SEEDLING PROGENY ANALYSIS IN SELECTED CASHEW *(Anacardium occidentale L.)* TYPES

BY

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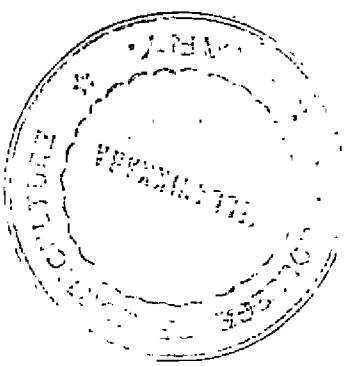

THESIS

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DECLARATION

I hereby declare that this thesis entitled "Seedling progeny analysis in selected cashew (*Anacardium occidentale* L.) types" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Vellayani,
20-12-1982.

SUSAMMA P.GEORGE

CERTIFICATE

Certified that this thesis entitled "Seedling progeny analysis in selected cashew (*Anacardium occidentale* L.) types" is a record of research work done independently by Smt. SUSAMMA P.GEORGE 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

INTRODUCTION

Cashew (Anacardium occidentale L.) is one of the most important nut crops grown in India. The pearly white kernel of its nut is acclaimed as the most sought after cocktail snack item in many developed countries. Today the international trade in cashew kernels and cashew shell oil is monopolised by India. We annually earn more than 100 crores of Rupees worth foreign exchange by exporting this 'luxury kernel' to many foreign countries especially U.S.A. and U.S.S.R. The cultivation and processing of this crop also provide employment opportunities for more than 1.5 lakh persons in our country.

The cashewnut tree is a native of tropical America from Mexico to Peru and Brazil and also of the West Indies. It has now become naturalised in many tropical countries including India. Cashew was introduced into India from Brazil by the Portuguese in the sixteenth century mainly for the control of soil erosion on the coasts.

In India, the cultivation of cashew is concentrated along the West and East Coasts, especially in the States of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh.

Cashew is also grown, to some extent, in the coastal districts of Maharashtra, Orissa, West Bengal and Assam. The total area under this crop comes to about 4.0 lakh hectares with an annual production of 1.80 lakh tonnes of raw cashewnuts.

In Kerala, cashew occupies an area of 1.05 lakh hectares producing annually 1.18 lakh tonnes of raw nuts which comes to about 65.6 per cent of the total raw nuts production in India. But this meagre output is quite insufficient to cater the full capacity of our processing units which is about 4.5 lakh tonnes per year. At present we make up this deficiency by large scale import of raw nuts, especially from East African countries. This source is now drying up as these countries have developed their own processing facilities, affecting not only our monopoly in the trade, but also creating a serious problem of unemployment among the workers traditionally employed in cashew processing. This calls for intense research on the genetic improvement of this crop.

The genesis of research on the genetic improvement of cashew is relatively recent and the progress so far achieved is by no means satisfactory. The main obstacle

to quick progress and the attainment of tangible results is the unique breeding problems presented by this crop. Cashew being a highly cross pollinated perennial tree exhibits a high degree of heterogenity in population raised from seedling progenies. Moreover the long generation period, the length of time required to attain steady bearing after flowering, the extensive field requirements for growing sufficient numbers of progenies for experimental purpose, the low establishment of air layers etc. have imposed heavy restrictions on the progress of breeding works on this crop.

Eventhough a very efficient method for large scale production of air layers has already been developed, its commercial use for large scale planting is still in jeopardy due to very low establishment under the rugged conditions prevailing in the prospective cashew areas in our State. Hence an immediate and total replacement of seedlings with clonal planting material is not feasible. The supply of quality seedlings from mother trees tested for their genetic superiority seems to be the only feasible alternative.

At present large scale production of cashew seedlings in the Departmental nurseries is done by using seednuts

collected from mother trees selected purely on the basis of phenotypic expressions. The genetic superiority of the selected mother trees could be identified only through progeny testing. Eventhough seedling progenies from individual mother trees were analysed by previous workers, no comparison among high, medium and low yielding groups of mother trees from the point of view of recovery of vigorous seedlings as well as correlation studies between the mother tree performance and seedling vigour has been done.

The present investigation was undertaken to study large number of cashew mother trees in relation to the characters of their seednuts and seedling progenies to formulate an efficient method of evaluation of mother trees in cashew for large scale production of quality seedlings.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The idea of progeny testing was first developed by Louis de Vilmorin (1856) in sugar beet. But it remained for Johannsen(1903, 1909) to use this method on a firm scientific basis for improving the self pollinated annual crops. The application of this principle in perennial crops to identify superior mother trees and to select superior seedlings is of recent origin. Selection of high yielding palms as seed parent has been recommended by coconut breeders through out the world as a method of genetic improvement of the palm and this practice has been in vogue in many countries including India (Abraham and Ninan, 1968). Similar recommendations are followed in the case of many other perennial crops like rubber, cocoa, cashew, nutmeg, clove, oilpalm, cardamom where large scale plantings are still done using seedlings raised from seeds collected from selected mother trees. Genetic studies on the progeny performance of cashew are very scanty and hence the review attempted here is extended over other perennial tree crops and vegetables also.

I. Variation in mother trees and their seedling progenies

1. Cashew

Naik(1949) reported that cashew trees differed greatly as regards to their fruiting behaviour, nut size and shape.

Rao and Rao(1953) reported that wide variations existed between trees in respect of yield of nuts ranging from less than two pounds to as much as 40 pounds per tree. They observed that individual trees capable of yielding upto 200 pounds did exist in a number of tracts which emphasises the wide variation existing in this crop and possible scope for selection from the existing plantations.

Mukherjee(1956) reported that cashew trees differed considerably with regard to their fruiting behaviour, colour, size and shape of apple and the nut size. He observed that plants producing big sized nuts yielded less than plants producing small sized nuts. He had classified the trees into different types based on colour, shape and size of apples and nuts. He is of opinion that this type of variation was due to the fact that plantations were raised from mixtures of unselected seeds. He has stressed the importance of mother trees selection for seed collection in cashew.

Rao and Hassan(1956) noted large amount of variation with regard to seed characteristics in cashew. They observed that the range of nut size was from 4.4 sq. cm to 12.7 sq. cm, volume of 10 nuts from 25 c.c to 125 c.c, shelling percentage from 25 to 50 and the number of nuts making up a pound from 48 to 212. They also found large variation in the economic characters of the mother trees and vast scope for selection for a general improvement of the market quality of nuts.

Aiyadurai and Koyamu(1957) also reported the variation in seedling trees of cashew. They noticed two distinct types of branching. In the first type branches arose from the trunk, four to five feet above the ground while in the second type, the trunk grew even upto a height of about 25 feet and then gave rise to branches. The first formed flowers were generally unisexual and male. As flowering progressed, bisexual flowers were produced. The proportion of bisexual to male flowers and fruit set seemed not only to depend on the period of flowering, but also vary from panicle to panicle and tree to tree. On an average a bearing tree yielded about 20 to 30 pounds of nuts with a range of five to 40 pounds.

Uttaman and Koyamu (1957) also noted considerable variation in cashew seedling progenies.

From the studies conducted at Cashew Research Station, Ullal, Aiyadurai(1966) reported that seeds of cashew exhibited considerable variation.

Murthy et al.(1975) observed that wide variations existed in cashew germplasm in height, girth, number of primary and secondary branches, leaf length, leaf breadh, plant spread, flowering behaviour, fruit set and nut yield.

Damodaran(1977) studied the variability in the F_1 population of four parental combinations in cashew. He found that F_1 progenies varied considerably within and between each cross for mean yield, weight of hundred nuts and mean weight of apples.

Gopikumar and Aravindakshan(1979) studied the variation in seedling characters of different cashew types in the nursery. High variability was recorded in various morphological characters within and between types. Compared to variation that existed between different types, the variation within a type was low. The weekly rate of increase in height, girth and internodal length varied considerably. They opined that greater caution must be exercised while releasing seeds of selected types as high yielders.

Venkataraman(1979) reported high variability in yield among the types of cashew even after rigorous initial selection. Progeny trials set out with selections from different states have also revealed a high variability in yield ranging from 6.250 kg to 19.530 kg per tree.

Ramadas and Thatham(1981) also estimated variability for the nut and kernel characters and mean tree yield in 38 cashew types maintained in the germplasm at the cashew Research Station, Vridhachalam.

2. Fruit crops

Shamel et al.(1918) reported that bud variations by mutations were very prominent in cirtus especially in sweet oranges.

Dickson(1929) studied the variation in vigour that existed in seedling propulation of apples. He found that some trees are very vigorous while others are highly depressed.

McKay and Crane(1956) found that chestnut seedlings from the variety Nanking were more uniform, vigorous and productive than those of other varieties.

Oppenhiemer(1956) after conducting a detailed survey of mango in India concluded that there was variation in

the performance of the same variety growing in the same orchard of homogeneous condition and orchard management. He also pointed out that 10 per cent of the mango trees were high yielders, 50 per cent were medium yielders and the 40 per cent low yielders.

Schander(1958) recorded much variability in the shape of leaves of apple seedlings.

Singh and Singh(1958) also reported that there is large variation present in seedling progenies of mango.

Pearce and Moore(1962) reported that the variability of clonal apple trees present at planting did not usually persist for more than a few years. They also noted that variability in apple was more under poor management conditions than under good conditions.

Bedard(1970) recorded high percentage of variation for the characters such as vigour, height and width of the plant, number of fruits and yield in strawberry.

Monohar et al.(1975) studied on the variability in grape cultivars(Vitis vinifera L.). A high amount of variability was recorded for weight per bunch, yield per vine and weight per berry.

3. Arecanut

Murthy and Bavappa(1960) recorded considerable variation in girth of arecanut palms growing in South Kanara area. No variation in the internodal distance was noted by them.

Naidu(1963) reported that in Arkalgud and Kytsandra area though there was no remarkable variation in the girth of stem of arecanut, there was wide variation in the internodal space.

4. Coconut

Satyabalan et al.(1972) reported considerable variation in yield in West Coast Tall variety of coconut palm. Maximum stabilization in yield was noted in the 28th year.

5. Oil palm

Ooi(1975) working on oil palm noted considerable variability in mean number of bunches per palm, mean weight per bunch and some fruit components namely kernel content, shell content and mesocarp content in open pollinated progeny population of the type Deli dura.

6. Cocoa

Bartley(1970) found that cocoa clones and hybrid seedlings variability in yield was very high during the

first three years of production. From the fourth year onwards the variation gradually decreased.

Subramonian and Balasimha(1981) studied the variability in pod and bean characters in some cocoa hybrids. Greater variability was found to exist for pod weight, number of beans per pod, weight of wet beans with and without pulp, weight of peeled, wet and dried beans.

7. Rubber

Paardekooper and Sanitsamoson(1969) noted clonal variation in latex flow pattern in rubber and they found that initial flow rate, plugging index and dry rubber content in latex varied in between and within clones.

Amma and Sethuraj(1975) reported clonal variation in latex flow characteristics and yield in rubber.

Senanayake(1975) conducted variability studies in eight year old rubber trees. There was variation in yield, but girth of trees and length of tapping cut was uniform.

II Seed characters and seedling vigour

Several reports are available on the influence of seed characters over seedling vigour and subsequent growth of plants. In several seed propagated crops many workers

have tried to fix up relative seed characters for the production of quality seedlings. The seed weight, size and density have often been quoted as measures of seed quality although there has been some confusion in these attributes.

1. Cashew

Only few reports are available in cashew regarding seed characters and seedling vigour.

Patel(1932) reported that plump, well shaped, medium sized, heavy nuts obtained from fully ripe fruits are best for seed purposes in cashew.

Turner(1956) reported that total viability in cashew was generally greater in seedlings raised from the nuts of high specific gravity. He also found that nuts of high density germinated more quickly than nuts of low density.

Rao et al.(1957) studied the germination in cashew in relation to seed size and found that medium nuts both by weight and size were preferable to heavy and light seeds.

Auckland(1961) found that in cashew, nuts of high density grade gave better germination and the resultant seedlings were more vigorous having thicker stems, more leaves and height than seedlings grown from nuts of low density grade.

From the research works conducted Cashewnut Research Station, Ullal, Aiyadurai (1966) reported that medium sized nuts were better than large nuts for sowing.

Northwood(1967) studied the performance of nuts from five different specific gravity classes viz. greater than 1.075, 1.050 - 1.075, 1.025-1.050, 1.000-1.025 and less than 1.000. Early growth and yield during the first three harvest years were better for trees grown from seeds of the two highest specific gravity classes. When the trees were five years old, the difference became negligent.

Sriram(1970) reported that germination of seed increased with the specific gravity of nuts. Such seedlings were more vigorous than those from seeds of lower specific gravity. Maximum germination was obtained by sowing seeds in a vertical position with stalk end upwards.

Ascenso and Milheiro(1971) found that high density nuts gave more vigorous seedlings than low density nuts.

Ibikunle and Komolafe(1973) reported that very small nuts gave unsatisfactory germination. Pre-soaking improved total germination and rate of germination.

Menon et al.(1979) reported the influence of seed vigour on seedlings of cashew. They found that germination was earlier and percentage of germination was higher with

seeds of higher specific gravity and seedlings from such seeds had better shoot growth and greater dry matter production.

2. Vegetable crops

Hewston(1964) found that many vegetable species produced larger seedlings when grown from larger seeds, but in the field such differences usually disppeared within the first few weeks of growth.

Halsey(1969) obtained early and better germination and emergence from larger seeds in tomato. He also found that yield was considerably influenced by seed size.

Gelmond (1971) reported that in lettuce large sized seeds produced more vigorous seedlings both in petridishes and in sand.

3. Fruit crops

Hume et al.(1946) while working on mangosteen observed that the percentage of seed germination increased with each 0.1 g increase in seed weight. They reported that the number of seedlings that survived, and their amount of growth increased with seed weight to a maximum of about 1.3 g above which there was no effect.

Sonwalker(1951) reported that big heavy seeds of jack showed a higher germination than small light seeds. He also reported that the plant vigour expressed in terms of height was definitely associated with the seed weight.

Purcelean(1956) reported that in black walnut (Juglans nigra) large seeds produced more vigorous seedlings than small seeds. The highest rate of germination was obtained by sowing large seeds.

McKay and Gossard(1959) reported that in Chinese Chestnut the largest nuts produced largest seedlings in the first year of growth, but after four years the difference had practically disappeared.

Reddy(1962) observed that in papaya larger the seeds, higher was the germination. Large seeds gave rise to more vigorous seedlings than seedlings raised from medium or small seeds.

Giri and Chawdhury(1966) reported that in mango germination and seedling vigour were positively correlated to seed weight.

Nazeem et al.(1980) reported that in jack the weight of the seeds does not influence the seedling characters in the types Varikka and Koozha.

4. Arecanut

Bavappa and Abraham (1961) studied the influence of seed weight on the quality of seedlings in Arecanut. Heavier nuts were found to give better germination and produce seedlings with better vigour. The percentage of quality seedlings received from heavier seed weight group was also found to be high.

5. Coffee

Osorio and Castillo(1969) found that in coffee the stem and root lengths were directly proportional to the initial seed weight.

6. Cocoa

Ravindran and Menon(1981) studied the specific gravity selection of seeds in cocoa and cashew. Seeds of cocoa and cashew were classified into different specific gravity groups using a water sugar system. The seeds from each group was studied for their performance with respect to germination, root growth, leaf production and dry matter accumulation. Seeds of higher specific gravity gave significantly earlier germination in cashew and better seedling growth and dry matter production in cocoa and cashew. They reported that in cashew a vigour index could be calculated based on germination rate and period required for germination. Seed specific gravity is found to be a convenient practical criterion for

assessing seed vigour. Elimination of lower specific gravity groups can enhance the speed and rate of germination as well as ensure vigorous seedlings.

III Mother tree selection and prepotency studies

1. Cashew

From a study of 300 selections over ten years, Dasarathi et al. (1972) reported that 3/3 Simhachalam and 9/8 Epurapalem were particularly promising. The former flowered early and in the off season, bearing over 20 per cent bisexual flowers per panicle, setting over eight fruits per panicle and yielding an average of 15.1 kg of large nuts per tree. The latter is a mid season bearer with over 20 per cent bisexual flowers per panicle, setting 5-7 fruits per panicle and yielding an average of 13.95 kg of medium sized nuts per tree.

Damodaran (1979) reported that there is great scope for identifying superior genetic stock of cashew by proper selection from existing population or by a planned programme of hybridization and selection. He also reported that selection of mother trees should be on the basis of the traits such as dwarf bushy stature, high degree of branching, short flowering period, high percentage of perfect flowers, high fruit set, high shelling percentage, medium sized nuts (5-8 g) and good apple quality.

Dasarathi (1979) reported that by mere selection of high yielding types as mother trees and collecting seeds from them, it is possible to get fairly good progenies. He also reported that 70 per cent of the seedling progenies are fairly true to type in important parental characters.

Gopikumar et al.(1979) reported that in cashew certain types transmitted characters strongly to their progenies, while others did not.

Nambiar (1979) conducted progeny studies with seedling progenies of different cashew types and found that types M 10/4, M 6/1, M 14/3 and M 76/1 from Vridhachalam and BLA 139-1 of Anakkayam were superior producing over 10 kg nuts per tree five years after planting.

From progeny trials conducted at the Regional Cashew Research Station, Vengurla, Maharashtra, Salvi (1979) reported that types Vengurla-1 and Vengurla 37/3 gave the highest yield at 20th year of planting. Hybrid No.5 (Ansur 1 × Veture 56) Hybrid No.11 and Hybrid No.19 (both midnapore Red X Veture 56) were also found superior. These three hybrids have medium sized to large nuts, high shelling percentage and large apple with high juice content.

Sriharibabu (1981) reported that necessity for identification of superior mother trees for propagation in cashew. According to him, high yielding trees generally possess compact canopy, more intensive branching habit, high percentage of flower bearing laterals, large proportion of bisexual flowers and fruit set of more than five nuts per panicle. He suggested that high yielders have to be selected in two stages as follows.

1. Initial marking of high yielders based on branching and flowering habits at the time of flowering.

2. Final marking of such initially identified trees during the time of fruiting and harvesting. He suggested that medium to large sized nuts are to be preferred for seed purposes.

2. Arecanut

Bavappa and Ramachander (1967a) found that phenotypically identical areca palm did not possess identical potentiality with regards to transmitting the genetic ability to produce more to the progeny. The distribution of those palms possessing the desired degree of transmittability did vary considerably in proportion and were found to be scattered randomly in a plantation.

Ramachander and Bavappa (1972) formulated a selection index in arecanut making use of the number of leaves and height of the plant measured at the time of transplanting. It was found that by effecting selection on the basis of this index resulted in enhancing a relative improvement of 332 percent.

3. Coconut

Patel (1938) proposed that the length of stem and the number of leaves presented in the crown should be considered as important criteria for motherpalm selection, since they are believed to influence characters that make the palm more ideal for seednut collection.

Liyanage (1953) substantiated that palm improvement in coconut could be effected to the tune of an additional percentage of around 50, by adhering strictly to scientific methods of motherpalm selection. He also reported that prospects of increasing the efficiency percentage upto 90 and above, through permitted open pollination among selected palms grown in isolation.

Harland (1957) opined that all high yielding mother palms of coconut need not produce high yielding progenies. He also stated that individuals with potentiality to yield better progeny could be identified on the basis of a study

of the performance of the progeny population. Such individuals even if indiscriminately pollinated by miscellaneous males possessed sufficient dominant yield genes to ensure the superiority of their progeny. He compared the situation in coconut with other open pollinated crops like cocoa, and showed that open pollinated plants differed in their capacity to transmit the higher yielding ability to their progenies.

Ninan and Pankajakshan(1961) conducted progeny studies in coconut, to find out the relationship between parent yield and seedling progeny characters with special reference to open pollinated and hybrid progenies of West Coast Tall and its bearing on the concept of prepotency in coconuts. The results indicated that on the basis of seedling performance it is possible to isolate superior mother trees capable of producing higher percentage of high yielding progenies. According to them, it is very important to separate plants whose better yields are due to their genetic superiority from those which give a better yield on account of the stand. It is found that those high yielders which continue to maintain significantly higher progeny values irrespective of the types of pollinating parents are inherently superior and may be regarded to have sufficient load of dominant yield characters to be

called as prepotents. The success of mother palm selection lies in the identification of trees among high yielders giving superior seedlings and their continued use in breeding work.

Liyanage(1967) conducted trials in coconut and suggested that seedling progeny analysis is effective in identifying prepotent palms.

Kannan (1976) studied about the performance of open pollinated progenies of T x D palms. Considerable reduction in the expression of hybrid vigour was noted from the first generation T x D to the second generation open pollinated progenies. About half the population gave higher yield of nut and copra than the parents while other half were low yielders.

Kannan and Nambiar (1979) studied the influence of mother palm and seedling selection on the performance of progenies in coconuts. Palms yielding more than 80 nuts per annum and palms selected at random on block nut basis were found to produce high yielding progenies, provided proper selection was done at the seedling stage. Palms giving an yield of less than 20 nuts are definitely unsuitable for seednut selection even with seedling selection.

Ramadasan et al.(1980) reported that in coconut, leaf area and girth at crown had high direct effects on shoot dry weight and were the most important characters for selection.

Iyer et al.(1981) conducted studies on the seedling progenies raised from the elite palms using a cumulative indexing procedure and compared with seedling progenies of certain prepotent palms which show a high rate of yield transmitting ability. Progenies from certain of these elite palms appeared more uniform than others thus bearing a close resemblance to those of prepotent palms.

IV Seedling selection

1. Cashew

Nayar (1979) reported that inspite of extensive studies on vegetative propagation in all the centres, an efficient method suitable for adoption on a commercial scale is yet to be developed. Hence an immediate and total replacement of seedlings with clonal planting material is not feasible. Because of this, supply of quality seedlings from parent trees tested for progeny performance is the only feasible alternative. He suggested that criteria for selection of high yielding seedling should be based on seedling characters.

2. Arecanut

Bavappa and Ramachander (1967b) established correlation between seedling characters with their yield during the first four years. They found that best seedlings had more than four leaves at planting time a collar girth exceeding 20 cm after one year and four or more nodes after two years in the field. By resorting to proper standards of selection the uneconomic low yielders can be reduced by about 50 per cent.

3. Coconut

Jack and Sands (1929) found that earlier germination of seednuts in coconut was associated with early bearing and consequent enhancement of production in terms of nut yield. Hence the early germination should be considered as an important criterion for selection of seedlings.

Liyanage (1953) suggested that careful standardised selection of seedlings is effective in ensuring better later performance of seedlings. He found that selection at this stage alone could effect an increase in nut yield to a percentage of about 10. In Srilanka, a comparative study of the yield data of selected and unselected seedlings over a period of 19 years have shown that an additional 12 per cent increase in yield can be attained for the selected genotypes.

Charles (1959) stated that in nursery selection of seedlings, the better ones were characterised by their expressed increase in vigour and progressively steady rate of development. Such seedlings have greater thickness at the neck region and possessed deep green colouration of the foliage. He also stated that positive vigour can be judged at the four leaf stage of the seedling in the nursery from the measured girth at base, size, spread and colour of leaves, rapidity of growth and over all sturdiness.

Pankajakshan and George Minnie(1961) carried out an investigation with one year old seedlings of the variety West Coast Tall to understand the relative importance and the interdependence of the three characters- girth, height and number of leaves. They reported that selection of coconut seedlings in the nursery should be based on vigour which is judged on the basis of the above three characters.

Sahasranaman (1962) reported that coconut seedlings in the nursery showed diverse growth habit and they opined that vigorous seedlings with short thick petioles and good girth at collar should be selected for high yield.

Ninan (1964) emphasised the need for seedling selection based on growth rate, and vigour for coconut improvement.

Satyabalan et al.(1968) studied hybrid seedlings of coconut and found that the characters that can be used to assess seedling vigour were the number of days taken for germination, girth at the collar of seedling, height of the seedling and the number of leaves produced in an year.

Satyabalan et al.(1975) conducted a study of seedling characters and yield attributes of 43 open pollinated progenies of eight high yielding West Coast Tall palms and indicated the scope of identifying prepotent palms based on progeny performance in the nursery for breeding as well as propagation at the commercial scale.

4. Rubber

Senanayake and Samaranayake (1976) suggested that in rubber the seedlings which germinated earlier continued to have higher growth rate in the nursery.

V Studies on leaf area

Bhagavan and Subhaiah (1979) conducted leaf area studies on cashew and they reported an easy technique of predicting the seedling vigour in cashew. Total leaf area is highly correlated with the total dry weight. A simple prediction equation was derived to estimate the total leaf

area based on linear measurements of second and middle leaf and the total number of leaves. The coefficient of predictability of leaf area based on this equation was very high (90.24 per cent). Individual leaf area of one year old seedling can be calculated by using the formula, leaf area = 0.74 + 0.668 p in a seedling where p is the product of maximum length and breadth of the leaf.

Murthy et al.(1979) reported a rapid non-destructive method to determine leaf area in cashew based on linear measurements. Leaf samples were collected randomly from different cashew trees. Correlations between linear measurements their product and actual leaf area were worked out. The exponential model involving length and breadth gave the best prediction equation $A = (-0.078) L^{0.843} B^{1.08}$ with r^2 as high as 96 to 98 per cent for estimating leaf area of cashew tree.

VI Association of characters

1. Cashew

Gopikumar et al.(1979) worked out simple and partial correlations between nut characters viz. weight, volume and L/B ratio and seedling characters viz. height, girth, number of leaves, number of primary branches and internodal length. Significant positive relationship is observed

between weight, volume and L/B ratio of nuts with seedling height and girth and number of leaves. Weight of nut had a negative correlation with internodal length of seedling. Height and girth recorded significant positive correlation with internodal length.

Nayar et al.(1979) studied the relationship between height, girth and spread with yield in cashew. The results of their study indicated that yield is positively correlated with spread. Girth and height are also positively correlated with yield. Plant vigour has got a profound influence on yield and each growth parameter contributed independently and jointly in enhancing the yield.

Ramadas and Thatham(1981) estimated the association of nut and kernel characters with yield in cashew. The correlation coefficients showed that none of the component characters had a significant association with raw nut yield of the tree. They opined that selection for yield improvement in cashew may be based on individual tree yield.

2. Fruit crops

Maney and Plagge (1920) found out correlation between twig growth, trunk circumference and leaf growth with the production of North West Greening variety of apples.

Warning (1920) obtained a close correlation between trunk circumference and yield of fruits in several varieties of apples.

Sudds and Anthoney (1929) reported that in apples, girth of trunk was directly correlated with yield of fruits.

Cunnings et al.(1933) reported that there was a positive correlation between growth and yield in cherries.

Teaotia et al.(1970) calculated the relationship between yield and vigour expressed as trunk diameter, tree spread and height in Dashehari mango. They reported that the tree spread was correlated with yield.

Nazeem et al.(1980) reported that significant correlation is not evident between volume of seeds and seedling characters.

Roy and Kochba (1981) obtained highly significant parent progeny correlation coefficients (0.7 - 0.9) for shell hardness, percentage of kernel in shell and kernel weight, kernel length and width as well as kernel colour and outer shell retention. There was a low correlation between nut and kernel weight.

3. Arecanut

Bavappa et al.(1964) observed negative significant correlations between time of germination and different morphological characters of arecanut seedlings. They formulated Bartlett's index of germination in arecanut having practical value for assessing germination pattern of seednuts. These indices have been found to be positively and significantly correlated with the vigour of sprouts.

Bavappa and Ramachander (1967a) observed that in Arecanut heritability for yield was comparatively low- Positive phenotypic and genotypic correlations were found to exist between the number of leaves of seedlings at the time of planting, girth at collar one year after planting with yield during the first two years of bearing.

4. Coconut

Patel(1937) noted that in coconut palm, characters like girth and number of leaves were positively and significantly correlated with yield.

Pankajakshan and George Minnie (1961) observed that girth at collar is positively correlated with height and number of leaves in coconut.

Satyabalan et al.(1972) observed that in West Coast Tall variety of coconut, height of the palm was significantly correlated with yield.

5. Rubber

Narayanan and Ho (1970) observed that in rubber there was a strong relationship between yield and girth of clones in the nursery.

Fernado and Silva (1971) reported that there is a positive correlation between latex content and growth in rubber.

MATERIALS AND METHODS

MATERIALS AND METHODS

The main objective of the present study is to formulate an efficient method of evaluation of mother trees and seedling progenies in cashew for large scale production of quality seedlings.

MATERIAL

Thirty mother trees from each of two superior cashew types namely Kottarakara-1 and Kottarakara-27 of eight and 22 years old respectively were selected from the Departmental cashew farm, Kottarakara for seednut collection. These two types belong to two distinct flowering groups namely early and late. Kottarakara- 1 is of early flowering type and the peak flowering season is December-January, whereas Kottarakara-27 belongs to late flowering type with the peak flowering season during April-May. Kottarakara-1 possesses light red coloured small apple with small nuts and kernel with average weight of 4.350 g and 1.350 g respectively. Kottarakara-27 is having yellow coloured big apple with bigger nuts and kernel with average weight of 6.750 g and 2.000 g respectively. The nuts collected from the selected mother trees formed the base material for the progeny study.

METHODS

Observations were taken on mother tree, seednut and seedling characters.

I. Studies on mother trees

The selected mother trees were given identification numbers in serial order from one to thirty under each type. On these selected trees morphological observations such as canopy size as determined by the maximum diameter of the canopy circle, girth of the trunk at one metre above the ground, average number of nuts per bunch and total yield of dry nuts per tree were taken. For taking the average number of nuts per bunch a random sample of ten bunches were selected from ten different sectors of the canopy circle of each tree and the mean calculated.

Fully matured nuts from well ripened apples of each of the sixty trees were collected separately and dried and stored for seed purpose. Harvest of Kottarakara-1 was completed by the middle of February 1981 and that of Kottarakara-27 was completed by the first week of May 1981. The total yield from each of the tree was recorded. The selected mother trees in the two types were grouped under three yield groups namely low, medium

and high based on their total yield. Accordingly there were seven low yielding , 17 medium yielding and six high yielding trees in Kottarakara-1 and five low yielding, 22 medium yielding and three high yielding trees in Kottarakara-27. This grouping was done on the basis of the property of normal distribution.

From each tree, a sample of 100 nuts was used for the progeny study. The sample was drawn from the plumpy lot selected through the usual water immersion technique.

II. Studies on the seednuts

1. Weight of nut

From each tree a random sample of five nuts was taken and their individual weight was recorded.

2. Volume of nut

The volume of each of the above nuts was found out by water displacement method.

3. Weight of kernel

Each of the above five nuts was split open and the corresponding kernel weight was recorded.

4. Volume of kernel

Corresponding kernel volume was also recorded by water displacement method.

From these the average weight and volume of a single nut and kernel were recorded for each tree.

III. Studies on the seedlings

To study the seedling progeny performance, 90 nuts from each tree under the two types were used. These nuts were sown individually in a medium consisting of equal parts of sand and top soil taken in polyethylene bags of 23 x 15 cm size at two centimetre depth with stalk end facing upwards. The seeds were sown on 3rd August 1981. Watering was done on alternate days with a rose-can upto two months and later daily during the summer months.

A random sample of 20 seedlings was selected from each mother tree for taking morphological observations. The following observations were taken on the seedlings.

1. Germination of seednuts

The number of days taken for commencement and completion of germination was recorded for each of the tree. Germination counts were taken daily from 18-8-81 and continued upto 30-8-81 and percentage of germination was calculated.

2. Growth parameters

The seedling height and leaf count were taken at monthly intervals commencing from 16-9-1981 and continued upto 16-5-82. Other growth parameters like girth at collar, length of internodes, leaf area and length of tap root were measured at the ninth month.

i. Seedling height

The height of the observational plants was measured from the collar region upto the growing tip.

ii. Number of leaves

Number of fully opened leaves was counted at monthly intervals.

iii. Total leaf area

For calculating the leaf area the maximum length and breadth of the middle leaf from each seedling was measured during the ninth month. The leaf area was calculated using the formula, $L = 0.74 + 0.668\ P$, where P is the product of maximum length and breadth (Bhagavan and Subbaiah, 1979). Total leaf area for each seedling was calculated separately by multiplying the individual leaf area by the total number of leaves.

iv. Length of internodes

Five internodal lengths among six middlemost leaves on the main shoot were measured and the mean was found out for each seedling.

v. Girth at collar

Girth at the collar region of each seedling was measured and recorded.

vi. Length of main (tap) root

Length of the main or taproot of the seedlings was measured during the ninth month.

vii. Seedling vigour

Vigour index for each seedling under each type was determined as per the property of normal distribution based on five growth parameters such as seedling height, total leaf area, length of internodes, girth at collar and length of taproot. Index scores of one, two and three were given for low, medium and high classes respectively for each seedling as suggested by Singh and Chaudhary (1979). Thus there was a minimum of five and maximum of 15 scores for each character. Seedlings having index scores higher to the middle score ie. 11 and above were considered as vigorous ones.

IV. Prepotency studies

1. Recovery of vigorous seedlings in different yield groups

The percentage of recovery of vigorous seedlings among the progeny of each mother tree under different yield groups was estimated separately for both types.

2. Identification of prepotent trees

Prepotency of mother trees was determined on the basis of recovery percentage of vigorous seedlings. For each type it was worked out and those trees which registered a higher recovery percentage over the mean of the type were identified as prepotent. Thus the prepotent trees under different yield groups were listed out for both types.

V. Statistical Analysis

Observations on mother tree characters, seednut characters and seedling characters were analysed by the analyses of variance techniques (Snedecer & Cochran, 1967 and Nigam and Gupta, 1979). Observations of seedlings at the third and ninth months were made use of. The critical differences were calculated for comparison of seedling characters of the two types. The coefficient of variation was also calculated for seedling characters

of the two types to find out the variation, if any, between the two types. Intercorrelations among the mother tree characters, seednut characters and seedling characters were also worked out.

RESULTS

RESULTS

The characters of 60 mother trees selected, the seednuts obtained from each and the seedling progenies raised were studied and the results are presented below:

I. Studies on mother trees

The characters of mother trees in terms of mean, range and coefficient of variation of canopy size, girth of trunk, average number of nuts per bunch and total yield of dry nuts per tree in Kottarakara-1 and Kottarakara-27 are presented in Table 1 and 2 respectively. The general mean of these characters for the two types are given in Table 3. The analysis of variance table is given in Appendix I.

1. Canopy size

In Kottarakara-1, maximum canopy size was recorded by Tree No.24 (15.70 m) and the minimum by Tree No.7 (6.10 m). Tree No.20 registered the highest value (16 m) for canopy size in Kottarakara-27 and Tree No.11 recorded the lowest value (9.40 m). The coefficient of variation for canopy size was 21.05 per cent in Kottarakara-1 and

Table 1. - Mother tree characters of Kottarakara-1

Tree No.	Canopy size m	Girth of trunk cm	Average number of nuts per bunch	Total yield kg
1	7.90	74	3	2.150
2	8.00	97	5	3.000
3	8.30	101	2	1.700
4	9.20	95	5	3.200
5	9.00	90	6	4.300
6	8.10	133	6	4.350
7	6.10	103	6	3.050
8	8.90	101	5	4.350
9	8.00	108	2	1.600
10	9.80	81	3	2.600
11	8.70	103	3	1.500
12	8.10	84	5	1.000
13	7.80	86	5	1.000
14	6.80	107	2	1.000
15	10.10	90	6	2.500
16	9.10	93	5	1.500
17	10.00	114	3	1.200
18	10.10	95	4	4.000
19	10.40	74	3	1.300
20	8.60	69	6	3.000
21	9.10	186	4	7.250
22	12.70	135	4	1.000
23	11.90	125	3	2.000
24	15.70	120	3	5.500
25	12.30	143	5	1.250

(Table contd.)

Table 1. (contd.)

Tree No.	Canopy size m	Girth of trunk cm	Average number of nuts per bunch	Total yield (kg)
26	11.25	171	4	1.600
27	10.80	120	2	1.800
28	9.20	115	2	1.600
29	13.20	170	2	1.800
30	12.25	137	3	1.600
Mean	9.71	110.67	3.90	2.460
Range	6.10-15.70	69-186	2-6	1.000-7.250
C.V	21.05	26.01	35.86	60.41

Table 2. - Mother tree characters of Kottarakara-27

Tree No.	Canopy size m	Girth of trunk cm	Average number of nuts/bunch	Total yield kg
1	12.70	116	5	10.000
2	11.70	120	4	1.000
3	13.10	180	4	1.000
4	11.90	100	5	1.600
5	14.80	162	5	1.400
6	15.00	143	5	1.000
7	14.75	121	5	1.500
8	12.30	126	4	1.500
9	12.70	116	5	1.500
10	13.00	138	4	1.000
11	9.40	82	5	2.000
12	11.00	120	5	2.000
13	12.60	126	3	4.000
14	9.50	98	5	1.500
15	11.20	92	4	1.800
16	13.40	162	4	2.000
17	13.70	106	5	1.900
18	13.00	127	5	1.500
19	12.10	111	5	2.800
20	16.00	192	4	1.000

(Table contd.)

(Table 2. contd.)

Tree No.	Canopy size m	Girth of trunk cm	Average number of nuts/bunch	Total yield kg
21	14.40	132	5	2.500
22	10.30	99	4	1.400
23	10.00	99	4	1.500
24	13.40	128	4	2.600
25	10.70	126	3	1.500
26	11.90	110	4	2.500
27	11.10	105	4	1.700
28	11.60	142	4	4.500
29	13.00	110	5	2.300
30	10.60	108	4	2.300
Mean	12.36	123.23	4.40	2.16
Range	9.40-16.00	82-192	3-5	1.000-10.000
C.V	13.28	20.19	13.88	76.97

Table 3. - Mean data for mother tree characters of Kottarakara-1 and Kottarakara- 27

Type	Canopy size m	Girth of trunk cm	Average number of nuts/bunch	Total yield kg
Kottarakara-1	9.71	110.67	3.90	2.46
Kottarakara-27	12.36	123.23	4.40	2.16
C D (0.05)	0.97	N.S	N.S	N.S

13.28 per cent in Kottarakara -27 (Table 1 and 2). Kottarakara-27 was superior to Kottarakara- 1 in terms of canopy size (Table 3).

2. Girth of trunk

Tree No. 21 recorded the maximum trunk girth (186 cm) in Kottarkara-1 whereas Tree No.20 registered the minimum for that type (69 cm). In Kottarakara-27, Tree No.20 registered the highest trunk girth (192 cm) and the lowest value was given by Tree No.11 (82 cm). The coefficient of variation for trunk girth in Kottarakara-1 was 26.01 per cent and in Kottarakara-27 it was 20.19 per cent (Table 1 and 2). The two types were not significantly different in terms of trunk girth.

3. Average number of nuts per bunch

The maximum value for average number of nuts per bunch was six and minimum two in Kottarakara-1. In Kottarakara-27, the maximum value was five and minimum three. The coefficient of variation for this character was 35.86 per cent for the first type and 20.19 per cent for the second type (Table 1 and 2). The two types did not differ significantly in respect of this character (Table 3).

4. Total yield of dry nuts per tree

Tree No. 21 registered the maximum yield (7.250 kg) and Tree numbers 12, 13, 14 and 22 recorded the minimum yield (1.000 kg) in Kottarakara-1. In Kottarakara-27, Tree No.1 registered the maximum yield (10.000 kg) and Tree numbers 2, 3, 6, 10 and 20 recorded the minimum yield (1.000 kg). The coefficient of variation for total yield was very high in both types. It was 60.41 per cent in Kottarakara-1 and 76.97 per cent in Kottarakara-27 (Table 1 and 2). The two types did not differ significantly in terms of total yield of dry nuts per tree (Table 3).

II. Studies on the seednuts

The mean data for weight and volume of nut and kernel of individual trees in Kottarakara-1 and Kottarakara-27 are presented in Table 4 and 5 respectively. The general mean data on these characters for the two mother tree types are given in Table 6. The analysis of variance table is given in Appendix-I.

1. Weight of nuts

In Kottarakara-1, Tree No. 1 recorded the highest seednut weight (8.556 g) whereas the lowest weight was

Table 4. - Mean data for nut characters in Kottarakara-1

Tree No.	Weight of nut g	Volume of nut c.c	Weight of kernel g	Volume of kernel c.c
1	8.556	7.80	2.240	2.18
2	7.058	6.66	2.360	2.20
3	5.908	5.60	1.710	1.42
4	5.698	5.38	2.150	2.00
5	6.790	6.50	2.150	2.00
6	5.872	5.46	1.760	1.42
7	6.348	5.96	1.770	1.48
8	5.910	5.74	1.520	1.20
9	6.054	5.56	1.750	1.40
10	6.074	5.54	1.810	1.52
11	5.772	5.16	1.620	1.36
12	5.844	5.48	1.640	1.22
13	5.452	5.90	1.340	1.14
14	6.414	5.54	1.780	1.54
15	6.922	6.42	1.830	1.50
16	5.652	5.32	1.690	1.30
17	5.836	5.34	1.558	1.20
18	6.512	6.12	1.790	1.66
19	6.940	6.34	1.960	1.66
20	6.732	6.18	2.020	1.70

(Table contd..)

(Table 4. contd.)

Tree No.	Weigh of nut g	Volume of nut c.c	Weigh of kernel g	Volume of kernel c.c
21	6.476	6.08	1.740	1.46
22	6.194	5.84	1.740	1.38
23	6.032	5.80	1.700	1.36
24	7.294	6.84	2.020	1.70
25	6.242	5.72	1.800	1.60
26	7.016	6.56	1.940	1.78
27	5.888	5.54	1.760	1.50
28	5.994	5.50	1.780	1.50
29	5.870	5.42	1.650	1.48
30	5.924	5.44	1.630	1.30
Mean	6.309	5.89	1.807	1.54
Range	5.452-8.556	5.16-7.80	1.340-2.360	1.14-2.20
C.V	10.01	9.60	11.90	17.50

Table 5. - Mean data for nut characters in Kottarakara-27

Tree No.	Weight of nut g	Volume of nut c.c	Weight of kernel g	Volume of kernel c.c
1	6.192	5.74	1.910	1.50
2	7.882	6.84	2.270	2.04
3	7.724	7.28	2.430	2.20
4	7.714	7.32	2.110	1.80
5	8.204	7.78	2.530	2.36
6	8.520	7.94	2.450	2.12
7	7.530	7.14	2.270	2.02
8	8.024	8.30	2.150	1.92
9	7.238	6.72	2.090	2.00
10	8.070	7.24	2.280	2.02
11	8.096	7.60	2.190	2.08
12	8.498	8.06	2.450	2.22
13	8.124	7.74	2.230	1.86
14	5.768	4.98	1.910	1.56
15	8.028	7.32	2.310	2.08
16	7.772	7.54	2.410	2.12
17	8.084	7.74	2.290	2.02
18	6.082	5.64	2.050	1.78
19	7.812	7.44	2.080	1.88

(Table contd..)

Table 5.contd.

Tree No.	Weight of nut g	Volume of nut c.c	Weight of kernel g	Volume of kernel c.c
20	8.780	8.32	2.430	2.10
21	8.470	7.92	2.310	2.04
22	7.668	7.36	2.300	1.96
23	7.272	6.76	2.440	2.20
24	7.480	7.12	1.930	1.66
25	5.718	5.32	1.920	1.62
26	8.266	7.76	2.330	2.04
27	7.870	7.56	2.300	2.02
28	5.396	4.70	1.830	1.56
29	5.558	5.24	1.810	1.50
30	7.218	6.92	2.244	2.04
Mean	7.502	7.04	2.226	1.94
Range	5.396-8.780	4.70-8.32	1.810-2.530	1.50-2.36
C.V	12.54	13.97	9.04	11.51

Table 6. - General mean data for nut characters of Kottarakara- 1 and Kottarakara - 27

Type	Weight of nut g	Volume of nut c.c	Weight of kernel g	Volume of kernel c.c
Kottarakara-1	6.309	5.89	1.807	1.54
Kottarakara-27	7.502	7.04	2.226	1.94
C.D (0.05)	0.42	0.42	0.11	0.13

given by Tree No.13(5.452 g). Tree No. 21 of Kottarakara-27 recorded the highest seednut weight (8.780 g) and the lowest was registered by Tree No.28 (5.396 g). The coefficient of variation for seednut weight was very low for both types (10.01 per cent in Kottarakara-1 and 12.54 per cent in Kottarakara-27). On comparing the two types, Kottarakara-27 was found to be significantly superior to Kottarakara-1 in terms of seednut weight (Table 6).

2. Volume of nuts

Tree No.1 recorded the highest volume of seednut (7.80 c.c.) whereas Tree No. 11 registered the lowest value (5.16 c.c.) in Kottarakara-1. In Kottarakara-27, the maximum volume was recorded by Tree No.20 (8.32 c.c.) and the minimum (5.24 c.c.) by Tree No.29. The coefficient of variation for volume of nuts was 9.60 per cent in Kottarakara-1 and 13.97 per cent in Kottarakara-27 (Table 4 and 5). In volume of nuts also Kottarakara-27 proved its superiority over Kottarakara-1 (Table 6).

3. Weight of kernel

Tree No.2 registered the maximum weight of kernel (2.360 g) whereas Tree No.13 registered the minimum value

(1.340 g) in Kottarakara-1. In Kottarakara-27, Tree No.5 recorded the highest value for weight of kernel (2.530 g) and the lowest by Tree No.29 (1.810 g). The variation between individual trees for this character was very low in both types. It was 11.90 per cent in Kottarakara-1 and 9.04 per cent in Kottarakara-27. (Table 5 and 6) Studies revealed that Kottarakara-27 maintained its superiority in weight of kernel also (Table 6).

4. Volume of kernel

In respect of volume of kernel Tree No.2 registered the highest (2.20c.c) and Tree No.13 the lowest value (1.14 c.c) in Kottarakara-1. In Kottarakara-27, Tree No.5 recorded the highest volume of kernel (2.36 c.c) and Tree numbers 1 and 29 recorded the lowest voluem (1.50 c.c). The variation for volume of kernel was also very low in both types. It was 17.50 per cent in Kottarakara-1 and 11.51 per cent in Kottarakara-27 (Table 4 and 5). Kottarakara-27 proved its merit over Kottarakara-1 in this character also (Table 6).

III. Studies on the seedlings

The data for germination of seednuts are presented in Table 7. Index score tables used for scoring the seedling vigour are given in Table 8 and 9 respectively for

Kottarakara-1 and Kottarakara-27. Mean values for seedling height, number of leaves, total leaf area, length of internodes, girth at collar, length of taproot and seedling vigour for individual trees of the two types are given in Table 10 and 11. The range, mean, standard deviation and coefficient of variation for germination percentage, seedling height, number of leaves, total leaf area, length of internodes, girth at collar, length of taproot and seedling vigour under each type are presented in Table 12 and 13. Data showing the mean values of the above characters for the three yield groups under each type are presented in Table 14 and 15 and the data showing the general mean values of the above mentioned characters for the two types are given in Table 16. The analysis of variance tables for the above characters of individual trees of Kottarakara-1 and Kottarakara-27 are given in Appendix II and III. The analysis of variance table for the above characters of the three yield groups and the two types is presented in Appendix IV.

1. Germination of nuts

The nuts of the two types started germination on the 15th day and completed germination by the 27th day of sowing. In Kottarakara-1, the maximum germination was given by Tree No.20 (98.88 per cent) and the minimum by

Table 7. - Percentage of germination of seeds from individual trees of Kottarakara-1 and Kottarakara-27

Tree No.	Germination percentage	
	Kottarakara-1	Kottarakara-27
1	72.22	91.11
2	92.22	94.44
3	92.22	88.88
4	88.88	72.22
5	72.22	76.66
6	88.88	80.00
7	80.00	75.55
8	81.11	66.66
9	90.00	55.55
10	71.11	73.33
11	82.22	66.66
12	85.55	52.22
13	33.33	57.77
14	75.55	90.00
15	75.55	71.11
16	80.00	62.22
17	51.11	76.66
18	70.00	92.22
19	64.44	67.77
20	98.88	63.33

(Table contd..)

Table 7.(contd.)

Tree No.	Germination percentage	
	Kottarakara-1	Kottarakara-27
21	86.66	63.33
22	94.44	68.88
23	77.77	74.44
24	85.55	81.11
25	86.66	92.22
26	81.11	66.66
27	87.77	84.44
28	93.33	91.11
29	91.11	95.55
30	92.22	86.66
Mean	80.73	75.96
Statistical significance	N.S	N.S

Table 8. - Index score table for Kottarakara-1

Seedling characters	Score 1	Score 2	Score 3
Seedling height (cm)	∠58.78	58.78- 106.60	>106.60
Total leaf area(sq.cm)	∠836.87	836.87-4531.31	>4531.31
Length of internodes (cm)	∠ 0.67	0.67- 2.17	> 2.17
Girth at collar (cm)	∠ 2.78	2.78- 4.59	>4.59
Length of taproot(cm)	∠31.66	31.66- 55.14	>55.14

Table 9. - Index score table for Kottarakara-27

Seedling characters	Score 1	Score 2	Score 3
Seedling height (cm)	∠ 47.84	47.84- 84.96	> 84.96
Total leaf area (sq.cm)	∠583.72	583.72-3269.96	>3269.96
Length of internodes (cm)	∠ 0.73	0.73- 2.09	> 2.09
Girth at collar (cm)	∠ 3.26	3.26- 4.90	>4.90
Length of taproot(cm)	∠ 37.01	37.01- 60.05	>60.05

Table 10. - Mean data for seedling height, number of leaves, total leaf area, length of internodes, girth at collar, length of taproot and seedling vigour of Kottarakara-1

Tree No.	Seedling height (cm)	Number of leaves	Total leaf area (sq. cm)	Length of internodes (cm)	Girth at collar (cm)	Length of tap root (cm)	Seedling vigour
1	2	3	4	5	6	7	8
1	71.20	31.40	1921.71	1.24	3.40	30.79	7.25
2	66.33	22.90	1394.40	1.38	3.25	29.14	6.20
3	70.53	28.55	1382.21	1.43	2.88	34.05	6.95
4	84.30	46.75	2120.89	1.61	3.35	32.73	8.70
5	96.85	37.35	2436.33	1.61	3.75	36.01	9.70
6	95.70	40.75	2774.57	1.60	3.75	39.00	9.50
7	92.40	54.45	3412.71	1.46	3.75	39.95	10.40
8	59.50	28.00	1699.44	1.42	3.28	38.18	7.40
9	67.23	49.70	3277.22	1.38	3.43	40.83	8.75
10	100.25	52.30	3609.38	1.83	3.70	39.08	10.80
11	99.15	54.40	3162.60	1.50	3.83	45.05	10.25
12	93.15	54.40	3376.79	1.31	4.25	46.45	10.45
13	76.20	50.25	2906.98	1.23	3.75	40.90	8.90
14	85.55	45.10	3314.15	1.57	3.70	43.75	9.90
15	87.65	44.85	2560.52	1.20	3.60	39.25	9.30
16	86.30	42.25	2756.91	1.38	3.45	48.35	9.80
17	73.50	38.95	2162.36	1.31	3.55	52.78	9.15
18	74.20	44.95	2486.78	1.20	3.85	46.50	8.55
19	75.00	36.25	2109.02	1.23	3.40	48.65	8.70
20	79.55	31.00	1795.30	1.33	3.40	48.95	8.90
21	93.10	53.45	2993.75	1.22	4.05	48.50	10.25
22	79.70	35.00	2261.81	1.38	3.70	49.90	9.45
23	78.15	47.95	2755.36	1.34	3.85	46.75	8.95
24	81.10	44.65	2642.99	1.55	4.00	48.60	10.55

(Table contd..)

Table 10. (contd.)

1	2	3	4	5	6	7	8
25	79.65	46.40	2682.40	1.09	3.60	47.30	8.85
26	94.10	53.50	3657.33	1.45	4.15	48.35	10.65
27	85.10	43.80	2786.74	1.57	3.63	45.73	9.85
28	92.65	53.60	3342.66	1.45	4.13	49.35	10.55
29	81.80	46.25	3191.59	1.54	4.03	48.90	10.80
30	80.90	51.80	3547.75	1.56	4.23	48.30	10.60
Mean	82.69	43.67	2684.09	1.41	3.69	43.40	9.36
C.D (0.05) forcomparing treatments	13.67	13.16	1103.15	0.364	0.541	6.28	1.513

Table 11. - Mean data for seedling height, number of leaves, total leaf area, length of internodes, girth at collar, length of taproot and seedling vigour of Kottarakara-27

Tree No.	Seedling height	Number of leaves	Total leaf area	Length of inter-nodes	Girth at collar	Length of tap root	Seedling vigour
	cm		sq.cm	cm	cm	cm	
1	2	3	4	5	6	7	8
1	54.95	25.25	1218.81	0.88	3.50	36.68	7.20
2	74.80	40.80	2189.83	1.24	4.13	43.80	9.60
3	64.15	28.50	1546.87	1.17	3.70	43.60	8.65
4	61.58	26.90	1427.22	1.09	3.45	36.40	7.85
5	74.15	29.20	1991.23	1.48	3.73	48.10	9.75
6	65.35	24.45	1195.93	1.13	3.58	44.75	7.90
7	69.06	37.90	2874.02	1.48	4.05	49.60	10.80
8	78.78	48.40	2888.57	1.43	4.63	47.95	10.75
9	81.95	44.85	2608.92	1.63	4.40	50.45	11.75
10	72.95	29.95	1837.37	1.53	4.65	52.25	11.20
11	68.88	27.70	1432.11	1.06	4.25	47.08	9.05
12	79.35	43.65	2615.72	1.97	4.53	49.70	11.65
13	72.35	42.50	3031.92	1.42	4.58	55.80	10.75
14	39.80	12.85	469.95	0.91	3.38	35.60	5.75
15	73.28	39.65	2449.65	2.25	4.65	53.80	12.20
16	60.75	18.40	1034.25	2.21	4.08	51.15	9.90
17	58.55	26.50	1288.88	1.61	8.93	51.15	9.35
18	48.20	36.45	1692.61	1.34	3.90	46.60	8.90

(Table contd..)

Table 11. (contd.)

1	2	3	4	5	6	7	8
19	50.35	34.55	1583.39	1.43	3.80	41.85	8.50
20	53.30	35.70	1405.36	1.48	3.85	42.05	8.40
21	44.50	19.85	762.96	1.25	3.48	40.50	6.85
22	72.40	32.45	2023.95	1.42	4.33	56.20	11.20
23	79.60	37.80	2567.32	1.50	4.33	57.20	11.55
24	78.45	37.15	2158.09	1.36	4.50	54.28	11.40
25	74.80	36.85	2349.84	1.27	4.05	55.00	10.60
26	74.70	37.70	2669.92	1.66	4.53	55.70	11.60
27	59.65	26.90	1509.15	1.10	3.95	51.90	8.25
28	64.30	29.75	1951.69	1.16	4.20	47.70	9.75
29	70.50	37.50	2482.20	1.41	3.95	51.90	10.25
30	70.65	35.10	2548.20	1.32	4.40	57.05	11.20
Mean	66.40	32.93	1926.84	1.41	4.08	48.53	9.78
C.D. 0.05% for comparing treatments	9.45	9.59	755.127	0.380	1.120	6.21	1.467

Table 12. - Range, mean, standard deviation and coefficient of variation for seedling characters and seedling vigour of Kottarakara-1

Sl. No.	Seedling characters	Range of values	Mean	Standard deviation	Coefficient of variation
1	Germination percentage	33.33 - 98.88	80.73	13.38	16.58
2.	Seedling height(cm)	59.50 - 100.85	82.69	23.91	28.91
3.	Number of leaves	22.90 - 54.45	43.67	22.44	51.38
4.	Total leaf area (sq.cm)	1382.21 -3657.33	2684.09	1847.22	68.82
5.	Length of internodes (cm)	1.09 - 1.83	1.41	0.75	52.90
6.	Girth at collar(cm)	2.88 - 4.25	3.69	0.91	24.60
7.	Length of taproot (cm)	29.14 - 52.78	43.40	11.74	27.05
8.	Seedling vigour	6.20 - 10.80	9.36	2.67	28.50

Table 13. - Range, mean, standard deviation and coefficient of variation for seedling characters and seedling vigour of Kottarkara-27

Sl. No.	Seedling characters	Range of values	Mean	Standard deviation	Coefficient of variation
1.	Germination percentage	52.22- 95.55	75.96	12.32	16.21
2.	Seedling height(cm)	39.80- 81.95	66.40	18.56	27.95
3.	Number of leaves	12.85- 48.40	32.93	17.10	51.92
4.	Total leaf area (Sq.cm)	469.95-3031.92	1926.84	1343.12	69.70
5.	Length of internodes (cm)	0.88- 2.25	1.41	0.68	48.13
6.	Girth at collar(cm)	3.38- 4.65	4.08	0.82	20.10
7.	Length of taproot(cm)	35.60- 57.20	48.53	11.52	23.74
8.	Seedling vigour	5.75- 12.20	9.78	2.84	29.02

Table 14. - Mean data for the seedling characters and seedling vigour under different yield groups of Kottarakara-1

Yield groups	Germination per centage	Seedling height (cm)	Number of leaves	Total leaf area (sq. cm)	Length of inter nodes (cm)	Girth at collar (cm)	Length of tap root (cm)	Seedling vigour
Low	70.15	80.39	43.57	2687.64	1.30	3.71	47.10	9.34
Medium	85.09	83.39	44.47	2745.60	1.45	3.65	42.09	8.76
High	80.74	83.41	41.50	2502.64	1.43	3.78	42.79	9.32
Statistical significance	N.S	N.S	N.S	N.S.	N.S	N.S	N.S	N.S

Table 15. - Mean data for the seedling characters and seedling vigour under different yield groups of Kottarakara-27

yield groups	Germination per centage	Seedling height (cm)	Number of leaves	Total leaf area (sq.cm)	Length of inter nodes (cm)	Girth at collar (cm)	Length of tap root (cm)	Seedling vigour
Low	79.99	66.11	32.00	1635.07	1.31	3.98	45.29	9.15
Medium	74.43	67.09	33.18	1974.01	1.46	4.10	49.51	9.40
High	79.99	64.07	32.67	2067.47	1.15	4.03	46.73	9.23
Statistical significance	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Table 16. - General mean data for the seedling characters and seedling vigour of Kottarakara-1 and Kottarakara-27

Type	Germination per centage	Seedling height (cm)	Number of leaves	Total leaf area (sq.cm)	Length of internodes (cm)	Girth at collar (cm)	Length of tap root (cm)	Seedling vigour
Kottarakara-1	80.73	82.69	43.67	2684.09	1.41	3.69	43.40	9.36
Kottarakara-27	75.96	66.40	32.93	1926.84	1.41	4.08	48.53	9.78
C.D(0.05) for comparing types	N.S	5.59	4.44	342.60	N.S	0.184	3.25	N.S

Table 17. - Progressive increase in height in centimtres of seedlings during the first nine months in the nursery for the three yield groups of Kottarakara-1

Yield groups	September	October	November	December	January	February	March	April	May
1	2	3	4	5	6	7	8	9	10
Low	15.67	30.13	40.78	43.63	46.02	53.04	61.81	68.42	80.39
Medium	17.50	32.17	42.42	44.57	46.53	53.68	61.98	68.07	83.39
High	16.47	32.06	43.26	45.71	47.71	56.42	63.93	68.23	83.41

Table 18. - Progressive increase in height in centimetres of seedlings during the first nine months in the nursery for the three yield groups of Kottarakara-27

Yield groups	September	October	November	December	January	February	March	April	May
1	2	3	4	5	6	7	8	9	10
Low	23.09	35.96	36.78	48.71	49.94	52.27	55.11	59.79	66.11
Medium	20.83	32.73	42.55	48.84	50.27	50.59	58.07	60.70	67.09
High	19.72	33.29	46.27	48.09	49.45	52.30	56.98	59.56	64.07

Table 19. - Progressive increase in height in centimetres of seedlings during the first nine months for Kottarakara-1 and Kottarakara- 27

Type	September	October	November	December	January	February	March	April	May
Kottara-kara-1	16.86	31.67	42.21	44.58	46.65	54.08	62.33	68.18	82.69
Kottara-kara-27	21.10	33.32	41.95	48.74	50.13	51.04	57.46	60.43	66.62

Tree No.13 (33.33 per cent). In Kottarakara-27, the maximum germination was registered by Tree No.29 (95.55 per cent) and the minimum (52.22 per cent) by Tree No.12 (Table 7). The coefficient of variation for germination of nuts was 16.58 per cent in Kottarakara-1 and 16.21 per cent in Kottarakara-27 (Table 12 and 13). There was no significant difference between the three yield groups of the two types for this character (Table 14 and 15). Similar was the case with general means of the two types also (Table 16).

2. Growth parameters

i) Seedling height

The maximum (100.25 cm) and minimum (59.50 cm) values for this character in Kottarakara-1 were scored by Tree numbers 10 and 8 respectively. In Kottarakara-27, the maximum (81.95 cm) and the minimum (39.80 cm) value for seedling height were registered by Tree numbers 9 and 13 respectively. The progressive increase in height of seedlings during the first nine month period in the nursery for the three yield groups of Kottarakara-1 and Kottarakara-27 are given in figure 1 and 2 based on Table 17 and 18 respectively. The above data for the two types are given in figure 3 based on Table 19. There was

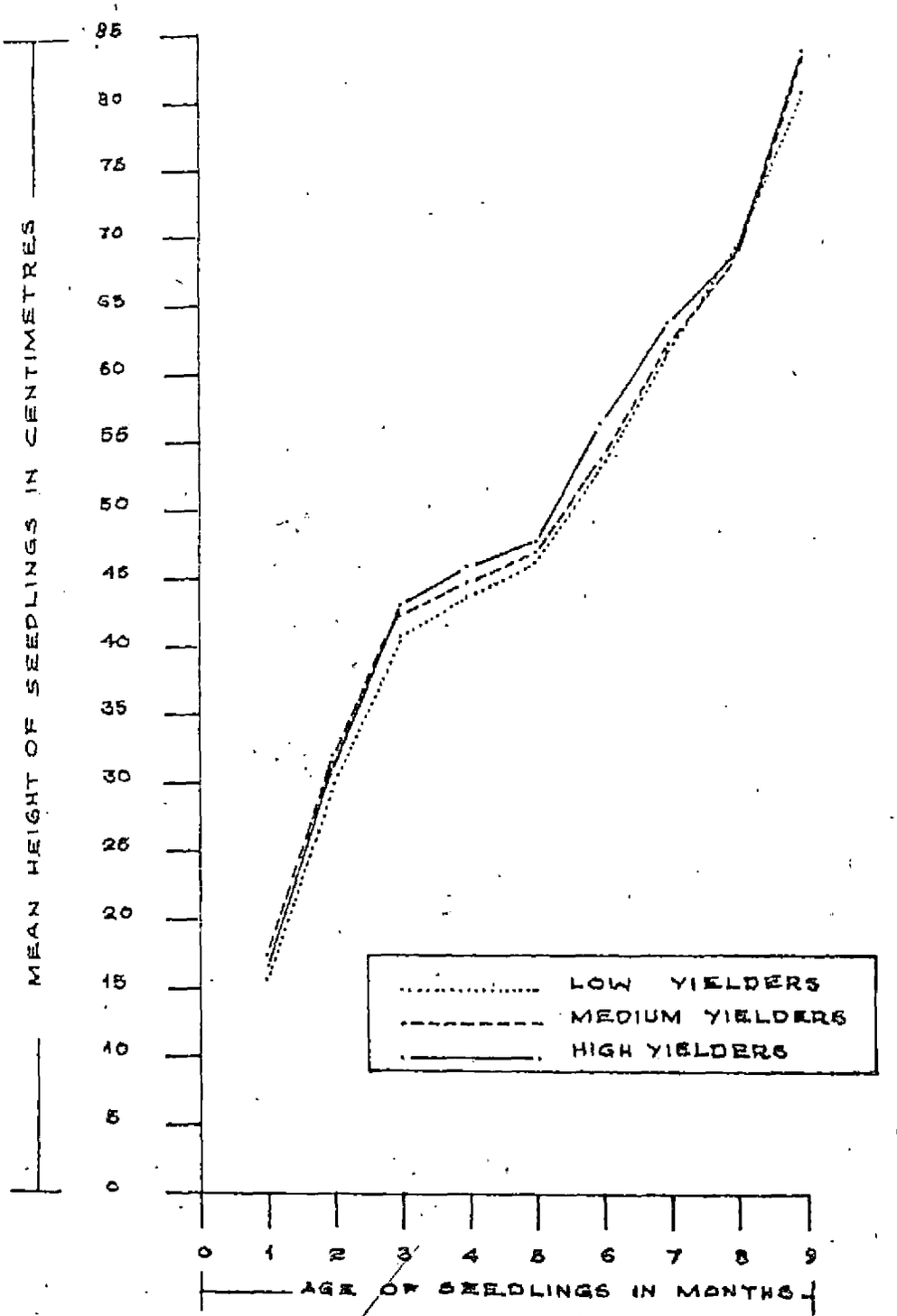

FIG: 1. GRAPH SHOWING THE PROGRESSIVE INCREASE IN HEIGHT OF SEEDLINGS DURING THE FIRST NINE MONTH PERIOD IN THE NURSERY FOR THE THREE YIELD GROUPS OF KOTTARAKARA-1

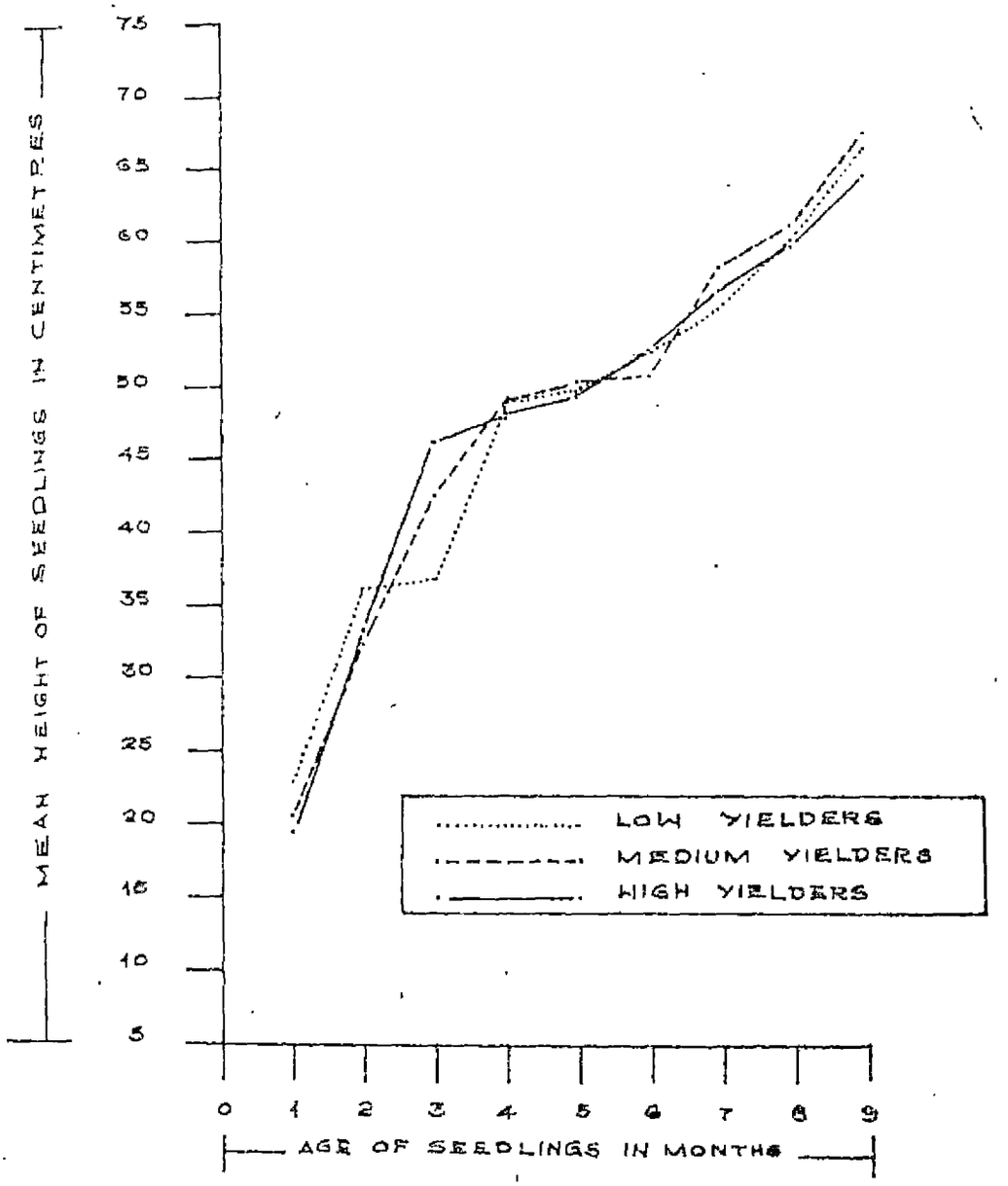

FIG: 2. GRAPH SHOWING THE PROGRESSIVE INCREASE IN HEIGHT OF SEEDLINGS DURING THE FIRST NINE MONTH PERIOD IN THE NURSERY OF SEEDLINGS FOR THE THREE YIELD GROUPS OF KOTTARAKARA-27

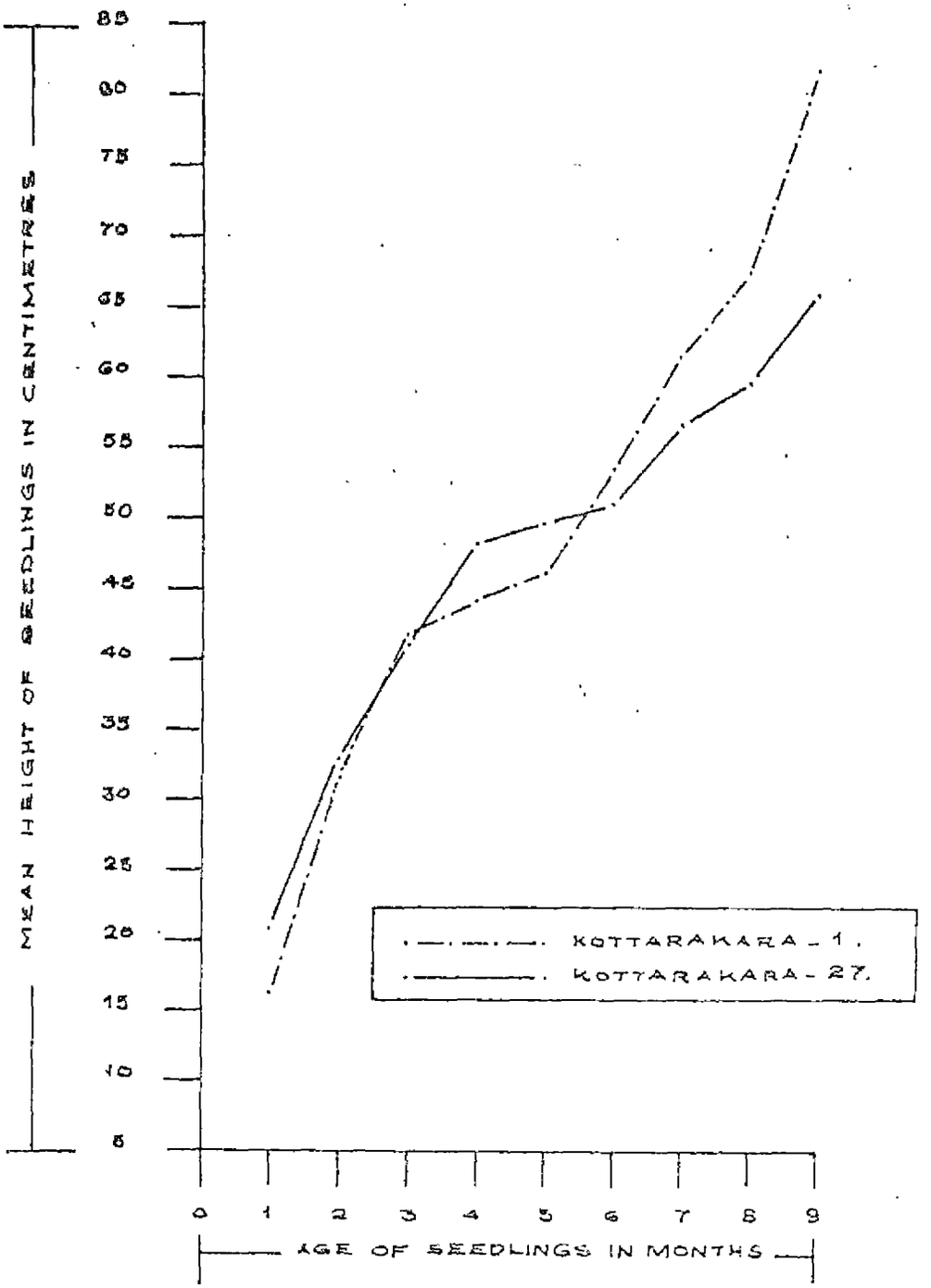

FIG. 3. GRAPH SHOWING THE PROGRESSIVE INCREASE IN HEIGHT OF SEEDLINGS DURING THE FIRST NINE MONTH PERIOD FOR KOTTARAKARA-1 & KOTTARAKARA - 27.

a steady increase in height during the first three months and thereafter there was only gradual increase in both types. But in Kottarakara-1, there was rapid increase in height during 8th and 9th months. The coefficient of variation for this character was 28.91 per cent in Kottarakara-1 and 27.95 per cent in Kottarakara-27 (Table 12 and 13). There was significant difference between the individual trees for seedling height in both types (Table 10 and 11). There was no significant difference between the three yield groups in both types (Table 14 and 15). But on comparing the general means, Kottarakara-1 was found to be significantly superior to Kottarakara-27 (Table 16).

ii) Number of leaves

In Kottarakara-1, Tree No.7 registered the maximum (54.45) and Tree No.2 the minimum (22.90) number of leaves after nine months of growth. (Table 10). In Kottarakara-27 for the same character, Tree No.8 registered the maximum (48.40) and Tree No.14 the minimum (12.85) value (Table 11). The coefficient of variation was 51.38 per cent in Kottarakara-1 and 51.92 per cent in Kottarakara-27 (Table-12 and 13). There was significant difference between the individual trees of both the types for this character (Table 10 and 11). But the yield groups did not differ

significantly for both types (Table 14 and 15). Studies also revealed that Kottarakara-1 was significantly superior to Kottarakara-27 in this character (Table 16).

iii) Total leaf area

In Kottarakara-1, Tree No.26 registered the maximum (3657.33 sq. cm) and Tree No.3 the minimum (1382.21 sq. cm) values for this character (Table 10). In the case of Kottarakara-27 the maximum (3031.92 sq. cm) and the minimum (469.95 sq. cm) values for this character were scored by Tree numbers 13 and 14 respectively. The coefficient of variation was 68.82 per cent in Kottarakara-1 and 69.70 per cent in Kottarakara-27 (Table 12 and 13). The individual trees of the two types differed significantly for total leaf area (Table 10 and 11). Between yield groups there was no significant difference in both types (Table 14 and 15). Comparing the general means, Kottarakara-1 was found to be superior to Kottarakara-27 (Table 16).

iv) Length of internodes

Tree No.10 of Kottarakara-1 registered the maximum (1.83 cm) and Tree No.25, the minimum (1.09 cm) values for this character (Table 10). In Kottarakara-27, Tree No.15 registered the maximum (2.25 cm) and Tree No.1, the

minimum (0.88 cm) values for length of internodes (Table 11). The coefficient of variation for this character in Kottarakara-1 was 52.90 per cent and for Kottarakara-27, it was 48.13 per cent (Table 12 and 13). The individual trees of both types differed significantly with regard to this character (Table 10 and 11). There was no significant difference between the three yield groups in both types (Table 14 and 15). Similar was the case with the general means for the two types also (Table 16).

v) Girth at collar

In Kottarakara-1, Tree No.12 registered the maximum (4.25 cm) and Tree No.3, the minimum (2.88 cm) values for girth at collar (Table 10). Tree No.11 of Kottarakara-27 registered the maximum (4.65 cm) and Tree No.14, the minimum (3.38 cm) values for this character (Table 11). The coefficient of variation for this character was 24.60 per cent in Kottarakara-1 and 20.10 per cent in Kottarakara-27 (Table 12 and 13). The individual trees of both types differed significantly in respect of this character (Table 10 and 11). Between the three yield groups there was no significant difference in both types (Table 14 and 15). On comparing the general means, Kottarakara-27 was found significantly superior to Kottarakara-1 (Table 16).

vi) Length of main (tap)root

Root studies revealed that in Kottarakara-1, Tree No.17 registered the maximum (52.78 cm) and Tree No.2 registered the minimum (29.14 cm) values for length of taproot (Table 10). In Kottarakara-27, Tree No.23 registered the maximum (57.20 cm) and Tree No.14 registered the minimum (35.60 cm) for this character (Table 11). The coefficient of variation for this character was 27.05 per cent in Kottarakara-1 and 23.74 per cent in Kottarakara-27 (Table 12 and 13). Individual trees of both types differed significantly for this character (Table 10 and 11) Between the three yield groups, there was no significant difference in both types (Table 14 and 15). But on comparing the general means, Kottarakara-27 was found to be significantly superior to Kottarakara-1 (Table 16).

vii) Seedling vigour

In Kottarakara-1, Tree No.10 registered the maximum (10.80) and Tree No.2, the minimum (6.20) values for seedling vigour (Table 10). In Kottarakara-27, Tree No.15 registered the maximum (12.20) and Tree No.14, the minimum (5.75) values for seedling vigour (Table 11).

The coefficient of variation for seedling vigour was 28.50 per cent in Kottarakara-1 and 29.02 per cent in Kottarakara-27 (Table 12 and 13). There was significant difference between the individual trees of both types for this character (Table 10 and 11). The three yield groups of the two types did not show any significant difference in respect of this character (Table 14 and 15). Similar was the case between the two types when their general means were compared for this character (Table 16).

IV. Prepotency studies

The data for recovery of vigorous seedlings and identification of prepotent trees of Kottarakara-1 and Kottarakara-27 are given in Table 20 and 21 respectively. The number of vigorous seedlings and prepotent trees obtained from the two types are shown in figure 4. Recovery of vigorous seedlings from different yield groups is shown in figure-5.

Table 20.- Recovery of vigorous seedlings from Kottarakara-1.

Tree No.	Yield group	Number of vigorous seedlings/20	Percentage of recovery	Remarks
1	2	3	4	5
1	Medium	1	5	
2	Medium	1	5	
3	Medium	Nil	Nil	
4	Medium	3	15	
5	High	8	40	Prepotent
6	High	7	35	Prepotent
7	Medium	9	45	Prepotent
8	High	1	5	
9	Medium	5	25	
10	Medium	13	65	Prepotent
11	Medium	9	45	Prepotent
12	Low	9	45	Prepotent
13	Low	4	20	
14	Low	10	50	Prepotent
15	Medium	5	25	
16	Medium	9	45	Prepotent
17	Low	6	30	
18	High	3	15	
19	Low	5	25	
20	Medium	6	30	

(Table contd.)

Table 20.(contd.)

Tree No.	Yield group	Number of vigorous seedlings/20	Percentage of recovery	Remarks
1	2	3	4	5
21	High	10	50	Prepotent
22	Low	4	20	
23	Medium	6	30	
24	High	11	55	Prepotent
25	Low	4	20	
26	Medium	11	55	Prepotent
27	Medium	8	40	Prepotent
28	Medium	10	50	Prepotent
29	Medium	13	65	Prepotent
30	Medium	10	50	Prepotent
Total		201	33.50	15 Prepotent trees

Table 21. - Recovery of vigorous seedlings from Kottarakara-27

Tree No.	Yield group	Number of vigorous seedlings/20	Percentage of recovery	Remarks
1	2	3	4	5
1	High	3	15	
2	Low	8	40	
3	Low	5	25	
4	Medium	3	15	
5	Medium	11	55	Prepotent
6	Low	1	5	
7	Medium	11	55	Prepotent
8	Medium	11	55	Prepotent
9	Medium	14	70	Prepotent
10	Low	11	55	Prepotent
11	Medium	5	25	
12	Medium	14	70	Prepotent
13	High	13	65	Prepotent
14	Medium	Nil	Nil	
15	Medium	14	70	Prepotent
16	Medium	9	45	Prepotent
17	Medium	6	30	
18	Medium	6	30	
19	Medium	6	30	

(Table contd.)

Table 21.(contd.)

Tree No.	Yield group	Number of vigorous seedlings/20	Percentage of recovery	Remarks
1	2	3	4	5
20	Low	3	15	
21	Medium	1	5	
22	Medium	15	75	Prepotent
23	Medium	14	70	Prepotent
24	Medium	15	75	Prepotent
25	Medium	10	50	Prepotent
26	Medium	11	55	Prepotent
27	Medium	5	25	
28	High	8	40	
29	Medium	11	55	Prepotent
30	Medium	13	65	Prepotent
Total		257	42.83	16 Prepotent trees

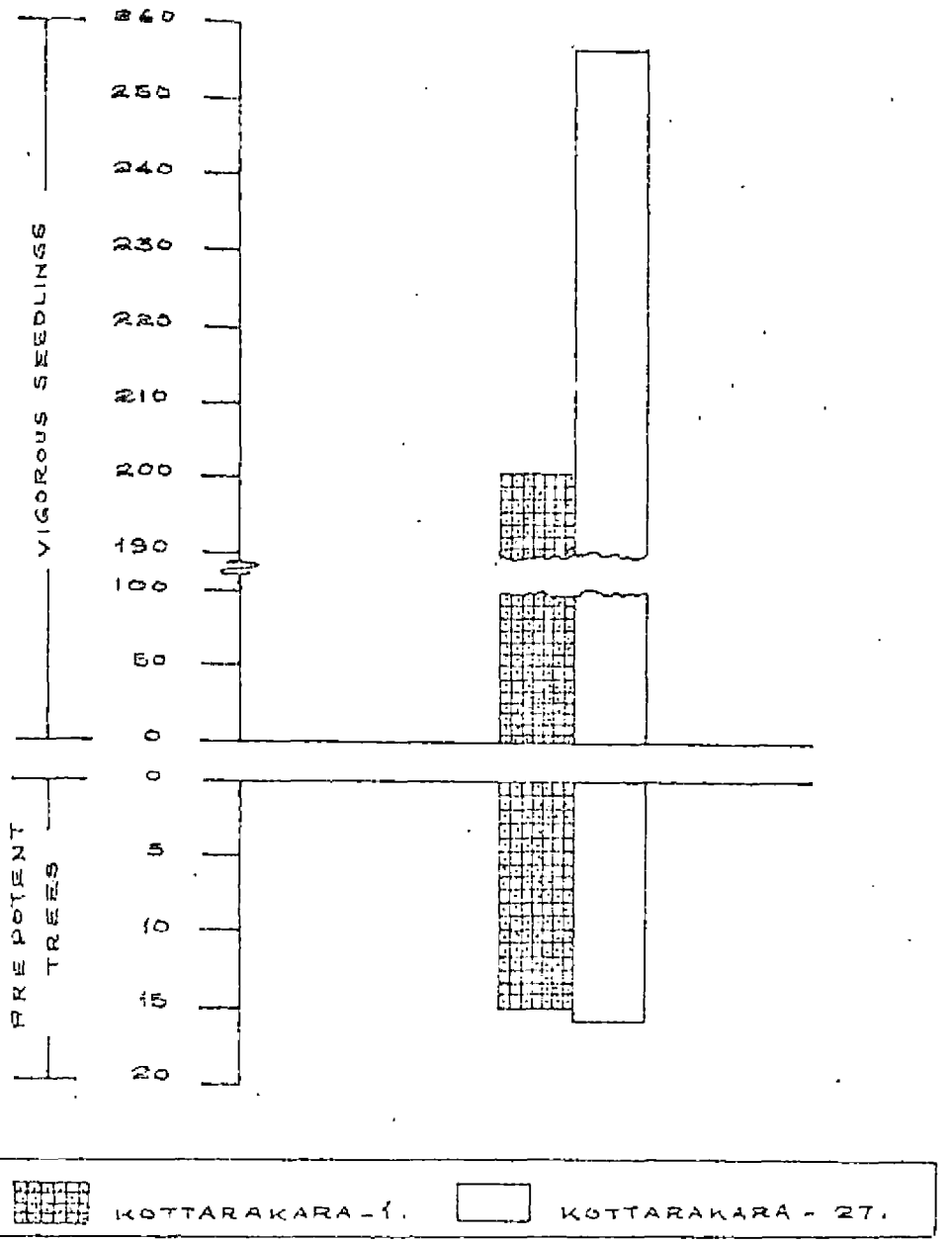

FIG: 4 BAR DIAGRAM SHOWING THE NUMBER OF VIGOROUS SEEDLINGS AND PREPOTENT TREES RECOVERED FROM KOTTARAKARA-1 AND KOTTARAKARA - 27.

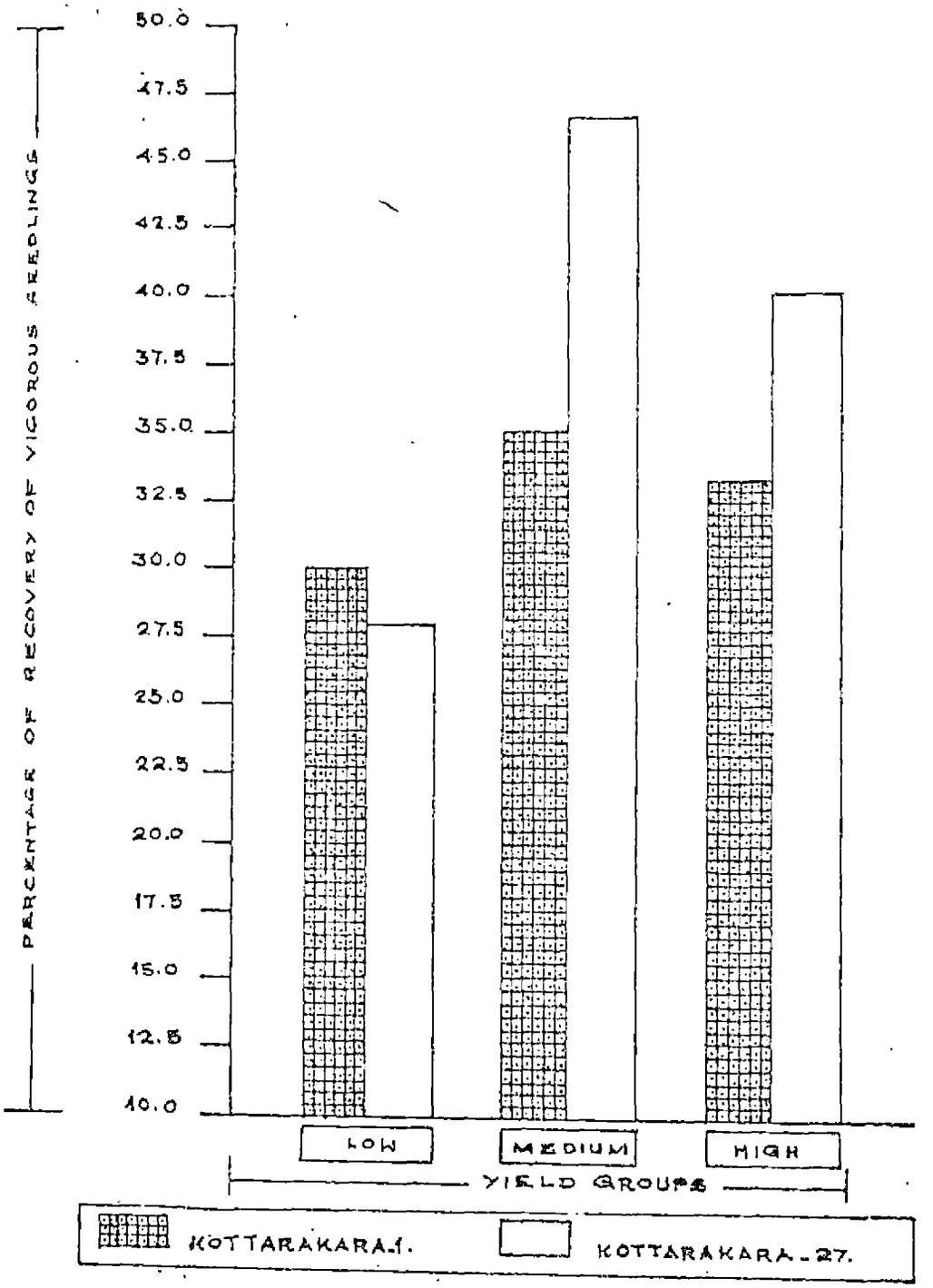

FIG: 5. BAR DIAGRAM SHOWING THE PERCENTAGE OF RECOVERY OF VIGOROUS SEEDLINGS FROM THE THREE YIELD GROUPS OF KOTTARAKARA-1 AND KOTTARAKARA-27

1. Recovery of vigorous seedlings from different yield groups

Out of the 600 seedling observed under each type, there were 201 vigorous seedlings in Kottarakara-1 and 257 vigorous seedlings in Kottarakara-27. In Kottarakara-1, Tree numbers 10 and 29 gave 13 vigorous seedlings each out of 20 seedlings studied (Table 20). In Kottarakara-27, Tree numbers 22 and 24 gave 15 vigorous seedlings each out of 20 seedlings studied (Table 21).

From the Table 22, it can be seen that, in Kottarakara-1 out of 140 seedlings studied in the low yielding group, 42 were vigorous giving a recovery of 30 percent vigorous seedlings. Out of the 340 seedlings observed in the medium yielding group, 119 were found to be vigorous giving a recovery of 35 per cent vigorous seedlings. In the high yielding group, out of 120 seedlings studied, 40 were found to be vigorous giving a recovery of 33.50 per cent vigorous seedlings.

In Kottarakara-27, there were 28 vigorous seedlings out of 100 seedlings studied in the low yield group, giving a recovery of 28 per cent vigorous seedlings.

Table 22. - Percentage of recovery of vigorous seedlings from the three yield groups of Kottarakara-1 and Kottarakara-27

	Low	Medium	High	Total	X^2 for yield groups	X^2 for types
Kottarakara-1	-	-	-	-	1.09	11.28**
Vigorous seedlings obtained	42	119	40	201	-	-
Number of seedlings studied	140	340	120	600	-	-
Percentage of recovery	30.00	35.00	33.33	33.5	-	-
Kottarakara-27	-	-	-	-	11.98**	11.28**
Vigorous seedlings obtained	28	205	24	257	-	-
Number of seedlings studied	100	440	60	600	-	-
Percentage of recovery	28.00	46.59	40.00	42.83	-	-

For comparing yield groups

X^2 2 df at 5 per cent level = 5.99

X^2 2 df at 1 per cent level = 9.21

For comparing types

X^2 1 df at 5 per cent level = 3.84

X^2 1 df at 1 per cent level = 6.64

** Significant at 1 per cent level.

Out of 440 seedlings studied in the medium yielding group, 205 were found to be vigorous giving a recovery of 46.59 per cent of vigorous seedlings. In the high yielding group there were 24 vigorous seedlings out of the 60 seedlings observed giving a recovery of 40.00 per cent vigorous seedlings.

These results indicate that the recovery was more in the medium yielding group followed by the high yielding group in both types. The low yielding group registered the lowest recovery.

The recovery of vigorous seedlings from the different yield groups in both the types was tested by the chi-square test of significance suggested by Gupta and Kapoor (1977). It was found that in Kottarakara-1 there was no significant difference between the yield groups in the recovery of vigorous seedlings. In Kottarakara-27, the yield groups differed significantly in respect of the recovery of vigorous seedlings. When the two types were tested, it was found that there was significant difference between the two types in the recovery of vigorous seedlings. Kottarakara-27 was found to be superior to Kottarakara-1 in respect of recovery of vigorous seedlings.

2. Identification of prepotent trees

Based on the percentage of recovery of vigorous seedlings of each type, prepotent trees were identified. The percentage of recovery of vigorous seedlings for the type Kottarakara-1 was 33.50 and that for Kottarakara-27 was 42.83. Those trees which registered a recovery above that of the mean recovery of the type were identified as prepotent trees.

Table 23. Percentage of recovery of prepotent trees from the three yield groups of Kottarakara-1 and Kottarakara-27

	Low	Medium	High	Total	X^2 for yield groups	X^2 for types
Kottarakara-1	-	-	-	-	2.01	0.04
Prepotent trees	2	9	4	15	-	-
Number of trees studied	7	17	6	30	-	-
Percentage of recovery	28.57	52.94	66.66	50.00	-	-
Kottarakara-27	-	-	-	-	2.97	0.04
Prepotent trees	1	14	1	16	-	-
Number of trees studied	5	22	3	30	-	-
Percentage of recovery	20.00	63.33	33.33	53.33	-	-

For comparing yield groups

X^2 2 df at 5 per cent level = 5.99

X^2 2 df at 1 per cent level = 9.21

For comparing types

X^2 1 df at 5 per cent level = 3.84

X^2 1 df at 1 per cent level = 6.84

It was found that there were 15 prepotent trees in Kottarakara-1. Out of the seven trees studied in the low yielding group, two were found to be prepotent, thus giving a recovery of 28.57 per cent prepotent trees. In the medium yielding group of 17 trees, nine were identified as prepotent giving a recovery of 52.94 per cent. Out of the six trees studied in the high yielding group, four were prepotent, thus giving a recovery of 66.66 per cent of prepotent trees.

In Kottarakara-27, out of the five trees studied in the low yielding group, only one was prepotent giving a recovery of 20 per cent prepotent trees. In the medium yielding group, there were 14 prepotent trees out of the 22 trees studied giving a recovery of 63.33 per cent prepotent trees. Out of the three trees studied in the high yielding group, only one was prepotent giving a recovery of 33.33 per cent prepotent trees (Table 23).

The recovery of prepotent trees in the three yield groups of the two types was subjected to chi-square test and it was found that the three yield groups did not differ significantly in respect of recovery of prepotent trees in both the types. Also there was no significant difference between the two types in respect of the recovery of prepotent trees.

V. Correlation studies

1. Based on data collected during the 3rd month

Results are presented in Table 24 and 25 for Kottarakara-1 and Kottarakara-27 respectively.

i) Correlation between characters of mother tree

There was significant positive correlation between canopy size and girth of trunk in both types. There was no significant correlation between any other characters of the mother tree in both types.

ii) Correlation between characters of mother tree and seednut

Total yield showed significant negative correlation with weight and volume of kernel in Kottarakara-27.

iii) Correlation between characters of mother tree and seedling

In Kottarakara-1, girth of trunk was positively and significantly correlated with seedling height and total leaf area. There was significant negative correlation between the average number of nuts per bunch and total leaf area in Kottarakara-27.

iv) Correlation between characters of seednut

Weight of nut showed significant positive correlation with volume of nut, weight and volume of kernel in both the types. Volume of nut was positively and significantly correlated with weight and volume of kernel. There was high significant positive correlation between weight and volume of kernel in both types.

v) Correlation between characters of seednut and seedling

In Kottarakara-27 weight and volume of nut and kernel recorded significant negative correlation with germination percentage. In Kottarakara-1, weight and volume of nut and weight of kernel showed negative significant correlation with number of leaves. Volume of kernel showed positive significant correlation with seedling height in Kottarakara-27.

vi) Correlation between characters of seedling

Germination of nuts was positively and significantly correlated with seedling height in Kottarakara-1. Seedling height and number of leaves showed significant positive correlation with total leaf area in both types. Seedling height and number of leaves recorded significant positive correlation in Kottarakara-27.

2. Based on data collected during the 9th month

Results are presented in Table 26 and 27 for Kottarakara-1 and Kottarakara-27 respectively.

Correlation between the characters of mother tree, mother tree and seednut and between seednuts were presented earlier.

i) Correlation between characters of mother tree and seedling

In Kottarakara-1, canopy size showed significant positive correlation with length of taproot, whereas it registered significant negative correlation with seedling height. There was no significant correlation between canopy size and number of leaves, length of internodes, girth at collar and total leaf area. Girth of trunk showed significant positive correlation with total leaf area, girth at collar and length of taproot, but no significant correlation with other seedling characters. Average number of nuts per bunch and total yield of dry nuts per tree were not showing any significant correlation with any of the seedling characters.

In Kottarakara-27, canopy size, girth of trunk and total yield of dry nuts per tree were not showing any

significant correlation with any of the seedling characters. The average number of nuts per bunch showed negative significant correlation with seedling height, total leaf area, girth at collar and length of taproot but no significant correlation with germination percentage, number of leaves and length of internodes.

ii) Correlation between characters of mother tree and seedling vigour

Girth of trunk showed significant positive correlation with seedling vigour in Kottarakara-1. In Kottarakara-27, the average number of nuts bunch showed negative significant correlation with seedling vigour. There was no significant correlation between other mother tree characters and seedling vigour in both types.

iii) Correlation between characters of seednut and seedling

In Kottarakara-1, volume of nut showed negative significant correlation with number of leaves, but it had no significant correlation with other characters of seedling. Weight of kernel was significantly and negatively correlated with number of leaves, total leaf area and length of taproot. Volume of kernel showed negative significant correlation with number of leaves and length of taproot, weight of the nut had

no significant correlation with the seedling characters studied.

In Kottarakara-27, weight of nut, showed significant negative correlation with germination percentage but no significant correlation with other seedling characters. Volume of nut, weight of kernel and volume of kernel showed significant negative correlation with germination percentage and significant positive correlation with length of internodes. There was no significant correlation for these three characters with the other seedling characters.

iv) Correlation between characters of seednut and seedling vigour

The seednut character showed no significant correlation with seedling vigour in both types.

v) Correlation between characters of seedling

In Kottarakara-1, the germination percentage of nuts showed no significant correlation with any of the seedling characters studied. But in Kottarakara-27, germination of nuts showed significant negative correlation with length of internodes and girth at collar. Seedling height recorded high positive correlation with number of leaves, total leaf area, length of internodes and girth at collar in both the types. Only Kottarakara-27 showed significant positive

correlation between seedling height and length of taproot. In both the types, number of leaves showed significant positive correlation with total leaf area, girth at collar and length of taproot, but no significant correlation with length of internodes. Total leaf area was positively correlated with girth at collar and length of taproot in both cases. Kottarakara-27 showed significant positive correlation between total leaf area and length of internodes. In Kottarakara-1, the length of internodes showed no significant correlation with girth at collar and length of taproot whereas in Kottarakara-27 there was high positive correlation of length of internodes with girth at collar and length of taproot. Girth at collar showed significant positive correlation with total leaf area and length of taproot in both cases.

DISCUSSION

DISCUSSION

The variation in a plant population is governed by genetic as well as environmental causes. Genetic variability is the basis for selection. Large amount of genetic variability exists in a cross-pollinated perennial crop like cashew which provides ample scope for selection in mother trees, seednuts and seedlings.

The present investigation is conducted with the objective of formulating an efficient method of evaluation of mother trees and their seedling progenies in cashew for large scale production of quality seed materials. For this purpose nursery was raised using seednuts collected from two cashew types namely Kottarakara-1 and Kottarakara-27. Morphological observations were taken on mother tree, seednut and seedling characters of the two types. The results obtained are discussed in the following section in the light of information already available.

Studies on mother trees

Of the four characters studied in the two cashew types namely canopy size, girth of trunk, average number of nuts per bunch and total yield of drynuts per tree,

high variability was noted only in total yield of drynuts per tree (Table 1 and 2). Variability in the other three characters was nominal ranging from 13.28 per cent to 35.86 per cent. Of the two types studied, Kottarakara-27 showed high variability in total nut yield with 76.97 per cent over 60.41 per cent found in Kottarakara-1. But in the other three characters studied, Kottarakara- 1 was having higher variability over Kottarakara-27. Such large variation in economic characters like nut yield of the mother trees of cashew was reported earlier by Rao and Rao (1953), Venkataraman (1979) and Ramadas and Thatham (1981). Monohar et al. (1975) reported such variability in yield in grapes and Satyabalan et al.(1972) in coconut.

On comparing mean data of the two mother tree types, it was found that only in canopy size they differed significantly. Kottarakara-27 was having a larger canopy (Table 3). Murthy et al.(1975) have reported such variation in plant spread in cashew. In respect of other mother tree characters both types were on par.

Studies on seednuts

A comparison of individual trees within the types revealed that the variation for the seednut characters studied such as weight and volume of nut and kernel was nominal. There was significant difference between the

two types with regard to these characters. Kottarakara-27 was found to be significantly superior to Kottarakara-1 in all the above characters. Many workers have reported the superiority of medium sized nuts over large and small nuts for the production of vigorous seedling in cashew (Patel, 1932; Rao et al, 1957; Aiyadurai, 1966 and Ibikunle and Komolafe, 1973). But in the present study no such correlation could be identified between the seednut characters and seedling vigour within types. This may be due to the fact that only plump seednuts obtained by water immersion technique were selected from each mother tree for raising the nursery. But the difference in seednut characters between the two types was clearly reflected in the total recovery of vigorous seedlings from each type. While Kottarakara- 1 has produced only 33.5 per cent vigorous seedlings, Kottarakara-27 has produced 42.83 per cent of such seedlings (Table 22). Several workers have reported that large sized seeds gave more number of vigorous seedlings (Hewston, 1964 in vegetables; Halsey, 1969 in tomato, Gelmond, 1971 in lettuce; Hume et al, 1946 in mangosteen, Purcelean, 1956 in walnut; Reddy, 1962 in papaya and Bavappa and Abraham , 1961 in arecanut). Hence the results of the present study

are in agreement with the findings that bigger and heavier seednuts produce more vigorous seedlings.

Studies on seedlings

The seedling characters studied include germination percentage, seedling height, number of leaves, total leaf area, length of internodes, girth at collar and length of tap root.

Germination of nuts

The nuts started germination on the 15th day of sowing and completed by the 27th day. The coefficient of variation for germination percentage was 16.51 per cent in Kottarakara-1 and 16.21 per cent in Kottarakara-27. This variation is only nominal (Table 8 and 9). There was no significant difference between the three yield groups in both types in respect of germination of nuts (Table 12 and 13). Similar was the case with the two types also. (Table 14). Earlier workers have reported that in cashew large nuts and nuts of high specific gravity gave better germination and more vigorous seedlings (Turner, 1956; Auckland, 1961; Sriram, 1970; Ascenso and Milheiro, 1971 and Menon et al., 1979) In the present study no positive correlation was obtained between seednut, kernel size or weight with germination percentage. This is logical since the variation in nut characters was minimum because of the selection practiced earlier in collecting the seed material from each

tree. But there was significant difference in nut characters between the two types. The superiority of Kottarakara-27 in the nut characters was clearly reflected in the larger recovery of vigorous seedlings from that type (Table 22). Hence the results of the present study are partially in agreement with earlier findings.

Growth parameters

Among the different seedling characters studied, number of leaves, total leaf area and length of internodes showed high variability in both types. Total leaf area recorded the maximum variability of 69.70 per cent in Kottarakara-1 and 68.82 per cent in Kottarakara-27. Regarding the number of leaves the coefficient of variation was 51.92 per cent and 51.38 per cent in Kottarakara-27 and Kottarakara-1 respectively. The coefficient of variation for length of internodes was 52.90 per cent in Kottarakara-1 and 48.13 per cent in Kottarakara-27. Gopikumar and Aravindakshan (1979) also obtained high variation for the inter nodal length of cashew seedlings. Regarding other characters such as seedling height, girth at collar and length of taproot, the variation was very nominal. The least variable parameter was the girth at collar of seedlings (24.60 per cent in Kottarakara-1 and 20.10 per cent in Kottarakara-27). Gopikumar and Aravindakshan (1979) also obtained similar results for girth at collar of seedlings.

There was significant difference for height, number of leaves, total leaf area, length of internodes, girth at collar and length of tap root of the seedlings between the individual trees of both types (Table 10 and 11). The three yield groups of both types did not differ significantly in any of the above mentioned characters (Table 12 and 13). From figure 1 and 2 it is evident that there was a parallelism in progressive increase in height during the first nine month among the different yield groups of the two types. However, there was significant difference between the two types in respect of these seedling characters (Table 14). Kottarakara-1 was significantly superior to Kottarakara-27 in respect of seedling height, number of leaves and total leaf area where as Kottarakara-27 showed significant superiority over Kottarakara-1 in respect of girth at collar and length of tap root (Table 14). Similar reports on variability of seedling characters have been made by McKay and Crane (1956) in chestnut, Gopikumar et al.(1979) in cashew and Sahasranaman (1962) in coconut.

Seedling vigour

Five growth parameters such as seedling height, total leaf area, length of internodes, girth at collar and length of taproot were used for finding out the seedling vigour index. Such a study has not been undertaken

so far in cashew. The maximum index score for a seedling was 15 and the minimum five. Thus seedlings giving an index score above the midvalue (11) were identified as vigorous seedlings. In recovery of vigorous seedlings, Kottarakara-27 was found to be significantly superior to Kottarakara-1 (Table -22). The superiority of seednut in Kottarakara-27 is seen reflected in the recovery of vigorous seedlings. The coefficient of variation for seedling vigour was 28.50 per cent in Kottarakara-1 and 29.02 per cent in Kottarakara-27 (Table 8 and 9). The seedlings of individual trees differed significantly in respect of seedling vigour in both types (Table 10 and 11). The selection of seedlings based on seedling characters have been reported by Nayar (1979) in cashew, Pankajakshan and George Minnie (1961), Sahasranaman (1962) and Kannan and Nambiar (1979) in coconut. The present study indicates the possibility of identifying prepotent trees with in the types based on seedling characters. But the real merit of such prepotent trees could be confirmed only through adult progeny analysis. The existence of the phenomenon of prepotency has been proved in crops like coconut (Harland, 1957; Ninan and Pankajakshan, 1961, Liyanage, 1967; and Iyer et al. 1981). From his study on cashew, Northwood (1967) concluded that trees grown

from nuts of higher specific gravity gave early growth and superior yield during the first three harvest years. When the trees were five years old, the difference was found to be small. Similarly Hewston (1964) found that many vegetable species almost invariably produce large seedlings, when grown from larger seeds, but in the field such difference usually disappeared within the first few weeks of growth. The present study indicates the possibility of utilising the large variability exhibited by seedling progenies from individual trees in cashew for screening them for vigour and to identify prepotent mother trees. But the results could be confirmed only through adult progeny analysis.

Prepotency studies

Recovery of vigorous seedlings from different yield groups

From the present investigation it is seen that medium yielding group gave maximum recovery of vigorous seedlings in both types. The medium yielding group of Kottarakara-27 gave 46.59 per cent and Kottarakara-1 35 per cent recovery of vigorous seedlings. The high yielding group of Kottarakara-27 gave 40 per cent and Kottarakara- 1 gave 33.33 per cent recovery of vigorous seedlings. The lowest recovery was from the low yielding group being 28 per cent in Kottarakara-27 and 30 per cent

in Kottarakara-1 (Table 22).

Chi-square test revealed that the three yield groups of Kottarakara-27 differed significantly in the recovery of vigorous seedlings. It was also noted that there was significant difference between the two types in respect of recovery of vigorous seedlings. Kottarakara-27 with a total recovery of 42.83 per cent was significantly superior to Kottarakara-1 which gave only 33.50 per cent recovery. These results indicate the superiority of certain cashew types over others in the capacity to produce more vigorous seedlings. Another important finding was that among the three yield groups studied the medium and high yielding groups were giving larger percentage of recovery of vigorous seedlings. In the present study the minimum nut yield per tree for selecting the medium yielding mother tree in Kottarakara-27 was fixed as 1.030 kg. Hence we can fix 1 kg per tree as the minimum yielding standard for selecting mother trees in Kottarakara-27. But the finding that among the two types studied Kottarakara-27 was giving significantly higher percentage of recovery of vigorous seedlings suggests that such limits will vary according to the types.

Identification of prepotent trees

Based on the percentage of recovery of vigorous seedlings from each tree, prepotent trees were identified for each type. Altogether there were 15 and 16 prepotent trees in Kottarakara-1 and Kottarakara-27 respectively. There was no significant difference among the three yield groups in the recovery of prepotent trees in both the types. Though Kottarakara-27 showed its superiority in a smaller scale, there was no significant difference between the two types in respect of recovery of prepotent trees also. This may be due to the fact that the frequency of superior genotypes in any cross-pollinated population was constant. But the degree of superiority may be varying in different populations. Hence the first step in identifying superior mother trees in cashew should be the selection of superior types. The selection of prepotent mother trees should be limited within such superior types. The possibility of identifying such prepotent trees based on seedling vigour has been reported by Ninan and Pankajakshan (1961) in coconut. But no such work has been seen done previously in cashew.

From the present investigation it is clear that all high yielders are not prepotent and individual trees differ in their genetic superiority to transmit desirable

characters to the progeny. Similar reports have been made by Harland (1957) in coconut and Bavappa and Ramachander (1967) in arecanut. The existence of prepotency has been reported earlier by Gopikumar et al. (1979) in cashew, Ninan and Pankajakashan (1961), Satyabalan et al.(1975) and Iyer et al. (1981), in coconut and Bavappa and Ramachander (1967) in Arecanut.

The major finding on which the present study is based is that the prepotency of a mother tree is expressed in the greater recovery of vigorous seedlings from it (Liyanage, 1953 and Satyabalan et al, 1975 in coconut). On that same principle, in cashew also, we could identify prepotent trees based on recovery of vigorous seedlings from individual trees under each type. In the present study 16 such prepotent trees were identified in Kottarakara-27 and 15 in Kottarakara-1. But the superior performance of the progeny of such trees in future could be confirmed only through adult progeny analysis. Such an adult progeny analysis is recommended as a future line of work in cashew.

Correlation studies

Correlation studies between the characters of mother tree revealed that there was significant positive correlation between canopy size and girth of trunk in both types.

No significant correlation could be obtained between the yield of nuts and other mother tree characters. Earlier workers have got significant relationship for yield with girth and spread in cashew (Nayar 1979). The contrary results in the present study may be due to the fact that major proportion of trees included in the study was under the medium and low yielding groups.

In general there was no significant correlation between characters of mother tree and seednut except for yield with weight and volume of kernel in Kottarakara-27 which was negative in expression. This is expected since high yield is always associated with smaller size of the individual produce.

Correlation studies between mother tree characters and seedling characters revealed that during the 3rd month of seedling growth, girth of trunk showed positive significant correlations with seedling height and total leaf area in Kottarakara-1. During the 9th month of seedling growth, girth of trunk showed significant positive correlation with total leaf area, girth at collar, length of taproot and seedling vigour in Kottarakara-1. This result suggests that while selecting mother trees in

cashew, girth of trunk should be considered as an important criterion. During the 9th month of seedling growth, the average number of nuts per bunch showed negative significant correlation with total leaf area, girth at collar and length of taproot in Kottarakara-27. This may be due to the fact that when average number of nuts per bunch increased the individual size and weight of the nuts decreased and hence the decreased vigour of seedlings as expressed in the decreased leaf area, girth at collar and length of taproot.

In Kottarakara-1, canopy size of the mother tree was significantly and positively correlated with length of taproot. Since length of taproot always indicate the vigour of a seedling it is logical to correlate the canopy size of a mother tree positively with the general vigour of its seedlings. So the present study suggests that canopy size should also be considered as an important criterion for mother tree selection in certain types.

Correlation studies between the characters of seednut have shown that there was high positive significant correlation between weight and volume of nuts and kernels. Gopikumar et al.(1979) also obtained similar associations between weight and volume of nuts. Hence the present

finding is in agreement with earlier results.

Correlation studies between seednut characters and seedling characters revealed that in Kottarakara-27 volume of kernel showed positive significant correlation with seedling height. During the 9th month of seedling growth it was found that there was significant positive correlation for volume of nut, weight and volume of kernel with length of internodes in Kottarakara-27. As length of internodes increases, seedling height also increases and seedling become more vigorous. Gopikumar et al. (1979) also obtained significant positive correlation between volume of nuts and seedling height. Volume of nut, weight and volume of kernel showed significant negative correlation with number of leaves in Kottarakara-1. Weight of kernel showed negative correlation with total leaf area and length of taproot. Volume of kernel also showed negative significant association with length of taproot in Kottarakara-1. Nazeem et al. (1980) reported negative correlation between volume of seeds and seedling characters in jack. This result suggests that selection of nuts based on size or weight may not be a dependable criterion for getting superior seedlings in cashew.

Among the seedling characters studied, significant positive correlation was noted between percentage of

germination and seedling height during the 3rd month in Kottarakara-1, but as seedlings attained nine months age, no significant correlation was noticed between these two characters. This result indicate that the early germination has only a transient effect on the seedling growth in cashew as against the findings in coconut by Jack and Sands (1929).

Seedling height and number of leaves showed significant positive correlation with total leaf area in both types during the 3rd and 9th month of seedling growth. During the 3rd month of seedling growth, in Kottarakara-27 there was significant positive correlation between seedling height and number of leaves. But seedling height showed significant positive correlations with number of leaves, length of internodes and girth at collar in both types during the 9th month of seedling growth. Gopikumar et al. (1979) also reported significant positive correlation for seedling height with number of leaves, length of internodes and girth at collar in cashew. Pankajakshan and George Minnie (1961) reported similar results in coconut. Since all these characters show significant positive correlation with seedling vigour, the height of the cashew seedlings at 3rd month of growth can be taken as a clear indication of seedling vigour. Since cashew seedlings are distributed

for planting during the third month of their growth in the nursery, this finding has got practical uses. If the maximum recovery of vigorous seedlings can be taken as an indication of the genetic potential of a particular tree, screening of cashew seedlings from selected prepotent mother trees of superior types at the 3rd month of their growth based on height can be fixed as a reliable nursery practice for obtaining superior planting materials in cashew.

In the present study the maximum recovery of vigorous seedlings was found to be 46.59 per cent in the superior type. Hence the tallest 50 per cent of seedlings in a three month old cashew nursery raised from seednuts collected from prepotent trees of superior types can be considered as superior planting material. But further testing of the adult progeny is necessary before recommending this as a viable cashew nursery practice.

Studies during the 9th month of seedling growth revealed that in Kottarakara-27, there was significant positive correlation between seedling height and length of taproot. Deep penetrating taproots were always considered as an indication of the inherent vigour and sturdiness of the concerned crop. Already it was seen

that Kottarakara-27 was significantly superior to Kottarakara-1 in this character. From the correlation studies we have seen that superiority of seedlings in this character can be easily identified by noting their height. Hence the present study again indicates the possibility of screening superior seedlings in a cashew nursery on the basis of height.

Number of leaves showed significant positive correlation with total leaf area, girth at collar and length of taproot in both types. In Kottarakara-27 length of internodes recorded positive significant correlation with total leaf area, girth at collar and length of taproot. Total leaf area was positively and significantly correlated with girth at collar and length of taproot in both types and with length of internodes in Kottarakara-27. Girth at collar and length of taproot also showed significant positive correlation in both types. Gopikumar et al.(1979) reported positive significant correlation between length of internodes and girth at collar in cashew.

All these findings in general indicate the close association of the important growth parameters of cashew seedlings in expressing the vigour of the seedlings. It was also noted that cashew types differ significantly

in the recovery of vigorous seedlings. Based on the recovery of vigorous seedlings we can identify prepotent mother trees within a superior type. Another important finding from the present study was that the vigour of cashew seedlings can be easily identified by noting the height of the seedlings. It was also noted that this principle of identifying vigorous seedlings by noting their height was not limited to any individual type, but generally applicable to all types.

SUMMARY

SUMMARY

The experiment was conducted with the objective of formulating an efficient method of evaluation of mother trees and their seedling progenies in cashew for large scale production of quality seed materials. Seednuts collected from thirty mother trees each from two types of cashew namely Kottarakara-1 and Kottarakara-27 were used for the study. From the analysis of data collected on characters of mother trees, seednuts and seedling progenies the following findings were obtained.

I. Mother tree characters

1. High variation was noticed in respectof yield in both the cashew types.
2. Low variation was noticed in canopy size of mother trees.
3. The two types used for the study differed significantly in respect of canopy size.
4. Correlation studies revealed that canopy size is positively correlated with girth of trunk. Similarly girth of trunk and seedling vigour showed positive significant correlation. Hence these characters should be considered as important criteria for mother tree selection in cashew.

II. Seednut characters

1. The variation was very low in respect of the seednut characters studied.

2. The two types differed significantly in the seednut characters such as weight and volume of nut and kernel. Kottarakara-27 was superior to Kottarakara- 1 for all the seednut characters.

3. All the seednut characters showed high positive significant correlation among themselves.

4. Selection of nuts based on size or weight is not a dependable criterion for getting superior seedlings in cashew since most of the seednut characters did not show significant association with seedling characters.

III. Seedling progeny analysis

1. The coefficient of variation for germination was very low in both types.

2. There was no significant difference between the three yield groups of the two types in the germination of nuts.

3. The variation for characters such as seedling height, girth at collar, length of taproot and seedling vigour was nominal in both the types.

4. Number of leaves, total leaf area and length of internodes showed high variation in both the types.

5. Individual trees of both the types differed significantly in respect of all the seedling characters as well as seedling vigour.

6. The yield groups did not show any significant difference in the growth parameters and seedling vigour.

7. There was significant difference between the two types in respect of seedling characters. Kottarakara-1 was superior for seedling height, number of leaves and total leaf area whereas Kottarakara-27 was superior for girth at collar and length of taproot.

8. Kottarakara-27 was significantly superior to Kottarakara-1 in terms of recovery of vigorous seedlings. The three yield groups of Kottarakara-27 differed significantly for the recovery of vigorous seedlings.

9. The medium yielding group of both types gave maximum recovery of vigorous seedlings.

10. There was no significant difference between the two types for the recovery of prepotent trees.

11. Seedling height recorded significant positive correlation with the other seedling characters during the 3rd and 9th month of study. Hence height of seedlings can be fixed as a basis for seedling selection in cashew nursery.

IV. General conclusions made

1. Cashew types differed significantly in the recovery of vigorous seedlings. Kottarakara-27 was found to be a superior type.

2. Rigorous screening is to be practiced in the nursery and only vigorous seedlings should be selected for planting.

3. Prepotent trees should be identified based on recovery of vigorous seedlings and from such identified trees, seednuts can be collected for large scale seedling production in cashew.

4. Seedling height during the 3rd month of growth can be considered as an indication of seedling vigour in the nursery and on the basis of this character the tallest 50 per cent seedlings can be considered

as superior planting material, provided the seednuts were selected from prepotent trees of superior types.

5. Adult progeny analysis is necessary to confirm the superiority of prepotent trees identified by seedling progeny analysis.

6. A four stage selection is to be practiced in cashew. First is the selection of superior types among different cashew types available in the germplasm based on the mean recovery of vigorous seedlings per mother tree. Second stage is the identification of prepotent mother trees within the type based on seedling progeny analysis. Seednut selection is the third stage of selection. Small sized and malformed seeds are to be discarded. The final phase of selection is seedling selection. Only the tallest 50 per cent seedlings should be selected.

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* Original not seen.

Appendix- I

Abstract of analysis of variance table for canopy size, girth of trunk, average number of nuts per bunch, total yield, weight of nut, volume of nut, weight of kernel and volume of kernel of Kottarakara-1 and Kottarakara-27

Source	df	Mean square							
		Canopy size	Girth of trunk	Average number of nuts per bunch	Total yield	Weight of nut	Volume of nut	Weight of kernel	Volume of kernel
1	2	3	4	5	6	7	8	9	10
Treatments	1	105.21**	2368.82	3.75	1.32	21.34**	19.95**	2.42**	2.46**
Error	58	3.56	749.00	1.21	2.57	0.66	0.67	0.05	0.06

** Significant at 0.01 level

APPENDIX

Appendix- I

Abstract of analysis of variance table for canopy size, girth of trunk, average number of nuts per bunch, total yield, weight of nut, volume of nut, weight of kernel and volume of kernel of Kottarakara-1 and Kottarakara-27

Source	df	Mean square							
		Canopy size	Girth of trunk	Average number of nuts per bunch	Total yield	Weight of nut	Volume of nut	Weight of kernel	Volume of kernel
1	2	3	4	5	6	7	8	9	10
Treatments	1	105.21**	2368.82	3.75	1.32	21.34**	19.95**	2.42**	2.46**
Error	58	3.56	749.00	1.21	2.57	0.66	0.67	0.05	0.06

** Significant at 0.01 level

Appendix- II

Abstract of analysis of variance table for seedling height, number of leaves, total leaf area, length of internodes, girth at collar, length of taproot and seedling vigour of individual trees of Kottarakara-1

Source	df	Mean square						
		Seedling height	Number of leaves	Total leaf area	Length of internodes	Girth at collar	Length of tap root	Seedling vigour
1	2	3	4	5	6	7	8	9
Treatments	29	2188.27**	1558.41**	8467878.50**	0.54*	2.03**	796.12**	27.98**
Error	570	486.41	450.94	316774.32	0.35	0.76	102.66	6.16

** Significant at 0.01 level

* Significant at 0.05 level

Appendix- III

Abstract of analysis of variance table for seedling height, number of leaves, total leaf area, length of internodes, girth at collar, length of taproot and seedling vigour of individual trees of Kottarakara-27

source	df	Mean square						
		Seedling height	Number of leaves	Total leaf area	Length of internodes	Girth at collar	Length of tap root	Seedling vigour
1	2	3	4	5	6	7	8	9
Treatments	29	2536.44 **	1351.11 **	9111255.65 **	2.06 **	7.33 **	770.66 **	54.86 **
Error	570	232.27	239.44	1484322.09	0.38	3.27	100.69	5.58

** Significant at 0.01 level

APPENDIX - IV

Abstract of analysis of variance table for seven characters of the seedling and seedling vigour of yield groups and types

Source	df	Mean square							
		Germination per centage	Seedling height	Number of leaves	Total leaf area	Length of internodes	Girth at collar	Length of tap root	Seedling vigour
1	2	3	4	5	6	7	8	9	10
Yield groups adjusted	2	152.50	19.45	17.00	169248.32	0.14	0.02	8.46	0.80
Types unadjusted	1	342.49	3980.62 *	1728.06 *	8600822.73 *	0.001	2.32 *	398.83 *	2.61
Yield groups unadjusted	2	132.57	29.90	2.27	32726.14	0.13	0.04	18.27	1.16
Types adjusted	1	382.35	3959.72 *	1757.52 *	8873867.09 *	0.01	2.29 *	374.20 *	1.89
Error	56	171.75	120.66	76.01	449841.11	0.06	0.13	40.83	2.14

* Significant at 0.05 level.

SEEDLING PROGENY ANALYSIS IN SELECTED CASHEW *(Anacardium occidentale L.)* TYPES

BY

SUSAMMA P. GEORGE

ABSTRACT OF THE THESIS

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ABSTRACT

Seedling progeny analysis of two different types of cashew namely Kottarakara-1 and Kottarakara-27 was done by raising nursery of seednuts collected from 30 mother trees each from the two types. The experiment was conducted at College of Agriculture, Vellayani during 1981-82.

From the analysis of data on mother tree characters, it was found that the two types did not differ significantly in yield per tree. They differed in respect of canopy size. There was high variation between the individual trees in yield for both types.

The analysis of seednut characters revealed that the two types differed significantly in respect of weight and volume of nut and kernel. Kottarakara-27 was found to be superior to Kottarakara-1. This superiority of seednut characters of Kottarakara-27 was reflected in the recovery of vigorous seedlings also.

The seednut characters showed positive significant correlation among themselves.

Analysis of seedling characters revealed that Kottarakara-1 was superior to Kottarakara-27 for seedling height,

number of leaves and total leaf area, but Kottarakara-27 was superior for girth at collar and length of tap root.

Individual trees of both types differed significantly in the seedling characters and seedling vigour but the three yield groups did not show any significant difference.

Kottarakara-27 was found to be significantly superior to Kottarakara- 1 in the percentage of recovery of vigorous seedlings.

In both the types the medium yielding group registered more recovery of vigorous seedlings.

There was no significant difference between the two types in the recovery of prepotent trees.

Correlation studies revealed that girth of trunk and seedling vigour showed significant positive correlation in Kottarakara-1. Canopy size was positively correlated with girth of trunk. Hence these two characters can be considered as important criteria for mother tree selection.

Seedling height showed significant positive correlation with most of the other seedling characters studied during the 3rd and 9th month of growth. Hence seedling height can be considered as an indication of seedling vigour.

Tallest 50 per cent seedlings in the nursery can be considered as superior planting material.

Based on seedling progeny analysis prepotent trees can be identified. But adult progeny analysis is essential to confirm the above results.