PROPAGATION STUDIES IN NUTMEG

BY

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THESIS

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D E C L A R A T I O N

I hereby declare that this thesis entitled "Propagation studies in Nutmeg" is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Vellanikkara,
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(LILA MATHEW, K.)

C E R T I F I C A T E

Certified that this thesis is a record of research work done independently by Kumari. Lila Mathew, K. 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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INTRODUCTION

I N T R O D U C T I O N

Nutmeg, *Myristica fragrans* Houtt is an important tree spice belonging to the family Myristicaceae. It is a native of Moluccas, East Indies and is now grown in a number of tropical countries of the world. The total area under this crop in India is estimated to be 262 hectares, producing 180 tons of nutmeg and 14 tons of mace while the annual world production of nutmeg is about 7000 tonnes and 1000 tonnes of mace, sixty per cent of which is produced in Indonesia.

The cultivation of this crop in India, is mainly confined to the Southern States of Kerala (134 ha) and in Courtallam - Burliar region in Tamil Nadu. In Kerala, it is mostly grown in small numbers in home-steads in the districts of Ernakulam, Kottayam and Trichur. In Tamil Nadu, it is cultivated in the hilly regions of Kanyakumari, Tirunelveli and Nilgiri districts. It is estimated that, nearly 14,500 trees are in bearing stage at present in the country, though large scale planting has been initiated only during the last 3 to 4 years in view of increased return obtained

from this crop. The entire quantity produced in India is consumed locally and it is estimated that India imports about 40 tonnes of nutmeg and mace annually. But the recent reports showed that, India exported small quantities of mace to other countries.

Myristica fragrans yields two products of commercial value, nutmeg and mace. The nutmeg of commerce is the ovoid kernel which is hard and brown, covered with a thin brittle shell. Surrounding this shell is the axil, scarlet in colour - which is the mace of commerce.

Mace is used as a culinary spice, largely as a flavouring agent. It contains the volatile oil, "macine". It is used for flavouring cigarettes and for chewing to counteract foul breath (Rosengarten, 1973 and Lewis and Lewis 1977). Medicinally, nutmeg acts as a stimulant, carminative and astringent. It is used in tonics and electurians and forms a constituent of preparations prescribed for dysentry, flatulence, malaria, rheumatism and early stages of leprosy. Its use as an abortificient is also reported.

An essential oil is extracted from nutmeg. It contains 25 to 40 per cent of fixed oil known as Oleum Myristicae expressum. The aromatic oil has butter-like consistency and is orange in colour. It contains 73 per cent trimyristin, 12.5 per cent volatile oil and 3.5 per cent fat of glycerol oleate and linoleate. The essential oil is used for flavouring cookies, cakes etc. and in medicines. Nutmeg butter is used in the manufacture of scented oils, perfumes and as flavouring agent in cooking and confectionary. The volatile oil from the leaf has weedicidal properties, it may also be used in dentifices, chewing gums etc. (Khan and Krishnaswamy, 1953). The fleshy pericarp of the fruit is used for pickles and jelly (Abraham, 1957).

Nutmeg is a dioecious or occasionally monoecious, evergreen aromatic tree; usually 10 - 20 metres high. The tree comes to bearing within 6 to 8 years of planting and the fruits are ready for harvest in about nine months after flowering. On an average, a good tree yields about 1000 fruits per year, though the yields may vary from 100 - 10,000.(Nair,1978).

Though the crop is available throughout the year, the peak harvesting periods are between March - April and August - September.

The main problem in nutmeg cultivation is its propagation. The existing trees are almost entirely raised from seeds and these present wide variation in productivity and other economic characters. Another major problem is with regard to the sex of the tree which cannot be determined before the tree flowers in 4 - 8 years time. This means that the unproductive male trees have to be retained and maintained at considerable expense till the tree flowers. A number of workers have studied these problems, but have not succeeded in finding out a method of identification of male chicks in early stage (Janse, 1898; Dienum, 1949 and Gunther, 1960).

Nicholas and Prycie (1958) after reviewing the literature on the subject came to the conclusion that female and male trees were produced approximately in equal numbers. Flach (1966) has stated that apparently there were two different sexes, first a

female only flowering sex and secondly, a male flowering sex. The latter can be subdivided into four different groups, as male, bisexual males, bisexuals and bisexual females.

The possibility of determination of sex at the seedling stage based on vegetative characters has been reported by several workers in the past. Prestie, 1884 and Janse, 1898 have reported that the sex of the plant at seedling stage can be identified based on the leaf form and venation. Phadnis and Choudhari (1971) have claimed that the sex can be determined from the colour of the leaf extract. Nair et al. (1977) have suggested that the shape of the calcium oxalate crystals in the leaf epidermis can help in the identification of sex in nutmeg seedlings.

Flach and Cruickshank (1969) suggested that controlled crosses between highly producing mother trees and various types of male flowering trees held possibilities of diminishing the percentage of male trees in the offspring. But none of the

above methods have proved to be reliable and completely successful. The only alternative that can be relied upon is to adopt vegetative propagation of female and male trees and converting the excess of male trees into productive females.

The present research work was undertaken to standardise an effective method of vegetative propagation, which can be adopted for the perpetuation of high yielding female trees and will also ensure the determination of the sex of the progeny, thereby avoiding the substantial cost of maintaining excess number of male trees until the flowering stage.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

In perennial crop production, the system of propagation adopted is of vital importance, because many of them are highly heterozygous and the genetic make up of the progeny largely depends upon the system of propagation adopted. Most of these crops are amenable to both seed and asexual methods of propagation. The work done on the propagation of nutmeg and some related crops are briefly reviewed here.

1. Seed Propagation:-

Nutmeg is generally propagated through seed. Well matured seeds are collected and the pericarp and aril are removed. Seeds are sown immediately after extraction, as the germination decreases substantially when the sowing is delayed after extraction. Sowing within 24 hours of extraction was found to be the best at Kallar. They are sown in raised beds. In Malaya, sometimes seeds are sown insitu (Shanmughavelu and Rao, 1977).

In clove, the common method of propagation is by seeds. Seeds are extracted from ripe fruits and sown immediately. Viability of seeds is short and it can be maintained for about two weeks if they are stored under moist conditions.

Cinnamon is propagated by seed. When the seed ripens, they are gathered, dried and heaped in a shady place till the skin and the pulp inside rots and turns black. After separation of the pulpy mass, the seeds are dried in shade and sown in raised beds.

1.1. Sowing

Nutmeg seeds are sown in raised beds. In Malaya, some seeds are sown in situ. (Shanmughavelu and Rao, 1977).

In Kerala it is observed that some of the cultivators sow the seeds vertically with about 1/3rd of the micropylar end up. Otherwise the stem gets bend and twisted during the process of germination.

Naik (1941) reported that sowing mango seeds with the plumule up helps to avoid the common distortion of the seedlings.

1.1.1 Germination:

Perll (1938) investigated the germination of nutmeg seeds from female trees growing at various distances from male flowering trees and found that germination percentage was more in seeds of female trees growing nearer to the male trees. Flach 1966 stated that the germination percentage would be less if the seeds were sown, 3 days after harvest.

1.1.2 Time taken for germination:

In nutmeg the maximum percentage of germination was between 50 and 80 days after sowing (Kannan 1971). According to Nair *et al.* (1977), germination took place in about 60 to 90 days. Nair (1978) also reported more or less similar results. Problems of seed propagation in other spice crops like cardamom, clove, cinnamon have been investigated by a number of workers.

Sowing of cardamom seeds soon after collection was found to be more advantageous than sowing after a lapse of 15 days. Germination was completed in about 6 weeks after sowing (Anon 1950-51).

In cinnamon, the seeds started germinating within 15 - 20 days and generally it would be completed in about 45 days (Anon 1952). It is reported that seeds of allspice require 15 to 45 days to complete germination (Nair and Nair 1969).

Nair (1970) reported that in clove, germination of seeds started from 20th day and extended upto 120 days.

1.13 Seed size and germination:

Experiments conducted so far revealed that in many crops seed size showed additive effects on germination.

Hume and Cobin (1946) conducted experiments to determine the effect of size of seed on germination, survival and subsequent growth of mangosteen seedlings. Percentage of seed germination

increased with each 0.1 g increase in seed weight from 0.2 to 1 g, above which there was little or no effect.

Son Walker (1951) reported that most of the jack seeds weighed from 3 to 6 g each. And those smaller than this is unsatisfactory for propagation. Larger seeds recorded better germination.

Burris and coworkers (1973) conducted a number of experiments to know whether the weight of soybean seed has relationship with plant performance. They stated that higher proportion of small seeds would adversely affect the crop stand.

1.2 Storage media and viability:

The prime object of seed storage is to preserve the seeds with the minimum reduction in viability when exposed to higher temperature and humidity obtaining in the planting medium. High temperature and humidity accelerated the life processes going on in the seeds and shortened the storage life of seeds. Burns and Prayng(1920) studied

the viability of stored mango seeds and found that they retained their viability for a short period only. They obtained 80, 84 and 20 per cent germination in mango when the seed stones were sown 30, 38 and 71 days after harvest respectively. According to Singh (1938), the seed stones of mango were viable for about 100 days.

Evans (1950) opined that the conditions required to preserve viability in mango seeds are free air and low rate of loss of water for seeds.

In cardamom the viability was lost to the extent of 50 per cent within one and a half months and 90 per cent within four months time (Anon 1950-51).

Clove seeds also lose viability in short time after harvest. But the viability can be retained for about one week by storing them in a cool dark place in moist sand or saw dust. Winters and Rodriguez-Colon (1953) stated that the seeds of mangosteen retained its viability at room temperature for four weeks or if stored in moist charcoal dust or peat moss; about twice that time.

Cacao seeds loose viability in a short period. Seeds could be kept viable for two months provided they have a moisture content of 50 per cent and a storage temperature of 8 - 13°C (Hunter 1959).

According to Simao (1959) the best method of storing mango seeds is by keeping the whole fruit at room temperature. Under this condition, the seeds remained viable for 70 days. Larger seeds stored better than small ones. But Singh (1960) is of the opinion that they lose viability in 4 to 5 weeks time.

Bajpai and Trivedi (1961) conducted an experiment to determine the viability of mango seed stones under different storage conditions. They stored mango seeds in 1. Charcoal powder in an atmosphere of 50 per cent R.H., maintained in a desiccator by the method suggested by Wilson (1921). 2. Packed in polythene bags. 3. Allowed to remain in the fruits. 4. Stored in a desiccator over calcium chloride (0 per cent R.H.) and 5. Kept in an open jar. Of all the methods tried, storage in charcoal dust in a desiccator (50 per cent R.H.) was the best and

retained 80 per cent viability even after 70 days, storage over calcium chloride turned out to be the worst of all the treatments and this emphasises the need of moisture for mango seed storage.

Chacko and Singh (1968) reported that seeds of grape stored in moist sand or saw dust retained high per cent of viability than those stored in polythene bags.

Experiments were conducted on cacao seed viability at Kallar and Burliar Fruit Station in Nilgiris during 1966-69. The following were the treatments (Anon 1969).

a) Seeds extracted with attached pulp and stored in finely ground charcoal.

b) Seeds retained in pods stored in finely ground charcoal.

c) Seeds retained in pods stored in polythene bags and finely ground charcoal and

d) Control.

Pods stored as such in polythene bags and dry charcoal powder retained the viability upto a period

of 30 days with a fair percentage of germination. Cacao seeds can be stored as such in polythene bags (200 gauge) without much loss of viability of seeds upto a period of five weeks from harvest.

Shanmughavelu and Rao (1977) stated that nutmeg seeds stored in polythene bags or moist sand remained viable for 15 days.

1.2.1 Factors affecting longevity of stored seeds:

The major factors known to influence the longevity of seed in storage are temperature, moisture content and oxygen pressure. (Owen 1956, Barton 1961, James 1967 and Roberts 1972). Numerous experiments have been conducted to delineate parameters that affect longevity of seeds. The relationship between temperature, moisture content and period of viability has been defined quantitatively by various workers for most of the crop seeds. Roberts (1973 a) devised equations to determine the half-viability period for various crops. eeds and also published a series of monographs to predict seed storability at given temperatures and seed moisture contents. Such

evaluations are affected by genotypic variations, seed maturity, mechanical damage, micro-organisms etc. Nevertheless, they offer guidelines for storage and longevity of seed lots.

In tropics, the storage of seeds to preserve viability presents greater problems due to the general adversity of the climate. Ambient relative humidity is sufficient to cause increase in seed moisture with resultant deterioration in viability.

Bass (1972) has delineated the storage conditions, packaging materials and seed moisture conditions suitable for optimum longevity of tree crops, agricultural and vegetable seeds. Sub-freezing temperatures (-18°C was best) and moisture contents at 2 to 7 per cent were seemed best for long-term storage in moisture proof containers.

Delouche et al. (1973) stressed proper prestorage handling coupled with conditioning of the storage environment as means of preserving viability. Harrington (1972, 1973 b) discussed the problems of

seed storage with regard to moisture and temperature control to minimize deterioration. Proper drying and packaging of seeds in moisture proof containers are necessary to prevent rehydration and to maintain viability during transit and storage periods.

Fungi and bacteria often cause adverse effects on seed viability. (Anderson *et al.* 1970) Christensen (1973) conducted extensive studies on influence of moisture content, temperature and storage time on changes in fungal organism and seed viability. Seeds that are free of fungi maintained high germinability and when such seeds were inoculated with fungi at the time of storage, complete loss of viability occured.

The physical and biological processes in the drying of seed were examined by Nellist and Hughes (1973). They reported that the loss of seed quality is due to respiration and or moulding. Apart from the environmental factors; genetical traits also affect seed longevity (James 1969).

1.3 Effect of gibberellic acid on germination of seeds:

In a number of trials conducted, plant regulators

have been shown to promote germination of seeds. Most of the dubious results have been obtained using auxin. Much clearer effects have been obtained by external application of gibberellins and gibberellic acid. Lona (1956) and Kahn et al. (1956) were among the first to show that gibberellic acid stimulated the germination of Lactuca sativa and L. scariola seeds in the dark. The effect of gibberellic acid seemed to be similar to that of light in promoting germination.

However, the results of a number of experiments conducted lead to the general conclusion that gibberellic acid and light (red) act only partially in the same way and that their mode of action is not identical (Ikuma and Thimann, 1960; Fujii et al. 1960).

The stimulatory effect of applied GAs on the germination of seeds has been widely reported (Lang, 1965; Stokes, 1965).

Gibberellin seed treatments have been found to be effective in promoting germination of small grain crops, fruit crops and vegetable crops. (Hayashi, 1940;

Wittwer and Bukovac, 1957; Morgan and Mees, 1958; Stowe and Yamaki, 1959; Nekrasova, 1960).

Wiggans and Martin (1961) conducted an experiment on this aspect. The results showed that by increasing the soaking time in gibberellic acid solution the germination was earlier.

Experiments with grape seed by Yeou-Der *et al.* (1962), Randhawa and Negi (1964), Chadha (1965), Chadha and Menon (1967), Randhawa and Pal (1967) have conclusively shown the usefulness of GA in seed germination. According to them, applications of GA stimulated and improved seed germination. It was found that all concentrations of GA strikingly increased the percentage of germination.

Shanmugavelu (1965 and 1969) reported the effects of plant growth regulators on seed germination. According to him, cashew seeds soaked in 100 ppm GA solution recorded about 100 per cent germination. But as the concentration increased further, the per cent of seed germination decreased.

Srivastava (1969) reported the influence of

Presowing treatment with GA on the seed germination. Singh and Motial (1970) conducted an experiment to study the effect of gibberellic acid and temperature on seed germination of Rauvolfia serpentina. They found that under field conditions, GA 500 ppm increased germination from 40 (control) to 89.5 per cent and survival was 100 per cent in both cases.

Farooqui et al (1971) studied the effect of growth regulators on the germination of sapota seeds. Even though all the growth regulators tried hastened and improved the germination percentage, maximum germination percentage was obtained by soaking the seeds in gibberellic acid in indoleacetic acid (25 and 50 ppm).

Shant and Rao (1973) reported that GA promoted seed germination in acid lime by soaking the seeds in 500 ppm. GA solution for 12 hours before sowing.

Bhujbal (1975), Gasiani and Salvadori (1975) and Ballington et al (1976), reported that gibberellic acid stimulated and increased the per centage of germination in fruit crops blueberry, ziziphus, aonla etc.

1.3.1 Effect on seedling growth:

Gibberellins are considered as a group of plant hormones with an action clearly distinguished from that of auxins. Treatment of a variety of plants with gibberellic acid (GA) was found to increase the shoot growth as a result of cell elongation (Nelson, 1957; Audus 1963; Devlin, 1966 and Singh 1967).

An increase in total plant height when the pecan seeds were dipped in GA solution was reported by Wiggans and Martin (1961). Yeou-Der *et al.* (1962) also reported that seedlings from grape seeds treated with GA were much taller than plants from untreated seeds. Kannan and Madhava Rao (1964) recorded the marked influence of GA on the stem height and the girth of the seedlings obtained from treated mango stones.

According to Shanmughavelu (1967, 1969) seedlings sprouted from GA soaked seeds of *Peltophorum sp* registered increased shoot length but the primary root length was comparatively less than that of the control in general.

Shant and Rao (1973) reported that gradual increase in plant height and girth were recorded with the increase in concentration upto 300 ppm GA in acid lime. Further increase in concentration of GA resulted in long and narrow leaves, die-back of apical portion and chlorosis of the leaves.

1.4 Effects of other growth regulators on seed germination and further growth:

The effects of Indoleacetic acid (IAA) on seed germination have been in dispute for a long time. Numerous workers have investigated the effect of IAA and similar substances on seed germination, and have obtained conflicting results-stimulation or inhibition being obtained, depending on the concentration of IAA and the type of the seed treated.

Shanmughavelu (1965) reported that treatment with both IAA and IBA (Indole butyric acid) resulted in a fairly high percentage of seed germination. Sinha *et al.* (1973) reported that 1000 ppm IAA induced highest germination and also produced longest shoots than control (Seeds).

Another plant hormone, cytokinin, was also found to affect germination of seeds. Miller (1958) showed that kinetin promotes germination of seeds. The natural kinetin-zeatin, also acts in the same way (Letham et al. 1964).

Cytokinins are involved both in the process of radicle elongation (Haber and Luippold, 1960; Pinfield and Stobart 1972) and cotyledon expansion. (Ikumma and Thimann, 1963; Kursanov et al. 1969).

Thomas et al. (1975 a) explained that very low concentrations of gibberellins which were normally ineffective on seed germination became effective when cytokinins were applied in combination.

Ethylene stimulates the germination of seeds with primary or secondary dormancy. But Haber (1926), Balls and Hale, (1940) reported that if seeds with high moisture content are soaked in ethylene - saturated water, germination of the seeds increased. Tao et al. (1974) showed that Kinetin plus ethrel synergistically enhanced germination.

Sinha et al. 1977 reported that Ethrel 1000 ppm

was the best dose for obtaining highest per cent of seed germination in Walnuts.

1.5 Effect of GA on Metabolism.

Gibberellins are now considered as a group of plant hormones with an action clearly distinguished from that of auxins. The work of Varner and his coworkers (1965) led to the discovery that gibberellic acid controlled the synthesis of alpha amylase in the aleurone layer which led to the hydrolysis of starch in the endosperm.

But Chen and Park (1973) reported the two sites of action of GA3 - one in the embryo and one in the aleurone layer of the endosperm. Thus the action of GA in the embryo is related to germination and the effects of GA on the activity of the enzymes in the cotyledons or in the endosperm are all post germination phenomena (Marriott and Northcote, 1975 and Van Onckelen et al. 1975).

2. Vegetative propagation:-

Vegetative propagation is the most common method adopted in most of the perennial crops, as it

is the only way of maintaining varietal characteristics, besides reducing the pre-bearing period. In nutmeg, the absence of any reliable method of identification of sex of the tree until it flowers, the standardisation of an effective method of vegetative propagation has an added importance. Approach grafting was tried in nutmeg as early as 1848 by Oxley (1848).

Ridley (1912) stated that the method of inarch grafting is both tedious and expensive. Deimum (1931) has mentioned that as early as 1894, grafting experiments were undertaken in the botanical garden at Bogor and Indonesia.

The technique of inarch grafting originally used has been described by Nicholas and Cruickshank (1964). Potted seedlings of about 18 inches tall and about the thickness of a pencil at the collar region were inarched to scions (twigs) of similar thickness by removing very thin sections of the bark, about 4 cm long on both stock and scion. These were then securely bound together with clear plastic tape, the seedling stock being tied to the female tree for support. The graft takes about four months

to unite, after which the scion is severed below the union.

In India, inarching or approach grafting was successfully done on root-stocks of Myristica fragrans and M. beddomaii.

Sundararaj and Varadarajan (1956) obtained 60 per cent success in approach grafting. The value of the trees obtained has been under investigation. So far there is no further report on this.

Grafts on M. beddomaii and M. malabarica in an observational trial developed into low, spreading trees whereas nutmeg seedlings generally developed into tall trees. The grafts come to flowering in 4 to 5½ years of planting as against 6 - 8 years taken by the seedlings (Anon, 1964).

Rasalam (1964) has claimed 100 per cent success in approach grafting on seedlings of cultivated and wild species of Myristica. Besides, grafts from chupons of female nutmeg trees as scions flowered in the second year after grafting.

Shanmughavelu and Rao (1977) reported 60 - 100

per cent success in inarching, at Kallar and Burliar Fruit Stations. Other methods of vegetative propogation were not successful.

Other crops.

Experiments conducted at Kallar and Burliar Fruit Stations revealed that inarching in cacao and clove were highly successful. (70 to 100 per cent). Current season's shoots proved better as scion material than past season's terminal shoots.

One field experiment was conducted at the Agricultural Research Station, Taliparamba, Kerala for a period of six years to study the performance of mango inarches on both polyembryonic and monoembryonic root-stocks (George and Nair, 1969) It was observed that inarches of Bennet Alphonso and Baneshan on polyembryonic root-stocks of Chandrakaran and Bappakai were superior to those on monoembryonic root-stock of 'Puliyan' both in vegetative growth and in yield.

According to Krochmal (1972) inarching has been used as a successful method of propagating tropical fruit trees like mango, avocado, sapodilla etc.

Rao (1975) suggested a new method for inarching mango which was useful for both propagation and rejuvenation. Instead of using a scion shoot on a growing tree, the scion shoot, excised under water was kept in a water-filled polythene bag during inarching to a seedling root-stock. Another polythene bag was placed over the top of the scion shoot while union took place.

Time, age and cost of inarching.

According to Naik (1941), the optimum time of inarching the mango seedlings was from February to July in South India. This was found true even for Punjab (Mukharjee, 1953). In Florida, Fahmy (1952) found a positive correlation between the amount of carbohydrate in the tissues and the degree of success in grafting and that early spring was the best time for good success was grafting. The rainy season was reported to be the best time for grafting (Hayes,1957).

Anammad (1966) reported that inarching was 80 per cent successful in two autumn seasons and 60 per cent and 84 per cent successful in two spring seasons in the case of guava. Stock-scion union was peripheral after 45 days, but complete after 75 days.

There is difference of opinion as to the age at which the stock should be grafted. Burns and Prayag (1920) held that 1½ to 2 years old seedlings were the best as stock seedlings for mango. Pope and Storey (1933) suggested that the stock should be 6 - 8 months old. 6 to 8 weeks old seedlings were successfully grafted by Verma (1942) to equally tender shoots. Sen (1939, 1941 and 1942), Naik (1941), Singh (1951) and Roy (1952) got good success with 3 to 4 month old seedlings.

Giri (1966) reported that in mango, the percentage of success with seedlings of vigorous growth (1.3 - 1.6 cm girth) was significantly higher than those of medium (1.0 - 1.29 cm) and low girth (0.7 - 0.99 cm).

Daily watering, which forms the largest single item of cost in producing inarch grafts could be largely eliminated by the use of polythene film. The cost of inarching in alkathene brand of polythene film, has been reported to be only Rs.0.41/graft by Garg (1954), and Rs.0.25 only by Rangacharlu and Venkatarao (1956) as against Rs.2:00 generally charged

by nursery men. Rao and Rao(1957) reported that in cashew inarch grafts, the cost could be reduced by using root-stocks potted in alkathene wrapping.

According to Majhail and Singh (1962), inarching in alkathene was found to be much inferior to inarching in pots. The youngest seedlings suffered the greatest losses.

2.2. Side grafting.

Side grafting of nutmeg has been reported to be successful at different places. Burns and Prayag (1920), Bailey (1927), and Pope and Storey (1933) have reported that side-tongue grafting is successful in mango.

More than 80 per cent success was obtained when side-grafting was done during July - August in South India. Chevalier (1936) and Stoffles (1939) have reported that in Java, only grafted (side-grafting) plants gave commercial success in quinine production. Krug and Celio(1946) obtained good results in side grafting with Cinchona Succirubra stock.

Naik (1949 a) reported almost 100 per cent

success in side grafting in the case of mangosteen. In avocado, side grafting was possible Gandhi (1952 b).

Side grafting was more satisfactory than crown grafting in avocado (Vogel, 1962).

Kanwar and Bajwa (1974) reported that mango seedlings of 8 - 18 months old were satisfactorily side-grafted with undefoliated scions of 7.5 cm long. And grafting in March - April or June - October gave the best results.

Gopimani (1978) had claimed some success in slotted side grafting in nutmeg with male tree as the root stock and defoliated branch of the female tree as scion.

Studies at Kerala Agricultural University, Vellanikkara showed 60 - 80 per cent success by side-grafting in cashew during the months of July and August.

2.3 Veneer grafting:

Veneer grafting has gained importance in recent years because of its manifold advantages over

inarching. Lynch (1941) and Ruehle (1948) first reported this technique in mango and guava respectively.

Nelson (1955 a) recommended veneer grafting in guava with scions 1.5 - 2.5 inches long from terminal flushes, with well developed axillary buds. The grafts were wrapped in vinyl plastic film, with a small opening at the top through which the bud can emerge.

Mukherjee and Majumdar (1961, 1962) reported that veneer grafting is a superior method of vegetative propagation in mango and the best time is during March - April.

After conducting an experiment to determine the suitability of veneer grafting, Thapar and Panwar (1963) suggested veneer grafting is a successful propagation method in mango.

Mukherjee and Majumder (1964) reported that veneer grafting was found to be successful in all months between March to July in mango. The scion growth was maximum in the grafts prepared during March - April. If grafting was carried out with scion sticks which were neither forced by defoliation nor enlarged normally, the success was very poor.

According to Jagirdar and Bhatti (1968) the percentage of take was increased by the use of mature scion wood, compared with immature wood in mango.

Bhandary and Mukherjee (1970) reported that maximum success in veneer grafting guavas was obtained in July, compared with that in March, April, June and August, with 1 to 2 month old scions shoots. The take was 85 per cent during July, but with older scions, it was less successful.

Studies at Ahamed Nagar indicated that veneer grafting was advantageous on cashew seedling root-stocks of not more than five months old and below 50 cm in height and having a girth of 4 - 5 cm (Phadnis, 1971).

Kar, Chadha and Singh (1973) tried various propagation methods in olive. Of the various methods, veneer grafting was considered to be the best method with 78 - 87 per cent success. There were no significant signs of graft incompatibility on Olea cuspidata root-stock in the nursery beds. Time taken by scion to sprout after grafting varied from 20 - 30 days.

Prasad, Singh and Sirohi (1973) conducted an experiment for two years to study the comparative performance of veneer grafting and patch budding in two varieties of mango. The results indicated that veneer grafting was significantly superior in respect of the percentage of success and vigour of sprouts as compared to patch budding. In the case of veneer grafting, minimum success was recorded in May and increasing trend was observed in June and July.

Rao and Kaul (1977) reported that July grafts were most successful (77 per cent take) in guava and their subsequent growth and leaf production were also greatest. Dipping the scion in kinetin (0-15 ppm) before grafting was detrimental to graft-take and made little difference in subsequent growth.

2.4 Wedge grafting:

Stoke, H.F. (1962) reported that green wood grafting was successfully adopted in Persimon and Black walnuts. Wedge grafting in cashew tried at the College of Agriculture, Bangalore had proved successful. 21 days old seedlings were used as

root-stocks and the terminal current season's shoot were used as scion shoots (Bhandary et al. 1974).

Amin (1978) advocated that in situ soft wood grafting was highly successful in mango. Success in grafting was obtained only when the grafting was done when the leaves were bronze in colour. Defoliated scion shoots were used for grafting. If the graft was successful, the new bronze coloured shoots would re-emerge within about one months time.

2.5 Budding:

The use of this technique in the propagation of nutmeg was demonstrated as early as 1848 by Oxley (1848) and the efforts of Ridley (1912), Postma(1935) and Deinum (1949) were also recorded. Postma(1935) gave an account of budding experiments on root-stocks of Myristica succedana in Indonesia. There was 30 per cent success. Deinum (1949) reported that the trees were healthy, but some what stunted.

Unsuccessful trials were made in 1956 in shield budding young nutmeg seedlings approximately 1/8 inches in diameter at the collar region. In

New Guinea, budding experiments were tried with Myristica fragrans and M. argenta as root-stocks, but they were not successful in the long run. Ochse reported that success in budding may be achieved only by using young root stocks and bud scions.

Other crops:

Chase (1947) and Gowda (1952) recommends shield budding in Walnut and avocado respectively. Gandhi (1952 b) found that forkert method is possible in avocado. Thapar and Rana (1961) reported some success in walnut budding.

According to Gur and Samish (1962) success in mango budding in the nursery decreased with age and reduced vigour of the rootstocks used. Bud take was better with root-stocks budded at the time of a growth flush, than during the rest period between two flushes, with the exception of 4 year old trees, where no difference was found covering the raffia, used for ty ing the buds, with paraffin improved bud-take under severe climatic conditions.

Singh and Singh (1954) reported fair success by budding in 'situ' at Sharanpur (U.P.). They tried budding in April

and June by different methods and they recommended patch budding as a better method when done in the month of June.

Hiyadatullah and Sadiq Ali (1955) while reviewing the work on mango budding in 'situ' in Punjab concluded that the spring budding season is superior to autumn season with a maximum success of 84.5 per cent.

Gandhi (1955) advocated that 'Forkart method of budding was found to be the best method when done in the months of July and August in mango.

According to Singh and Srivastava (1962) in mango July budding was the best with 100 per cent success (Forkart method). The percentage of success and the time taken by the buds to sprout were affected by the factors like temperature, humidity and rainfall. Davis (1963) reported some success on budding of walnut.

Srivastava (1964) reported that Forkert budding was 100 per cent success in guava. Jagirdar and Ali (1965) reported that in mango, bud take was more in 9 month old seedling stocks than in two year old stocks.

Patch budding had been proved to be quite

successful in cashew at different places (Anon 1966). Hamilton and Nakasone (1967) obtained success in Forkert method of budding in guava.

According to Teaotia and Maurya (1970), patch method of budding was superior when compared to the other methods of vegetative propagation in mango. Studies also revealed that activated bud resulted in significantly higher percentage of bud sprout than dormant buds.

Among the various vegetative propagation methods tried in mango, budding gave the best final results in mango eventhough the stock thickness was inferior to inarching (Singh and Sirohi 1972). Prasad, Singh and Sirohi (1973) obtained 60 per cent success in patch budding during the month of May in mango. Pathak and Srivastava (1974) advocated that for getting maximum success in walnut budding, invigorated buds should be used for budding particularly in the months of June and July.

Kar, Chadha and Singh (1975) reported that in olive also, patch budding gave 75 per cent success while that of shield budding gave only 46.67 per cent bud take.

Palaniswamy and Haneef (1976) had reported 71 per cent success by patch budding cashew in July. In March, April, September and October 50 - 58 per cent success was obtained. The buds sprouted after about 25 days and grew vigorously.

Singh et al. (1978) reported that patch budding is superior to chip budding in guava and maximum take was obtained during the month of August.

Other propagation methods in nutmeg.

Propagation by cuttings was reported by Cheesman and Spencer 1936. In an experiment conducted at Trinidad, Nicholas and Pryde (1936) obtained about 50 per cent success with hard wood or semihard wood cuttings of nutmeg. The cuttings were initially treated with 05 per cent IBA solution following a second treatment eight weeks later. This method of propagation was time consuming, as it took at least six months to root.

Fielden and Garner (1940) quoting a kew report, note that wounded cuttings will root quicker.

Nicholas and Cruickshank (1964) reported that only 10 per cent ultimate success was there with cuttings in Grenada. The growth of the cuttings was slow. Flach (1966) reported that in some experiments in a hot house under a mist humidifier, it was proved possible to root various types of cuttings.

Air layering.

Denium (1949) reported about air-layering in nutmeg in Moluccas. Macmillan (1954) cited air layering as a method of propagating nutmeg. Nicolas (1956) described an old method used in Trinidad. In Grenada air layering had developed into a practical method of vegetative propagation (Nicholas and Cruickshank, 1964).

Flach (1966) reported that in New Guinea air-layering was proved to be quite possible, provided young water-shoots were chosen and the marcots were made just before the trees begin a flush period, about 60 per cent rooted within six months. The marcots proved successful only when the basal wound closed rapidly with callus.

Cruickshank (1973) explained the method of

air-layering developed in Grenada. Rooting occured in about 4 to 8 months' time. Then they were severed from the tree and potted. They are then hardened off in closed concrete bins, covered with clear plastic and watered thrice daily for a period of 6 to 8 weeks. After this period the bin covers were gradually lifted until the plants were fully exposed. Further root development took place during hardening which lasted for 2 - 3 months, depending upon the weather. Rooting efficiency was increased from about 30 to 43 per cent.

MATERIALS AND METHODS

MATERIALS AND METHODS

The investigations were carried out at the Instructional Farm of the College of Horticulture and at the District Agricultural Farm, Mannuthy. Representative samples were taken for the different studies and the data were collected during the period from April 1978 to July 1979. The methods adopted for the different investigations are briefly described below:-

1. Seed Propagation:

Only seeds from mature fruits as indicated by the splitting of the pericarp were taken for sowing. The pericarp and aril were removed before sowing. The weight of the seeds were determined and they were grouped under two categories viz., heavy, weighing 9 g and above and light, weighing less than 9 g.

Seed beds, 90 to 120 cm wide, 15 cm high and of convenient length were prepared and pandals were erected to provide shade. Seeds were sown either vertically or flat with the micropylar end up. A layer

of sand was then spread over the seeds. Watering was done daily with a rose can. The sprouted seeds were transferred from the seed beds to polythene bags soon after sprouting.

1.1 Germination as affected by the time of sowing and the time taken for germination:-

Ten seeds from heavy and light groups were sown on 9th May 1978 and the trial was repeated at monthly intervals till August and then in the months of November and December. No sowing was done during the remaining months, as fresh seeds were not available during those months.

The number of days taken from commencement to completion of germination and the percentage of germination in each of the above categories obtained under each month of sowing were recorded.

1.2 Germination as affected by different methods of storage:-

The seeds from each group were stored in moist sand and metalic tins for 15 and 30 days. The following

five treatments were included in this study.

Treatments:

1. Sowing seeds immediately after harvest.
2. Sowing 15 days after storage in moist sand.
3. Sowing 15 days after storage in metallic tin.
4. Sowing 30 days after storage in moist sand.
5. Sowing 30 days after storage in metallic tin.

The germination percentage and number of days taken for sprouting were recorded seperately for the two classes of seeds as described above.

1.3 Effect of treatment of seeds with gibberellic acid:-

Fully matured seeds were collected in April 1979 and soaked in gibberellic acid solutions of 0, 50, 100, 200, 500 and 1000 ppm concentrations for 0, 6, 12, 18 and 24 hours. The number of replications was six. Seed soaking treatments took place at room temperature, 30 ± 3°C. Twelve seeds were used for each treatment which were sown on raised beds under shade. The data on per cent of seed germination and number of days taken for germination were recorded seperately for each treatment.

1.4 Relationship between the weight of seeds and growth of the seedlings in the nursery:-

The following growth parameters of the seedlings were measured at monthly intervals (for two months) in heavy as well as light groups and were compared.

1.4.1 Height:-

The height of each seedling was measured from collar region to the tip.

1.4.2 Girth:-

The girth of each seedling was measured at one centimetre above the ground level.

1.4.3 Number of leaves:-

The number of leaves produced in each seedling was counted.

1.5 Effect of gibberellic acid treatment on the growth of the seedlings:-

The growth parameters as indicated above were recorded for each treatment at 30 and 60 days after transplanting.

2. Vegetative Propagation:

Nutmeg is a dioecious tree in which the sex cannot be identified until flowering. Besides, an effective method of vegetative propagation will enable the production of progenies possessing all the beneficial characters of superior selections. Vegetative progenies also commence bearing earlier than seedling trees, as in the case of many other vegetatively propagated plants. With the above objective, the following methods of vegetative propagation were tried.

2.1 Inarching:

The studies were initiated in the month of April 1978 and repeated at monthly intervals for ten months.

Nutmeg seedlings of about 1½ - 2 years in age, having a stem thickness of about 20 - 25 mm were used as rootstock plants. Twenty grafts were prepared in each month. A half cut was made after about one and a half months of the operation. Successful grafts were seperated at the end of about three months. The

top portion of the rootstock plant was cut off at the time of seperation. The seperated grafts were placed under shade and watered regularly. Some grafts dried up after seperation. The final counts were taken two month after seperation. By this time the unsuccessful grafts could be identified.

The growth data of the grafts were compared with that of seedling plants of same age and were recorded two weeks after seperation and two months after establishment. The mean height, girth of the stem, mean number of branches produced and the mean number of leaves of successful grafts were recorded and compared with mean values of the above parameters of ten seedling plants.

2.2 Side grafting:

The trials were initiated in June 1978 and completed in January 1979. Ten grafts were prepared in every month, using Myristica fragrans seedlings of 8 - 12 months age as rootstocks. The twigs used for side grafting were of about nine months old. These were precured by cutting off the major portion

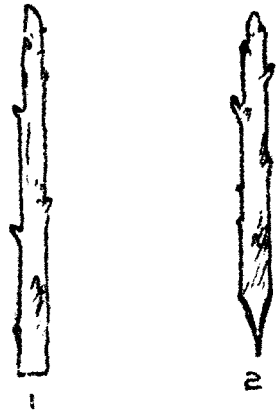
of the leaves, about two weeks prior to the date of grafting. This was done to activate the dormant buds.

Two parallel, cuts of about one inch long was made on the bark of the stock. Then a horizontal cut was made in the upper end of the parallel cuts. This would enable the peeling of the bark at the time of grafting. The scion shoots of about 10 - 15 cm long were inserted into the lifted bark, after giving a wedge shaped cut corresponding to the length of the bark on the stock. The scion and the root-stock were bound together with a polythene tape. (Fig.1.a).

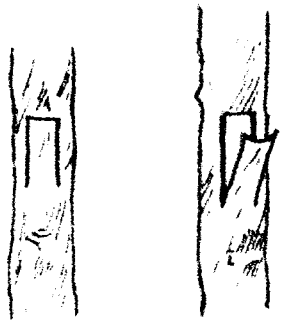
The grafted plants were kept in an enclosed polythene chamber to provide a humid atmosphere to the grafts. The humidity inside the chamber was maintained at saturation point by spraying water into the chamber thrice a day by lifting polythene from one side of the chamber. After the spray, the loose ends of the polythene sheets were plastered with wetted soil.

The grafted shoots began to sprout in about a months time and they were taken out from the humidity

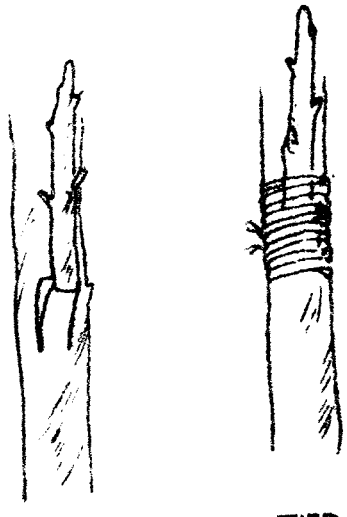
FIG-1a SIDE GRAFTING



PREPARATION OF THE SCION



PREPARATION OF THE STOCK.



SCION INSERTED

TIED WITH WAXED STRING

chamber. The top portion of the stock plants were cut off and the grafts were then hardened by taking them out of the humid chamber for short periods initially and by increasing the time of exposure gradually for a period of about two weeks.

2.3 Veneer grafting:

The trial was started in May 1978 and repeated at monthly intervals for a period of eight months. Seedling plants of about 1½ - 2 years old were used as rootstock.

Selection of scion stick is very important for the success of this method. The scion sticks used were terminal or lateral shoots of 7 - 12 cm long and usually of pencil thickness. The degree to which the terminal bud has developed gives the best indication as to its suitability. A swollen terminal bud that will burst in 10 to 15 days is ideal. This is secured by cutting of three quarters of the leaf lamina of one season old dormant shoots about two weeks before grafting.

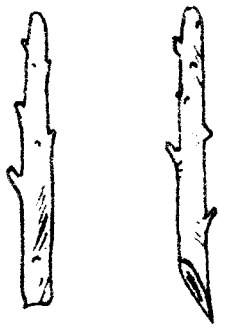
Two types of shoots used as scion were - (1) those arising from the adventitious buds on the stems or main branches of the mother tree and growing vertically and (2) those growing as lateral branches.

Having selected the right type of root-stock and scion, a slanting cut of about 2.5 cm long was given on one side of the stem of the stock and the bark along with wood is removed by giving another oblique cut. (Fig. 1b). Corresponding cuts were made on the scion shoot at the bottom so that it will fit in the cut made on the stock. The scion is then placed in such a way that the cambia of both stock and scion come in close contact. It was then wrapped tightly with alkathene tape of 200 - 300 gauge thickness.

These grafts were also kept in humid chamber made of polythene film and watered regularly.

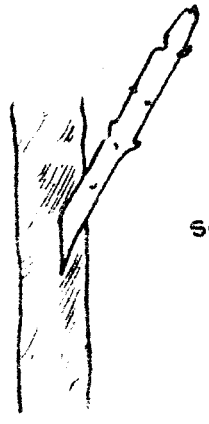
When the scion begins to sprout in about three weeks, the top portion above the graft union of the root-stock was removed, thus forcing the buds to grow more rapidly. The plastic wrapper is removed after about one to two months.

(No. 15) VENEER GRAFTING

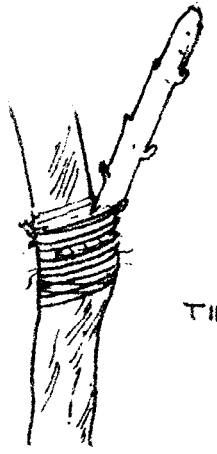


PREPARATION OF THE SCION.

PREPARED STOCK



SCION INSERTED.



TIED WITH WAXED STRING.

The sprouted plants were hardened in the same manner as in the case of side grafts.

2.4 Wedge grafting:

The trial was initiated on 3rd January 1979 and repeated six times at fortnightly intervals. Ten grafts were prepared on each occasion.

Seedlings of about one year in age, which are in actively growing stage, as indicated by pale green colour of the shoots at the terminal portions were used as root-stocks.

Scion shoots were selected from healthy growing, disease free female trees. Lateral branches of about one centimetre girth with dormant bud were used. All the leaves were removed from the selected branch keeping one centimetre of the petiole attached to the branch. These branches were allowed to remain as such on the tree for 8 to 10 days.

Method of grafting:

The top portion of the fresh growth developed on the stock plant was decapitated with a knife, at a

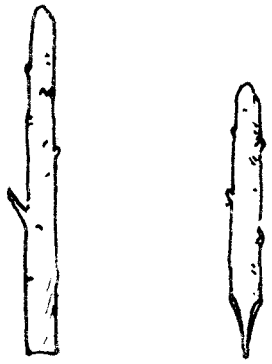
height of 6 - 8 cm of the fresh stem. The stump was split into two to a length of about 3 cm from the tip. The cut portion will look like a fork or the letter 'V'. Pre-cured scion shoots of the same thickness as the stock stump and about 8 - 10 cm long are used for grafting. The lower end of the scion stick is cut into wedge shape of about 3 cm long by giving slanting cuts from both sides (Fig. 1 c). The scion wedge was then inserted into the cleft on the stock and secured firmly with transparent polythene strip, 2 cm wide and of about 200 gauge thickness. The prepared grafts were kept in humid chamber made of polythene film and watered regularly.

After fifteen days, the grafts were examined. If the scion remained green, it meant that the graft was a success. However, new flush will re-emerge within about a month's time from which only one is retained. The sprouted plants were hardened in the same manner as in the case of side-graft.

One month after the production of new flushes, the length, girth and number of leaves were noted along with the percentage of survival of grafts.

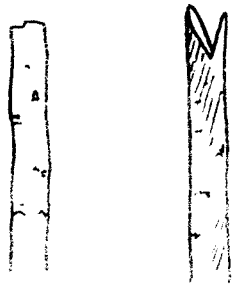
FIG-1c

WEDGE GRAFTING



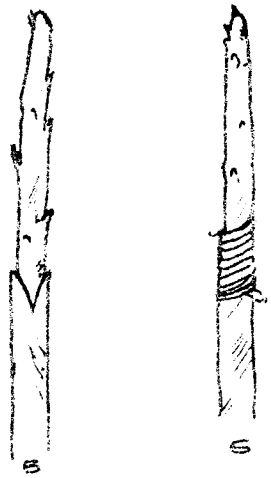
1 2

PREPARING THE SCION.



3 4

PREPARING THE STOCK.



6 5

SCION INSERTED

TIED WITH POLYTHENE STRAP.

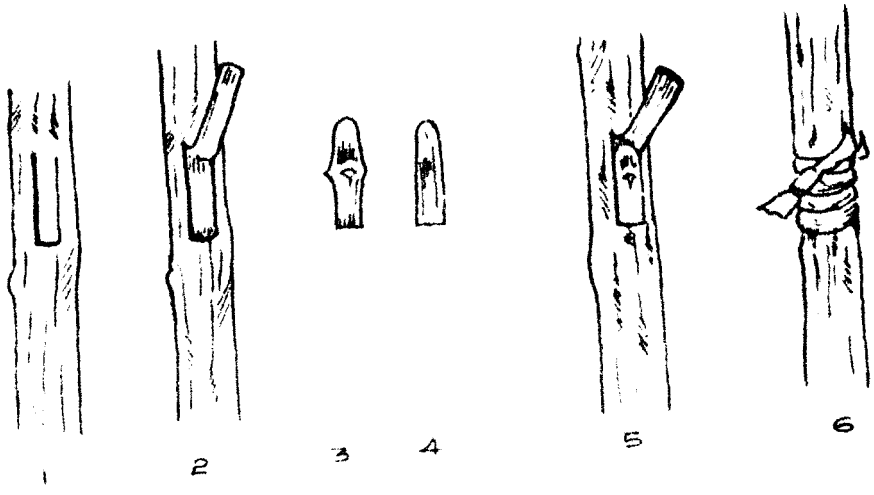
3. Budding:

The trial was done during a period of six months, starting from May 1978. Nutmeg seedlings of one year in age and uniform in growth were used as root-stock and the bud wood (Scion) was taken from one season old shoots of vigorous female trees having unsprouted dormant buds. The budding was done by Forkert method as described below.

A horizontal cut of about 0.5 cm was made in the bark at a height of 15 cm on the root-stock. At the two ends of the cut, two parallel vertical cuts were made upwards so that the flap of bark can be carefully peeled and lifted for insertion of the bud. Immediately after this, the buds were taken out from the scion stick just leaving a small portion of the petiole. The prepared bud piece to fit into the lifted bark portion was inserted in the stock. The bud was covered with the bark flap made previously on the stock, which covered the whole bud. The whole of the operated portion was covered with polythene tape of about 200 gauge (Fig.1.d).

FIG-1d.

FORKERT BUDDING



1,2 - PREPARING THE STOCK.

3,4 - PREPARED BUD.

5 - BUD INSERTED.

6 - TIED WITH POLYTHENE STRIP.

After about three weeks, the polythene covering was unwrapped, the flap of bark was lifted and the bud was examined. In the case of successful bud union, the bud piece remained green in colour, in which case, the bark was cut off and the bud piece secured to the stock by polythene tape.

Statistical analysis:

Statistical analysis of the data was conducted using the analysis of variance technique as suggested by Snedecor and Cochran, (1967). For the comparative study of growth parameters of grafts and seedlings the students' 't' test was applied (Snedecor and Cochran,1967).

RESULTS

EXPERIMENTAL RESULTS

The different aspects of propagation of nutmeg which were studied during the course of these investigations are presented below:-

1. Seed Propagation:

The different factors which affect the success in seed propagation are germination under different conditions such as the time of sowing, the time taken for germination and the period of storage. The effects of treatment with GA were also studied. Studies were also made regarding the relationship between the weight of the seed and the growth parameters like height of the seedling, girth of the stem and the number of leaves produced which were indicative of seedling vigour.

1.1 Germination as affected by the time of sowing and the time taken for germination:

The main periods during which nutmeg seeds are available for harvest are from May to August and November - December. As already indicated earlier, the seeds were grouped into two main categories; namely

heavy seeds weighing 9 g and more and light seeds having a weight of less than 9 g. The percentage of germination under the above two groups and the time taken for sprouting during different months of sowing are presented in Table 1 and Fig. 1.

It may be seen from Table 1 that there is significant difference in the germination percentage between the heavy and light seeds and also between the different months of sowing in the case of heavy seeds. There is significant difference between the number of days taken for germination in both the heavy and light groups.

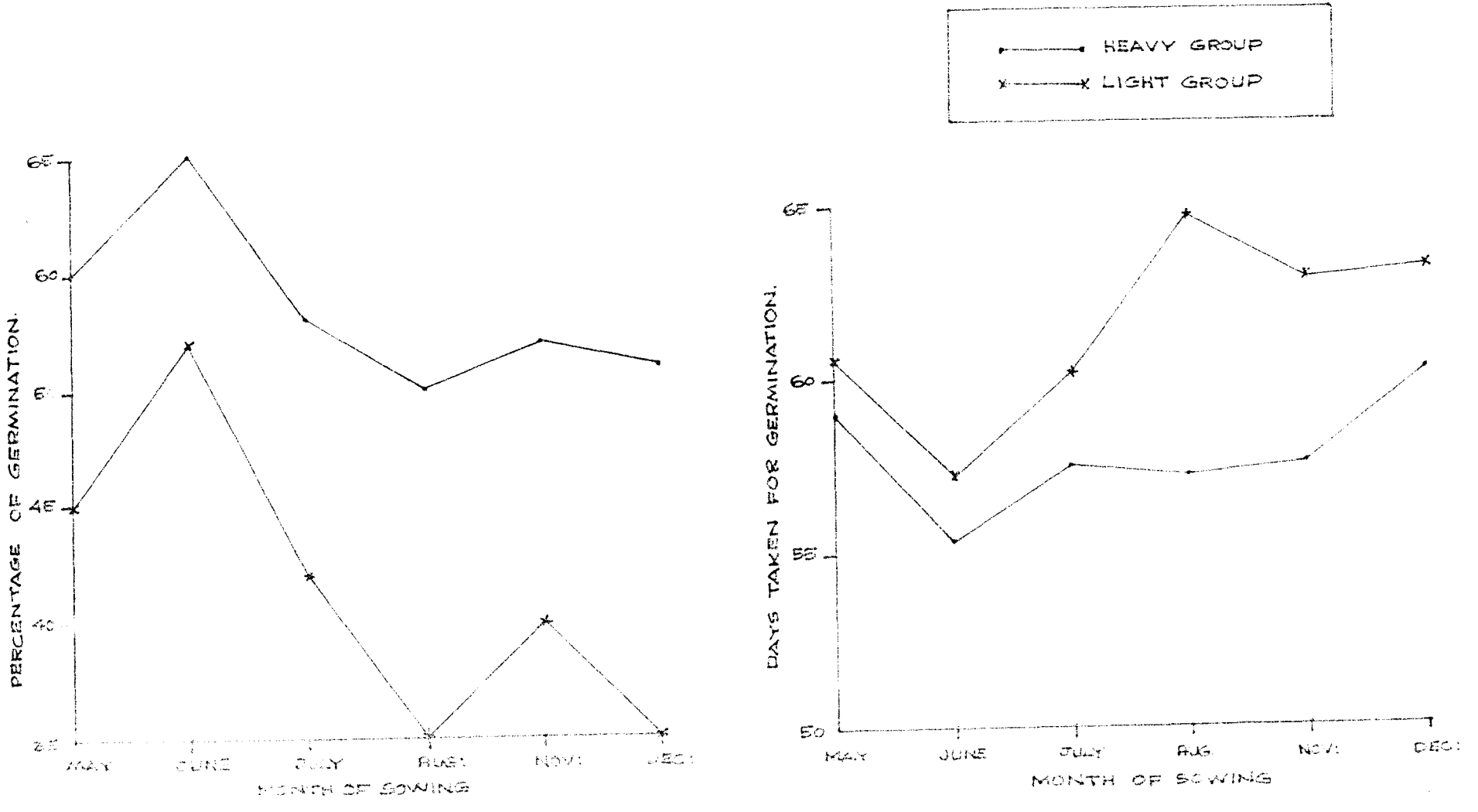
The highest percentage of germination in both the groups were obtained during the month of June and the minimum was during the months of August and December. In respect of the time taken for germination, it was quicker during the month of June and the maximum number of days taken was 60.5 during the month of December in the heavy group and 64.76 in August sowing in the case of light group. Thus the data revealed that the best time for sowing seeds was in

Table 1. Mean percentage of germination and the number of days taken for germination during different months.

Month of sowing		Percentage of germination		Number of days taken for germination		Mean percentage of germination*	
		Heavy	Light	Heavy	Light	Heavy	Light
May	1978	60	45	59.00	60.60	42.15	31.58
June	1978	65	52	55.63	57.62	49.89	34.29
July	1978	62	42	57.80	60.08	41.49	30.13
August	1978	50	35	57.34	64.76	35.44	27.66
November	1978	52	40	57.80	62.80	36.66	29.95
December	1978	51	35	60.50	63.10	35.84	27.18
F test				Sig	Sig	Sig	NS
SD 0.05%				2.61	2.69	2.02	-

*The data were transformed for statistical analysis by using angular transformation.

F.G-1 MEAN PERCENTAGE OF GERMINATION AND NUMBER OF DAYS TAKEN FOR GERMINATION UNDER DIFFERENT MONTHS OF SOWING.



June when the percentage of germination was highest and the number of days taken for germination was the minimum.

1.2 Germination as affected by different methods of storage:

Seeds were sown soon after harvest and after storage in moist sand and metalic tins for 15 and 30 days respectively. The percentage of germination obtained under the above methods of storage in both heavy and light groups are given in Table 2.

The data show that the highest percentage of germination was obtained under treatment 1 (Sowing immediately after harvest). Storage under moist sand was next best in both the groups, giving 46.7 per cent germination in the case of heavy seeds and 31.7 per cent in the case of light seeds. Under storage in metalic containers, the germination percentage was considerably less, being only 35 per cent in the heavy group and 20.7 per cent in the light group. Under treatment 5 (Sown 30 days after storage in metallic tin) the percentage of germination was very low (Fig.2).

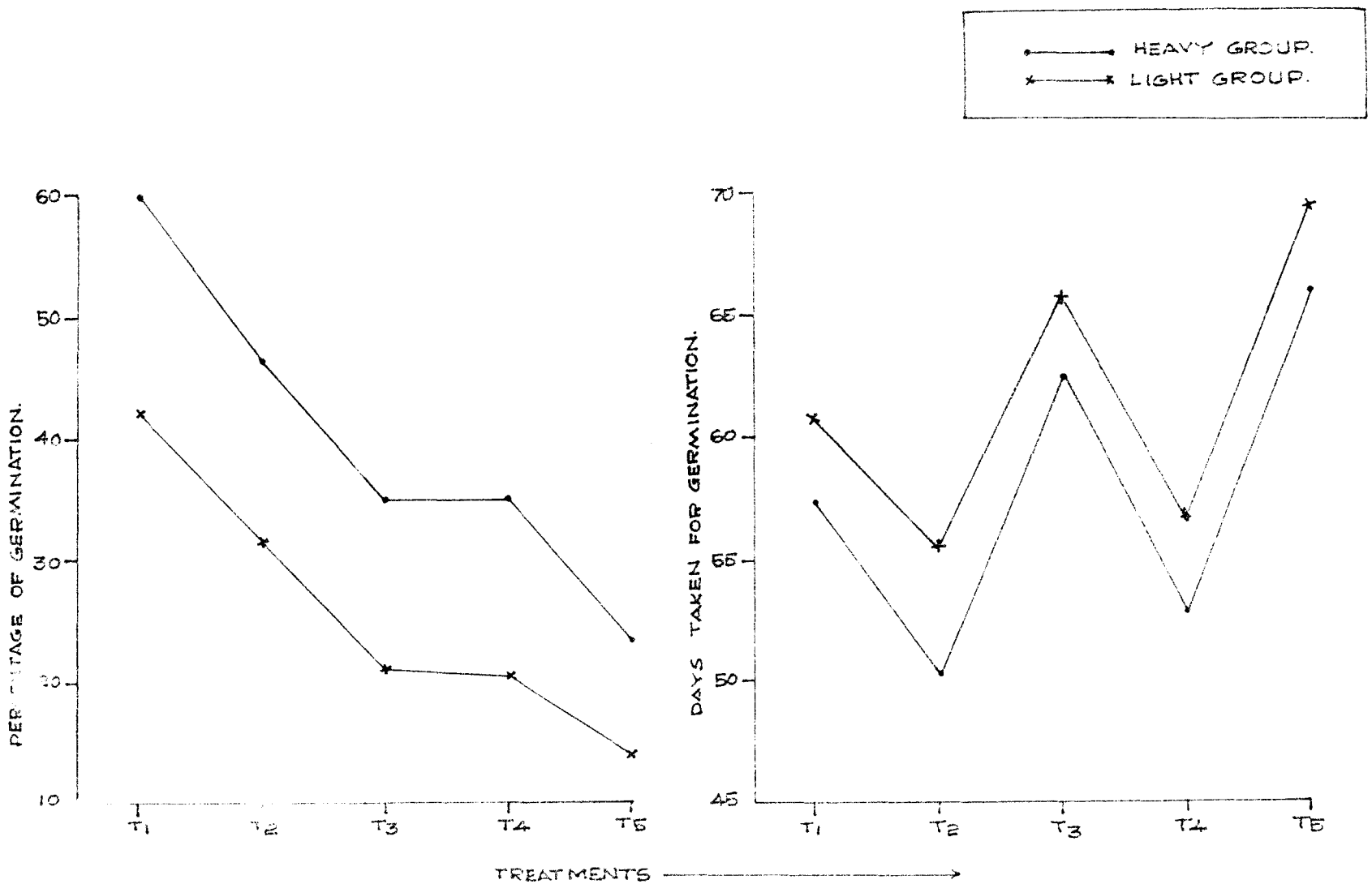
Table 2. Mean percentage of germination under different methods of storage and the number of days taken for germination.

Treatment Number	Treatment	Percentage of germination		Number of days taken for germination		Mean percentage of germination *	
		Heavy	Light	Heavy	Light	Heavy	Light
1.	Sown immediately after harvest	60.0	42.0	57.28	60.84	49.89	40.15
2.	Sown 15 days after storage in moist sand	46.7	31.7	50.01	55.08	43.08	34.21
3.	Sown 15 days after storage in metallic tin	35.0	21.0	62.40	65.75	36.22	26.32
4.	Sown 30 days after storage in moist sand	35.0	20.7	52.77	56.88	36.22	26.32
5.	Sown 30 days after storage in metallic tin	23.3	14.0	65.92	68.92	28.78	22.50
	F test			Sig	Sig	Sig	Sig.
	CD 0.05%			2.38	2.46	1.86	4.78

*The data were transformed for statistical analysis by using angular transformation.

F. g - 2

MEAN PERCENTAGE OF GERMINATION AND NUMBER OF DAYS TAKEN FOR GERMINATION UNDER DIFFERENT STORAGE CONDITIONS.



Therefore, it is best to sow the seeds soon after harvest. If this is not possible due to any reason, the next best method is to store the seeds in moist sand by which the viability can be retained for about 15 days without much reduction in germination. The storage in metalic tins results in substantial reduction in germination percentage and therefore it cannot be recommended as an effective method of seed storage for nutmeg.

It may also be seen from the above table that the number of days taken for germination was minimum (50.01) in treatment 2 (sowing the seeds 15 days after storage in moist sand) as compared to 65.92 days in the case of treatment 5 (Sown 30 days after storage in metalic tin) in the heavy group. In the light group also, treatment 2 took the minimum number of days (55.08) for germination as compared to 68.92 in treatment 5 (Fig.2).

It was also seen that the mean number of days taken for germination in the case of treatment 1 namely sowing immediately after harvest was slightly

more than in the case of treatment 2 ie. storage in moist sand for 15 days. This is perhaps due to the fact that storing under moist sand is providing more or less the same or better conditions for germination as in the seed beds of freshly harvested seeds.

1.3 Effect of treatment of seeds with gibberellic acid:

Treatment with the plant growth regulators have been found to be effective in obtaining better germination and also in the initial stages of growth in the case of many plants. Among the different growth regulators used, gibberellic acid treatment was found to be the most effective in seed treatment. Therefore the following studies were undertaken.

1.3.1 Effect of soaking seeds in gibberellic acid solution on germination:

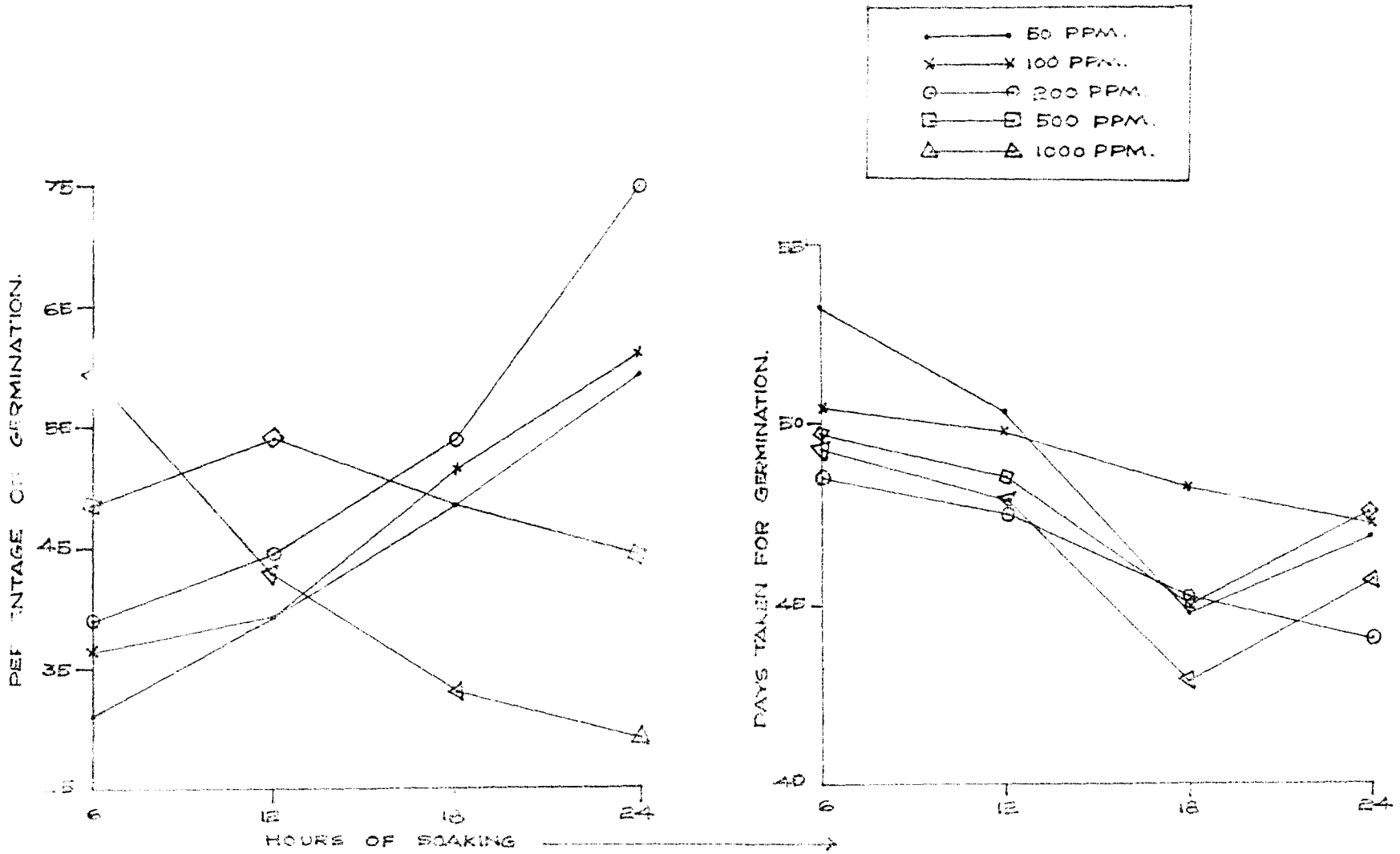
Samples of freshly harvested seeds were soaked in gibberellic acid solutions of 50, 100, 200, 500 and 1000 ppm for 6, 12, 18 and 24 hours. The percentage of germination obtained under different treatments were compared with the control (zero hour of soaking). The data are presented in Table 3.

Table 3. Mean percentage of germination under different concentrations for different periods of soaking.

Treatment No.	Hours of soaking	Percentage of germination under different concentrations of G.A.				
		50 ppm	100 ppm	200 ppm	500 ppm	1000 ppm
1.	6	31.0 (33.78)	36.5 (37.09)	39.3 (38.80)	48.7 (44.23)	59.5 (51.50)
2.	12	39.3 (38.82)	39.3 (38.82)	44.7 (41.93)	54.0 (47.30)	43.2 (41.50)
3.	18	48.9 (44.23)	51.3 (45.77)	54.0 (47.3)	48.7 (44.23)	33.7 (35.51)
4.	24	59.6 (50.61)	61.0 (51.38)	75.0 (60.1)	44.7 (41.93)	29.1 (32.84)
	F test	Sig	Sig	Sig	NS	Sig
	CD 0.05%	4.48	4.05	4.30	-	5.01

Transformed data are given in brackets.

FIG-3 PERCENTAGE OF GERMINATION AND THE NO. OF DAYS TAKEN FOR GERMINATION UNDER DIFFERENT CONCENTRATIONS OF GA FOR DIFFERENT PERIODS OF SOAKING.



The data showed that the highest percentage of germination was obtained (75) when the seeds were soaked for 24 hours in 200 ppm gibberellic acid as compared to the mean per cent germination of 51 obtained in the case of direct sown seeds without any plant growth regulator treatment (vide T-1 in Table 2). Minimum germination of 29.1 per cent was recorded in the case of treatment with 1000 ppm gibberellic acid, the soaking time being 24 hours (Fig.3). The data also show that the percentage of germination was increased as the time of soaking was increased in respect of 50, 100 and 200 ppm concentrations, while it was reduced in the case of 1000 ppm concentration.

1.3.2 Effect of gibberellic acid on the time taken for germination:

It was found that the time taken for germination was also affected by gibberellic acid treatment. The number of days taken for germination in the case of seed treatment for different periods in different concentrations are presented in Table 4.

It may be seen from Table 4 that the minimum

Table 4. Number of days taken for germination under different concentrations for different periods of soaking.

Treatment No.	Hours of soaking	Concentrations of gibberellic acid				
		50 ppm	100 ppm	200 ppm	500 ppm	1000 ppm
1	6	53.23	50.16	48.67	49.78	49.33
2	12	50.37	48.88	47.68	48.67	47.75
3	18	44.82	47.93	45.13	45.00	44.67
4	24	46.80	47.08	44.00	47.55	45.65
F test		Sig	NS	Sig	NS	Sig
CD 0.05%		3.62	-	2.71	-	3.77

time taken for germination was in the case of soaking seeds for 24 hours in 200 ppm gibberellic acid (44.0) followed by 44.67 days in the case of 1000 ppm gibberellic acid, the soaking time being 18 hours. In freshly sown seeds without GA treatment the minimum time taken for germination was 59.06 days given in Table 2 . The mean value of T_1 (of heavy and light seeds).

It may be seen that the seeds soaked in 200 ppm gibberellic acid solution for 24 hours significantly reduced the time taken for germination.

1.4 Relationship between weight of seeds and growth of seedlings in the nursery:

The growth of seedlings obtained from heavy as well as light seeds was studied and compared. The height of the seedling, girth of the stem and the number of leaves of the seedlings, 30 days and 60 days after transplanting were recorded and the data are presented in Table 5(a) and 5(b) respectively.

The data show that on the 30th and 60th days after transplanting, the height of the seedlings was

maximum under treatment 2 in the case of heavy seeds and in treatment 1 in the case of light seeds. However the differences were not statistically significant. The minimum height was recorded by treatment 5 at the end of 30 days and at the end of 60 days in respect of heavy seeds. In the light group, treatment 3 and treatment 4 registered the minimum height on the 30th and 60th days after transplanting respectively (Fig.4).

It may also be seen from the tables 5(a) and (b) that in respect of the girth of the stem, there was significant difference between the seedlings from heavy and light group of seeds. But within the group, the differences were not statistically significant. Treatment 1 recorded the maximum girth at the end of 30 days as well as 60 days after transplanting in both the groups. The minimum girth was recorded by treatment 5 in heavy and light group of seeds both at the end of 30 and 60 days after transplanting (Fig.5).

The data showed that the treatments did not

Table 5(a). Height, girth of stem and number of leaves of seedlings on the 30th day of transplanting.

Treatment No.	Treatment	Heavy			Light		
		Height (cm)	Girth (cm)	No. of leaves*	Height (cm)	Girth (cm)	No. of leaves
1	Sowing immediately after harvest	14.51	1.04	2.73 (1.65)	14.22	0.99	2.75 (1.65)
2	Sowing after 15 days storage in moist sand	14.74	1.02	2.73 (1.65)	14.08	0.98	2.65 (1.61)
3	Sowing after 15 days storage in metallic tin	14.31	1.02	2.80 (1.67)	13.54	0.99	2.68 (1.63)
4	Sowing after 30 days storage in moist sand	14.55	1.02	2.67 (1.63)	13.58	0.98	2.75 (1.65)
5	Sowing after 30 days storage in metallic tin	13.68	1.00	2.67 (1.63)	13.74	0.98	2.73 (1.65)
	F test	Ns	Ns	Ns	Ns	Ns	Ns

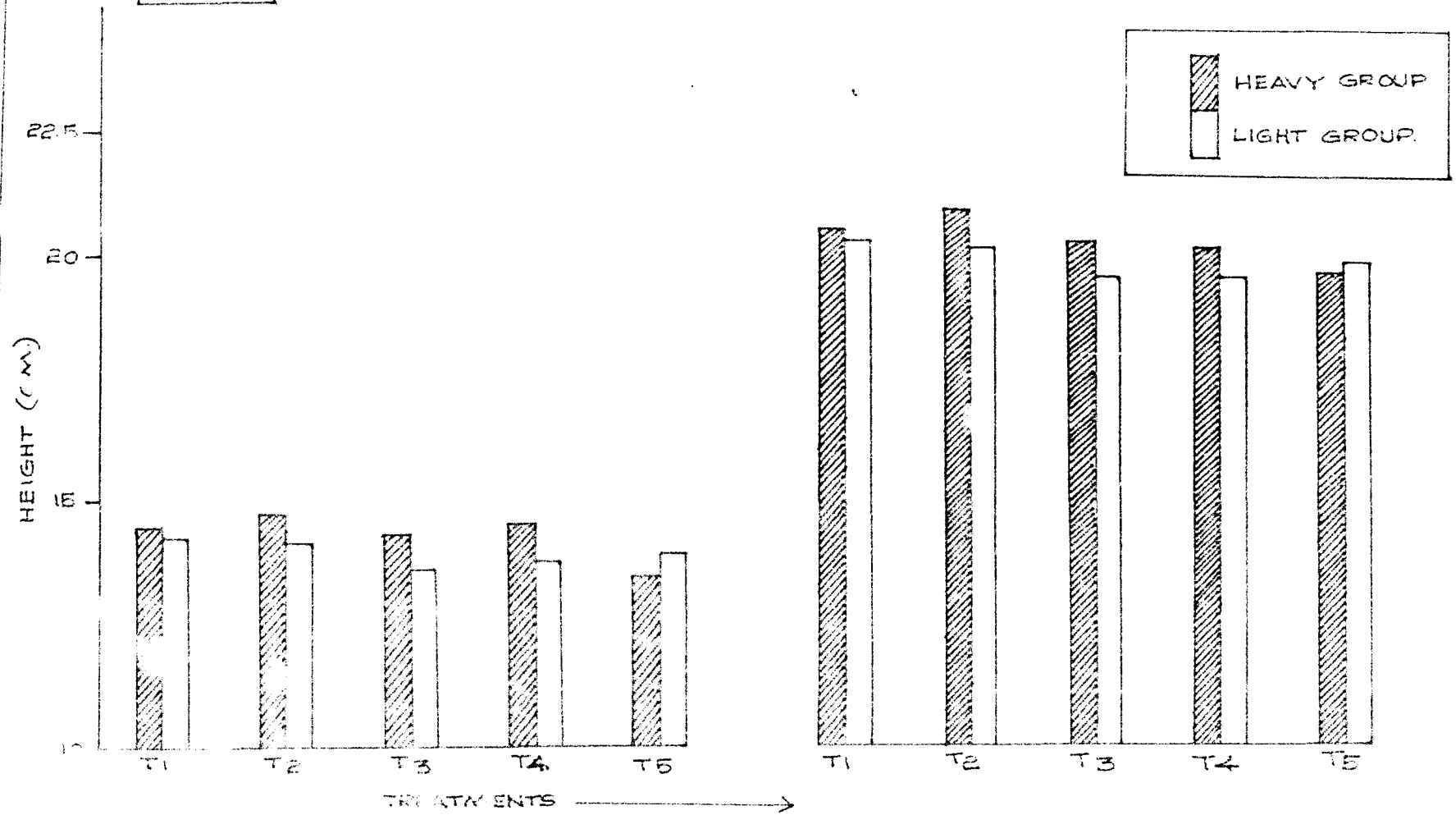
*The data were transformed by using square root transformation and are given in the brackets

Table 5(b). Height, girth of stem and number of leaves of seedlings on 60th day of transplanting.

Treatment No.	Treatment	Heavy			Light		
		Height (cm)	Girth (cm)	No. of leaves*	Height (cm)	Girth (cm)	No. of leaves*
1	Sowing immediately after harvest	20.51	1.70	3.50 (1.86)	20.22	1.53	3.33 (1.82)
2	Sowing after 15 days storage in moist sand	20.98	1.67	3.37 (1.82)	20.08	1.50	3.33 (1.82)
3	Sowing after 15 days storage in metallic tin	20.36	1.64	3.42 (1.85)	19.54	1.48	3.33 (1.82)
4	Sowing after 30 days storage in moist sand	20.05	1.67	3.17 (1.77)	19.50	1.50	3.40 (1.84)
5	Sowing after 30 days storage in metallic tin	19.64	1.61	3.17 (1.78)	19.76	1.48	3.33 (1.82)
	F test	NS	NS	NS	NS	NS	NS

*The data were transformed by using square root transformation and are given in the brackets.

FIG-4 HEIGHT OF THE SEEDLINGS ON 30th AND 60th DAYS OF TRANSPLANTING.



T_1 Sowing seeds immediately after harvest.

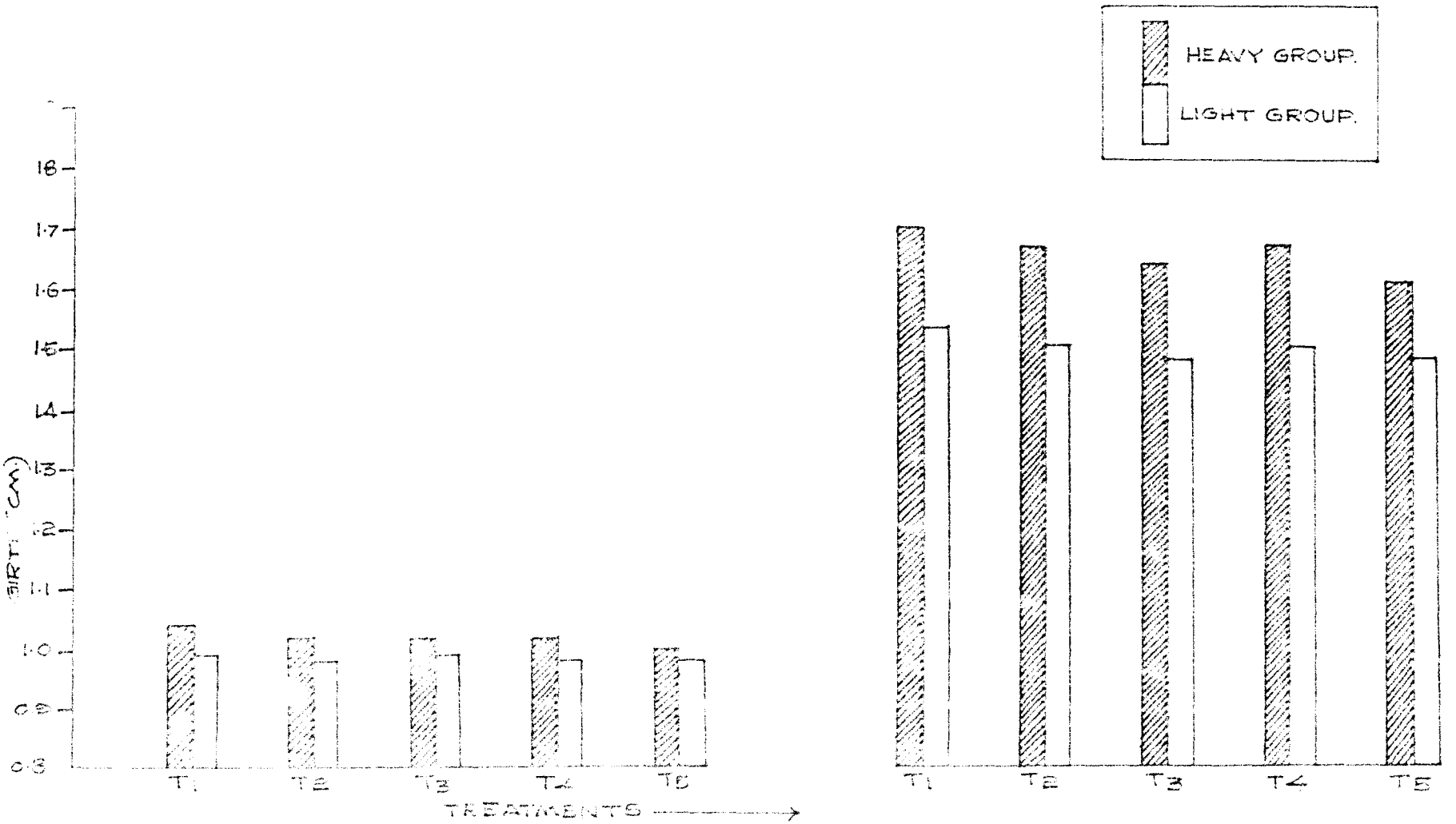
T_2 Sowing 15 days after storage in moist sand.

T_3 Sowing 15 days after storage in metallic tin.

T_4 Sowing 30 days after storage in moist sand.

T_5 Sowing 30 days after storage in metallic tin.

FIG-5 GIRTH OF THE SEEDLINGS ON 30th AND 60th DAYS OF TRANSPLANTING.



differ significantly in both the groups with regard to the number of leaves at the end of 30 and 60 days of transplanting.

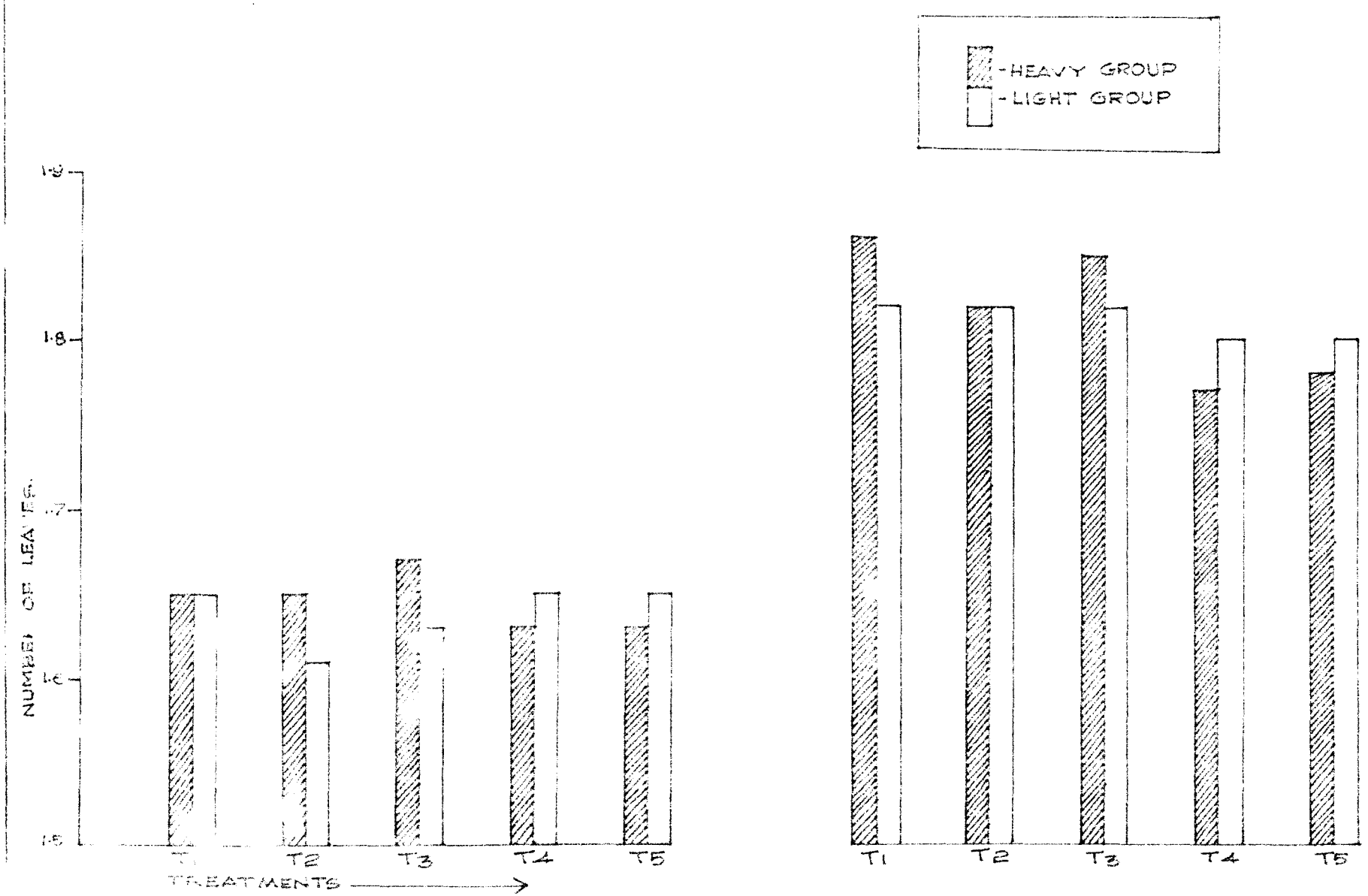
There was no significant difference in respect of height and number of leaves during the first two months of nursery growth. Seedling vigour was however reflected in respect of the percentage of germination, time taken for germination and the girth of the seedlings at the end of 60 days between the heavy and light group of seeds.

1.5 Effect of gibberellic acid treatment on the growth of the seedlings:

The effect of gibberellic acid treatment on three growth parameters, - namely height of the seedlings, girth of the stem and the number of leaves produced at the end of 30 days and 60 days after transplanting were recorded which are presented in Tables 6a, b and c.

It may be seen from Table 6(a) that the maximum height of 16.62 cm and 24.52 cm at the end of 30 and 60 days of transplanting was recorded in the case of

FIG-6 NUMBER OF LEAVES PRODUCED ON 30TH AND 60TH DAYS OF TRANSPLANTING.



gibberellic acid treatment at a concentration of 1000 ppm for soaking of 6 hours, closely followed by 16.37 cm and 24.38 cm respectively in the case of 24 hours soaking in 200 ppm gibberellic acid (Fig. 7). However it may be pointed out that in respect of the percentage of germination, and the time taken for germination, soaking for 24 hours in 200 ppm gibberellic acid was the best. Therefore that treatment is to be preferred rather than the treatment with 1000 ppm gibberellic acid solution, as the difference between the two treatments in respect of height was insignificant.

The data presented in Tables 6(b) and (c) revealed that there were no significant differences between the different treatments in respect of the girth of the seedlings and the number of leaves per seedling at the end of 30 and 60 days of growth in the nursery. In respect of both these characters, soaking for 24 hours in 200 ppm gibberellic acid solution ranked first or were on par with the treatment, soaking for 6 hours, in 1000 ppm gibberellic acid (Fig. 8 and 9).

Table 6(a). Effect of different concentrations of gibberellic acid on the height of the seedlings at 30 and 60 days of transplanting.

Sl. No.	Hours of soaking	Height of the seedlings (cm) Concentrations of gibberellic acid									
		50 ppm		100 ppm		200 ppm		500 ppm		1000 ppm	
		30 days	60 days	30 days	60 days	30 days	60 days	30 days	60 days	30 days	60 days
1	6	14.12	22.12	14.67	22.70	14.29	22.79	15.23	23.07	16.62	24.52
2	12	14.36	22.38	15.62	23.45	15.57	23.20	16.01	24.36	16.10	23.95
3	18	14.38	22.68	15.75	23.92	16.30	24.29	15.81	23.81	14.88	22.88
4	24	15.06	23.13	16.04	24.15	16.37	24.38	15.25	22.57	14.21	22.38
	F test	Sig	Sig	Sig	Sig	Sig	Sig	NS	NS	Sig	Sig
	CD 0.05%	0.47	0.55	0.87	0.47	0.36	0.64	-	-	0.85	0.77

FIG-7. EFFECT OF DIFFERENT CONCENTRATIONS OF GIBBERELLIC ACID ON THE HEIGHT OF THE SEEDLINGS, 30th AND 60th DAYS AFTER TRANSPLANTING.

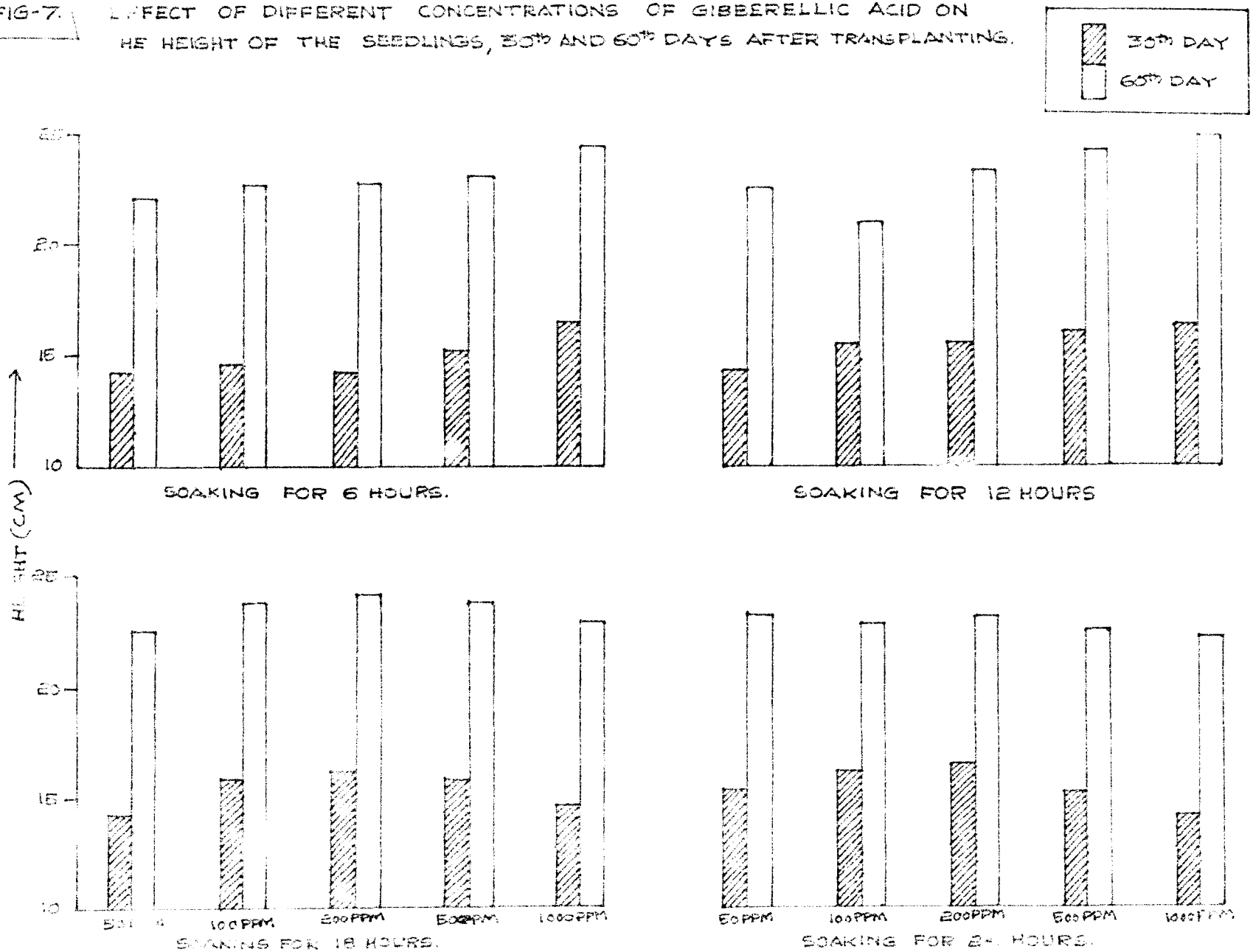
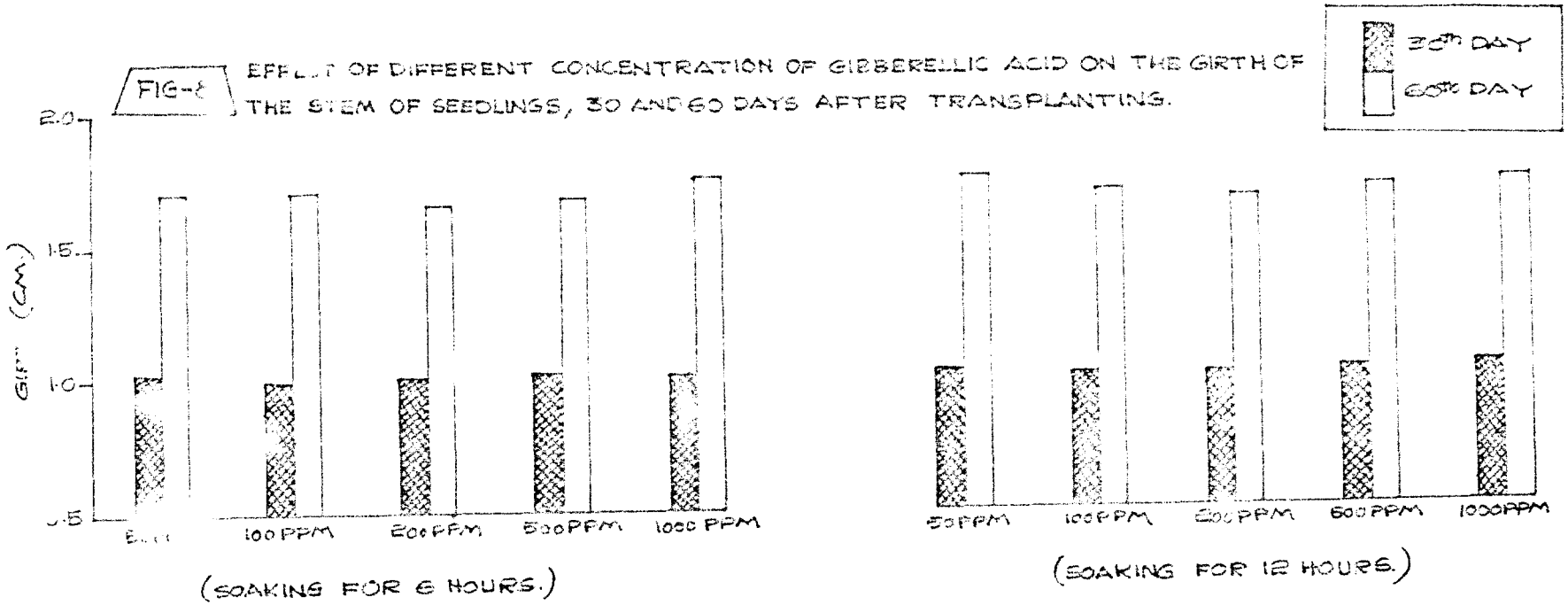


Table 6(b). Effect of different concentrations of gibberellic acid on the girth of the stem of seedlings, 30 and 60 days after transplanting.

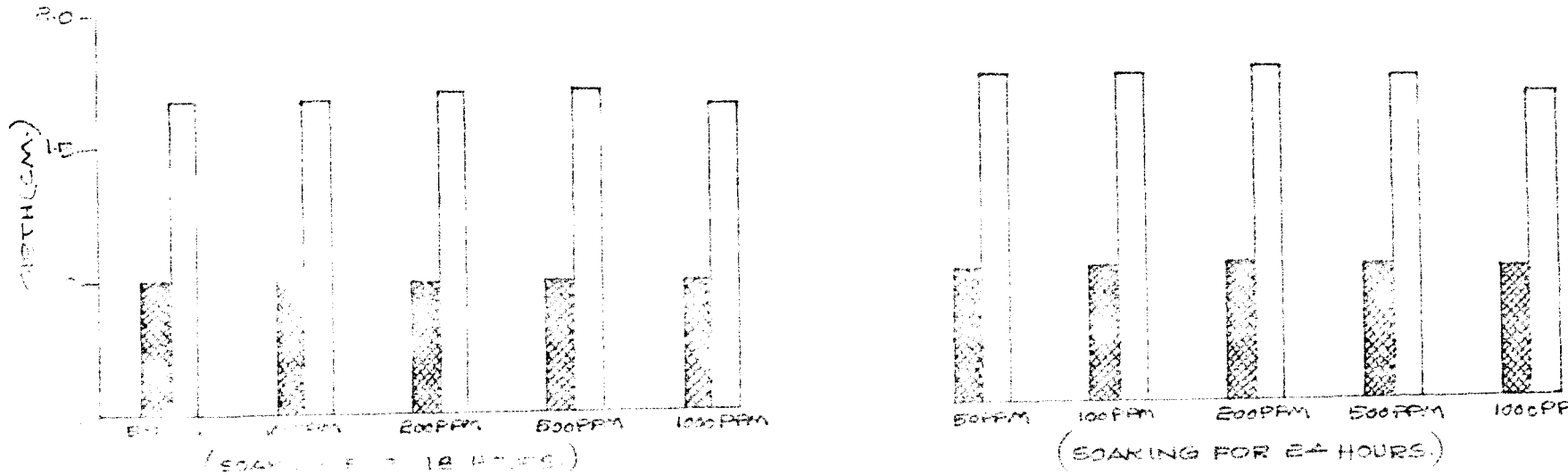
Sl. No.	Hours of soaking	Girth of the seedlings (cm) Concentrations of gibberellic acid									
		50 ppm		100 ppm		200 ppm		500 ppm		1000 ppm	
		30 days	60 days	30 days	60 days	30 days	60 days	30 days	60 days	30 days	60 days
1	6	1.02	1.70	0.99	1.70	1.01	1.68	1.02	1.69	1.01	1.76
2	12	1.02	1.76	1.01	1.70	1.01	1.69	1.01	1.71	1.02	1.72
3	18	1.00	1.68	1.00	1.69	0.99	1.70	0.99	1.71	0.98	1.67
4	24	1.00	1.74	1.01	1.74	1.02	1.76	1.00	1.71	0.93	1.63
	F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

FIG-6 EFFECT OF DIFFERENT CONCENTRATION OF GIBBERELLIC ACID ON THE GIRTH OF THE STEM OF SEEDLINGS, 30 AND 60 DAYS AFTER TRANSPLANTING.



(SOAKING FOR 6 HOURS.)

(SOAKING FOR 12 HOURS.)



(SOAKING FOR 18 HOURS.)

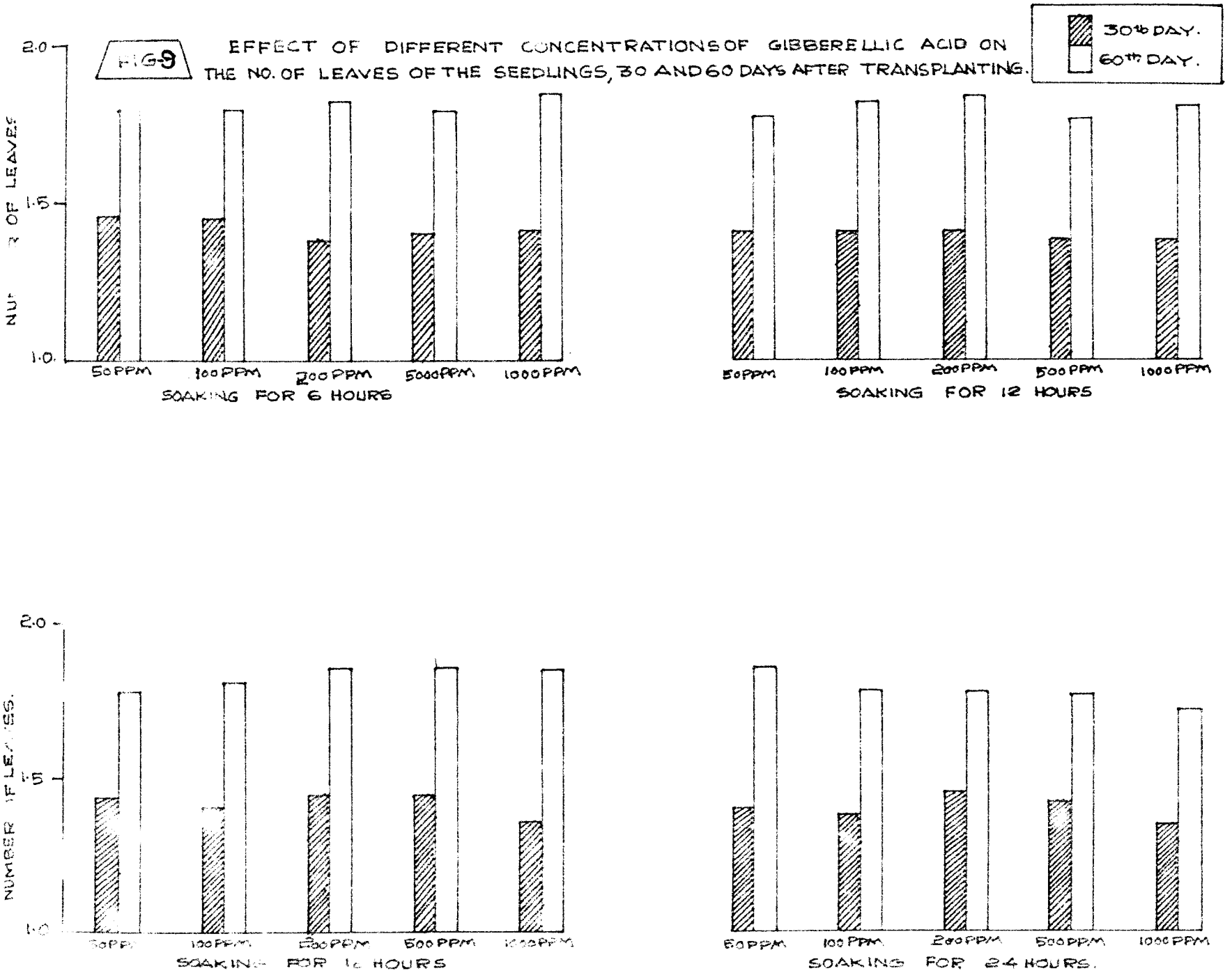
(SOAKING FOR 24 HOURS.)

Table 6(c). Effect of different concentrations of gibberellic acid on the number of leaves of the seedlings, 30 and 60 days after transplanting.

Sl. No.	Hours of soaking	Number of leaves Concentrations of gibberellic acid									
		50 ppm		100 ppm		200 ppm		500 ppm		1000 ppm	
		30 days	60 days	30 days	60 days	30 days	60 days	30 days	60 days	30 days	60 days
1	6	2.12 (1.46)	3.24 (1.80)	2.08 (1.44)	3.24 (1.80)	1.90 (1.38)	3.30 (1.82)	2.00 (1.41)	3.24 (1.80)	2.00 (1.41)	3.42 (1.85)
2	12	2.00 (1.41)	3.12 (1.77)	2.00 (1.41)	3.30 (1.82)	2.00 (1.41)	3.38 (1.84)	1.90 (1.38)	3.14 (1.77)	1.90 (1.38)	3.24 (1.80)
3	18	2.08 (1.44)	3.06 (1.75)	2.00 (1.41)	3.24 (1.80)	2.08 (1.44)	3.30 (1.82)	2.08 (1.44)	3.30 (1.82)	1.90 (1.38)	3.24 (1.80)
4	24	2.00 (1.41)	3.42 (1.85)	1.90 (1.38)	3.12 (1.77)	2.08 (1.44)	3.40 (1.84)	2.00 (1.41)	3.14 (1.77)	1.82 (1.35)	2.90 (1.70)
F test		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

The data were transformed by using square root transformation for statistical analysis and are given in parenthesis.

FIG-9 EFFECT OF DIFFERENT CONCENTRATIONS OF GIBBERELLIC ACID ON THE NO. OF LEAVES OF THE SEEDLINGS, 30 AND 60 DAYS AFTER TRANSPLANTING.



Considering all the important factors affecting seed germination, period of viability and the growth characteristics, it may be concluded that soaking the seeds for 24 hours in 200 ppm gibberellic acid solution ranked first and was significantly superior to all the other treatments.

2. Vegetative Propagation:

The results of the different investigations on vegetative propagation of nutmeg are presented below:-

2.1 Inarch grafting:

This method of grafting is successfully adopted in many horticultural plants. Therefore, this method was tried in the case of nutmeg in the present studies. 1½ to 2 year old nutmeg seedlings were used as the stock plants for inarching. In order to standardize the time of grafting, monthly trials were carried out from April 1978 to January 1979. The remaining two months were left out as the season was too hot and dry, for any propagation work. Twenty grafts were made in every month during the above period and the percentage of successful grafts are presented in Table 7.

Table 7. Percentage of success of inarch grafting, obtained in different months.

Month		No. grafted	No. survived	Percentage
April	1978	20	15	75
May	"	20	16	80
June	"	20	19	95
July	"	20	18	90
August	"	20	17	85
September	"	20	18	90
October	"	20	17	85
November	"	20	16	80
December	"	20	14	70
January	1979	20	13	65

The data show that 95 per cent success was obtained during the month of June and 80 to 90 per cent success was obtained during the months of May, July, August, September, October and November. Therefore it may be seen that the inarching was highly successful during the period from May to November (Fig. 10).

Growth of inarched grafts as compared to that of seedlings:

Average height, girth of the stem, number of leaves and number of lateral branches of the grafts were compared with those of the seedlings of the same age as that of root-stocks. The comparative growth characters of both the grafts and seedlings are given in Table 8.

It is evident from the table that the average height of the seedlings were significantly higher than that of the grafts - both at two weeks after seperation and two months after establishment. With regard to the girth of the stem, there was no significant difference between the seedlings and the grafts.

Regarding the production of leaves, the seedlings

FIG-10 PERCENTAGE OF SUCCESS IN DIFFERENT METHODS OF GRAFTING.

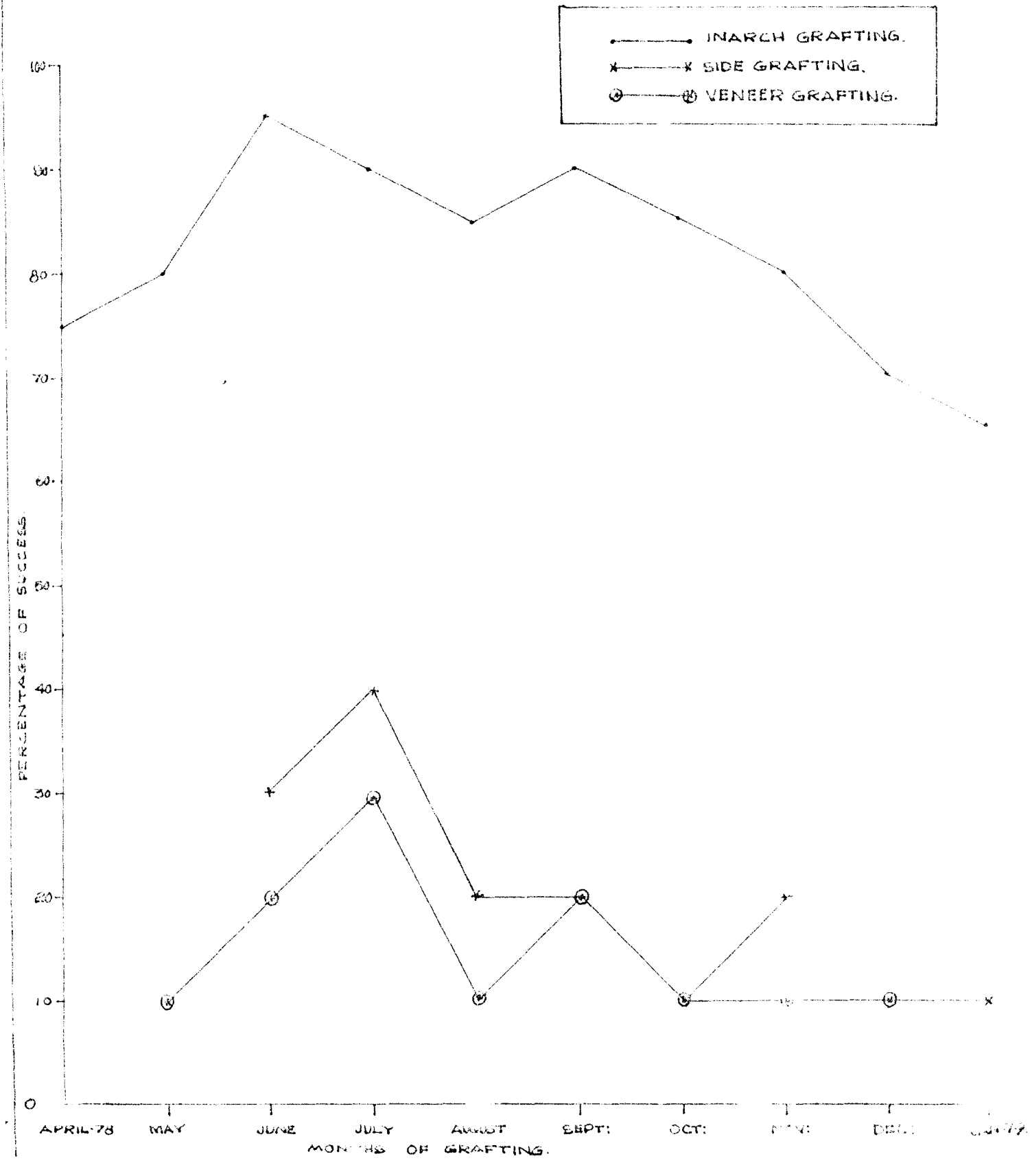


Table.9 Comparative growth parameters of successful inarch grafts as compared to the seedlings.

Month	Two weeks after separation								Two months after separation							
	Height (cm)		Girth (cm)		Number of leaves		Number of branches		Height (cm)		Girth (cm)		Number of leaves		Number of branches	
	S*	G**	S	G	S	G	S	G	S	G	S	G	S	G	S	G
April 1978	42	33	2.4	2.4	21	14	5	4	44	36	2.5	2.4	20	15	5	4
May ,,	40	31	2.4	2.2	18	12	5	1	43	36	2.6	2.1	15	13	5	3
June ,,	38	30	1.6	1.8	16	12	3	4	40	33	1.8	2.0	16	14	3	4
July ,,	32	25	2.0	1.8	14	16	4	4	35	28.4	2.1	1.9	15	17	4	4
August ,,	36	28	1.5	1.6	12	14	3	3	39	32	1.5	1.6	13	14	3.	4
September 1978	43	32	2.6	2.2	18	16	3	2	44	35	2.6	2.2	19	17	3	2
October ,,	38	29	1.8	1.6	20	13	4	3	41	32	2.0	1.7	20	13	4	3
November ,,	40	31	2.6	2.0	18	12	5	1	43	36	2.6	2.1	15	13	5.	3
December ,,	33	26	2.0	1.8	13	14	3	4	35	30	2.0	1.8	13	15	3	4
January 1979	34	27	1.6	1.5	14	10	2	3	37	31	1.6	1.8	15	11	3	4
t test	Sig		Sig		Sig		Sig		Sig		Sig		Sig		Sig	

* Seedling

**Graft

ranked first at the time of establishment and the grafts were significantly inferior to the seedlings in this respect. But in two months time, the number of leaves of the grafts came upto the standard of seedlings.

In respect of the number of lateral branches, both the grafts and seedlings recorded more or less same number, two weeks after establishment. Two months after the first observation also the number of lateral branches produced were one par in both seedlings and grafts.

2.2 Side-grafting:

Side-grafting was tried during a period of 8 months from June 1978 to the following January 1979. The number of grafts done, the number succeeded and the percentage of success are given in Table 9.

It may be seen from Table 9 that the maximum percentage of success was obtained during the month of July (40%) followed by June giving 30 per cent success. The success was relatively poor during the remaining months.

Table 9. Percentage success of side-grafts obtained during different months.

Month		Number grafted	Number survived	Percentage of success
June	1978	10	3	30
July	"	10	4	40
August	"	10	2	20
September	"	10	2	20
October	"	10	1	10
November	"	10	2	20
December	"	10	1	10
January	1979	10	1	10

Growth of side grafts as compared to the seedlings:

Average height, girth of the stem, number of leaves and number of lateral branches of the side-grafts were compared with that of the seedlings of the same age as the root stocks. The comparative growth characteristics of both the side-grafts and seedlings are given in Table 10.

It may be seen from Table 10 that in respect of the average height and girth of the stem, the seedlings were significantly better than that of the grafts both two weeks after and two months after separation.

Regarding the number of leaves and the number of lateral branches, the grafts were significantly inferior to those of the seedlings, two weeks after separation as well as two months after separation.

2.3 Veneer grafting:

Veneer grafting was done at monthly intervals during a period of eight months, starting from May 1978 to December 1978. The number of grafts done, the number succeeded and the percentage of success are given in Table 11.

Table 10. Comparative growth parameters of successful side-grafts as compared to the seedlings.

Month		Two weeks after seperation								Two months after seperation							
		Height (cm)		Girth (cm)		No. of leaves		No. of branches		Height (cm)		Girth (cm)		No. of leaves		No. of branches	
		S*	G**	S	G	S	G	S	G	S	G	S	G	S	G	S	G
June	1978	21	13	1.6	1.1	3	3	1	-	23	18	1.7	1.3	4	3	1	-
July	"	19	14	1.5	1.2	4	2	-	-	21	18	1.6	1.4	5	3	-	-
August	"	22	13	1.4	1.2	5	2	1	-	25	16	1.5	1.5	5	2	2	1
September	"	18	11	1.5	1.1	4	2	-	-	21	15	1.5	1.2	5	3	1	1
October	"	20	12	1.3	1.0	4	1	-	-	21	16	1.5	1.2	4	3	1	-
November	"	18	16	1.5	1.1	6	2	2	-	20	19	1.6	1.3	6	4	2	-
December	"	19	13	1.4	1.2	5	2	1	-	20	17	1.6	1.3	5	2	1	-
January	1979	21	14	1.6	1.3	5	2	1	-	23	18	1.6	1.5	5	3	2	1
F test		Sig		Sig		Sig		Sig		Sig		Sig		Sig		Sig	

* Seedling

** Graft

The data presented in Table 11 show that the month July was the most congenial time for veneer grafting, giving 30 per cent success. It is followed by June and September, giving 20 per cent success. The success was relatively poor during the remaining months.

Growth of veneer grafts as compared to the seedlings:

The comparative growth characteristics (mean height, girth, no. of leaves, and no. of branches) of both veneer grafts and seedlings are given in Table 12.

It may be seen from Table 12 that the mean height and girth of the seedlings were significantly higher than that of the grafts, both at the time of establishment and also two months after establishment.

The production of leaves and lateral branches were also better in the case of seedlings than in the grafts.

2.4 Wedge grafting:

Wedge grafting is successfully adopted in many horticultural plants. In the present investigations also this method of grafting was tried six times at

Table 11. Percentage success of veneer grafts obtained during different months.

Month		No. grafted	No. succeeded	Percentage of success
May	1978	10	1	10
June	"	10	2	20
July	"	10	3	30
August	"	10	1	10
September	"	10	2	20
October	"	10	1	10
November	"	10	1	10
December	"	10	1	10

Table 12. Comparative growth parameters of successful veneer grafts as compared to the seedlings.

Month of grafting		At the time of establishment								Two months after establishment							
		Height (cm)		Girth (cm)		No. of leaves		No. of branches		Height (cm)		Girth (cm)		No. of leaves		No. of branches	
		S*	G**	S	G	S	G	S	G	S	G	S	G	S	G	S	G
May	1978	20	12	1.4	1.0	4	1	-	-	22	16	1.6	1.2	4	3	-	-
June	"	21	13	1.5	1.3	5	1	1	-	24	18	1.6	1.3	6	4	2	-
July	"	22	14	1.6	1.2	4	1	-	-	25	18	1.7	1.3	5	4	1	1
August	"	18	12	1.4	1.1	3	2	1	-	22	16	1.5	1.4	5	3	1	-
September	"	20	11	1.6	1.0	4	2	1	-	22	17	1.6	1.2	6	4	1	1
October	"	21	13	1.6	1.4	6	1	1	-	23	18	1.6	1.4	6	3	2	1
November	"	21	13	1.4	1.3	5	2	2	-	24	17	1.4	1.4	4	4	1	-
December	"	20	12	1.5	1.1	5	2	1	-	22	16	1.6	1.4	5	4	1	-
F test		Sig		Sig		Sig		Sig		Sig		Sig		Sig		Sig	

* Seedling

** Graft

fortnightly intervals during the period from 3-1-1979 to 18-3-1979. The percentage of success obtained in this trial is presented in Table 13 & in Fig 11.

It may be seen from Table 13 that maximum success of 40 per cent by this method was obtained when grafted on 18-1-1979, closely followed by grafting in the first week of January and in the first week of February, giving 30 per cent success. Wedge grafting done during March 18th gave the minimum percentage of success (10%).

Growth of wedge-grafts as compared to the seedlings:

The comparative growth parameters of wedge-grafted plants and seedlings of same age are presented in Table 14. It may be seen from Table 14 that the mean height of the seedlings were significantly higher than that of grafts at both times of measurement.

In respect of mean girth, the seedlings were significantly better than the grafts at the time of first observation, but the grafts came on par with the seedlings after two months of establishment.

Seedlings had more number of leaves as well as branches than those of grafts at both the time of measurement.

Table 13. The percentage success in wedge-grafting.

Date of grafting	No. grafted	No. succeeded	Percentage of success
January 3rd 1979	10	3	30
January 18th 1979	10	4	40
February 3rd 1979	10	3	30
February 18th 1979	10	2	20
March 3rd 1979	10	2	20
March 18th 1979	10	1	10

FIG-11.

THE PERCENTAGE SUCCESS IN WEDGE-GRAFTING.

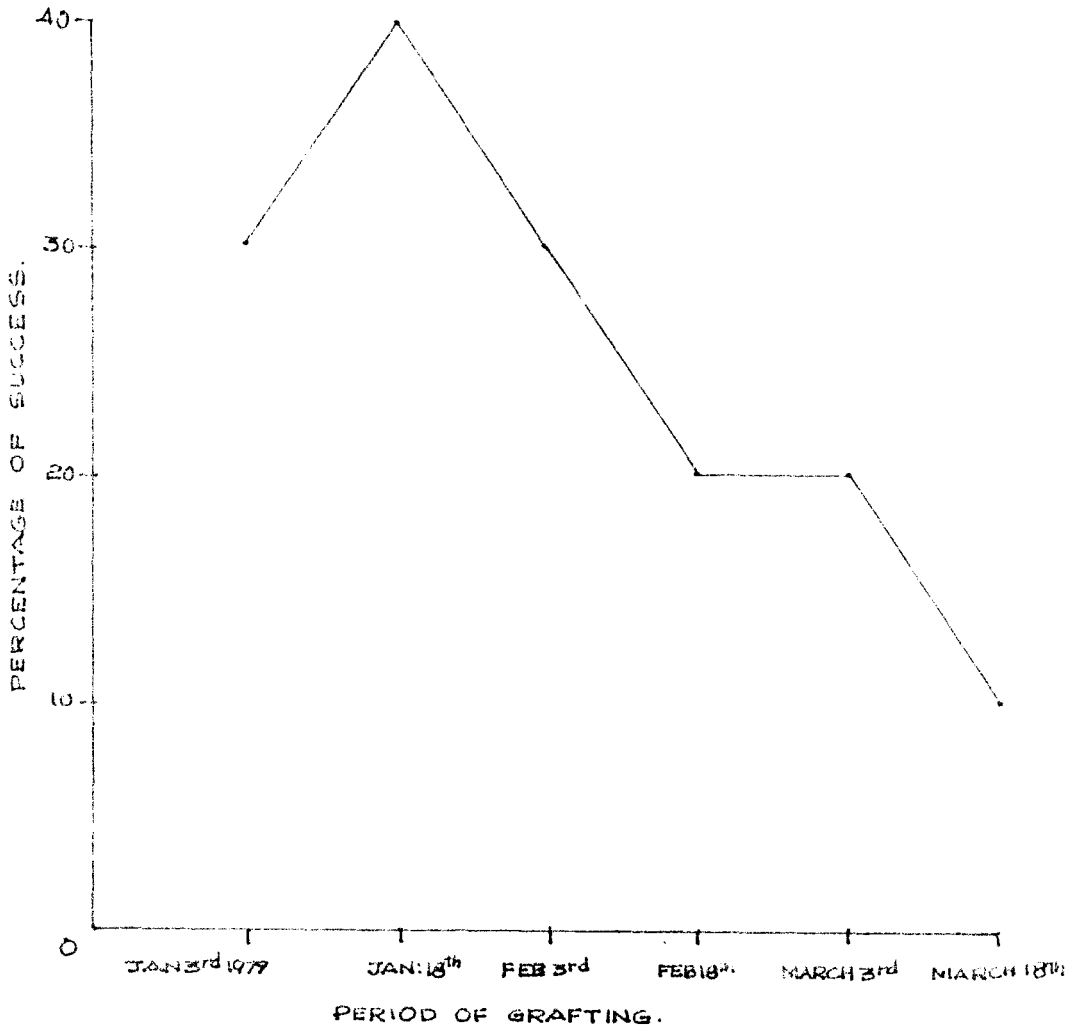


Table 14. Comparative growth parameters of successful wedge grafts as compared to the seedlings.

Period	Two weeks after establishment								Two months after establishment							
	Height (cm)		Girth (cm)		No. of leaves		No. of branches		Height (cm)		Girth (cm)		No. of leaves		No. of branches	
	S*	G**	S	G	S	G	S	G	S	G	S	G	S	G	S	G
January 3rd 1979	15	12	1.4	1.0	5	2	2	-	19	17	1.7	1.6	5	4	2	1
January 18th 1979	16	14	1.4	1.0	4	2	1	-	20	18	1.6	1.6	5	4	1	1
February 3rd 1979	19	15	1.4	1.1	3	1	1	-	23	19	1.7	1.6	4	3	1	-
February 18th 1979	18	13	1.3	1.1	5	2	1	-	21	17	1.5	1.5	6	4	2	1
March 3rd 1979	18	14	1.3	1.0	4	1	1	-	21	18	1.6	1.4	4	3	1	-
March 18th 1979	17	14	1.3	1.0	6	1	2	-	20	17	1.4	1.2	5	2	2	-
't' test	Sig		Sig		Sig		Sig		Sig		Sig		Sig		Sig	

* Seedling

** Graft

Budding:

Forkert budding was done at monthly intervals during a period of six months, starting from May 1978 to October 1978. The buddings were prepared at a time and were kept in moist chamber. The buds remained green during the period of keeping them under moist conditions, but none of them survived when taken out of the moist condition. The number of budding done and the number of 'take' in each lot are given below:

Month		No. budded	No. of 'take'
May	1978	10	2
June	"	10	3
July	"	10	4
August	"	10	2
September	"	10	3
October	"	10	2

The above results indicate that budding may be successful provided the period of keeping them under moist conditions and the process of 'hardening' them are standardised.

DISCUSSION

D I S C U S S I O N

The wide popularity, that had been earned by nutmeg as a money spinning tree spice among the cultivators of Kerala is now diminishing due to several problems which stand in the way of its successful cultivation. Poor viability of seeds, high mortality in the nursery, dioecious nature of the plant, extreme succeptibility to hot weather and drought are some of the major problems experienced by the growers. The present investigations were undertaken to study the different aspects of propagation of the crop and to find out a solution to the problem of identification of the sex in the nursery stage itself so as to avoid the huge expenditure involved in growing the excess number of male trees upto the flowering stage. It is also necessary to standardise the methods of propagation which are found effective and practicable.

The results of the present studies showed that the highest percentage of germination of 65 per cent was obtained during the month of June using seeds which are sown immediately after harvest. It is reported by Flach (1966) that the germination of nutmeg seeds varied

from 35 to 70 per cent. Perll (1938) also reported that the germination of nutmeg seeds vary widely depending on the collection of seeds from trees of different yield groups and from female trees which are situated at different distances from the male trees. The possible reasons for these differences have not been explained by him. No such relationship were found in the present studies. The atmospheric humidity and temperature conditions obtained during the month of June might be more condusive for the germination of nutmeg seeds as compared to that of the remaining months.

The data also showed that there was significant difference between heavy and light seeds both in the per cent of germination and the time taken for germination. Hume and Cobin (1943) reported that smaller seeds gave lower percentage of germination as compared to the heavier seeds.

Nutmeg seeds lose viability quickly, especially if allowed to dry in the sun. The seeds were stored in two environments viz., in moist sand and in metallic

bins for 15 and 30 days and then sown to test the viability. The results showed differences in germination in the two methods of storage and also in the period of storage. The germination percentage was reduced to 14 per cent in the case of seeds stored for 30 days in metalic tin (light group). In the case of seeds stored in moist sand, it was only 21 per cent at the end of 30th day of storage.

In the case of heavy group also, seeds stored in moist sand gave much higher germination than those stored in metalic tin. But the seeds which were sown immediately after harvest gave the highest germination percentage in both the groups.

Shanmughavelu and Rao (1977) had reported that the viability of nutmeg seeds was not affected when stored for 15 days in polythene bags or moist sand. However, the present studies indicated that the germination percentage is significantly reduced by storage for 15 days under moist sand. In the case of cocoa seeds, seeds were extracted and stored along with the pulp in finely ground charcoal. The seeds retained in pods and stored in finely ground charcoal remained

viable upto a period of 5 weeks after harvest without much loss in viability.

It appeared from the above results that the most crucial factors determining the viability and germination of nutmeg seeds were a suitable combination of temperature and moisture. But the effect of temperature cannot be readily isolated from that of moisture. The temperature and moisture conditions obtaining in moist sand might be more conducive to keep up the viability of seeds as compared to the dry and higher temperature conditions obtaining in storage in metallic bin.

The results also showed that the number of days taken for germination was less in the case of seeds stored in moist sand for 15 days and 30 days than the direct sown seeds. This may be due to the fact that storing seeds in moist sand provided more or less same conditions as those obtained in seed beds.

The studies on the effects of soaking the seeds in gibberellic acid in different concentrations and for different periods of soaking indicated that treatment with gibberellic acid in concentration of 200 ppm for 24 hours had significant effect on germination and subsequent growth of the seedlings as compared to the untreated seeds. While the lower

concentrations of gibberellic acid also indicated favourable effects to a lesser extent than that of 200 ppm, the higher concentration of 1000 ppm had an adverse effect on germination, when the soaking time was increased for 24 hours. The favourable effects of lower concentrations were enhanced with the time of soaking. The stimulatory effect of gibberellic acid treatment on the germination as well as the subsequent growth of the seedlings had been reported by several workers working on different fruit crops (Elson, 1954, Kahn et al. 1957, Wittwer and Buckovac, 1957, Fogle and Mc Crory, 1960).

It was also found that the time taken for germination was less in the case of gibberellic acid treated seeds when the concentration was 200 ppm for 24 hours.

The results of the present studies showed that the growth of the seedlings obtained from gibberellic acid treated seeds was significantly higher than those from untreated seeds. The height of the seedlings at the end of 30 and 60 days after transplanting was

maximum in the case of seeds treated with 1000 ppm GA and the soaking time was 6 hours. However, the above concentration was found to be adverse in effect in respect of the percentage of germination.

Considering the favourable effects on the percentage of germination and the growth of the seedlings, the concentration of 200 ppm and the soaking time of 24 hours were found to be the best.

Studies on the action of GA on seed germination and seedling growth have indicated that the first step in the germination of seeds was the breakdown of starch by enzyme action and this was accelerated by gibberellic acid. In respect of growth of seedlings, the effect of gibberellic acid is brought about by cell elongation.(Yeou-Der et al. 1962, Shanmughavelu, 1969). This may be due to an increase in endogenous auxin content. It may also be possible that the ultimate effect of GA is by indirectly lowering the activity of IAA - oxidase reaction and to raise the auxin levels in the plant (Brain, 1959).

The results also showed that when the soaking time was increased (500 and 1000 ppm concentrations)

the plant height was decreased. This may be due to some injurious effects from the stronger solutions.

In most of the perennial crops, the common methods of propagation are vegetative, because the progenies will be true to type, come to bearing earlier than the seedling trees and are generally more productive. In nutmeg, vegetative propagation if successful has an added advantage of knowing the sex of the progeny from the very beginning of the growth of the plant.

The results of inarch-grafting showed that nutmeg is amenable to inarch grafting. The data showed that 95 per cent success was obtained during the month of June and 80 to 90 per cent during July to November and in April. The reason for the high rate of success during June lies in the active growth of plants in this part of the year, which favoured quick union between stock and scion. Moreover the high atmospheric humidity that prevailed during the rainy season kept the scion shoots green without drying. The high mortality of grafts after detachment from April, December and January may be due to the unfavourable seasonal conditions that prevailed at the time of

grafting. Inarch grafting during the months of April, December and January gave relatively low success possibly due to inadequate flow of sap in the stock and scion at this time of the year. Sundararaj and Varadarajan (1956) had reported 60-100 per cent success in approach grafting on seedlings of cultivated and wild spices of nutmeg. Shanmughavelu and Rao (1977) also, claimed 60-100 per cent success in nutmeg inarching. A number of workers reported about the high percentage of success in inarch grafting in fruit crops like mango, guava, avocado and plantation crops like cacao, clove etc. (George and Nair, 1969, Krochmal, 1974, Rao, 1975).

Thus the observations recorded above revealed that the method of inarch grafting can be successfully adopted in the propagation of nutmeg. However, the growth of the grafts were found to be relatively poor as compared to the seedlings. The results of the present studies also indicate that the success of operation was largely related to the growth activity of the plant and the climatic conditions prevailing at the time of operation.

The results showed that side-grafting during the month of July gave the highest per cent of success (40) which was followed by grafting in June, giving 30 per cent success. Success in side-grafting when done during the months of July - August and June - October had been reported by Naik (1949a) and Kanwar and Bajwa (1974) in mango. Gopimani (1978) obtained some success in side-grafting in nutmeg.

The success obtained during the month of July may perhaps be due to the congenial climatic conditions that prevailed during that time.

But while considering the growth of the grafts and seedlings, seedlings were seen better than that of grafts.

The success in veneer-grafting of nutmeg depended mainly on the season. Bhandary and Mukherjee (1970) reported more success in July than in April or June, while Mukherjee and Singh (1965) reported more success in April than in March, May or June. In the present investigations veneer-grafting in June and September gave slightly better success then in May, August, October, November and December with the highest (30 per cent) in July.

Warm and humid weather conditions and active growth of the stock plants in June - July may have helped the union of the stock and the scion to a great extent. Other months were seen unsuitable for veneer-grafting. The unsuitability of March and April for grafting was recorded by Gedara (1960) and Mukherjee and Singh (1965).

The results on growth of the seedlings showed that grafts were significantly inferior to that of the seedlings in the initial stages of establishment.

The data showed that wedge-grafting during the month of January was effective with 40 per cent success. The month of February was also seen to be suitable. However, grafting during the month of March was not congenial.

Amin (1978) reported that in mango this method can be adopted as a successful vegetative propagation method since it can be done insitu. In nutmeg also there is ample scope for insitu wedge-grafting. This method offers much promise as the growth of the grafts came upto the standard of seedlings of the same age within about two months time (in respect of girth of the stem).

The results discussed above clearly indicated that inarch-grafting gave nearly cent per cent success. But the sluggish nature of its growth discouraged its popularisation among cultivators. Methods like side-grafting and veneer-grafting have also shown some success; but here also the slow growth pattern of grafts was a disadvantage. But the recently developed wedge-grafting offers much scope because of its reliable success and of its appreciating growth pattern when compared to the seedlings of the same age group. As a reliable, quick and cheap method (when compared to inarching), this method has a chance of becoming popular among nutmeg cultivators.

SUMMARY

S U M M A R Y

Studies on the propagation of nutmeg by seed as well as vegetative methods were undertaken at the Instructional Farm of the College of Horticulture and at the District Agricultural Farm, Mannuthy during the year 1978-79. The results of these studies are summarised below:

The highest percentage of germination in heavy as well as light seeds was obtained when the seeds were sown in June (65 per cent and 52 per cent) and the minimum was during the months of August (34 per cent) and December (35 per cent). The time taken for germination was least when the sowing was done in June. There was significant difference between the heavy and the light group of seeds in respect of the percentage of germination and also in the time taken for germination.

Seeds which were sown immediately after harvest gave the maximum percentage of germination (60 per cent). But seeds stored in moist sand maintained the viability much better than those stored in metallic containers. It was also revealed that the number of days taken for

germination was less in seeds stored in moist sand as compared to seeds stored in metallic container.

Seeds soaked in gibberellic acid 200 ppm for 24 hours gave quicker germination as well as higher percentage of germination as compared to other concentrations of GA and soaking periods.

There was significant difference in the growth of the seedlings in respect of girth between the two groups namely heavy and light seeds. There was no significant difference in respect of height and number of leaves in the seedlings derived from the two groups.

Treatment with gibberellic acid had significant effect on the height of the seedlings. Seeds soaked in GA 1000 ppm for 6 hours gave the maximum height (24.52 cm) which was closely followed by the treatment 200 ppm gibberellic acid where the soaking time was 24 hours.

In respect of the girth of the seedlings and the number of leaves produced, eventhough there was no significant difference between different concentrations, soaking for 24 hours in 200 ppm gibberellic acid solution was the best.

Inarch grafting was highly successful in nutmeg, which gave 95 per cent success when done during the month of June.

The growth of the grafts was also satisfactory. After two months of separation, the girth and number of leaves produced by the grafts were on par with that of the seedlings of the same age.

The best period for side-grafting in nutmeg was during the months of June - July. But the growth of the grafts were comparatively poor in the initial stage as compared to that of seedlings.

Veneer grafting was also a success in nutmeg and the maximum percentage of success (30) was obtained during the month of July.

Wedge grafting on one year old nutmeg seedlings gave 30 - 40 per cent success under humid chamber conditions. Here the growth of the grafts (regarding the girth) was on par with that of the seedlings at the end of two months. The method needed further standardization for adoption on large scale.

REFERENCES

REFERENCES

Abraham, P. 1957. Have a few spice trees in your garden. Indian Frng. 7 (8) : 28-31.

Ahamad, R. 1966. Some studies on the vegetative propagation of guava (Psidium guajava.) W. Pakist. J. agric. res. 4 : 68-79.

Amin, R.S. 1978. in situ soft wood grafting in mango. Indian Hort. 23 (3) : 7-11.

*Anderson, J.D., Baker, J.E. and Worthington, E.K. 1970. Quoted by Khan, A.A., in The Physiology and Bio chemistry of Seed Dormancy and Germination on page 226. North Holland Publishing Company. Oxford. 1977.

Anon. 1950-'51. Quoted by Shanmughavelu, K.G., and Rao, V.N.M. 1977. Spices and Plantation crops. Page 157. Popular Book Depot, Madras.

Anon. 1952. Cinnamomum zeylenicum. Wealth of India.

Anon. 1964. Quoted by Shanmughavelu, K.G., and Rao, V.N.M. 1977. Spices and Plantation Crops. Popular Book Depot, Madras.

Anon. 1966. Cashew budding Quz. Agric. Locamb. 18 : 126-127.

Anon. 1969. Quoted by Shanmughavelu, K.G., and Rao, V.N.M. 1977. Spices and Plantation crops. Page 153-154. Popular Book Depot, Madras.

Anon, 1978. Annual Progress Report of the A.I.C. . and Cashew Improvement Project for 1977-'78. Page 10.

Audus, L.J. 1963. Plant Growth Substances. Leonard Hill (Books) Ltd., London.

Bailey, L.H. 1927. Standard Cyclopedia of Horticulture. Macmillan & Co., London.

Bajpai, P.N., and Trivedi, P.K. 1961. Storage of mango seed stone. Hort. Advance. 5 : 228-229.

Ballington, J.R., Calletta, G.J., and Pharr, D.M. 1976. Gibberellin effects on rabbiteya blue berry seed germination. Hort. Science. 11 (4) : 410-411.

*Balls, A.K., and Hale, W.S. 1940. Quoted by Khan, A.A. 1977. in The Physiology and Bio chemistry of Seed Dormancy and Germination on page 158-176. North Holland Publishing Company, Oxford, 1977.

Barton, L.V. 1961. Seed Preservation and Longevity. Leonard Hill, London.

*Bass, L.N. 1972. Quoted by Khan, A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination on page 221-234. North Holland Publishing Co. Oxford. 1977.

Bhandary, K.R., and Mukherjee, S.K. 1970. Effect of season, age and source of scion and ringing on veneer grafting of guava. Indian J. agric. sci. 40 : 495-501.

Bhandary, K.R., Shetty, K.P.V., and Shet, M. 1974. Propagation of cashew by wedge grafting. J. Plantation crops. 2 (1) : 37

Bhujbal, B.G. 1975. Improvement in seed propagation of aonla. (Phyllanthus emblica L.) Res. J. Mahatma Phule agric. Univ. 6 (1) : 73-75.

Brain, P.W. 1959. Effects of gibberellin on plant growth and development. Biol. Rev. 34 : 37-84.

Burns, W., and Prayag, S.H. 1920. The book of mango. Bull. Bombay. Dept. Agric: 103.

*Burris, J.S., Edje, D.T., and Wahab, A.H. 1973. Quoted by Khan, A.A. 1977. The Physiology and Bio chemistry of Seed Dormancy and Germination. page 221-234. North Holland Publishing Co., Oxford.

*Casini, E., and Salvadori, S. 1976. (Observations and research on the use of various growth regulators in the germination of seed of fruit trees). Osservazioni ericerche sull' impiego di alcuni regolatori dicrescita nella germinazione deisemi di piante da frutto. La Nuova. A.O.P.I. Dice-mbre 1975/Gingno 1976. 22 pp.

Chacko, E.K. and Chase, R.N. 1968. Studies on the germination and longevity of fruit tree seeds. Indian J. Hort. 25 : 94-103.

Chadha, K.L. 1965. Studies on the phenotypic variability and seed germination in some grape cultivars. Unpublished thesis submitted to post graduate school, Indian agric. Res. Inst. New Delhi.

Chadha, K.L., and Menon, V.N. 1967. Studies on germination of grape seed. II. Germination of freshly extracted and after ripened grape seeds as influenced by treatments of GA. J. Res. PAU. submitted.

Chase, S.B. 1947. The modified patch bud. Comb. Proc. Mtg. West. Reg. Pl. crop. soc. 136-139.

Cheesman, E.E., and Spencer, G.E. 1936. Propagation of cuttings in tropical climate. Trop. Agric. Trin. 13 : 201-203.

*Chen, S.S.C., and Park, W.M. 1973. Quoted by Khan, A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. p. 96-97. North Holland Publishing Co. Oxford. 1977.

Cheveliar, A. 1936. Cinchona cultivation in warm countries. Rev. Bot. sppl. 16. Cit. Hort. Abst. 8 : 382.

*Christensen, O.M. 1973. Quoted by Khan, A.A. 1977. The Physiology and Bio chemistry of Seed Dormancy and Germination.

Cruickshank, A.M. 1973. Some aspects of the nutmeg investigation programme in Greneda. Tropical Products Institute Proceedings. Spices : 105-111.

Davis, B.H. 1963. The modified patch bud. Comb. Proc. Mtg. West. Reg. Pl. Crop. Soc. 136-139.

Deinum, H. 1931. De noot musaat cultuur op de Banda. (Nutmeg culture in Banda Islands). Land bouw 7 : 467-492.

Deinum, H. 1949. Nutmeg and Mace. DeLandboum in de Indischa Archipel. 2 : 655-683 's Graventage.

*Delouche, J.C., Mathees, R.K., Dougharty, G.M., and Boyd, A.M. 1973. Quoted by Khan A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. North Holland Publishing Co. Oxford.

Devlin, R.M. 1966. Plant Physiology. Reinhold Publishing Corporation, New York.

El-Gobashy, A.S. 1969. Physiological studies on gibberellic acid. Ph. D. Thesis A' in Shams University, Cairo.

Elson, G.W., Heming, H.G., and Radley, M. 1954. The plant growth promoting properties of GA - a metabolic product of the fungus gibberella fujikuroii. J. Sci. Food and agric. 5 : 602-612.

Evans, H. 1950. Results of some experiment of the preservation of cacao seed in viable condition. Trop. agric. 27 : 48-50

Farooqui, A.A., Nalawadi, U.G., and Sulladmath, U.V. 1971. Effect of growth regulators on the germination of sapota. Mysore J. agric. sci. 5 (3) : 341-343.

Fielden, G., and Garner, R.J. 1940. Vegetative propagation of tropical and sub tropical plantation crops. Tech. commun (13) Imp. Bur. Hort. Plant. Crops.

Fhamy, I. 1952. Grafting studies on macademia and sapodilla in relation to carbohydrates using pre-girdled scions. Proc. Fla. St. Hort. Soc. 65 : 140-145.

Flach, M. 1966. Nutmeg cultivation and its sex problem. Medad Landb Hogesch. Wageningen. 66 : 87.

Flach, M., and Cruickshank, A.M. 1969. Nutmeg. Reprinted from outlines of perennial crop breeding in the Tropics. F.P. Ferwer da and F. Wilt. Miscellaneous papers (4) Land bouwhogeschool, 511.

Fogle, H.W., and Me Crory, C.S. 1960. Effect of cracking, after-ripening and gibberellin on germination of Lambert cherry seed. Proc. Amer. Soc. Hort. Sci. 76 : 134-138.

*Fujii, J., Isikawa, S., and Nakagawa, A. 1960. Quoted by Khan, A.A 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. North Holland Publishing Co. Oxford.

Gandhi, S.R. 1952. The Avacado. Bombay Dept. Agri. Bul. 188.

Gandhi, S.R. 1955. The Mango. Farm Bull. (6) : KAR, New Delhi.

Garg, M.L. 1954. Mango grafting made easy and cheap. Indian J. Hort. 11 : 145-146.

George, P.V., and Nair, T.N. 1969. On the performance of mono and poly embryonic root stocks in mango grafts. Agri. Res. J. Kerala. 7 (1) : 7-9.

Giri, A. 1966. Effect of varying girth of seedling stocks on percentage success in inarching in spring and autumn season in mango. Pakist. J. Sci. 18 : 76-78.

Godara, P.S.,1960. Propagation studies in mango (Mangifera indica, L.), guava (Psidium guajava L.) and Phalsa (Grewia asiatica L.) unpublished thesis. IARI, New Delhi.

Gopimani, R. 1978. Male trees can be converted to females. (Malayalam article). Malayala Manorama (News paper). July 26. p. 3 col.1-5.

Gowda, M.C.M. 1952. The cultivation of avacado pear in Mysore State. Mysore Agri. F. 28 : 1-7.

Gunther, E. 1960. Nutmeg and Mace in Grenada. Coffee and Tea Ind. (The flavour field) 84 : 49-52.

Gur, A., and Samish, R.M. 1962. The role of growth substances in the budding of mango. Hort. Advance 6 : 1-18.

* Haber, E.S. 1926. Quoted by Khan, A.A. 1974. The Physiology and Bio chemistry of Seed Dormancy and Germination. page 158-176. North Holland Publishing Co. Oxford.

*Haber, A.H., and Luippold, H.J. 1960. Quoted by Khan, A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. page 111-138. North Holland Publishing Co. Oxford.

Hamilton, R.A., and Nakasone, H.Y. 1967. Bud grafting of superior guava cultivars. Hawaii Fm. Sci. 16 (2) : 6-8.

*Harrington, J.F., 1972 and 1973. Quoted by Khan, A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. page 111-176. North Holland Publishing Co. Oxford.

Hayashi, T. 1940. Biochemical studies on Bukanae fungus of rice. Part 6. Effect of gibberellin on the activity of analyse in germinated cereal grains. J. agric. Chem. Soc. Japan. 16 : 531-538.

Hayes, 1957. Fruit growing in India. Kitabistan, Allahabad.

Hiyadathullah, and Sadiqali. 1955. Review of mango budding 'in situ' work in Punjab. Pb. Fruit J. (Pakistan) 19 (72 & 73).

Hume, E.P., and Cobin, M. 1946. Relation of seed size to germination and early growth of mango-steen (Garcinia mangostana.). Proc. Amer. Soc. Hort. Sci. 48 : 298-302.

Hunter, J.R. 1959. Germination in Theobroma cacao. Cacao 4 (4) : 1-8.

*Ikuma, H., and Thimann, K.V. 1960. Quoted by Khan, A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. North Holland Publishing Co. Oxford.

Jagirdar, A.P., and Ali, Z. 1965. Effect of age and variety of stock plants on the bud take in mango. Agri. Pakist. 16 : 461 - 466.

Jagirdar, S.M., and Bhatti, M.S. 1968. Effect of type of scion wood and age of stock on the success of veneer grafting in mango. W. Pakist. J. agric. Res. 6 (1) : 88-97.

James, E. 1967. Preservation of stock seeds. Adv. Agron. 19 : 87-

*James, E. 1969. Quoted by Khan, A.A. 1977 in The Physiology and Bio chemistry of seed Dormancy and Germination. Page 220-234.

*Janse, J.H. 1898. De-noot muskaat cultuur in de Minahasra enop de Banda elander. (Nutmeg growing in the Minalessa and Banda Islands). Med I'slands plantent. 28 : 1-230.

Kannan, K. 1971. Certain techniques for raising mutmeg seedlings. Arec and spices Bull. 2 (4) : 8-10.

Kannan, K. and Madhava Rao, V.N. 1964. Effect of gibberellic acid on seed germination, seedling growth and graft take in mango. Madras Agri. J. 51 : 77-78.

Kanwar, J.S., and Bajwa, M.S. 1974. Propagation of Mango by side grafting. Indian J. agric. Sci. 44 (5) : 270-272.

Khan, A.J.A., Goss and Smith, D.E. 1957. Effect of gibberellin on germination of lettuce seed. Science. 125 : 645-646.

Khan, F.F., and Krishnaswamy, A.R. 1953. A new essential oil nutmeg and its possible economic uses. Sci. and Cult. 19 (4) : 186-188.

Kar, P.L., Cadha, T.R., and Singh, R.P. 1973. Studies on vegetative propagation of Olive. Prog. Hort. 5 (2) : 1-9.

Krochmal, A. 1974. Inarching as a method of propagating tropical fruit trees. World Crops. 23 (4) : 218-1219.

*Krug, C.A. and Celio, S.N.A. 1946. Investigation on the acclimetisation of Cinchona in the State of Sao paulo. Biol. Abs. 21.

*Kursanov, A.L., Kulaeva, O.N. and Mukulovich, J.P. 1969. Quoted by Khan, A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. page 111-138. North Holland Publishing Co. Oxford.

*Lang, A. 1965. Encydop. Plant Physiol. 25/2: 848-893.

Letham, D.S., Shannon, J.S. and Mc Donald, I.R. 1964. Proc. Chem. Soc: 230.

Lewis, W.H. and Lewis, E.M.P.F. 1977. Medical Botany - Plants affecting Man's health. John Wiley and Sons, New York.

*Lona, F. 1956. Quoted by Khan A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. Page 416-428. North Holland Publishing Co. Oxford.

Lynch, S.J. 1941. Nursery propagation and top working of mangoes. Bull. Fla. agric. Exp. Stn. 560.

Macmillan, H.F. 1954. Tropical planting and gardening. 5th Edition London : 326-327.

Majhail, H.S., and Singh, K.K. 1962. Inarching in Mango - II. The optimum period of grafting and age of stock seedling. Punjab Hort. J : 2 (2) : 109-113.

*Marriott, K.M. and Northcote, D.H. 1975. Quoted by Khan, A.A. 1977. in The Physiology and Bio chemistry of Seed Dormancy and Germination. Page 97-99. North Holland Publishing Co. Oxford.

*Miller, C.O. 1958. Plant Physiol. 33 : 115.

Morgan, D.C., and Mees, G.C. 1958. GA and growth of crop plants. J. agric. sci. 50 : 45-49.

Mukherjee, S.K. 1953. The mango, its botany cultivation, uses and further improvement especially as observed in India. Econ. Bot. 7 (2) : 130-162.

Mukherjee, S.K., and Majumdhar, P.K. 1961. Veneer grafting has its own advantages. Indian Hort. 6 : 3.

Mukherjee, S.K. and Majumdhar, P.K. 1962. Performance of veneer grafting in comparison to other methods of propagation in Mango Curr: Sci. 31 : 174-175.

Mukherjee, S.K. and Majumdhar, P.K. 1964. Effect of different factors on the success of veneer grafting. Indian J. Hort. 21 : 46-50.

Mukherjee, S.K., and Singh, Y.M. 1965. Effect of season and nature of shoots on veneer grafting of guava (Psidium guajava L.) Sci. and Cult. 31 : 31-33.

Naik, K.C. 1941. Studies on the propagation of mango, Mangifera indica. L. Indian J. agric. Sci. 11 : 756-768.

Naik, K.C. 1949. South Indian fruits and their culture. Madras.

Nair, M.R. 1978. Clove and Nutmeg. Indian Fmg. 28 (4) : 10-13.

Nair, P.C.S. 1970. Two Spice Crops - clove and cinnamon. Arecamut and Spices. 2 (2) : 1-5.

Nair, B.K., Rai, R. and Valsala, P.A. 1977. A simple morphological technique for distinguishing the sex of nutmeg seedlings. Curr. Sci. 46 (5) : 156-157.

Nair, P.C.S., and Nair, M.K.C. 1969. All spice - Indian Spices 6 : 17.

Nekrasova, T.V. 1960. The effect of gibberellic acid on seed germination and seedling growth of fruit trees. Fiziol. Rast. 7 : 106-109.

* Nellist, M.E., and Huges, M. 1973. Quoted by Khan, A.A. 1977. The Physiology and Bio chemistry of Seed Dormancy and Germination. Page 221-234. North Holland Publishing Co. Oxford.

*Nelson, R.O. 1955. Propagation of guavas by graftage. ibid: 228-231.

Nelson, T.C. 1957. Early responses of some seurthern tree spices to GA J. Forestry. 55 : 518-520.

Nicholas, R. 1956. Private Comm. (U.W.I.Trinidad)

Nicolas, R., and Cruickshank, A.M. 1964. Vegetative propagation of nutmeg (Myristica fragrans) in Greneda. Trop. Agric. Trin. 41 (2) : 141-146.

Nicolas, R., and Pryde, J.E.P. 1958. The vegetative propagation of nutmeg (M. fragrans) by cuttings. Trop. Agric. Trin. 35 (2) : 119-129.

Ochse, J.J. 1931. Fruit and fruit culture in Dutch East Indies. G. Kolff and Co., Batavia.

*Owen, E.B. 1956. The storage of seeds for the maintenance of viability. Common Wealth Agric. Bureau, Farnham Royal, England.

Oxley, T. 1848. Some accounts of nutmeg and its cultivation. J. Ind. Archipel. and E. Asia. 2 : 64.

Palaniswamy, V., and Hameed, A.S. 1976. Study of propagation of cashew by patch budding. South Indian Hort. 23 (1) : 24-25.

Pathak, R.K., and Srivastava, R.P. 1974. Studies on vegetative propagation of Walnut. 11. Propagation by budding. Prog. Hort: 7 (3) : 19-24.

* Perll, W.O. 1938. Selective Van het zaadgoed Van de Muskaanoot (Selection of seeds of nutmeg). Alg. Landb. Weekbl. Ind. 22 : 489-590.

Phadnis, N.A. 1971. Studies in the raising of cashew (Anacardium occidentale L.) Indian Cashew J. 8 (2) : 7-13.

Phadnis, N.A., and Choudhari, K.G. 1971. Sex determination in the seedling stage of nutmeg. Trop. sci. 13 (4) : 265-274.

*Pinfield, N.J., and Stobard, A.K. 1972. Planta 104 : 134. Quoted by Khan, A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. Page 27-46. North Holland Publishing Co. Oxford.

Pope, W.T. 1929. Mango culture in Hawaii. Hawaii Agric. Expt. Sta. Bull. 58.

Pope, W.T., and Storey, W.B. 1933. Grafting tropical fruit trees in Hawaii. Circ. Hawaii agric. Exp. stn. 6.

*Postama, A. 1935. Vooloopige Mededeling Over hst. Oculeren Van noot muskaat (Preliminary communication on bud grafting nutmeg). Land bow. 10 : 450.

Prasad, A., Singh, R.D., and Sirohi, R.S. 1973. Comparative study of veneer grafting and patch budding in Mangifera indica L. C.V. Dashehari. Punjab Hort. J. 23 (1) : 30-55.

Prestoe. 1884. Sexes of nutmeg trees. Gardeners chron. 148 (1) : 315.

Randhawa, G.S., and Negi, S.S. 1964. Preliminary studies on seed germination and subsequent seedling growth on grape. Indian J. Hort. 21 (3 & 4) :

Randhawa, G.S., and Pal, N.C. 1967. Further studies on seed germination and subsequent seedling growth in grapes (Vitis spp) unpublished.

Rangachailu, V.S., and Venkatarao, M. 1956. Air grafting of mango (A new technique in the grafting of mango without the aid of soil and water). Andhra Agric. J 3 (5)

Rao, K.M. 1975. Inarching in mango with a difference - a possible common method for both propagation and rejuvenation. Lalbag. 20 (1/2) : 9-12.

Rao, G.R., and Kaul, G.L. 1977. Effect of Kinetin on the success of veneer grafting on guava (Psidium x guajava L.) in different seasons under tarai conditions of U.P. Indian J. Hort. 34 (2) : 137-141.

Rao, V.N.M., and Rao, I.K.S. 1957. Studies on the vegetative propagation of cashew (Anacardium occidentale. L) Approach grafting without the aid of plastic film wrappers. Indian J. agric. sci. 27 (3) : 267-275.

Ridley, H.N. 1912. Nutmeg and mace: Spices. London Macmillan and Co. Ltd. 449.

Roberts, E.H. 1972. Viability of seeds. Chapman and Hall, London.

Roberts, E.H. 1973. Seed Sci. Technol. 1 : 515-527. Quoted by Khan, A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. Page 97-98. North Holland Publishing Co. Oxford.

Roy, R.S. 1952. A consolidated report of the fruit scheme. Bihar, 2-4-1934 to 31.3-51. Govt. Printing Press, Bihar.

Rosengarten, F. Jr. 1973. Spices then and now. Tropical products Institute Conference Proceedings. Spices: 15-21.

Ruchle, C.D. 1948. The common guava. A neglected fruit with a promising future. Econ. Bot. 2 : 306-325.

Samish, R.M., and Gur, A. 1962. Experiments with budding avacado. Proc. Amer. Soc. Hort. Sci. 81 : 194-201.

Sen, P.K. 1939. Annual reports of Fruit Research Station, Sabour for 1938-39. Supdt. Govt. Printing, Bihar, Patna.

Sen, P.K. 1941. Effect of Indole Butyric acid and three other acids on rooting of litchi cuttings. Proc. 28th Indian Sci. Congr: 262.

Sen, P.K. 1942. Annual reports of Fruit Research Station, Sabour for 1940-41. Supdt., Govt. Printing, Bihar, Patna.

Shanmughavelu, K.G. 1965. Studies on the effect of growth regulators on cashew (Anacardium occidentale L). The Southern Forest Rangers College Magazine. 9-16.

Shanmughavelu, K.G. 1967. A note on the effect of GA on the root and shoot weights of some tree spices. Madras agric. J. 54 (1) : 44-45.

Shanmughavelu, K.G. 1969. Studies on some aspects of the physiological action of GA on some tree plant species. South Indian Hort. 17 (3&4) : 62-70.

Shanmughavelu, K.G., and Rao, V.N.M. 1977. Spices and Plantation Crops. Popular Book Depot, Madras.

Shant, P.S., and Rao, S.N. 1973. Note on the effect of gibberllic acid on seed germination and seedling growth of acid lime. Prog. Hort. 5 (3) : 63-67.

Simao, S. 1959. A study of the germinating power of mango seeds. An Esc. Agric. Queiroz. 16 : 289-297.

Singh, A. 1967. Plant Physiology. Asia Publishing House, New York. 1967.

Singh, L.B. 1951. Propagating jack fruit (Artocarpus integrifolia) by air layering with hormones. Curr. sci. 20 : 102-103.

Singh, L.B. 1960. The Mango - botany, cultivation and utilization. Leonard Hill, London.

Singh, S. 1938. Propagation of mango in Punjab. Punjab Fruit J. 3 (11) : 499-501.

Singh, R.D., and Dhar, L. 1977. A note on clonal propagation under intermittant mist. Prog. Hort. 8 (4) : 25-26.

Singh, C.B., and Motial, V.S. 1970. Effect of gibberllic acid (GA3) and temperature on seed germination of Rauvolfia serpentina Pl. sci. 2 : 109-111.

Singh, U.R., Pandey, I.C., Upadhayay, N.P., and Prasad, R.S. 1978. Propagation of guava by budding. Punjab Hort. J. 28 (1 & 2) : 68-71.

Singh, L.B., and Singh, R.L. 1954. Mango budding in situ in U.P. Annual Report of Plain Fruit Research Scheme, U.P. 1950-53.

Singh, A.R., and Sirohi, R.K. 1972. Relative efficiency of different methods of propagation influencing the growth of mango. Hort. Advance 9 : 25-26.

Singh, J.R., and Srivastava, R.P. 1962. Studies in budding of mango. I. Indian J. Hort. 19 (3 & 4) : 130-134.

Sinha, M.M., Pal, R.S., and Koranga, D.S. 1977. Studies on the seed germination of Walnut. Prog. Hort. 8 (4) : 69-74.

Sinha, M.M., Verma, J.P., and Koranga, D.S. 1973. Studies on the seed germination of guava. (Psidium guajava L). Effect of scarification and plant growth regulator treatments. Prog. Hort. 5 (2) : 37-40.

Snedecor, G.W., and Cochran, W.G. 1967. Statistical Methods. Oxford and IBH Publishing Co. New Delhi.

Son-Walker, M.S. 1951. A study of jack fruit seeds. Indian J. Hort. 8 (2) : 27-30.

Srivastava, R.P. 1964. Aonla. Propagation through better budding methods. Indian Hort. 8 (2) : 15-16.

Srivastava, R.P. 1969. The influence of presowing treatment with GA on the germination and growth of fruit plants. I. Hill Lemon and Malta. 9 (1&2) : 71-73.

Stoffles, E.H.J. 1939. Lequinquina (cinchona) cit. Hort. Abst. 9 : 10-18.

Stoke, H.F. 1962. Immediate green wood grafting. A.R.North. Nut GRS' Ass. 37-38.

Stokes, P. 1965. Quoted by Khan, A.A. 1977. in The Physiology and Bio chemistry of Seed Dormancy and Germination. Page 78-106. North Holland Publishing Co. Oxford.

Stowe, B.A., and Yamaki, T. 1959. Gibberellins stimulant plant growth. Science. 129 : 807-816.

Sundararaj, T.S., and Varadarajan, E.N. 1956. Propagation of nutmeg on different root stocks. South Indian Hort. 4 : 85-86.

Tao, K.L., Mc Donald, M.B., and Khan, A.A. 1974. Quoted by Khan A.A 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. Page 27-46. North Holland Publishing Co. Oxford.

Teaotia, S.S., and Maurya, V.N. 1970. Studies in the propagation of mango by budding. Prog. Hort. 2 (1) : 35-44.

Thapar, A.R., and Panwar, J.P. 1963. Studies on the side veneer grafting of mango. Himachal Hort. 4 (2) : 1-8.

Thapar, A.R., and Rana, R.S. 1961. Vegetative propagation of Walnut (Juglans regia L). Himachal. Hort. 2 (2) : 35-38.

*Thomas, S.M., and Apress, T. 1972. Quoted by Khan, A.A. 1977. in The Physiology and Bio chemistry of Seed Dormancy and Germination. North Holland Publishing Co. Oxford.

*Thomas, T.H., Palevitch, D., Biddington, N.L., and Austin, R.B. 1975. Quoted by Khan A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. Page 111-138. North Holland Publishing Co. Oxford.

*Vanoncklen, H.A., Canbeegs, R., and De Greef, J.A. 1975. Quoted by Khan, A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. Page 95-97. North Holland Publishing Co. Oxford.

*Varner, J.E., Ramchandra, G., and Chrispeels, M.J. 1965. Quoted by Khan A.A. 1977 in The Physiology and Bio chemistry of Seed Dormancy and Germination. North Holland Publising Co. Oxford.

Verma, S.N. 1942. A novel mango graft. Punjab. Fruit. J. 6 : 118-123.

*Vogel, R. 1962. Notes on the history and future of avocado growing in Corsica. Rapp. Annu. Inst. frane. reeh. fruit outre-mer. 17 : 243-244.

Wiggans, S.C., and Martin, L.W. 1961. Effect of GA on germination and seedling growth of pecans. Proc. Amer. Soc. Hort. Sci. 77 : 295-300.

Wilson, P.E. 1921. Strength of sulphuric acid in percentage by wt to give a R.H. at different temperatures. J. Industr. Engng. Chem. 13 : 326-331.

Winters, H.F., and Rodriguez - Colon, F. 1953. Storage of mangosteen seed. Proc. Amer. Soc. Hort. sci. 61 : 340-346.

*Wittwer, S.H., and Bucovac, M.J. 1957. Gibberellins and Higher plants. VIII. Seed treatment for beans, peas, and sweet corn. Quar. Bull. Mitch. 40 : 215-254.

Yeou-Der, K., Weaver, R.J., and Pool, R.M. 1962. Effect of low temperature and growth regulators on germination of seeds of 'Tokay' grapes. Proc. Amer. Soc. Hort. Sci. 92 : 323-330.

*Original not seen.

Appendix I. Analysis of variance for percentage of germination and the number of days taken for germination during different months and different storage conditions.

Source	df	Mean square			
		% of germination		No. of days taken for germination	
		Heavy	Light	Heavy	Light
Months	5	42.91**	34.56**	21.55**	32.73**
Treatments	4	320.92**	295.76**	208.63**	204.08**
Storage time (A)	1	306.73**	246.59**	0.73^{NS}	2.73^{NS}
Method of storage (B)	1	306.73**	168.70**	983.46**	774.07**
Interaction (A x B)	1	0.53^{NS}	13.27**	57.75**	37.26**
Direct sowing verses others	1	669.68**	754.47**	1.23^{NS}	3.19^{NS}
Error	20	2.37	15.69	3.92	4.16
Total	29				

** Significant at 1% level
NS Not significant

Appendix II. Analysis of variance for percentage of germination

Source	df	Mean squares				
		50 ppm	100 ppm	200 ppm	500 ppm	1000 ppm
Hours	3	313.52**	259.94**	529.07**	87.28**	1229.14**
Replications	5	1.2	2.02	1.32	7.93	0.48
Error	15	13.24	10.84	12.25	171.93	248.45
Total	23					

** Significant at 1% level

Appendix III. Analysis of variance for the number of days taken for germination

Source	df	Mean squares				
		50 ppm	100 ppm	200 ppm	500 ppm	1000 ppm
Hours	3	102.95**	10.49**	26.12**	25.15**	36.8**
Replications	5	2	0.15	5.99	6.21	2.08
Error	15	8.63	3.38	4.84	8.68	9.41

** Significant at 1% level

Appendix IV. Analysis of variance for the seedling height of both heavy and light groups (One and two months after transplanting)

Source	df	Mean squares			
		Heavy		Light	
		One month	Two months	One month	Two months
Treatments	4	0.995^{NS}	1.43^{NS}	0.55^{NS}	0.62^{NS}
Months	5	0.22	0.07	0.36	0.34
Error	20	1.09	0.82	0.69	0.71
Total	29				

NS - Not significant

Appendix V. Analysis of variance for the seedling girth of heavy and light groups (One month and two months after transplanting)

Source	df	Mean squares			
		Heavy		Light	
		One month	Two months	One month	Two months
Months	5	0.002	0.008	-	0.002
Treatments	4	0.0025^{NS}	0.01^{NS}	-	0.003^{NS}
Error	20	0.0012	0.013	0.00009	0.005
Total	29				

NS - Not significant

Appendix VI. Analysis of variance for the number of leaves of heavy and light groups (One month and two months after transplanting)

Source	df	Mean squares			
		Heavy		Light	
		One month	Two months	One month	Two months
Months	5	0.0008	0.004	-	0.06
Treatments	4	0.0019^{NS}	0.01^{NS}	0.07^{NS}	-
Error	20	0.039	0.02	0.025	0.045
Total	29				

NS - Not significant

Appendix VII. Analysis of variance for the height of the seedlings treated with different concentrations of gibberellic acid - one month and two months after transplanting

Source	df	Mean squares				
		50 ppm	100 ppm	200 ppm	500 ppm	1000 ppm
		(One month after transplanting)				
Replication	5	0.11	0.29	0.02	0.79	0.06
Treatment	3	1^{NS}	2.1^{NS}	5.58**	0.94^{NS}	7.29**
Error	15	0.14	0.52	0.10	0.68	0.48
		(Two months after transplanting)				
Replications	5	0.18	0.02	0.33	0.24	0.14
Treatments	3	1.14^{NS}	2.33^{NS}	3.75*	3.77*	5.93**
Error	15	0.20	0.16	0.26	0.55	0.38
Total	23					

** Significant at 1% level

* Significant at 5% level

NS - Not significant

Appendix VIII. Analysis of variance for the girth of the seedlings treated with different concentrations of gibberellic acid - one month and two months after transplanting

Source	df	Mean squares				
		50 ppm	100 ppm	200 ppm	500 ppm	1000 ppm
		(One month after transplanting)				
Replications	5	0.0004	-	0.0002	0.006	-
Treatments	3	0.0013^{NS}	0.003^{NS}	0.0007^{NS}	0.001^{NS}	0.003^{NS}
Error	15	0.0018	0.003	0.0015	0.003	0.003
		(Two months after transplanting)				
Replications	5	0.002	0.002	-	0.004	-
Treatments	3	0.007^{NS}	0.003^{NS}	0.007^{NS}	-	0.017^{NS}
Error	15	0.014	0.015	0.013	0.011	0.008
Total	23					

NS - Not significant

Appendix IX. Analysis of variance for the number of leaves produced by the seedlings treated with different concentrations of gibberellic acid

Source	df	Mean squares				
		50 ppm	100 ppm	200 ppm	500 ppm	1000 ppm
		(One month after transplanting)				
Replications	5	0.02	0.01	0.006	0.002	0.006
Treatments	3	0.003^{NS}	0.003^{NS}	0.007^{NS}	0.003^{NS}	0.007^{NS}
Error	15	0.02	0.02	0.02	0.04	0.02
		(Two months after transplanting)				
Replications	5	0.004	0.008	0.01	0.006	-
Treatments	3	0.01^{NS}	0.003^{NS}	0.003^{NS}	0.003^{NS}	0.04^{NS}
Error	15	0.03	0.02	0.03	0.03	0.02
Total	23					

NS - Not significant

PROPAGATION STUDIES IN NUTMEG

BY

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ABSTRACT OF A THESIS

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COLLEGE OF HORTICULTURE

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A B S T R A C T

The studies on the propagation of nutmeg (Myristica fragrans Houtt) were carried out at the Instructional Farm of the College of Horticulture, and at the District Agricultural Farm, Mannuthy during the period from April 1978 to July 1979.

The studies consisted of two methods - namely, the seed propagation and vegetative propagation. The seed propagation studies included viability studies and the effect of growth regulators on germination and the subsequent growth of the seedlings. Under vegetative propagation, the main objective was to standardise an economical and effective method of vegetative propagation of nutmeg.

The studies revealed that maximum per cent and quicker germination was obtained by sowing the seeds during the month of June and there was significant difference between the heavy and light group of seeds. Seeds stored in moist sand remained viable for a longer period than those stored in metalic containers.

Gibberellic acid treatment had significant effect

on the germination of seeds and the subsequent growth of the seedlings. Seeds treated with 200 ppm GA for 24 hours gave good results as compared to other treatments.

Among the different methods of vegetative propagation tried, inarch grafting gave the highest per cent of success - about 95 per cent during the month of June. The growth of the grafts was poor when compared to the seedlings of same age during the initial stages, but the growth was progressive and satisfactory after two months (of seperation).

Other methods of vegetative propagation viz., side-grafting, veneer grafting and wedge grafting were also successful upto 40 per cent, but the growth of the grafts was less than that of the seedlings. However, these methods need standardisation for use on a large scale programme of propagation of nutmeg.