COCONUT HUSK POTS.

$b_1$. MIXTURE - 1
$b_2$. MIXTURE - 2
$b_3$. MIXTURE - 3

$C_1$. GA 100 ppm.
$C_2$. GA 200 ppm.
$C_3$. UREA 0.5 PERCENT.
$C_4$. GA 100 ppm. + UREA 0.5 PERCENT.
$C_5$. GA 200 ppm. + UREA 0.5 PERCENT.
$C_6$. CONTROL.

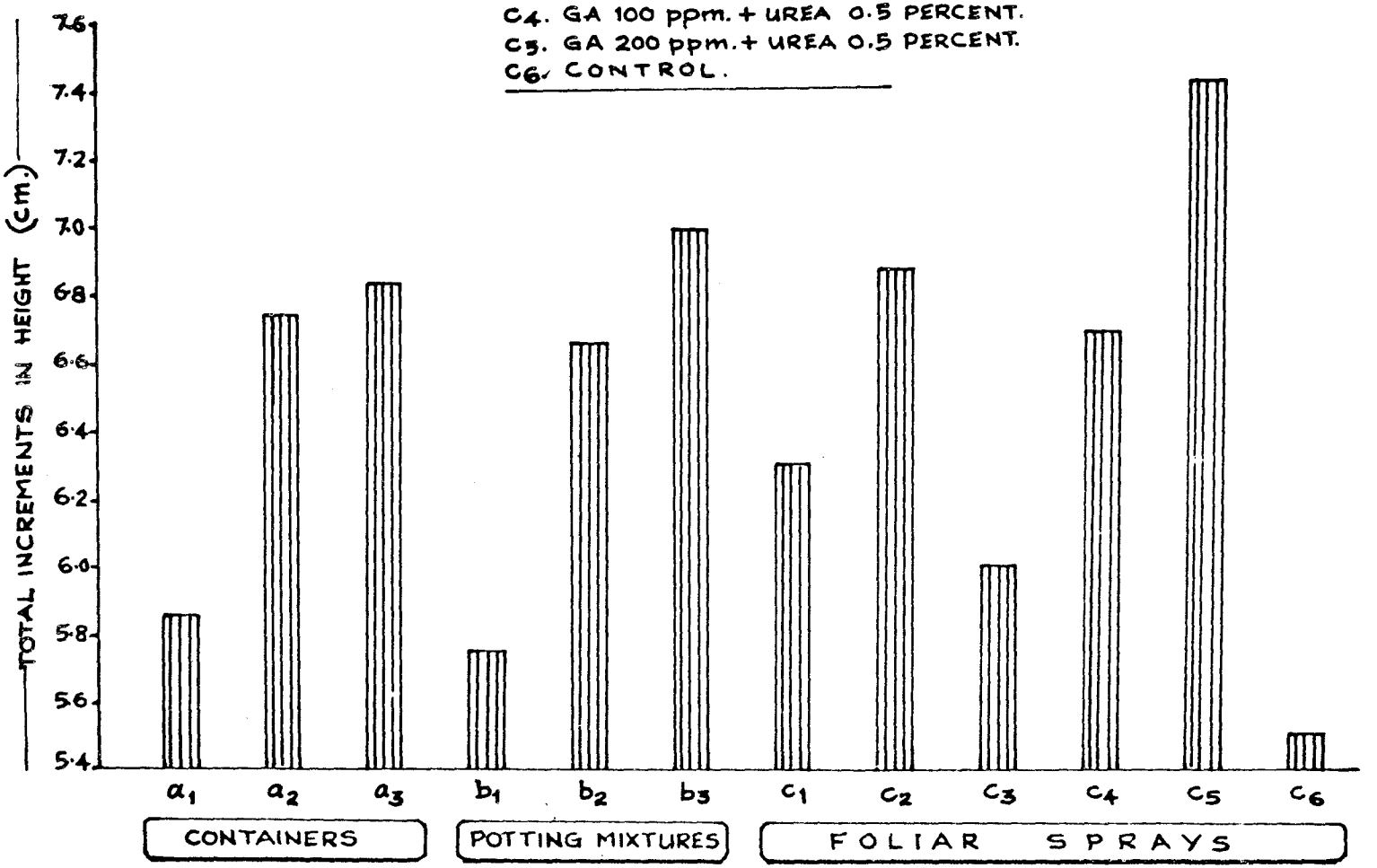


FIG. 3. EFFECT OF CONTAINERS, POTTING MIXTURES AND FOLIAR SPRAYS ON TOTAL INCREMENTS IN HEIGHT AFTER SEVEN MONTHS OF GROWTH IN THE NURSERY.

of the height increment for the third month showed that the seedlings sprayed with GA 200 ppm + urea 0.5 per cent, GA 100 ppm + urea 0.5 per cent and GA 200 ppm were on par. These were superior to the other treatments. Significant increase in height increment was produced by spraying GA 100 ppm + urea 0.5 per cent during the fourth month. During the fifth month, the seedlings receiving distilled water spray, GA 200 ppm + urea 0.5 per cent and GA 200 ppm, were on par and recorded largest height increments. The analysis of height increment for the sixth and seventh month showed that the seedlings sprayed with GA 200 ppm + urea 0.5 per cent and GA 200 ppm were on par and superior to the other treatments. The total height increment upto the seventh month showed the seedlings receiving GA 200 ppm + urea 0.5 per cent as the best treatments.

The "type of container x potting mixture" interaction was significant. It was found that during the first month, the seedlings raised in clay pots with Mixture 1, polythene bags with Mixtures 2 and 3 and coconut husk pots with Mixture 2 and 3 were on par and more effective than the other treatment combinations. The differences in height increment during the second, fourth, fifth, sixth and seventh months were not significant. During the third month, polythene bags as well as coconut husk pots with Mixture 3 were found to be the superior treatments. An analysis of the total increments in height

showed that the seedlings raised in coconut husk pots and polythene bags with Mixture 3 were on par, but superior to all the other treatment combinations.

The results showed that no significant difference was noticed between the treatments during the first, second and also during the fourth month. The height increments for the third month showed the seedlings grown in clay pots as well as polythene bags and treated with GA 200 ppm + urea 0.5 per cent and coconut husk pots sprayed with GA 100 ppm or GA 100 ppm + urea 0.5 per cent to be on par. These were superior to be other treatment combinations. The mean increments in height for the fifth month indicated that the seedlings in coconut husk pots and treated with GA 200 ppm + urea 0.5 per cent was superior to the others. During the sixth month, the seedlings in the polythene bags and coconut husk pots treated with GA 200 ppm + urea 0.5 per cent were on par, and superior to the others. The mean increments in height during the seventh month, showed that the seedlings in polythene bags treated with GA 200 ppm + urea 0.5 per cent, coconut husk pots treated with GA 200 ppm or GA 200 ppm + urea 0.5 per cent which were on par, were the most effective ones. The analysis of the total height increment revealed that the seedlings in coconut husk pot and polythene bags and treated with GA 200 ppm + urea 0.5 per cent were on par and superior to the other treatments. The results also showed that the difference in height increments upto the fourth month was not significant. During the fifth month, the

seedlings grown in Mixture 3 and treated with GA 200 ppm + urea 0.5 per cent recorded the maximum height increment. The mean increment in height during the sixth month showed that the seedlings in Mixture 2 and sprayed with GA 100 ppm + urea 0.5 per cent or GA 200 ppm + urea and Mixture 3 sprayed with GA 200 ppm, or urea 0.5 per cent or with GA 200 ppm + urea 0.5 per cent were on par and superior to all the other treatments. During the seventh month the seedlings in Mixture 2 treated with GA 200 ppm + urea 0.5 per cent and Mixture 3 with GA 200 ppm or with GA 200 ppm + urea 0.5 per cent were on par and the effective treatments. An analysis of the total increments in height revealed that the maximum increments in height was recorded by the seedlings in Mixture 3 and Mixture 2 and sprayed with GA 200 ppm + urea 0.5 per cent.

iv. Number of leaves

The mean increments in number of leaves during the first to seven months and the total increments in height after seven months of growth in the nursery are presented in Table 10 and the analysis of variance in Appendix VII. The data have been presented in Fig. 4 also.

When data relating to mean increments in leaf number during the second and third month and the total increments in number of leaves after seven months of growth were analysed, coconut husk pots were found to be superior to polythene bags

Table 10. Effect of containers, potting mixtures and foliar sprays on mean increments in number of leaves upto the seventh month and total increments in number of leaves after seven months of growth.

| Treatments | Increments in number of leaves during the | | | | | | | Total increments in number of leaves after seven months of growth |
|---|---|---|---|---|---|---|---|---|
| | First month | Second Month | Third month | Fourth month | Fifth month | Sixth month | Seventh month | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| $a_1$ | 1.092 | 1.263 | 1.307 | 1.411 | 1.540 | 1.853 | 1.811 | 10.30 |
| $a_2$ | 1.215 | 1.488 | 1.520 | 1.520 | 1.425 | 1.511 | 2.237 | 10.96 |
| $a_3$ | 1.341 | 1.600 | 1.655 | 1.681 | 1.576 | 1.610 | 1.994 | 11.43 |
| $SE_m$ | 0.066 | 0.037 | 0.039 | 0.041 | 0.041 | 0.047 | 0.052 | 0.074 |
| C.D. (0.05) | — | 0.100 | 0.109 | — | — | — | — | 0.206 |
| $b_1$ | 1.155 | 1.304 | 1.359 | 1.368 | 1.443 | 1.511 | 1.874 | 9.94 |
| $b_2$ | 1.185 | 1.385 | 1.462 | 1.529 | 1.429 | 1.561 | 2.098 | 10.67 |
| $b_3$ | 1.307 | 1.633 | 1.691 | 1.692 | 1.670 | 1.898 | 2.120 | 12.09 |
| $SE_m$ | 0.066 | 0.037 | 0.039 | 0.041 | 0.041 | 0.047 | 0.052 | 0.074 |
| C.D. (0.05) | — | 0.103 | — | — | — | 0.131 | — | 0.206 |
| $c_1$ | 1.177 | 1.304 | 1.481 | 1.488 | 1.411 | 1.611 | 2.118 | 10.53 |
| $c_2$ | 1.393 | 1.496 | 1.659 | 1.696 | 1.607 | 1.829 | 2.125 | 11.60 |
| $c_3$ | 1.074 | 1.444 | 1.407 | 1.474 | 1.488 | 1.444 | 1.848 | 10.23 |
| $c_4$ | 1.229 | 1.555 | 1.555 | 1.651 | 1.452 | 1.655 | 1.270 | 11.40 |
| $c_5$ | 1.304 | 1.629 | 1.614 | 1.570 | 1.733 | 2.085 | 2.410 | 12.41 |
| $c_6$ | 1.119 | 1.274 | 1.244 | 1.341 | 1.393 | 1.318 | 1.410 | 9.20 |
| $SE_m$ | 0.093 | 0.052 | 0.055 | 0.057 | 0.054 | 0.066 | 0.074 | 0.104 |
| C.D. (0.05) | — | 0.146 | 0.155 | 0.162 | 0.164 | 0.185 | 0.356 | 0.290 |

Table 10 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| $a_1b_1$ | 1.177 | 1.133 | 1.266 | 1.355 | 1.622 | 1.627 | 2.105 | 10.04 |
| $a_1b_2$ | 0.988 | 1.244 | 1.355 | 1.500 | 1.400 | 1.894 | 1.638 | 10.02 |
| $a_1b_3$ | 1.111 | 1.411 | 1.300 | 1.377 | 1.588 | 2.038 | 1.838 | 10.84 |
| $a_2b_1$ | 1.111 | 1.322 | 1.211 | 1.244 | 1.277 | 1.455 | 1.677 | 9.32 |
| $a_2b_2$ | 1.155 | 1.433 | 1.477 | 1.511 | 1.330 | 1.277 | 1.711 | 10.97 |
| $a_2b_3$ | 1.377 | 1.711 | 1.866 | 1.800 | 1.666 | 1.800 | 2.32 | 12.58 |
| $a_3b_1$ | 1.177 | 1.455 | 1.600 | 1.566 | 1.427 | 1.450 | 1.838 | 10.46 |
| $a_3b_2$ | 1.411 | 1.477 | 1.550 | 1.577 | 1.550 | 1.510 | 1.944 | 11.00 |
| $a_3b_3$ | 1.433 | 1.866 | 1.810 | 1.900 | 1.755 | 1.855 | 2.200 | 12.82 |
| $SE_m$ | 0.144 | 0.064 | 0.068 | 0.071 | 0.072 | 0.081 | 0.090 | 0.127 |
| C.D. (0.05) | — | — | 0.190 | — | — | — | 0.252 | 0.355 |

$a_1$ Clay pot

$a_2$ Polythene bag

$a_3$ Cocoonut husk pot

$b_1$ Mixture 1

$b_2$ Mixture 2

$b_3$ Mixture 3

$c_1$ GA 100 ppm

$c_2$ GA 200 ppm

$c_3$ Urea 0.5 per cent

$c_4$ GA 100 ppm + urea 0.5 per cent

$c_5$ GA 200 ppm + urea 0.5 per cent

$c_6$ Control

Table 10 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| $a_1c_1$ | 0.995 | 1.088 | 1.355 | 1.120 | 1.511 | 1.733 | 2.177 | 9.98 |
| $a_1c_2$ | 1.622 | 1.311 | 1.488 | 1.266 | 1.622 | 1.215 | 1.955 | 11.22 |
| $a_1c_3$ | 0.711 | 1.200 | 1.133 | 1.666 | 1.400 | 1.611 | 1.633 | 9.22 |
| $a_1c_4$ | 1.200 | 1.355 | 1.311 | 1.311 | 1.533 | 1.900 | 2.033 | 10.93 |
| $a_1c_5$ | 1.177 | 1.400 | 1.400 | 1.577 | 1.711 | 2.255 | 2.144 | 11.73 |
| $a_1c_6$ | 0.888 | 1.222 | 1.155 | 1.444 | 1.440 | 1.466 | 1.222 | 8.73 |
| $a_2c_1$ | 1.200 | 1.177 | 1.422 | 1.200 | 1.266 | 1.488 | 1.355 | 10.26 |
| $a_2c_2$ | 1.220 | 1.444 | 1.711 | 1.422 | 1.533 | 1.577 | 2.440 | 11.62 |
| $a_2c_3$ | 1.177 | 1.488 | 1.377 | 1.688 | 1.511 | 1.222 | 2.066 | 10.42 |
| $a_2c_4$ | 1.155 | 1.666 | 1.688 | 1.488 | 1.266 | 1.666 | 2.444 | 11.57 |
| $a_2c_5$ | 1.288 | 1.666 | 1.577 | 1.600 | 1.644 | 1.888 | 2.444 | 12.06 |
| $a_2c_6$ | 1.244 | 1.488 | 1.333 | 1.555 | 1.333 | 1.222 | 1.666 | 9.82 |
| $a_3c_1$ | 1.377 | 1.644 | 1.666 | 1.355 | 1.455 | 1.611 | 1.822 | 11.36 |
| $a_3c_2$ | 1.333 | 1.733 | 1.777 | 1.777 | 1.666 | 1.755 | 1.977 | 11.96 |
| $a_3c_3$ | 1.333 | 1.644 | 1.711 | 1.733 | 1.555 | 1.488 | 1.840 | 11.04 |
| $a_3c_4$ | 1.333 | 1.644 | 1.666 | 1.622 | 1.555 | 1.400 | 2.330 | 11.71 |
| $a_3c_5$ | 1.444 | 1.822 | 1.866 | 1.777 | 1.844 | 2.110 | 2.644 | 13.44 |
| $a_3c_6$ | 1.220 | 1.111 | 1.240 | 1.466 | 1.400 | 1.266 | 1.344 | 9.05 |
| $SE_m$ | 0.161 | 0.090 | 0.096 | 0.100 | 0.101 | 0.114 | 0.127 | 0.179 |
| C.D. (0.05) | — | 0.253 | — | — | — | — | — | 0.502 |

Table 10 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| $b_1c_1$ | 1.222 | 1.333 | 1.377 | 1.400 | 1.233 | 1.455 | 1.666 | 9.27 |
| $b_1c_2$ | 1.577 | 1.288 | 1.511 | 1.577 | 1.711 | 1.555 | 1.860 | 10.49 |
| $b_1c_3$ | 0.955 | 1.333 | 1.222 | 1.200 | 1.511 | 1.377 | 1.550 | 9.04 |
| $b_1c_4$ | 1.133 | 1.422 | 1.555 | 1.533 | 1.266 | 1.655 | 2.500 | 11.16 |
| $b_1c_5$ | 1.066 | 1.488 | 1.355 | 1.400 | 1.466 | 1.822 | 2.440 | 11.04 |
| $b_1c_6$ | 0.977 | 1.155 | 1.133 | 1.220 | 1.446 | 1.200 | 1.440 | 8.65 |
| $b_2c_1$ | 1.066 | 1.244 | 1.511 | 1.533 | 1.377 | 1.622 | 2.220 | 10.62 |
| $b_2c_2$ | 1.222 | 1.444 | 1.644 | 1.600 | 1.311 | 1.511 | 2.460 | 11.17 |
| $b_2c_3$ | 1.111 | 1.400 | 1.333 | 1.577 | 1.400 | 1.266 | 1.860 | 9.91 |
| $b_2c_4$ | 1.155 | 1.422 | 1.444 | 1.713 | 1.422 | 1.622 | 2.150 | 10.93 |
| $b_2c_5$ | 1.422 | 1.622 | 1.644 | 1.444 | 1.800 | 1.988 | 2.580 | 12.51 |
| $b_2c_6$ | 1.133 | 1.177 | 1.200 | 1.311 | 1.266 | 1.355 | 1.280 | 8.84 |
| $b_3c_1$ | 1.244 | 1.533 | 1.550 | 1.533 | 1.622 | 1.755 | 2.460 | 11.71 |
| $b_3c_2$ | 1.377 | 1.755 | 1.822 | 1.911 | 1.800 | 2.422 | 2.040 | 13.13 |
| $b_3c_3$ | 1.155 | 1.800 | 1.666 | 1.644 | 1.550 | 1.677 | 2.120 | 11.73 |
| $b_3c_4$ | 1.400 | 1.822 | 1.666 | 1.711 | 1.666 | 1.688 | 2.150 | 12.13 |
| $b_3c_5$ | 1.422 | 1.770 | 1.844 | 1.866 | 1.933 | 2.400 | 2.400 | 13.68 |
| $b_3c_5$ | 1.244 | 1.488 | 1.400 | 1.488 | 1.444 | 1.400 | 1.530 | 10.11 |
| $SE_m$ | 0.161 | 0.090 | 0.096 | 0.100 | 0.101 | 0.114 | 0.127 | 0.179 |
| C.D. (0.05) | — | — | — | — | — | 0.321 | 0.356 | 0.502 |

$a_1$. CLAY POTS.
$a_2$. POLYTHENE BAGS.
$a_3$. COCONUT HUSK POTS.

$b_1$. MIXTURE-1.
$b_2$. MIXTURE-2.
$b_3$. MIXTURE-3.

$C_1$. GA 100 ppm.
$C_2$. GA 200 ppm.
$C_3$. UREA 0.5 PERCENT.
$C_4$. GA 100 ppm + UREA 0.5 PERCENT
$C_5$. GA 200 ppm + UREA 0.5 PERCENT.
$C_6$. CONTROL.

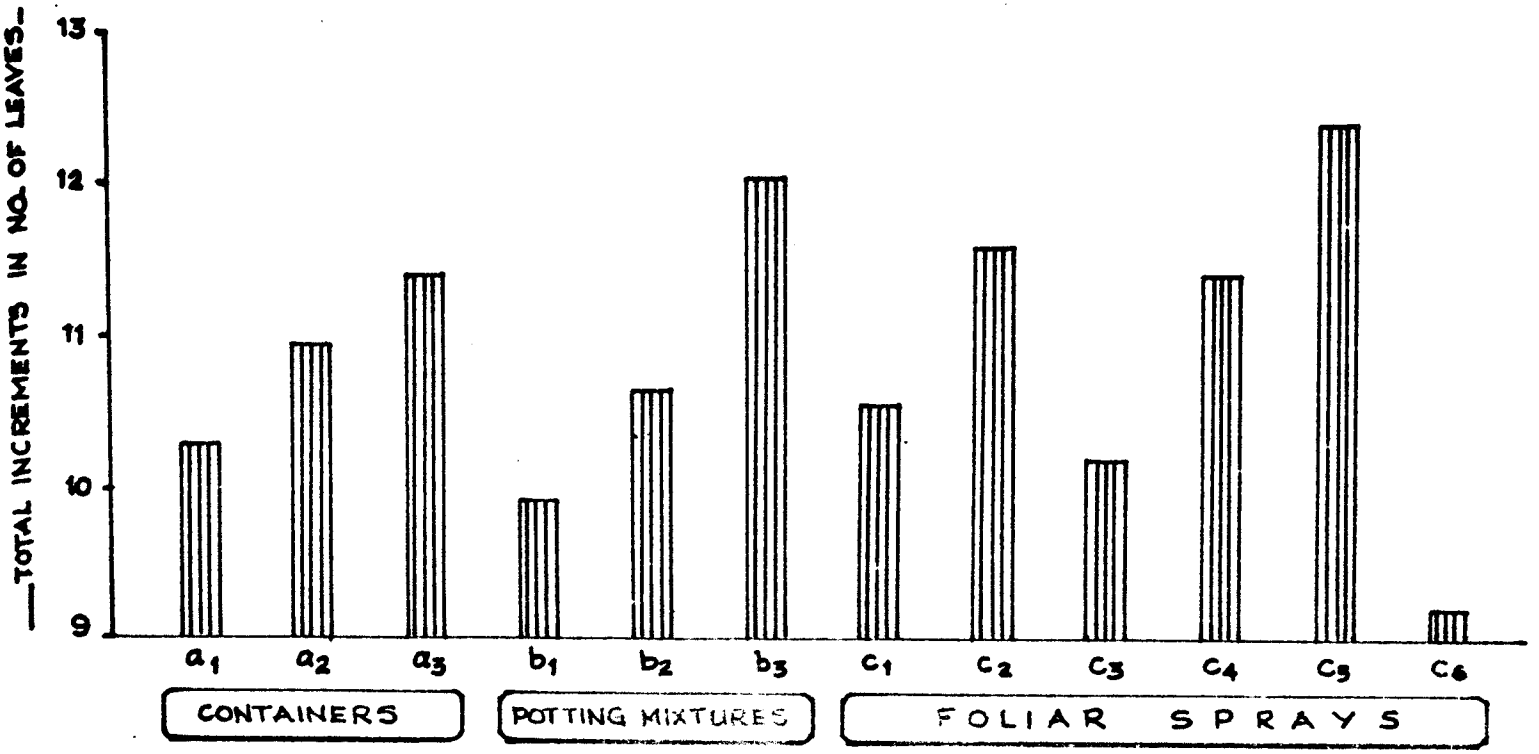


FIG. 4. EFFECT OF CONTAINERS, POTTING MIXTURES AND FOLIAR SPRAYS ON INCREMENTS IN NUMBER OF LEAVES AFTER SEVEN MONTHS OF GROWTH IN THE NURSERY.

and clay pots. The potting mixtures influenced the increments in number of leaves significantly, during the second and sixth months. During the second and sixth months Mixture 3 was significantly superior to Mixture 2 and Mixture 1. The total increments in leaf number also showed similar results. The booster sprays influenced the increments in leaf number except during the first month. During the second, third and fourth months the seedlings sprayed with GA 200 ppm, GA 100 ppm + urea 0.5 per cent and GA 200 ppm + urea 0.5 per cent were on par and superior to the other treatments. An analysis of the increments in leaf number during the fifth and sixth months indicated that the seedlings sprayed with GA 200 ppm and GA 200 ppm + urea 0.5 per cent were on par and superior to the other treatments. During the seventh month, the seedlings treated with GA 100 ppm, GA 200 ppm, GA 100 ppm + urea 0.5 per cent and GA 200 ppm + urea 0.5 per cent were on par and superior to the control. The total increments in number of leaves revealed that the seedlings receiving GA 200 ppm + urea 0.5 per cent spray was the significantly superior treatment.

The "type of container x potting mixture" interaction did not show any significant effect during the first six months except during the third. During the third month, the seedlings in the polythene bags with Mixture 2 and coconut husk pots with Mixture 3 were on par and found to be superior to the other treatments. During the seventh month, the seedlings in

clay pots with Mixture 1, polythene bags with Mixture 3 and coconut husk pots with Mixture 3 were on par and these were superior to the others. The total increments in number of leaves after seven months of growth suggested that the coconut husk pots and polythene bags with Mixture 3 were significantly superior to the other treatment combinations. The results also showed significant effect in leaf increment only during the second month. During the second month the seedlings in polythene bags and coconut husk pots treated with GA 100 ppm or 200 ppm in combination with urea 0.5 per cent, coconut husk pots with GA alone (100 ppm or 200 ppm) as well as coconut husk pots with urea along (0.5 per cent) were on par and better than the other treatment combinations. The total increments in number of leaves after the seven months of growth suggested that the seedlings raised in coconut husk pots and treated with GA 200 ppm + urea 0.5 per cent was significantly superior to the other treatments. The 'type of potting mixture x booster spray' interaction indicated no significant difference upto the fifth month. During the sixth month, the seedlings in Mixture 3 treated with GA 200 ppm and with GA 200 ppm + urea 0.5 per cent were on par and superior to all the other treatments. During the seventh month, the seedlings raised in the three mixtures and sprayed with GA 200 ppm and urea 0.5 per cent, Mixture 1 with GA 100 ppm + urea 0.5 per cent and Mixtures 2 and 3 with GA 100 ppm were on par and superior to the other treatment

combinations. After seven months of growth, the total increments in number of leaves showed the seedlings raised in Mixture 3 treated with GA 200 ppm + urea 0.5 per cent to be significantly superior to the others.

v. Girth of the seedlings

The mean increments in girth of the seedlings during the first to seven months of growth and the total increments in girth after seven months of growth in the nursery are presented in Table 11 and the analysis of variance in Appendix VIII. The data have been presented in Fig. 5 also.

The containers did not influence the mean increments in girth during the periodof observation, except during the third and seventh months. The mean values for the third month indicated that the seedlings in the coconut husk pots were significantly superior to polythene bags and clay pots, which were on par. During the seventh month, the seedlings raised in the clay pots found to be the best. After seven months of growth, the total increments indicated that the seedlings of coconut husk pots were significantly better than the other two types of containers. The potting mixtures did not show any significant effect during the first and second months. The mean values for increments in girth during the third and fourth months suggested that the seedlings of Mixture 3 was superior to the other two treatments. During the seventh month,

Table 11. Effect of containers, potting mixtures and foliar sprays on mean increments in girth upto the seventh month and total increments in girth after seven months of growth.

| Treatments | Increments in girth (cm) during the | | | | | | | Total increments in girth after seven months of growth |
|---|---|---|---|---|---|---|---|---|
| | First month | Second month | Third month | Fourth month | Fifth month | Sixth month | Seventh month | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| $a_1$ | 0.0266 | 0.0425 | 0.0300 | 0.0267 | 0.0422 | 0.0355 | 0.0607 | 0.2403 |
| $a_2$ | 0.0285 | 0.0529 | 0.0311 | 0.0415 | 0.0433 | 0.0407 | 0.0441 | 0.2807 |
| $a_3$ | 0.0355 | 0.0413 | 0.0481 | 0.0426 | 0.0581 | 0.0541 | 0.0366 | 0.3370 |
| $SE_m$ | 0.0017 | 0.0023 | 0.0017 | 0.0021 | 0.0023 | 0.0027 | 0.0025 | 0.0034 |
| C.D. (0.05) | — | — | 0.0049 | — | — | — | 0.0069 | 0.0095 |
| $b_1$ | 0.0274 | 0.0388 | 0.0322 | 0.0244 | 0.0451 | 0.0355 | 0.0644 | 0.2314 |
| $b_2$ | 0.0263 | 0.0468 | 0.0374 | 0.0377 | 0.0492 | 0.0433 | 0.0465 | 0.2774 |
| $b_3$ | 0.0370 | 0.0511 | 0.0463 | 0.0526 | 0.0492 | 0.0510 | 0.0285 | 0.3492 |
| $SE_m$ | 0.0017 | 0.0023 | 0.0017 | 0.0021 | 0.0023 | 0.0027 | 0.0025 | 0.0034 |
| C.D. (0.05) | — | — | 0.0049 | 0.0059 | — | — | 0.0069 | 0.0095 |
| $c_1$ | 0.0288 | 0.0422 | 0.0377 | 0.0281 | 0.0481 | 0.0440 | 0.0450 | 0.2659 |
| $c_2$ | 0.0303 | 0.0503 | 0.0296 | 0.0370 | 0.0511 | 0.0244 | 0.0548 | 0.2911 |
| $c_3$ | 0.0303 | 0.0429 | 0.0326 | 0.0330 | 0.0402 | 0.0355 | 0.0400 | 0.2585 |
| $c_4$ | 0.0303 | 0.0462 | 0.0348 | 0.0400 | 0.0511 | 0.0355 | 0.0466 | 0.2940 |
| $c_5$ | 0.0362 | 0.0437 | 0.0481 | 0.0511 | 0.0592 | 0.0421 | 0.0652 | 0.3577 |
| $c_6$ | 0.0251 | 0.0481 | 0.0351 | 0.0380 | 0.0355 | 0.0311 | 0.0311 | 0.2468 |
| $SE_m$ | 0.0025 | 0.0032 | 0.0023 | 0.0029 | 0.0034 | 0.0039 | 0.0035 | 0.0048 |
| C.D. (0.05) | — | — | 0.0069 | 0.0081 | 0.0091 | — | 0.0098 | 0.0135 |

Table 11 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| $a_1b_1$ | 0.0255 | 0.0422 | 0.0355 | 0.0266 | 0.0522 | 0.0322 | 0.0300 | 0.2466 |
| $a_1b_2$ | 0.0255 | 0.0444 | 0.0277 | 0.0220 | 0.0333 | 0.0433 | 0.0377 | 0.2355 |
| $a_1b_3$ | 0.0288 | 0.0411 | 0.0266 | 0.0311 | 0.0411 | 0.0311 | 0.0422 | 0.2388 |
| $a_2b_1$ | 0.0300 | 0.0411 | 0.0300 | 0.0233 | 0.0411 | 0.0300 | 0.0244 | 0.2211 |
| $a_2b_2$ | 0.0266 | 0.0488 | 0.0244 | 0.0344 | 0.0477 | 0.0377 | 0.0411 | 0.2261 |
| $a_2b_3$ | 0.0288 | 0.0688 | 0.0388 | 0.0666 | 0.0411 | 0.0544 | 0.0666 | 0.3600 |
| $a_3b_1$ | 0.0266 | 0.0333 | 0.0311 | 0.0233 | 0.0422 | 0.0440 | 0.0311 | 0.2266 |
| $a_3b_2$ | 0.0266 | 0.0472 | 0.0400 | 0.0444 | 0.0660 | 0.0488 | 0.0600 | 0.3355 |
| $a_3b_3$ | 0.0533 | 0.0433 | 0.0733 | 0.0600 | 0.0655 | 0.0688 | 0.0844 | 0.4488 |
| $SE_m$ | 0.0030 | 0.0039 | 0.0030 | 0.0036 | 0.0041 | 0.0047 | 0.0043 | 0.0058 |
| C.D. (0.05) | 0.0086 | — | — | — | — | — | — | 0.0165 |

$a_1$ Clay pot
$a_2$ Polythene bag
$a_3$ Coconut husk pot

$b_1$ Mixture 1
$b_2$ Mixture 2
$b_3$ Mixture 3

$c_1$ GA 100 ppm
$c_2$ GA 200 ppm
$c_3$ Urea 0.5 per cent
$c_4$ GA 100 ppm + urea 0.5 per cent
$c_5$ GA 200 ppm + urea 0.5 per cent
$c_6$ Control

Table 11 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| $a_1c_1$ | 0.0266 | 0.0355 | 0.0422 | 0.0220 | 0.0400 | 0.0444 | 0.0288 | 0.237 |
| $a_1c_2$ | 0.0222 | 0.0577 | 0.0266 | 0.0280 | 0.0440 | 0.0244 | 0.0466 | 0.251 |
| $a_1c_3$ | 0.0266 | 0.0355 | 0.0311 | 0.0220 | 0.0400 | 0.0355 | 0.0244 | 0.222 |
| $a_1c_4$ | 0.0288 | 0.0355 | 0.0266 | 0.0220 | 0.0422 | 0.0355 | 0.0266 | 0.217 |
| $a_1c_5$ | 0.0311 | 0.0444 | 0.0244 | 0.0330 | 0.0511 | 0.0422 | 0.0644 | 0.284 |
| $a_1c_6$ | 0.2440 | 0.0466 | 0.0288 | 0.0310 | 0.0355 | 0.0311 | 0.0288 | 0.228 |
| $a_2c_1$ | 0.0266 | 0.0440 | 0.0288 | 0.0288 | 0.0511 | 0.0288 | 0.0377 | 0.246 |
| $a_2c_2$ | 0.0288 | 0.0555 | 0.0266 | 0.0511 | 0.0480 | 0.0466 | 0.0511 | 0.308 |
| $a_2c_3$ | 0.0288 | 0.0513 | 0.0244 | 0.0422 | 0.0310 | 0.0266 | 0.0355 | 0.242 |
| $a_2c_4$ | 0.0266 | 0.0577 | 0.0288 | 0.0440 | 0.0440 | 0.0422 | 0.0511 | 0.295 |
| $a_2c_5$ | 0.0377 | 0.0444 | 0.0533 | 0.0440 | 0.0510 | 0.0466 | 0.0600 | 0.337 |
| $a_2c_6$ | 0.0220 | 0.0622 | 0.0244 | 0.0377 | 0.0310 | 0.0533 | 0.0288 | 0.253 |
| $a_3c_1$ | 0.0330 | 0.0466 | 0.0422 | 0.0330 | 0.0530 | 0.0488 | 0.0688 | 0.313 |
| $a_3c_2$ | 0.0400 | 0.0377 | 0.0355 | 0.0310 | 0.0600 | 0.0422 | 0.0666 | 0.313 |
| $a_3c_3$ | 0.0355 | 0.0400 | 0.0422 | 0.0355 | 0.0550 | 0.0422 | 0.0600 | 0.311 |
| $a_3c_4$ | 0.0355 | 0.0455 | 0.0488 | 0.0513 | 0.0660 | 0.0644 | 0.0622 | 0.368 |
| $a_3c_5$ | 0.0400 | 0.0422 | 0.0666 | 0.0755 | 0.0750 | 0.0800 | 0.0711 | 0.451 |
| $a_3c_6$ | 0.0288 | 0.0355 | 0.0533 | 0.0266 | 0.0377 | 0.0466 | 0.0355 | 0.264 |
| $SE_m$ | 0.0040 | 0.0055 | 0.0042 | 0.0051 | 0.0059 | 0.0061 | 0.0061 | 0.0084 |
| C.D. (0.05) | — | — | 0.0120 | — | — | — | — | 0.0230 |

Table 11 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| $b_1c_1$ | 0.0355 | 0.0355 | 0.0311 | 0.0222 | 0.0466 | 0.0311 | 0.0311 | 0.226 |
| $b_1c_2$ | 0.0288 | 0.0355 | 0.0288 | 0.0220 | 0.0444 | 0.0311 | 0.0111 | 0.220 |
| $b_1c_3$ | 0.0220 | 0.0330 | 0.0355 | 0.0244 | 0.0511 | 0.0244 | 0.0266 | 0.222 |
| $b_1c_4$ | 0.0244 | 0.0466 | 0.0266 | 0.0222 | 0.0511 | 0.0333 | 0.0200 | 0.224 |
| $b_1c_5$ | 0.0311 | 0.0444 | 0.0266 | 0.0288 | 0.0466 | 0.0488 | 0.0330 | 0.262 |
| $b_1c_6$ | 0.0222 | 0.0377 | 0.0422 | 0.0260 | 0.0311 | 0.0440 | 0.0288 | 0.233 |
| $b_2c_1$ | 0.0244 | 0.0355 | 0.0400 | 0.0244 | 0.0422 | 0.0466 | 0.0466 | 0.260 |
| $b_2c_2$ | 0.0266 | 0.0355 | 0.0220 | 0.0377 | 0.0488 | 0.0330 | 0.0466 | 0.275 |
| $b_2c_3$ | 0.0244 | 0.0330 | 0.0244 | 0.0244 | 0.0422 | 0.0444 | 0.0422 | 0.253 |
| $b_2c_4$ | 0.0266 | 0.0466 | 0.0311 | 0.0400 | 0.0511 | 0.0577 | 0.0550 | 0.295 |
| $b_2c_5$ | 0.0311 | 0.0444 | 0.0422 | 0.0511 | 0.0640 | 0.0555 | 0.0755 | 0.360 |
| $b_2c_6$ | 0.0244 | 0.0377 | 0.0244 | 0.0244 | 0.0460 | 0.0222 | 0.0244 | 0.220 |
| $b_3c_1$ | 0.0266 | 0.0377 | 0.0422 | 0.0377 | 0.0550 | 0.0444 | 0.0577 | 0.311 |
| $b_3c_2$ | 0.0355 | 0.0600 | 0.0377 | 0.0533 | 0.0600 | 0.0488 | 0.0866 | 0.377 |
| $b_3c_3$ | 0.0440 | 0.0488 | 0.0377 | 0.0488 | 0.0330 | 0.0355 | 0.0511 | 0.300 |
| $b_3c_4$ | 0.0400 | 0.0433 | 0.0466 | 0.0577 | 0.0510 | 0.0511 | 0.0644 | 0.362 |
| $b_3c_5$ | 0.0466 | 0.0400 | 0.0733 | 0.0733 | 0.0660 | 0.0664 | 0.0856 | 0.451 |
| $b_3c_6$ | 0.0288 | 0.0511 | 0.0400 | 0.0440 | 0.0288 | 0.0644 | 0.0450 | 0.293 |
| $SE_m$ | 0.0043 | 0.0056 | 0.0042 | 0.0051 | 0.0059 | 0.0067 | 0.0061 | 0.0084 |
| C.D. (0.05) | — | — | 0.0120 | — | — | — | 0.0170 | 0.0210 |

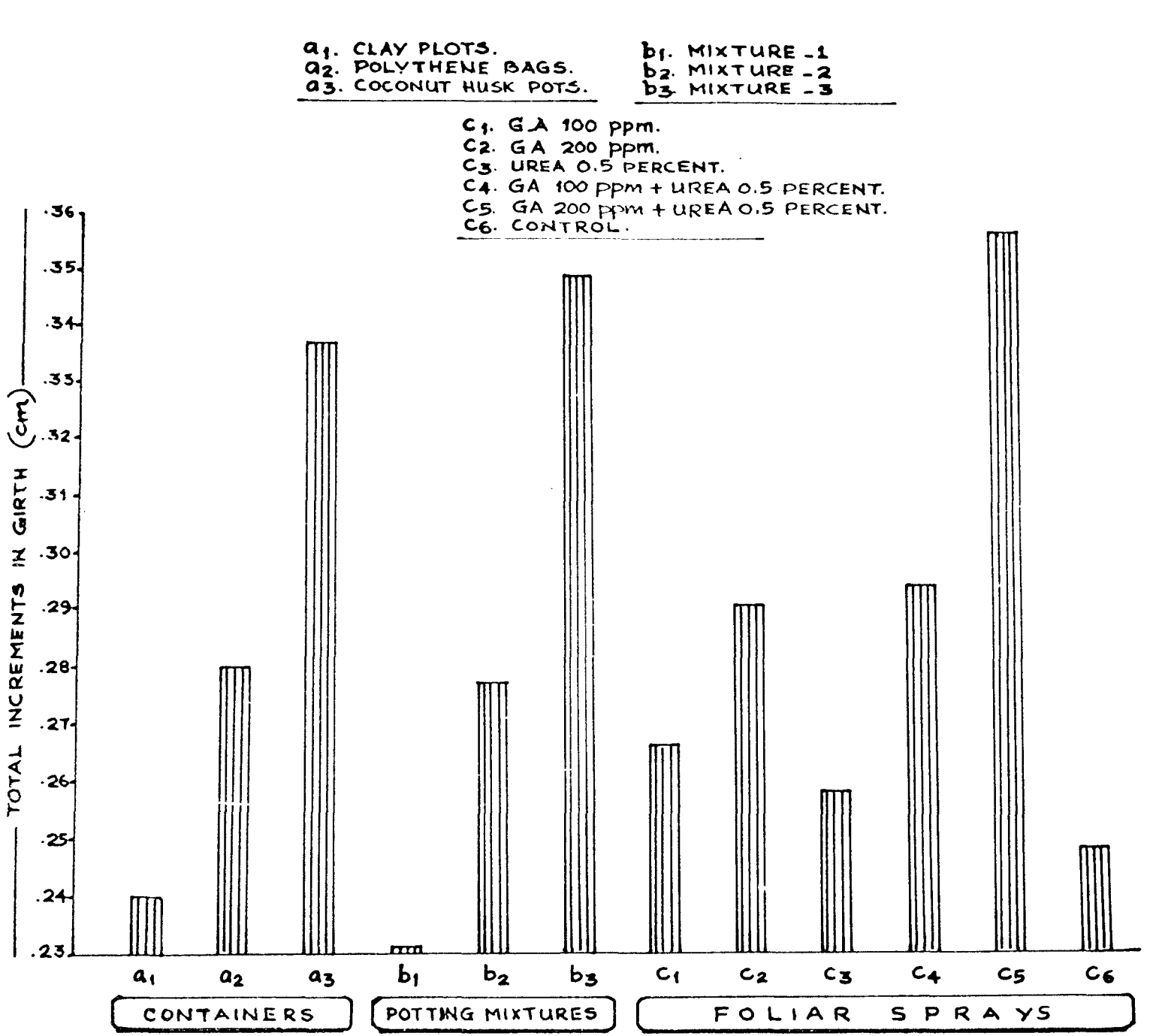


FIG. 5. EFFECT OF CONTAINERS, POTTING MIXTURES AND FOLIAR SPRAYS ON INCREMENTS IN GIRTH OF SEEDLINGS AFTER SEVEN MONTHS OF GROWTH IN THE NURSERY.

the seedlings in Mixture 1 produced significantly more girth increment. The total girth increment upto seven months indicated that the seedlings in Mixture 3 were significantly superior. The booster sprays did not exert any significant effect during the first, second and sixth months. During the third and fourth months, the seedlings sprayed with GA 200 ppm + urea 0.5 per cent was significantly superior to the other treatments. The mean increments in girth during the fifth month showed that the seedlings treated with GA 200 ppm, GA 100 ppm + urea 0.5 per cent and GA 200 ppm + urea 0.5 per cent were on par and superior to the other treatments. During the seventh month, the seedlings treated with GA 200 ppm + urea 0.5 per cent was found to be the significantly superior treatment. The total increments in girth after seven months of growth suggested that the seedlings receiving GA 200 ppm + urea 0.5 per cent was the superior treatment.

The seedlings grown in coconut husk pots with Mixture 3 was found to be the superior treatment with respect to increments in girth during the first month. The mean increments in girth did not show any significant difference upto the seventh month. The total increments in girth after seven months of growth also indicated the seedlings grown in coconut husk pots with Mixture 3 to be significantly superior treatment. The "type of containers x booster spray" interaction did not show any significant effect, except during the third month, when the seedlings of coconut

husk pots sprayed with GA 200 ppm + urea 0.5 per cent was significantly superior to all the other treatments. The total increments in girth after seven months of growth also confirmed the superiority of this combination. There was significant difference between the treatments only during the third and seventh months. During the third and seventh months, the seedlings grown in Mixture 3 and treated with GA 200 ppm + urea 0.5 per cent was found to be significantly superior to the other treatment combinations. During the seventh month the seedlings in Mixture 3 treated with GA alone (200 ppm) was on par with the above treatment. The total increments in girth after seven months of growth also showed the seedlings raised in Mixture 3 and treated with GA 200 ppm + urea 0.5 per cent to be significantly superior.

vi. Fresh weight of seedlings

The data have been presented in Table 12 and results of the analysis of variance presented in Appendix IX. The results are also presented in Fig. 6. The data showed that the seedlings of coconut husk pots was significantly superior to polythene bags and clay pots. Among the three mixtures used, the seedlings in Mixture 3 was found to be significantly superior. Booster spray of GA 200 ppm + urea 0.5 per cent was found to be significantly superior. The data revealed that the seedlings in coconut husk pots with Mixture 3 was superior. The results indicated that

Table 12. Effect of containers, potting mixtures and foliar sprays on fresh weight, increments in root length, leaf area, length of internodes and dry weight of clove seedlings.

| Treatments | Fresh weight (g) | Increments in root length (cm) | Leaf area ($cm^2$) | Length of internodes (cm) | Dry weight (g) |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| $a_1$ | 1.761 | 8.30 | 68.57 | 1.55 | 0.773 |
| $a_2$ | 2.028 | 9.70 | 71.56 | 1.66 | 0.995 |
| $a_3$ | 2.305 | 9.88 | 73.31 | 1.84 | 1.173 |
| $SE_m$ | 0.007 | 0.055 | 0.31 | 0.01 | 0.005 |
| C.D. (0.05) | 0.020 | 0.155 | 0.87 | 0.03 | 0.015 |
| $b_1$ | 1.876 | 8.24 | 65.40 | 1.68 | 0.915 |
| $b_2$ | 2.044 | 9.64 | 71.23 | 1.72 | 0.972 |
| $b_3$ | 2.174 | 10.02 | 76.77 | 1.65 | 1.053 |
| $SE_m$ | 0.007 | 0.055 | 0.31 | 0.01 | 0.005 |
| C.D. (0.05) | 0.020 | 0.155 | 0.87 | 0.03 | 0.015 |
| $c_1$ | 1.867 | 9.11 | 72.49 | 1.69 | 0.906 |
| $c_2$ | 2.052 | 9.75 | 72.87 | 1.74 | 1.005 |
| $c_3$ | 2.107 | 8.84 | 69.48 | 1.68 | 0.996 |
| $c_4$ | 2.090 | 9.47 | 73.77 | 1.70 | 1.055 |
| $c_5$ | 2.356 | 10.64 | 78.93 | 1.76 | 1.190 |
| $c_6$ | 1.714 | 7.99 | 59.23 | 1.54 | 0.728 |
| $SE_m$ | 0.010 | 0.079 | 0.44 | 0.02 | 0.007 |
| C.D. (0.05) | 0.028 | 0.221 | 1.24 | 0.05 | 0.021 |

$a_1$ Clay pot
$a_2$ Polythene bag
$a_3$ Coconut husk pot

$b_1$ Mixture 1
$b_2$ Mixture 2
$b_3$ Mixture 3

$c_1$ GA 100 ppm
$c_2$ GA 200 ppm
$c_3$ Urea 0.5 per cent
$c_4$ GA 100 ppm + urea 0.05 per cent
$c_5$ GA 200 ppm + urea 0.5 per cent
$c_6$ Control

Table 12 contd.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| $a_1b_1$ | 1.67 | 7.09 | 64.08 | 1.55 | 0.712 |
| $a_1b_2$ | 1.76 | 8.88 | 69.43 | 1.53 | 0.775 |
| $a_1b_3$ | 1.84 | 8.92 | 72.27 | 1.57 | 0.833 |
| $a_2b_1$ | 1.88 | 8.58 | 64.54 | 1.65 | 0.939 |
| $a_2b_1$ | 2.01 | 10.07 | 71.12 | 1.73 | 0.955 |
| $a_2b_2$ | 2.02 | 10.51 | 78.86 | 1.59 | 1.089 |
| $a_2b_3$ | 2.10 | 9.05 | 67.61 | 1.88 | 1.096 |
| $a_3b_1$ | 2.35 | 9.97 | 73.13 | 1.89 | 1.186 |
| $a_3b_2$ | 2.46 | 10.63 | 79.19 | 1.86 | 1.236 |
| $a_3b_3$ | | | | | |
| $SE_m$ | 0.01 | 0.09 | 0.54 | 0.02 | 0.093 |
| C.D. (0.05) | 0.03 | 0.27 | 1.52 | — | 0.026 |
| $a_1c_1$ | 1.70 | 8.00 | 70.63 | 1.62 | 0.755 |
| $a_1c_1$ | 1.77 | 8.96 | 67.26 | 1.61 | 0.788 |
| $a_1c_2$ | 1.84 | 8.06 | 69.06 | 1.49 | 0.755 |
| $a_1c_3$ | 1.77 | 8.71 | 76.22 | 1.55 | 0.861 |
| $a_1c_4$ | 1.93 | 9.34 | 69.46 | 1.60 | 0.914 |
| $a_1c_5$ | 1.53 | 6.73 | 58.63 | 1.46 | 0.565 |
| $a_1c_6$ | 1.89 | 9.55 | 73.79 | 1.60 | 0.822 |
| $a_2c_1$ | 2.03 | 9.80 | 72.66 | 1.71 | 1.088 |
| $a_2c_2$ | 2.11 | 8.95 | 68.60 | 1.68 | 1.028 |
| $a_2c_3$ | 2.04 | 9.95 | 73.51 | 1.71 | 1.083 |
| $a_2c_4$ | 2.40 | 11.22 | 79.85 | 1.76 | 1.222 |
| $a_2c_5$ | 1.69 | 8.86 | 60.62 | 1.48 | 0.743 |
| $a_2c_6$ | 2.00 | 9.66 | 73.05 | 1.84 | 1.082 |
| $a_3c_1$ | 2.35 | 10.49 | 78.70 | 1.92 | 1.217 |
| $a_3c_2$ | 2.37 | 9.52 | 70.77 | 1.87 | 1.204 |
| $a_3c_3$ | 2.45 | 9.75 | 71.59 | 1.83 | 1.221 |
| $a_3c_4$ | 2.73 | 11.36 | 89.12 | 1.93 | 1.434 |
| $a_3c_5$ | 1.91 | 8.38 | 58.44 | 1.67 | 0.876 |
| $a_3c_6$ | | | | | |
| $SE_m$ | 0.02 | 0.136 | 0.76 | 0.03 | 0.013 |
| C.D. (0.05) | 0.05 | 0.38 | 2.15 | — | 0.037 |

Table 12 contd.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| $b_1c_1$ | 1.76 | 8.09 | 66.81 | 1.71 | 0.855 |
| $b_1c_2$ | 1.87 | 8.46 | 68.75 | 1.74 | 0.904 |
| $b_1c_3$ | 1.95 | 7.66 | 56.33 | 1.61 | 0.921 |
| $b_1c_4$ | 1.91 | 8.17 | 68.95 | 1.67 | 1.052 |
| $b_1c_5$ | 2.14 | 9.56 | 77.15 | 1.81 | 1.117 |
| $b_1c_6$ | 1.59 | 7.50 | 54.61 | 1.53 | 0.643 |
| $b_2c_1$ | 1.84 | 9.37 | 71.57 | 1.68 | 0.833 |
| $b_2c_2$ | 2.06 | 10.09 | 72.55 | 1.80 | 1.002 |
| $b_2c_3$ | 2.11 | 9.26 | 73.52 | 1.78 | 0.987 |
| $b_2c_4$ | 2.11 | 10.07 | 75.49 | 1.76 | 1.032 |
| $b_2c_5$ | 2.39 | 11.17 | 72.71 | 1.75 | 1.188 |
| $b_2c_6$ | 1.74 | 7.86 | 60.66 | 1.54 | 0.740 |
| $b_3c_1$ | 1.98 | 9.85 | 79.10 | 1.67 | 0.981 |
| $b_3c_2$ | 2.22 | 10.70 | 77.32 | 1.69 | 1.108 |
| $b_3c_3$ | 2.26 | 9.40 | 77.76 | 1.64 | 1.108 |
| $b_3c_4$ | 2.24 | 10.16 | 76.87 | 1.67 | 1.108 |
| $b_3c_4$ | 2.53 | 11.19 | 86.94 | 1.72 | 1.264 |
| $b_3c_6$ | 1.80 | 8.61 | 62.62 | 1.54 | 0.802 |
| $SE_m$ | 0.02 | 0.13 | 0.76 | 0.03 | 0.013 |
| C.D. (0.05) | 0.05 | 0.19 | 2.15 | — | 0.037 |

$a_1$. CLAY POTS.
$a_2$. POLYTHENE BAGS.
$a_3$. COCONUT HUSK POTS.

$b_1$. MIXTURE-1
$b_2$. MIXTURE-2
$b_3$. MIXTURE-3

$C_1$. GA 100 ppm.
$C_2$. GA 200 ppm.
$C_3$. UREA 0.5 PERCENT.
$C_4$. GA 100 ppm + UREA 0.5 PERCENT.
$C_5$. GA 200 ppm + UREA 0.5 PERCENT.
$C_6$. CONTROL.

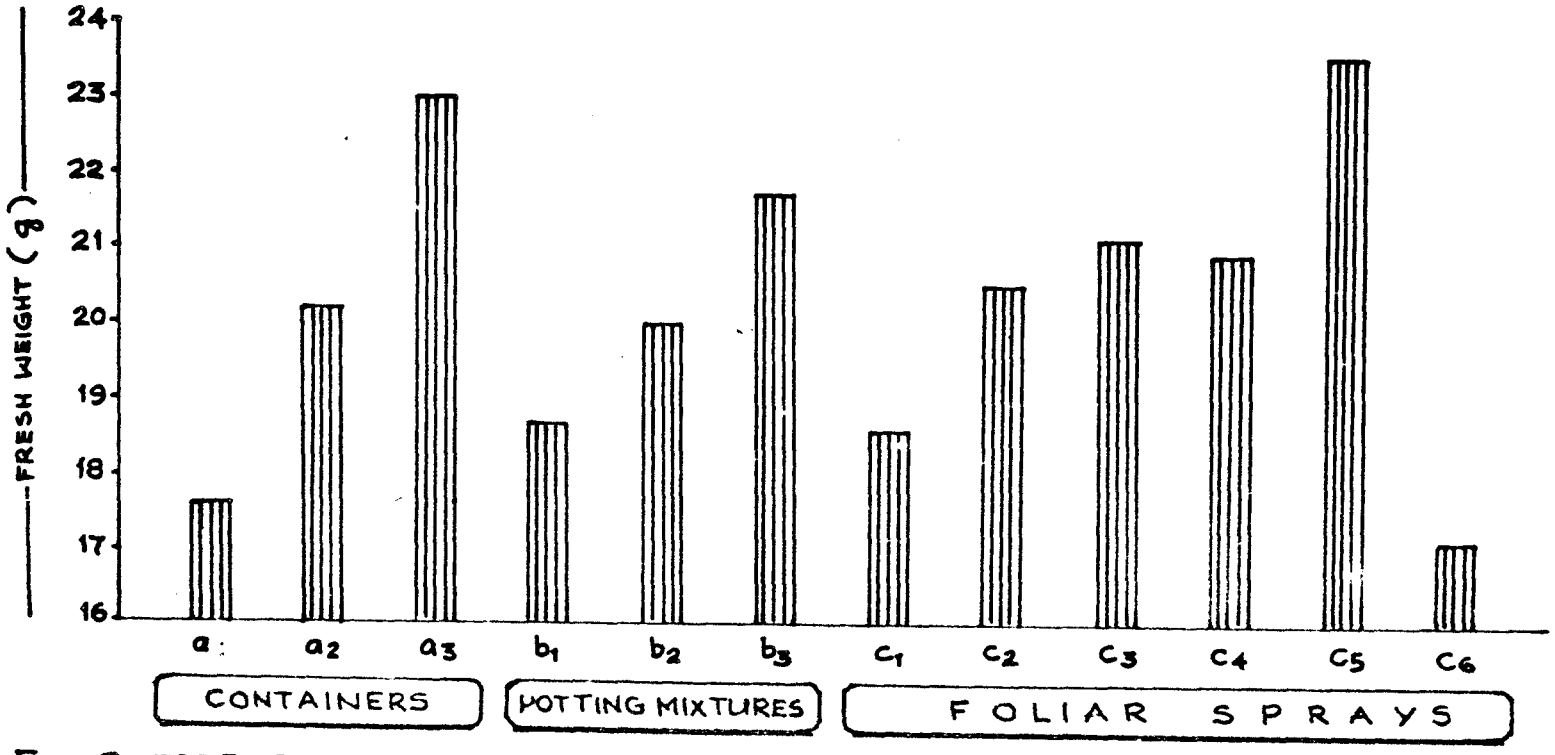


FIG. 6. EFFECT OF CONTAINERS, POTTING MIXTURES AND FOLIAR SPRAYS ON FRESH-WEIGHT OF THE SEEDLINGS AFTER SEVEN MONTHS OF GROWTH IN THE NURSERY

the seedlings of coconut husk pots treated with GA 200 ppm + urea 0.5 per cent was significantly superior to all the other treatment combinations. The data also indicated that the seedlings in Mixture 3 and treated with GA 200 ppm + urea 0.5 per cent was superior to the other treatment combinations.

vii. Length of the tap root

The data presented in Table 12 and the results of the analysis of variance table in Appendix IX. The data have been presented in Fig. 7 also. The data showed that the seedlings of coconut husk pots was significantly superior to the other treatments. Among the potting mixtures, the seedlings in Mixture 3 was significantly superior to the other two. The booster spray of GA 200 ppm + urea 0.5 per cent resulted in significant increase in the length of the tap root of the seedlings. The results showed that the seedlings in coconut husk pots and polythene bags with Mixture 3 were on par and significantly superior to the other treatment combinations. The data revealed that the seedlings in coconut husk pots treated with GA 200 ppm + urea 0.5 per cent and polythene bags treated with GA 200 ppm + urea were on par and produced significantly longer roots. The data also indicated that the seedlings in Mixture 2 with GA 200 ppm + urea 0.5 per cent and Mixture 3 with GA 200 ppm + urea 0.5 per cent were on par and superior to the other treatment combinations.

viii. Leaf Area

The table 12 presents the effect of different treatments on total leaf area after seven months of growth. The results of the analysis of variance is presented in Appendix IX. The data have been presented in Fig. 8 also. The results revealed that the coconut husk pots was superior to the polythene bags and clay pots. Among the potting mixtures, the seedlings in Mixture 3 proved to be significantly better. The booster spray of GA 200 ppm + urea 0.5 per cent was found to be the most effective treatment in increasing the leaf area. The data showed that the seedlings in coconut husk pots with mixture 3 was the significantly superior treatment. The results showed the seedlings of coconut husk pots with GA 200 ppm + urea 0.5 per cent to be the most effective and superior. The data also revealed that the seedlings in Mixture 3 treated with GA 200 ppm + urea 0.5 per cent was significantly superior when compared to the other treatments.

ix. Mean Internodal length.

The effect of the different treatments on mean internodal length was presented in Table 12 and the results of the analysis of variance in Appendix IX. The data have been presented in Fig. 9 also. The mean internodal length of the seedlings showed that the seedlings from coconut husk pots was significantly superior to the other treatments. Among the potting mixtures,

$a_1$. CLAY PLOTS.
$a_2$. POLYTHENE BAGS.
$a_3$. COCONUT HUSK POTS.

$b_1$. MIXTURE-1.
$b_2$. MIXTURE-2.
$b_3$. MIXTURE-3.

$C_1$. GA 100 ppm.
$C_2$. GA 200 ppm.
$C_3$. UREA 0.5 PERCENT.
$C_4$. GA 100 ppm + UREA 0.5 PERCENT.
$C_5$. GA 200 ppm + UREA 0.5 PERCENT.
$C_6$. CONTROL.

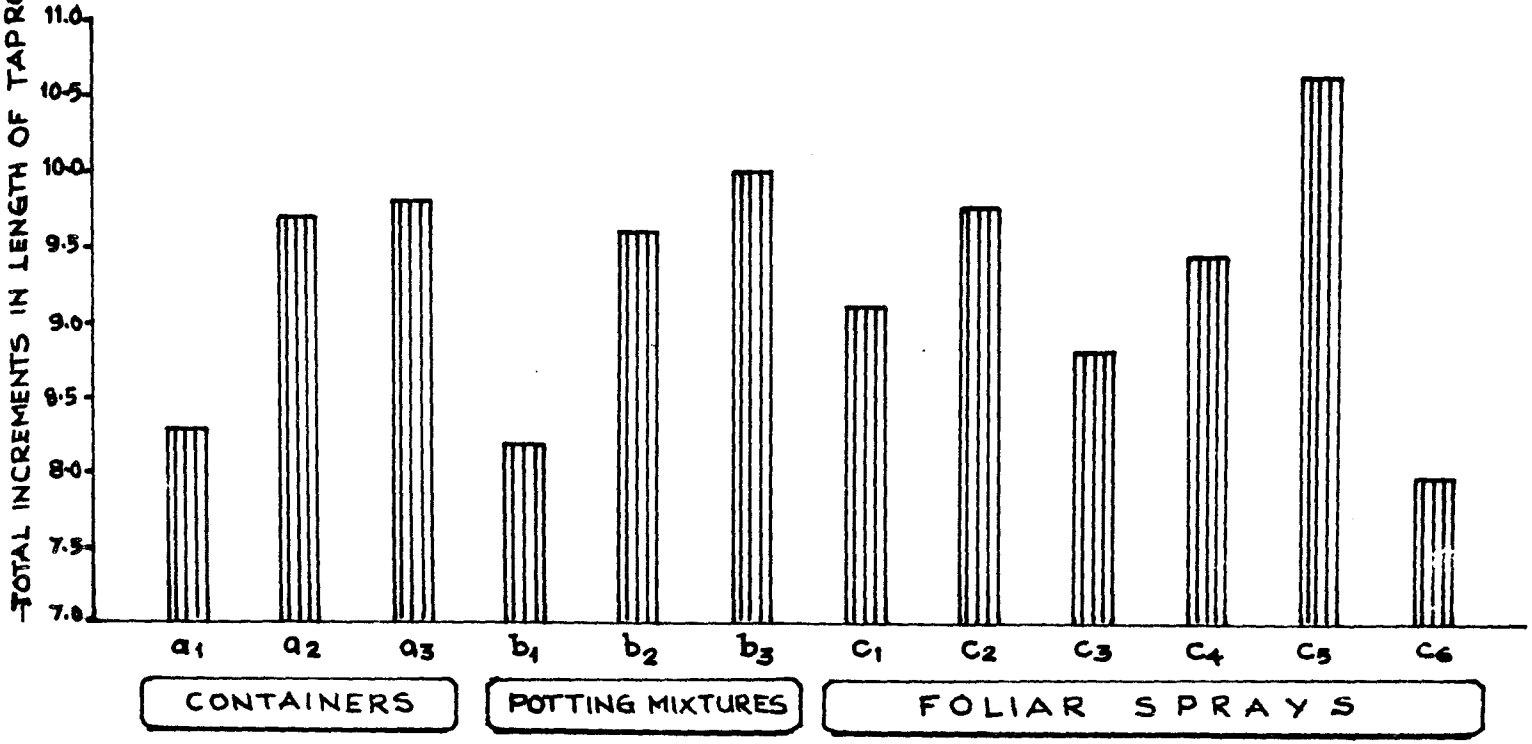


FIG.7.-EFFECT OF CONTAINERS, POTTING MIXTURES AND FOLIAR SPRAYS ON TOTAL INCREMENTS IN LENGTH OF THE TAP ROOTS AFTER SEVEN MONTHS OF GROWTH IN THE NURSERY.

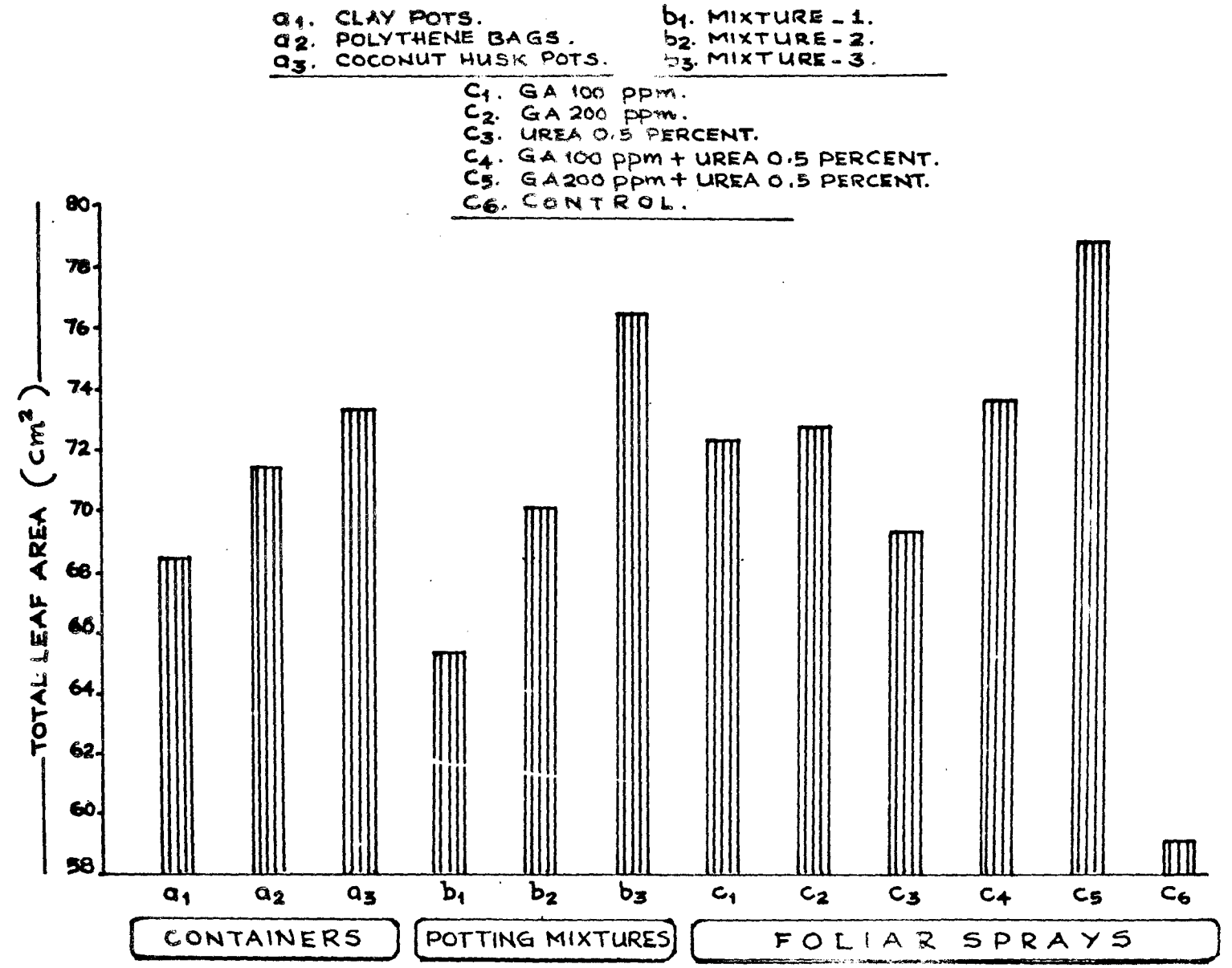


FIG. 8. EFFECT OF CONTAINERS, POTTING MIXTURES AND FOLIAR SPRAYS ON TOTAL LEAF AREA AFTER SEVEN MONTHS OF GROWTH IN THE NURSERY.

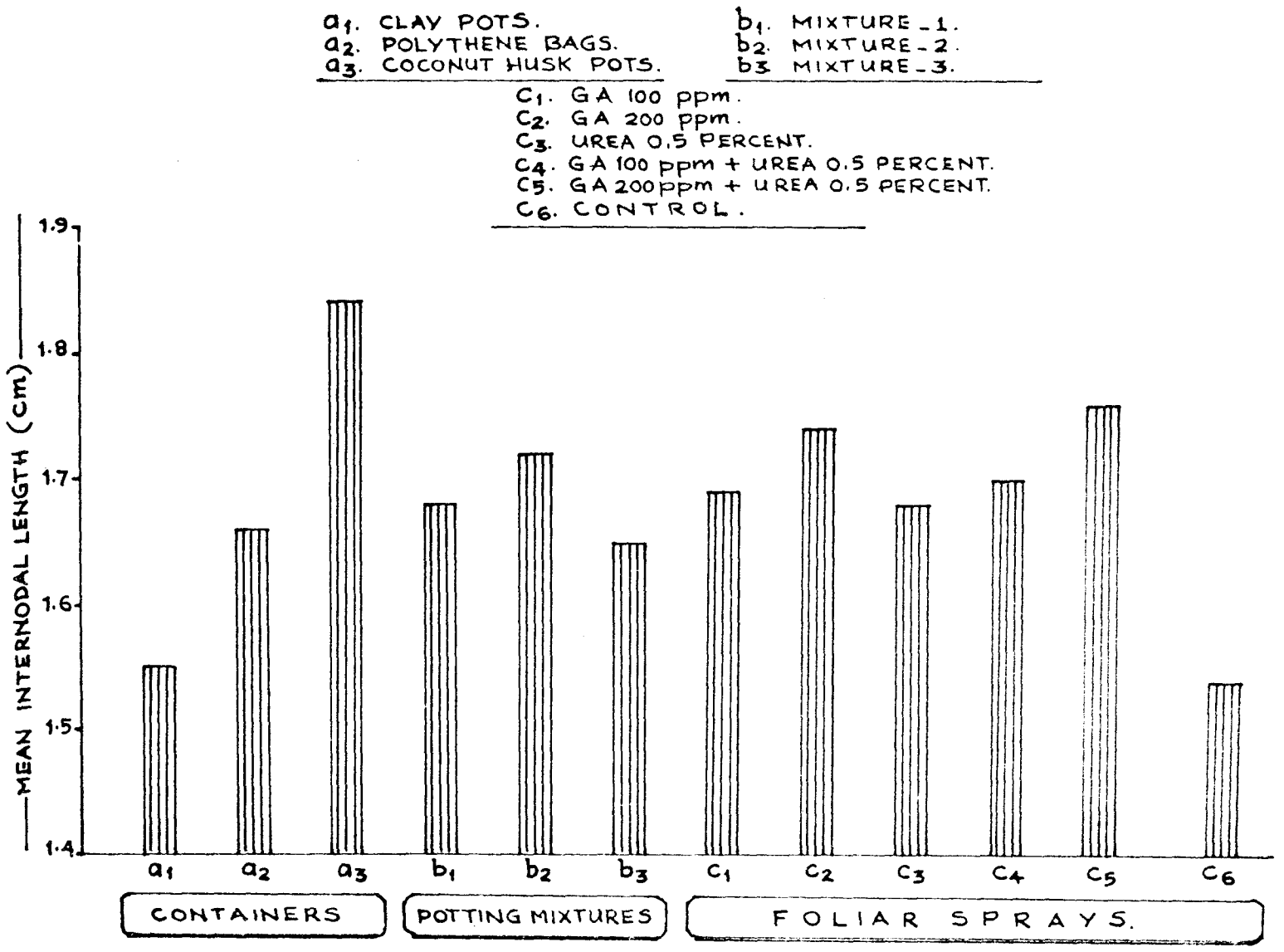


FIG. 9. EFFECT OF CONTAINERS, POTTING MIXTURES AND FOLIAR SPRAYS ON MEAN INTERNODAL LENGTH OF THE SEEDLINGS AFTER SEVEN MONTHS OF GROWTH IN THE NURSERY.

$a_1$. CLAY POTS.
$a_2$. POLYTHENE BAGS.
$a_3$. COCONUT HUSK POTS.

$b_1$. MIXTURE-1.
$b_2$. MIXTURE-2.
$b_3$. MIXTURE-3.

$C_1$. GA 100 ppm.
$C_2$. GA 200 ppm.
$C_3$. UREA 0.5 PERCENT.
$C_4$. GA 100 ppm + UREA 0.5 PERCENT.
$C_5$. GA 200 ppm + UREA 0.5 PERCENT.
$C_6$. CONTROL.

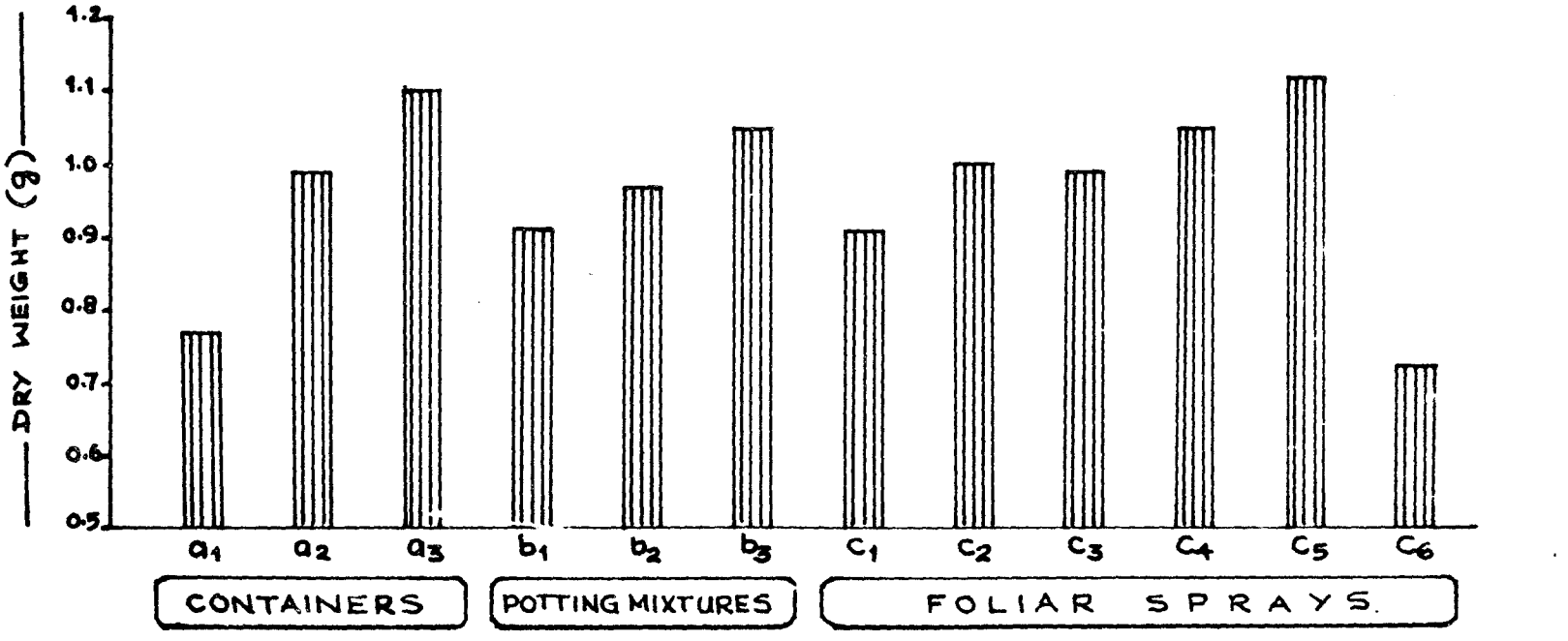


FIG. 10.-EFFECT OF CONTAINERS, POTTING MIXTURES AND FOLIAR SPRAYS ON THE DRY WEIGHT OF THE SEEDLINGS AFTER SEVEN MONTHS OF GROWTH IN THE NURSERY.

the seedlings of Mixture 2 was superior to Mixture 1 and 3. The foliar spray of GA 200 ppm + urea 0.5 per cent was the best treatment. The different factors among themselves were not statistically significant in the case of leaf area.

x. Dry weight of the seedlings

The effect of different treatments on dry weight of the seedlings are given in Table 12 and the analysis of variance in Appendix ix. The data have been presented in Fig. 10 also. The data showed that the seedlings grown in coconut husk pots or Mixture 3 or spray of GA 200 ppm + urea 0.5 per cent were superior treatments. The results showed that the seedlings in coconut husk pot with Mixture 3 was the most effective and significantly superior treatment. The data revealed that the seedlings in coconut husk pots treated with GA 200 ppm + urea 0.5 per cent was superior to all the other treatment combinations. The data also showed that the seedlings in Mixture 3 treated with GA 200 ppm + urea 0.5 per cent was the significantly superior treatment.

xi. Evaluation of the vigour of the seedlings by scoring technique

In order to assess the overall vigour of the seedlings as a result of the different treatments, a scoring technique was adopted. The characters for which scores were given include height, number of leaves, girth, fresh weight leaf area and dry weight.

Table 13. Effect of containers, potting mixtures and foliar sprays on the vigour of the seedlings after seven months of growth.

| Treatments | Height | Number of leaves | Girth | Leaf area | Fresh weight | Dry weight | Total score out of a possible maximum of 18 |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| $a_1$ | 1 | 2 | 2 | 2 | 1 | 1 | 9 |
| $a_2$ | 2 | 2 | 2 | 2 | 2 | 2 | 12 |
| $a_3$ | 2 | 2 | 3 | 2 | 3 | 3 | 15 |
| $b_1$ | 1 | 1 | 1 | 1 | 2 | 2 | 8 |
| $b_2$ | 2 | 2 | 2 | 2 | 2 | 2 | 12 |
| $b_3$ | 3 | 3 | 3 | 3 | 3 | 2 | 17 |
| $c_1$ | 2 | 2 | 2 | 2 | 2 | 2 | 12 |
| $c_2$ | 2 | 2 | 2 | 2 | 2 | 2 | 12 |
| $c_3$ | 2 | 2 | 2 | 2 | 2 | 2 | 12 |
| $c_4$ | 2 | 2 | 2 | 3 | 2 | 2 | 13 |
| $c_5$ | 3 | 3 | 3 | 3 | 3 | 3 | 18 |
| $c_6$ | 1 | 1 | 2 | 1 | 1 | 1 | 7 |
| $a_1b_1$ | 1 | 1 | 2 | 1 | 1 | 1 | 7 |
| $a_1b_2$ | 2 | 1 | 1 | 2 | 1 | 1 | 8 |
| $a_1b_3$ | 2 | 2 | 2 | 2 | 2 | 1 | 11 |
| $a_2b_1$ | 1 | 1 | 1 | 1 | 2 | 2 | 8 |
| $a_2b_2$ | 2 | 2 | 1 | 2 | 2 | 2 | 11 |
| $a_2b_3$ | 3 | 3 | 3 | 3 | 2 | 3 | 17 |
| $a_3b_1$ | 2 | 2 | 1 | 1 | 2 | 3 | 11 |
| $a_3b_2$ | 3 | 2 | 3 | 2 | 3 | 3 | 16 |
| $a_3b_3$ | 3 | 3 | 3 | 3 | 3 | 3 | 18 |

$a_1$ Clay pot
$a_2$ Polythene bag
$a_3$ Coconut husk pot

$b_1$ Mixture 1
$b_2$ Mixture 2
$b_3$ Mixture 3

$c_1$ GA 100 ppm
$c_2$ GA 200 ppm
$c_3$ Urea 0.5 per cent
$c_4$ GA 100 ppm + urea 0.5 per cent
$c_5$ GA 200 ppm + urea 0.5 per cent
$c_6$ Control

Table 13 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| $a_1c_1$ | 1 | 1 | 1 | 2 | 1 | 1 | 7 |
| $a_1c_2$ | 2 | 2 | 2 | 1 | 1 | 1 | 9 |
| $a_1c_3$ | 1 | 1 | 1 | 2 | 1 | 1 | 7 |
| $a_1c_4$ | 2 | 2 | 1 | 3 | 1 | 1 | 10 |
| $a_1c_5$ | 2 | 3 | 2 | 2 | 2 | 2 | 13 |
| $a_1c_6$ | 1 | 1 | 2 | 1 | 1 | 1 | 7 |
| $a_2c_1$ | 2 | 2 | 1 | 3 | 2 | 2 | 12 |
| $a_2c_2$ | 3 | 3 | 2 | 2 | 2 | 2 | 14 |
| $a_2c_3$ | 2 | 2 | 3 | 2 | 2 | 2 | 14 |
| $a_2c_4$ | 2 | 2 | 2 | 3 | 2 | 2 | 13 |
| $a_2c_5$ | 3 | 3 | 3 | 3 | 3 | 3 | 18 |
| $a_2c_6$ | 1 | 1 | 2 | 1 | 1 | 1 | 7 |
| $a_3c_1$ | 2 | 2 | 3 | 1 | 2 | 2 | 12 |
| $a_3c_2$ | 3 | 3 | 3 | 3 | 3 | 3 | 18 |
| $a_3c_3$ | 2 | 2 | 3 | 2 | 3 | 3 | 15 |
| $a_3c_4$ | 3 | 3 | 3 | 2 | 3 | 3 | 17 |
| $a_3c_5$ | 3 | 3 | 3 | 3 | 3 | 3 | 18 |
| $a_3c_6$ | 1 | 1 | 2 | 1 | 2 | 1 | 8 |

Table 13 contd.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| $b_1c_1$ | 1 | 1 | 1 | 1 | 1 | 1 | 6 |
| $b_1c_2$ | 2 | 2 | 1 | 2 | 2 | 2 | 11 |
| $b_1c_3$ | 1 | 2 | 1 | 1 | 2 | 2 | 9 |
| $b_1c_4$ | 1 | 2 | 1 | 2 | 2 | 2 | 10 |
| $b_1c_5$ | 2 | 3 | 2 | 3 | 3 | 3 | 16 |
| $b_1c_6$ | 1 | 1 | 1 | 1 | 1 | 1 | 6 |
| $b_2c_1$ | 2 | 2 | 2 | 2 | 2 | 1 | 11 |
| $b_2c_2$ | 3 | 2 | 2 | 3 | 2 | 2 | 13 |
| $b_2c_3$ | 2 | 1 | 2 | 3 | 2 | 2 | 12 |
| $b_2c_4$ | 3 | 2 | 3 | 3 | 2 | 2 | 15 |
| $b_2c_5$ | 3 | 3 | 3 | 2 | 3 | 3 | 17 |
| $b_2c_6$ | 1 | 1 | 1 | 1 | 1 | 1 | 6 |
| $b_3c_1$ | 3 | 3 | 3 | 3 | 2 | 2 | 16 |
| $b_3c_2$ | 3 | 3 | 3 | 3 | 3 | 3 | 18 |
| $b_3c_3$ | 2 | 3 | 3 | 3 | 3 | 2 | 16 |
| $b_3c_4$ | 3 | 3 | 3 | 3 | 3 | 2 | 17 |
| $b_3c_5$ | 3 | 3 | 3 | 3 | 3 | 3 | 18 |
| $b_3c_6$ | 1 | 1 | 2 | 1 | 1 | 1 | 7 |

The scores obtained for the different treatments are presented in Table 13. The seedlings which obtained scores of 16, 17 and 18, out of a possible maximum of 18, were considered as vigorous, those with 13, 14 and 15 as medium vigorous and those below 12 as weak. Seven treatments produced seedlings with a score of 18. These treatments were coconut husk pots with Mixture 3, coconut husk pots with GA 200 ppm, coconut husk pots with GA 200 ppm + urea, polythene bags with GA 200 ppm + urea 0.5 per cent, GA 200 ppm + urea 0.5 per cent, Mixture 3 with GA 200 ppm and Mixture 3 with GA 200 ppm + urea 0.5 per cent. Eight other treatments also produced vigorous seedlings, but with scores of 16 or 17. The least vigorous seedling (score 6) were produced by three treatments. These treatments were, Mixture 1 with GA 100 ppm, Mixture 1 distilled water spray and Mixture 2 with distilled water spray.

5. <u>Survival and of growth clove seedlings as influenced by transplanting to the main field with or without the containers</u>

Data on the effect of different containers on the survival of clove seedlings in the mainfield six months after transplanting are presented in Table 14. The data have been presented in Fig.11 also. The data showed that the coconut husk pots recorded 85 per cent survival as against 60 per cent and 50 per cent, respectively for polythene bags and clay pots. Coconut husk pots were significantly superior to polythene bags and clay pots at 5 per cent level of significance. Polythene bags were found

Table 14. Effect of different containers on the field survival of the clove seedlings, after six months of transplanting.

| Containers | Survival (per cent) | Chisquare |
|---|---|---|
| Clay pots | 50* | Clay pots x coconut husk pots = 5.58 |
| Polythene bags | 60 | Clay pot x polythene bags = 0.404 |
| Coconut husk pots | 85+ | Polythene bags x coconut husk pots = 3.134 |

* Significant at 5 per cent level.

\+ Significant at 10 per cent level.

a - CLAY POTS.
b - POLYTHENE BAGS.
c - COCONUT HUSK POTS.

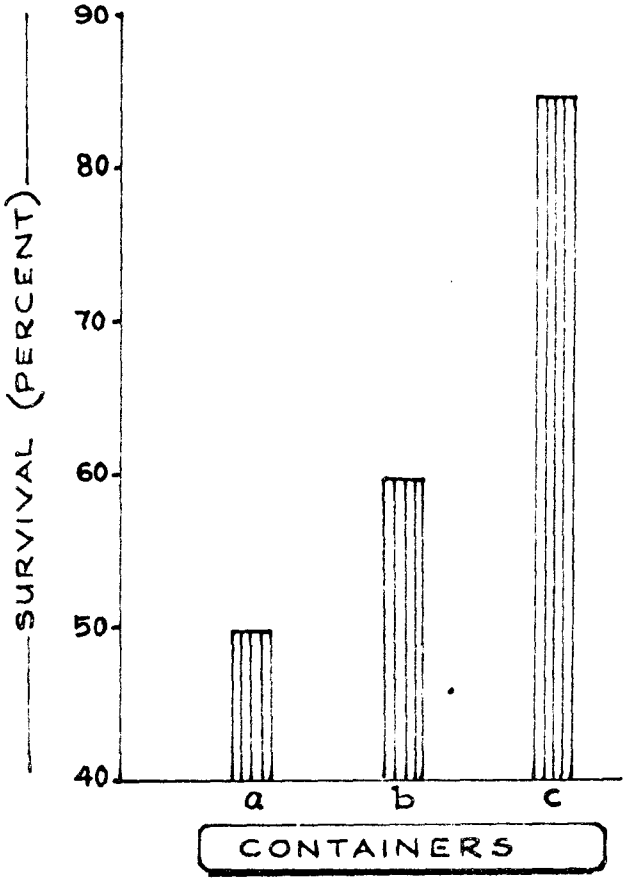


FIG. 11.—SURVIVAL OF SEEDLINGS AFTER SIX MONTHS OF TRANSPLANTING TO THE MAIN FIELD.

to be superior to the clay, pots at 10 per cent level of significance.

The effect of the containers on increments in height of the transplanted seedlings is presented in Table 15 and the results of the analysis of variance in Appendix X. The data showed no significant difference in height increments upto the fourth month. Between the fourth and sixth month, the seedlings transplanted along with coconut husk pots recorded more height.

The effect of the containers on increments in number of leaves of the seedlings transplanted to the mainfield, are presented in Table 16 and the analysis of variance in Appendix XI. The data showed no significant effect upto the fourth month. Between fourth and sixth months, the coconut husk pots produced significant increase in leaf number than polythene bags and clay pots.

The effect of the three types of containers on increments in girth of the seedlings transplanted to the mainfield are presented in Table 17 and the analysis of variance in Appendix XII. The data showed no significant difference in girth increments upto the sixth month.

Table 15. Effect of different containers on increments in height of the seedlings after two, four and six months of transplanting to the mainfield.

| Containers | Increments in height (cm) after two months | four months | sixth months |
|---|---|---|---|
| Clay pots | 0.60 | 2.34 | 4.47 |
| Polythene bags | 0.87 | 2.60 | 5.28 |
| Coconut husk pots | 0.86 | 3.23 | 5.98 |
| | $SE_m$ | $SE_m$ | $SE_m$ |
| Clay pot x polythene bag | 0.042 | 0.120 | 0.134 |
| Clay pot x coconut husk pot | 0.039 | 0.111 | 0.125 |
| Polythene bag x coconut husk pot | 0.037 | 0.105 | 0.118 |
| | C.D. (0.05) | C.D. (0.05) | C.D. (0.05) |
| Clay pot x polythene bag | — | — | 0.38 |
| Clay pot x coconut husk pot | — | — | 0.35 |
| Polythene bag x coconut husk pot | — | — | 0.34 |

Table 16. Effect of different containers on increments in number of leaves after two, four and six months of transplanting to the mainfield.

| Containers | Increments in number of leaves after | | |
|---|---|---|---|
| | two months | four months | six months |
| Clay pots | 2.30 | 5.10 | 7.70 |
| Polythene bags | 2.66 | 7.42 | 9.67 |
| Coconut husk pots | 3.23 | 6.82 | 11.18 |
| | $SE_m$ | $SE_m$ | $SE_m$ |
| Clay pot x polythene bag | 0.267 | 0.296 | 0.395 |
| Clay pot x coconut husk pot | 0.248 | 0.276 | 0.367 |
| Polythene bag x coconut husk pot | 0.237 | 0.261 | 0.346 |
| | C.D. (0.05) | C.D. (0.05) | C.D. (0.05) |
| Clay pot x polythene bag | — | — | 1.13 |
| Clay pot x coconut husk pot | — | — | 1.05 |
| Polythene bag x coconut husk pot | — | — | 0.99 |

Table 17. Effect of different containers on increments in girth after two, four and six months of transplanting to the mainfield.

| Containers | Increments in girth (cm) after | | |
|---|---|---|---|
| | two months | four months | six months |
| Clay pots | 0.17 | 0.33 | 0.46 |
| Polythene bags | 0.21 | 0.40 | 0.53 |
| Coconut husk pots | 0.23 | 0.40 | 0.52 |
| | $SE_m$ | $SE_m$ | $SE_m$ |
| Clay pot x polythene bag | 0.013 | 0.022 | 0.019 |
| Clay pot x coconut husk pot | 0.012 | 0.021 | 0.018 |
| Polythene bag x coconut husk pot | 0.011 | 0.019 | 0.017 |

# DISCUSSION

## DISCUSSION

Short viability of seeds, low percentage of germination, high mortality, slow rate of growth of the seedlings in the nursery and low percentage survival of seedlings transplanted to the mainfield are some of the problems confronting the clove growers in the State. The present studies were carried out with the objectives of finding solutions to these problems. The results obtained are discussed in this chapter.

### 1. Germination of seeds as influenced by period of collection of seed, weight of seeds and removal of pericarp

The results presented in Table 1 revealed that the highest germination (51.5 per cent) was recorded by the seeds collected and sown during June 1979. The seeds of May 1979 was found to be the second best. Influence of period of collection of seeds has been reported in nutmeg (Mathew, 1979), Cocoa (Atanda and Jacob, 1970 ; Keshavachandran, 1979) and tea Sanikidze, (1977). In the case of nutmeg, which has similar climatic and cultural requirements as clove, the best month of seed collection was found to be June (Mathew, 1979). The higher percentage of germination obtained during the month of June can be attributed to the optimum temperature and humidity conditions during that month.

The data presented in Table 1 also revealed better germination with the use of heavier seeds. Kannan (1972) and

Sriram (1977) also recorded beneficial effects with regard to percentage germination by using heavier seeds in clove. The heavier seeds may have more "initial capital" as compared to the lighter ones (Heydecker, 1974), thus giving advantage.

The studies also revealed significant increase in germination, as a result of removal of pericarp. The seeds with seedcoat intact gave 37.3 per cent germination, as against 58.2 per cent when the pericarp was removed before sowing. Similar results were obtained by Sriram (1977) and Nair et al. (1979) in cloves. The removal of pericarp might have rendered the embryo more accessible to water and oxygen in the surrounding atmosphere or might have facilitated faster imbibition of water, thus initiating the germination process (Hartman and Kester, 1972).

Though the seeds collected and sown during June recorded maximum percentage of germination, the July seeds took less time for the commencement of germination and also for recording 50 per cent germination. An analysis of the physical characteristics of seeds collected during the three months as presented in Table 18 revealed that, as compared to the June seeds, the seeds collected during July had less average weight. Further, the incidence of pests (unidentified, Pyraustidae, Lepidoptera was more in the latter.

Table 18. Physical characteristics of the seeds collected during May, June and July.

| Period of collection | Average volume/seed (c.c.) | Average weight/ seed (g) | Pest incidence (per cent) |
|---|---|---|---|
| May | 1.98 | 1.88 | 2.8 |
| June | 1.92 | 1.79 | 3.4 |
| July | 1.70 | 1.65 | 8.7 |

But for these two defects, the July seeds may have given better germination also.

2. Germination of seeds as affected by GA treatment

The data presented in Table 2 indicated that GA at the concentrations tried (100, 200, 300 and 400 ppm) exhibited inhibitory effect on germination. Such inhibitory effects have been recorded in blue berry, (Ballington et al. 1976), coffee (Valio, 1976) and rice (Sircar, 1963). It is possible that either the levels of GA tried were high or the clove seeds contain GA in sufficient quantities as observed by Simpson (1965). The seed treatments with GA not only affected the percentage of germination, but also extended the time for completion of germination. It may be worthwhile to try lower levels of GA in future experiments to obtain higher percentage of germination.

3. Growth and vigour of the seedlings as influenced by period of seed collection, weight of seeds and removal of pericarp

The data recorded in tables 3, 5 and 6 indicate that

May sowings (irrespective of weight of seeds) produced significantly vigorous seedlings as compared to June and July sowings. As can be seen from Table 18, the seeds collected during May were larger and free from pests and disease attack, than those of June and July. The "initial capital" within the seed (Haydecker, 1974) and the inherent health of the seeds could be cited as possible reasons for the vigour of the seedlings obtained. Ovcharov (1969) obtained striking differences in the biosynthetic activity of the seedlings resulting from seeds of different weights in several crops.

The present study indicated that the presence of seedcoat though affected percentage of germination, did not influence vigour of the seedlings. This observation may seem contradictory to those obtained by Kannan (1972), Sriram, (1977) and Nair et al. (1979). It may be pointed out that the above workers have recorded healthier seedlings from peeled seeds and they have not studied the vigour of the seedlings for a period of four months.

4. Effect of containers, potting mixtures and foliar sprays on the growth and vigour of clove seedlings

Among the three types of containers used for growing the seedlings from the primary nursery, the coconut husk pots were found significantly superior to polythene bags and clay pots (Tables 9 to 13). The coconut husk pots can be made fairly

early as described in page 20. At the end of seven months of observation, the husk portion was seen to have disintegrated partially. The favourable effects exhibited by coconut husk pots may be attributed to its ability to maintain temperature, humidity and moisture levels, favourable for the growth of the seedlings. As can be seen from the Table 7, the water holding capacity of the coconut husk pots was higher than that of polythene bags and clay pots. Further, the total porosity of this container was also very high, as compared to that of the other two. All these factors together might have contributed for the better vigour of the seedlings. Eastoe and Pollard (1959) attributed high permiability and porosity of the pot wall to be responsible for the favourable effect on the growth of container grown plants. Perishable types of containers have given better rate of growth of seedlings in coffee (Figueiredo and others, 1964), cocoa (Reyes and Armas, 1965), arecanut (Appaiah, 1970) and in cashew air layers (Rajeevan, 1978). Similar beneficial effects must have been available to the seedlings grown in coconut husk pots also.

Among the potting mixtures used, Mixture 3 consisting of one part soil, one part sand and one part powdered cowdung with bonemeal @ 2 teaspoons/pot and powdered groundnut cake @ 2 teaspoons/pot was identified as the best. The addition of bonemeal and groundnut cake must have improved the physical

properties of the mixture, as indicated by increase in pore space and water holding capacity (Table 7). The resultant impsovement in aeration must have also been responsible for the vigour of the seedlings.

In the present studies, foliar spray of GA 200 ppm + urea 0.5 per cent produced significantly vigorous seedlings. Increased rate of growth of seedlings have been obtained by researchers in guava (Reddy, 1963), jack (Sharmugavelu, 1971) nutmeg (Mathew, 1979), cocoa (Nichols, 1959 and Are, 1964), lemon (Randhawa and Singh, 1959), sweet orange (Shant and Rao, 1973), peach (Carlone, 1959), cherry (Hall and Lewis, 1959), apple (Powell et al. 1959) and pecan (Shreve and Campbell, 1967) by GA treatment. Gilliam and Wright (1977) observed increased root length as a result of application of GA, along with different levels of nitrogen.

An analysis of the interaction between 'type of container x potting mixtures', "type of container x booster spray" and "type of potting mixture x booster spray" were significant (Tables 9 to 13). The seedlings raised in coconut husk pots with Mixture 3, coconut husk pots sprayed with GA 200 ppm + urea 0.5 per cent and seedlings grown in any container with Mixture 3 and sprayed with GA 200 ppm + urea 0.5 per cent were found to be superior in the production of vigorous seedlings. The studies have indicated that by selecting appropriate containers, potting mixtures and booster sprays, the rate of

growth of clove seedlings could be enhanced.

5. Survival and growth of clove seedlings as influenced by transplanting with or without the container to the mainfield

The data presented in Table 14 revealed that transplanting the clove seedlings to the mainfield with the cocoonut husk pots intact gave 85 per cent survival (after six months). The seedlings grown in clay pots and transplanted carefully to the mainfield gave only 50 per cent survival. The better results obtained in the case of coconut husk pots could be the result of practically no disturbance or shock to the root system of the seedlings. Further, the coconut husk pots gave protection to the root system and the decomposed husk material added organic matter in the root zone. The combined effect of all these must have resulted in the higher survival rate of the seedlings. Better field survival of plants raised in decomposable types of containers were reported by Benstead (1950) in cocoa, Harer (1962) and Snock (1965) in coffee, Albuquerque et al. (1958), Shetty and Bhaktal (1965) and Rajeevan (1978) in cashew, Serier (1966) in oilpalm, Appaiah (1970) in arecanut and Singrot et al. (1970) in Zizyphus mauritiana.

Though differences in survival of the seedlings have been observed among the three types of containers, the results presented in tables 15, 16 and 17 indicated no significant difference in the growth of the surviving seedlings, upto a

period of four months. During the period from four to six months, the seedlings from coconut husk pots produced better growth. This may be due to the enrichment of organic matter in the rootzone as a result of the disintegration of the container. It may also be pointed out that the organic matter thus added to the rootzone may have improved the water holding capacity of the soil.

From the preceding discussion of results, it can be tentatively concluded that the seeds may be collected and sown during the month of May for obtaining superior seedlings. Heavy or medium seeds weighing more than 1.5 g each may give better results. Removal of pericarp may be effective in hastening germination and for giving higher percentage of germination. GA at the levels tried exhibited inhibitory effects and as such further studies with lower levels of GA are worthwhile. For enhanced rate of growth, the seedlings may be transplanted to coconut husk pots with a mixture consisting of one part soil, one part sand and one part powdered cowdung with bonemeal 2 teaspoons/pot and powdered groundnut cake 2 teaspoons/pot (Mixture 3). Seedlings grown in coconut husk pots and transplanted to the mainfield along with the pots may give better survival. Spraying GA 200 ppm + urea 0.5 per cent to the seedlings growing in coconut husk pots with any medium or in Mixture 3 in any container may hasten the growth of young seedlings. The studies revealed that by using better management practices in the nursery, growth of clove seedlings can be enhanced thereby reducing the juvenile phase.

# SUMMARY

## SUMMARY

Studies were conducted at the Instructional Farm attached to the College of Horticulture, Vellanikkara during 1979-80 to find out the methods to increase the percentage of germination of clove seeds, to accelerate the rate of growth of seedlings, and to increase the percentage survival of seedlings transplanted to the mainfield. Seeds collected during the months of May, June and July were classified as heavy, medium and light, and sown with or without the pericarp. Germination as well as the various growth parameters were observed. In another experiment, the effect of GA treatment on germination of clove seeds was investigated. In a third experiment, clove seedlings from the primary nursery were transplanted to three different types of containers filled with three types of potting mixtures. The seedlings were also given chemical booster sprays (GA and urea). The various growth parameters were observed to find out the effect of the types of containers, potting mixtures and the chemical sprays on the rate of growth of clove seedlings. In another experiment, the clove seedlings from the primary nursery which were grown in different types of containers were transplanted to the mainfield with or without the container to assess the rate of survival and the rate of growth of seedlings.

The salient findings of the studies are summarised below:

1. The seeds collected and sown during the month of June recorded

the highest percentage of germination (51.5). However, when the rate of growth and vigour of the seedlings were considered, the seeds collected and sown during May were superior to the others, irrespective of their weight.

2. Though heavy seeds (weighing more than 2 g) recorded the highest percentage of germination (51.9) the rate of growth of seedlings obtained from heavy and medium seeds were on par.

3. The removal of pericarp, though increased the percentage of germination (58.2 per cent as against 37.3 per cent in the control) did not significantly influence the rate of growth of the resultant seedlings.

4. GA at the concentrations tried (100, 200, 300 and 400 ppm) exhibited inhibitory effect on the germination of clove seeds (11.3 to 24.6 per cent as against 48.0 per cent in the control).

5. The seedlings from the primary nursery transplanted to improvised coconut husk pots filled with a mixture containing one part soil, one part sand and one part powdered cowdung with bonemeal @ 2 teaspoons/pot and powdered groundnut cake @ 2 teaspoons/pot (Mixture 3) exhibited higher rate of growth as compared to those under other treatments. Similar rate of growth was obtained when the seedlings were grown in coconut husk pots (with any one of the three mixtures tried) or with Mixture 3 (in any one of the three containers tried), supplemented by booster sprays

of GA 200 ppm + urea 0.5 per cent at the first and the third month of transplanting.

6. Transferring the seedlings from the primary nursery to coconut husk pots at the second month and transplanting them to the mainfield with the container intact, at the ninth month gave higher rate of survival (85 per cent as against 50 to 60 per cent when the seedlings grown in polythene bags and clay pots were transplanted after depotting). Such seedlings exhibited better rate of growth also as compared to seedlings grown in clay pots or polythene bags.

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# APPENDICES

APPENDIX I

Summary of analysis of variance table for the effect of period of collection of seeds, weight of seeds and removal of the pericarp on percentage of germination, number of days for the first germination, number of days for the 50 per cent germination and number of days for the completion of germination.

| Source | df | Mean squares | | | |
|---|---|---|---|---|---|
| | | Percentage of germination (after arcsine transformation) | Number of days for first germination | Number of days for 50 per cent germination | Number of days for the completion of germination |
| | | | After square root transformation | | |
| Block | 2 | 15.72 | 0.001 | 0.106 | 0.141 |
| A | 2 | 127.12** | 1.35** | 1.007** | 1.024 |
| B | 2 | 101.17** | 0.033 | 0.024 | 0.424 |
| AB | 4 | 7.36 | 0.006 | 0.049 | 0.255 |
| C | 1 | 1970.97** | 5.42 | 4.477 | 4.495 |
| AC | 2 | 12.01 | 0.15 | 0.009 | 0.222 |
| BC | 2 | 0.63 | 0.021 | 0.007 | 0.036 |
| ABC | 4 | 1.43 | 0.018 | 0.073 | 0.634 |
| Error | 34 | 1.72 | 0.038 | 0.033 | 0.011 |

**Significant at 1 per cent level.

APPENDIX II

Summary of analysis of variance table for the effect of GA on percentage of germination, number of days for the first germination, number of days for the 50 per cent germination and number of days for the completion of germination.

| Source | df | Mean quares | | | |
|---|---|---|---|---|---|
| | | Percentage of germination (after arcsine transformation) | Number of days for first germination | Number of days for 50 per cent germination | Number of days for the completion of germination |
| | | | After square root transformation | | |
| Block | 2 | 0.0180 | 0.0379 | 0.0855 | 5.458 |
| Treatments | 4 | 0.0180 | 0.0298 | 1.0596** | 272.062* |
| Error | 8 | 0.0180 | 0.0586 | 0.0216 | 9.532 |

**Significant at 1 per cent level.

*Significant at 5 per cent level.

## APPENDIX III

Summary of analysis of variance table for the effect of period of collection of seeds, weight of seeds, removal of pericarp on mean increments in height during the first to four months and total increments in height after four months of growth.

| Source | df | Mean squares | | | | |
|---|---|---|---|---|---|---|
| | | first month | second month | third month | fourth month | Total increments in height after four months of growth |
| Block | 2 | 0.0055 | 0.0125 | 0.0011 | 0.0069 | 0.069 |
| A | 2 | 0.0049 | 0.0098 | 0.1717** | 0.391* | 1.141** |
| B | 2 | 0.0046 | 0.0777** | 0.1208** | 0.091* | 0.867** |
| AB | 4 | 0.0031 | 0.0344** | 0.0119 | 0.1205* | 0.187** |
| C | 1 | 0.0167 | 0.0522** | 0.1048 | 0.0824* | 0.574 |
| AC | 2 | 0.0026 | 0.0297 | 0.0212 | 0.0417* | 0.205 |
| BC | 2 | 0.0013 | 0.0174 | 0.0085 | 0.0374* | 0.433 |
| ABC | 4 | 0.0042 | 0.0426** | 0.0154 | 0.0349* | 0.112 |
| Error | 34 | 0.0011 | 0.0029 | 0.0026 | 0.0015 | 0.014 |

** Significant at 1 per cent level.

* Significant at 5 per cent level.

APPENDIX IV

Summary of analysis of variance table for the effect of period of collection of seeds, weight of seeds, removal of pericarp on increments in number of leaves from the first to four months and total increments in number of leaves after four months of growth.

| Source | df | Mean squares | | | | |
|---|---|---|---|---|---|---|
| | | first month | second month | third month | fourth month | Total increments in number of leaves after four months of growth |
| Block | 2 | 0.735 | 0.2696 | 0.1016 | 0.2724 | 0.4238 |
| A | 2 | 1.422** | 0.4346 | 0.4872 | 0.0224 | 4.6022** |
| B | 2 | 0.0422 | 1.7468 | 0.8822 | 0.1562 | 2.6605 |
| AB | 4 | 0.1563 | 0.1496 | 0.7894 | 0.4779 | 0.8453 |
| C | 1 | 0.0224 | 1.4668 | 0.0816 | 1.434 | 6.4757 |
| AC | 2 | 0.2068 | 0.4790 | 0.7905 | 0.685 | 2.1207 |
| BC | 2 | 0.3029 | 0.1524 | 0.6199 | 0.0363 | 0.6979 |
| ABC | 4 | 0.3032 | 0.1629 | 0.5972 | 1.2979 | 0.4854 |
| Error | 34 | 0.0581 | 0.1504 | 0.1352 | 0.1159 | 0.1725 |

** Significant at 1 per cent level.

APPENDIX V

**Summary of analysis of variance table for the effect of period of collection of seeds, weight of seeds and removal of pericarp on mean increments in girth during the first to four months and total increments in girth after four months of growth.**

| Source | df | Mean squares | | | | |
|---|---|---|---|---|---|---|
| | | first month | second month | third month | fourth month | Total increments in girth after four months of growth |
| Block | 2 | 0.000968 | 0.000200 | 0.000216 | 0.000505 | 0.002316 |
| A | 2 | 0.000024 | 0.000072 | 0.000105 | 0.000716 | 0.003350 |
| B | 2 | 0.000810 | 0.000505 | 0.000205 | 0.000555 | 0.006730** |
| AB | 4 | 0.000296 | 0.000636 | 0.002269 | 0.000855 | 0.001460 |
| C | 1 | 0.000002 | 0.001666 | 0.000016 | 0.000668 | 0.016016 |
| AC | 2 | 0.000035 | 0.000505 | 0.003170 | 0.000412 | 0.003530 |
| BC | 2 | 0.000274 | 0.000038 | 0.000050 | 0.000109 | 0.001372 |
| ABC | 4 | 0.000774 | 0.000952 | 0.001147 | 0.000357 | 0.000569 |
| Error | 34 | 0.000156 | 0.000317 | 0.000387 | 0.000311 | 0.000344 |

** Significant at 1 per cent level.

## APPENDIX VI

**Summary of analysis of variance table for the effect of containers, potting mixtures and foliar sprays on mean increments in height during the first to seven months and total increments in height after seven months of growth.**

| Source | df | Mean squares | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | first month | second month | third month | fourth month | fifth month | sixth month | seven month | Total increments in height after seven months of growth |
| Block | 2 | 0.0035 | 0.0082 | 0.0207 | 0.0167 | 0.0153 | 0.0159 | 0.0308 | 0.0323 |
| A | 2 | 0.0190 | 0.0311 | 0.0722 | 0.5513 | 0.5111** | 1.451* | 0.9858** | 15.335* |
| B | 2 | 0.0022 | 0.0002 | 0.5555** | 1.286** | 1.707* | 1.135* | 0.7225** | 22.603* |
| AB | 4 | 0.0251** | 0.0163 | 0.1310** | 8.658 | 0.148 | 0.0206 | 0.1417 | 0.298* |
| C | 5 | 0.0042 | 0.0097 | 0.1913* | 0.2805** | 0.818* | 0.5737* | 0.4992* | 12.106* |
| AC | 10 | 0.0078 | 0.0053 | 0.0982* | 0.0332 | 0.0832* | 0.0632* | 0.1104** | 0.3365* |
| BC | 10 | 0.0017 | 0.0058 | 0.0210 | 0.0725 | 2.345** | 0.1394* | 0.0931** | 0.4038* |
| ABC | 20 | 0.0059 | 0.0080 | 0.0637* | 0.0327 | 0.0342* | 0.0949* | 0.1121* | 0.2032* |
| Error | 106 | 0.0020 | 0.0045 | 0.0169 | 0.0433 | 0.0087 | 0.0096 | 0.0331 | 0.0451 |

** Significant at 1 per cent level.

* Significant at 5 per cent level.

APPENDIX VII

Summary of analysis of variance table for the effect of containers, potting mixtures and foliar sprays on mean increments in number of leaves during the first to seven months and total increments in number of leaves after seven months of growth.

| Source | df | Mean squares | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | first month | second month | third month | fourth month | fifth month | sixth month | seventh month | Total after 7 months growth |
| Block | 2 | 0.2884 | 0.0269 | 0.0195 | 0.0452 | 0.0178 | 0.0167 | 0.0419 | 0.111 |
| A | 2 | 0.8313 | 1.5928** | 1.66** | 1.0007 | 0.840 | 1.6908 | 1.96 | 17.23** |
| B | 2 | 0.3498 | 1.9158** | 1.2635 | 1.2474 | 0.990 | 2.39* | 1.002 | 64.14** |
| AB | 4 | 0.2717 | 0.0602 | 0.537** | 0.4481 | 0.278 | 0.2596 | 2.758* | 7.69* |
| C | 5 | 0.3789 | 0.5288** | 0.624** | 0.4561** | 0.4679** | 2.033* | 3.435* | 35.12* |
| AC | 10 | 0.2992 | 0.2212** | 0.1036 | 0.0555 | 0.0522 | 0.122 | 0.252 | 1.65* |
| BC | 10 | 0.1715 | 0.02602 | 0.0704 | 0.0986 | 0.2039 | 0.327** | 0.5696** | 1.67* |
| ABC | 20 | 0.1093 | 0.1984* | 0.145 | 0.1043 | 0.3475 | 0.6459* | 0.541* | 3.61* |
| Error | 106 | 0.2338 | 0.0734 | 0.0829 | 0.0904 | 0.0920 | 0.1181 | 0.146 | 2.90 |

** Significant at 1 per cent level.

* Significant at 5 per cent level.

## APPENDIX VIII

**Summary of analysis of variance table for the effect of containers, potting mixtures and foliar sprays on mean increments in girth during the first to seven months and total increments in girth after seven months of growth.**

| Source | df | Mean squares | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | first month | second month | third month | fourth month | fifth month | sixth month | seventh month | Total increments in girth after seven months of growth |
| Block | 2 | 0.00006 | 0.00008 | 0.00025 | 0.0002 | 0.0056 | 0.00009 | 0.0075 | 0.0039 |
| A | 2 | 0.00118 | 0.00220 | 0.00558** | 0.00428 | 0.00430 | 0.00492 | 0.00821** | 0.1279* |
| B | 2 | 0.00188 | 0.00207 | 0.00398** | 0.0111** | 0.00029 | 0.00342 | 0.01749** | 0.1900* |
| AB | 4 | 0.00125** | 0.00129 | 0.00316 | 0.00222 | 0.00250 | 0.00162 | 0.00230 | 0.06227* |
| C | 5 | 0.00034 | 0.00028 | 0.00109** | 0.00176** | 0.0018** | 0.00159 | 0.0376* | 0.042* |
| AC | 10 | 0.00007 | 0.00054 | 0.00073* | 0.00104 | 0.00030 | 0.00098 | 0.00062 | 0.0760* |
| BC | 10 | 0.00028 | 0.00037 | 0.00077* | 0.00040 | 0.00067 | 0.00099 | 0.00111** | 0.00684* |
| ABC | 20 | 0.00012 | 0.00021 | 0.00044* | 0.00030 | 0.00070 | 0.00063 | 0.00066 | 0.0051* |
| Error | 106 | 0.00016 | 0.00028 | 0.00016 | 0.00024 | 0.00030 | 0.00041 | 0.00013 | 0.00063 |

** Significant at 1 per cent level.

* Significant at 5 per cent level.

## APPENDIX IX

**Summary of analysis of variance table for the effect of containers, potting mixtures and foliar sprays on fresh weight, total increments in root length, leaf area, mean internodal length and dry weight of the seedlings after seven months of growth.**

| Source | df | Mean squares | | | | |
|---|---|---|---|---|---|---|
| | | Fresh weight | Increments in root length | Leaf area | Mean internodal length | Dry weight |
| Block | 2 | 0.0077 | 0.187 | 2.239 | 0.0477 | 0.00003 |
| A | 2 | 4.002* | 40.91* | 308.39* | 1.17* | 2.160* |
| B | 2 | 1.202* | 47.41* | 1745.82* | 0.0544** | 0.2567* |
| AB | 4 | 0.0597* | 0.982** | 48.16** | 0.0439 | 0.0112** |
| C | 5 | 1.3114* | 21.53* | 1172.35* | 0.169* | 0.6449* |
| AC | 10 | 0.0847* | 0.869* | 158.64* | 0.0198 | 0.0179* |
| BC | 10 | 0.0145* | 0.797* | 152.78* | 1.614 | 0.0091* |
| ABC | 20 | 0.0081* | 0.595* | 105.08* | 0.0194** | 0.0077* |
| Error | 106 | 0.0028 | 1.674 | 5.317 | 0.0096 | 0.0015 |

** Significant at 1 per cent level.

* Significant at 5 per cent level.

APPENDIX X

Summary of analysis of variance table for the effect of containers on mean increments in height of the plants after two, four and sixth months of transplanting.

| Source | df | Mean squares | | |
|---|---|---|---|---|
| | | two months | four months | six months |
| Treatments | 2 | 0.2693 | 2.9065 | 7.2806** |
| Error | 36 | 0.0195 | 0.1562 | 0.1956 |

** significant at 1 per cent level.

APPENDIX XI

Summary of analysis of variance table for the effect of containers on increments in number of leaves of plants after two, four and six months of transplanting.

| Source | df | Mean squares | | |
|---|---|---|---|---|
| | | two months | four months | six months |
| Treatments | 2 | 2.9590 | 15.6512 | 38.2531** |
| Error | 36 | 0.7729 | 0.9524 | 1.701 |

** Significant at 1 per cent level.

APPENDIX XII

Summary of analysis of variance table for the effect of containers on increments in girth of plants after two, four and six months of transplanting.

| Source | df | Mean squares | | |
|---|---|---|---|---|
| | | two months | four months | six months |
| Treatments | 2 | 0.0134 | 0.0182 | 0.0153 |
| Error | 36 | 0.0019 | 0.0055 | 0.0043 |

# STUDIES ON THE EFFECT OF CONTAINERS, POTTING MIXTURES AND GROWTH REGULATORS ON GROWTH AND SURVIVAL OF CLOVE SEEDLINGS

BY

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ABSTRACT OF THE THESIS

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## ABSTRACT

Studies were undertaken at the Instructional Farm, attached to the College of Horticulture, Vellanikkara during 1979-80 to find out the methods to increase the percentage germination of clove seeds, to accelerate the rate of growth of the seedlings and to improve the percentage survival of the seedlings transplanted to the mainfield. The seeds collected during May, June and July were classified as heavy, medium and light and sown with or without the pericarp. The seeds collected and sown during the month of June recorded the highest percentage of germination. However, the May seeds were superior with respect to rate of growth and vigour of the resultant seedlings. Though heavy seeds recorded the highest percentage of germination, heavy and medium seeds were on par when the rate of growth of the seedlings was considered. The removal of pericarp increased the percentage germination, but did not influence the rate of growth of the resultant seedlings.

GA at the concentrations ranging from 100 to 400 ppm exhibited inhibitory effects on germination of clove seeds.

The clove seedlings from the primary nursery when transplanted to improvised coconut husk pots filled with a mixture containing one part soil, one part sand and one part powdered cowdung with bonemeal @ 2 teaspoons/pot and powdered

groundnut cake @ 2 teaspoons/pot, exhibited higher rate of growth. Spraying of GA 200 ppm + urea 0.5 per cent to the clove seedlings transplanted to coconut husk pots or growing in one of the three potting mixtures tried, enhanced their rate of growth.

Transferring the seedlings from the primary nursery to coconut husk pots at the second month and transplanting them to the mainfield with the container intact at the ninth month gave higher rate of survival.