PROGENY STUDIES IN WEST COAST TALL COCONUT PALMS OF DIFFERENT YIELD GROUPS

BY
M. BINDU

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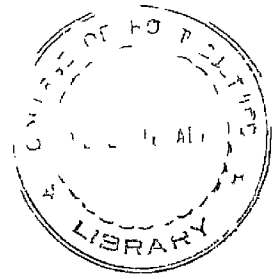

DECLARATION

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

Bindu M

Vellayani,
18-9-1982.

BINDU M

C E R T I F I C A T E

Certified that this thesis, entitled "Progeny studies in West Coast Tall coconutpalms of different yield groups", is a record of research work done independently by Kum. BINDU. M. Under my guidance and supervision and that it has not formed previously the basis for the award of any degree, fellowship or associateship to her.

K. Gopakumar

K.GOPAKUMAR
(Associate Professor,
Department of Plant Breeding)
CHAIRMAN
ADVISORY COMMITTEE

College of Agriculture,
Vellayani.
18-9-1982.

APPROVED BY

CHAIRMAN

SHRI. K. GOPAKUMAR

MEMBERS

1. Dr. P.MANIKANTAN NAIR

2. ~~SHRI. YAGEEN THOMAS~~ Dr K C George

3. SHRI. E.P. KOSHY

EXTERNAL EXAMINER

16/11/93

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Bindu. M

BINDU. M.

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INTRODUCTION

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The bounds of benefit, that could be resolved through the application of breeding methodology on crop communities, are expanding day by day. For the sake of convenience, in inducing advantageous rectification of identified defects and deficiencies, it is established vital to categorize such communities into identifiable aggregates, based on scientifically explainable specific criteria. Two such major categories of importance, made in this context, are the one comprised, exclusively, of annuals and seasonals, referred to popularly as the field crops, and the other of the perennials.

An established list of breeding methodology, consisting of crop introduction, selection, combination breeding, and breeding for mutations, polyploidy and heterosis, is being considered routinely for developing a desirably ideal and stable community that maintains its identity through generations alongwith the possession of adequate flexibility that enables the class to withstand favourably the adverse impulses originating as a consequence to the unavoidable exposure of the constituent

individuals to changing environment, so as to prevent total extinction from setting in. However, making of a proper choice of a particular method or a combination of methods as detailed above, needs a sensible and logical consideration of the category to which the crop concerned belongs, whether it is a perennial or field crop. Perennials, as a rule, owing to the presence of a considerable proportion of limitations that are mainly accountable towards their relatively prolonged life cycle and span of life, and due to the difficulties that make the adoption of particular methods for imparting changes felt as desired, call for an entirely different approach as against crops belonging to the other category. In this study, an appraisal of a chosen approach, involving a Systematic Pedigree Progeny Analysis, in the coconutpalm is made.

Among the vast diversity of perennial crops that are being cultivated in Kerala, the coconutpalm (Cocos nucifera Linn.) undoubtedly, is the most important from the economic point of view. As compared to several other crops, of importance in the state, particularly the seasonals and annuals, in this crop, varietal diversity is relatively scarce. The two predominant varieties,

referred to often, are the Talls and the Dwarfs. The crop, in general, exhibits a highly specific adaptation requirement, their normal growth and performance being confined exclusively to the tropics, preferably to the coastal belts where there is availability in plenty of rainfall. It does not tolerate higher altitude even in the tropics. Sub communities in this crop, within the varieties mentioned above, identifiable on the basis of the size of the fruit, which is referred to popularly as the nut, and the intensity and distribution of pigment coloured other than green, on various parts that constitute the crown, are recognised. Further, the crop being in cultivation for a prolonged period, in significantly diverse ecogeographic pockets, along the coconut growing tract, seems to have established itself into reasonably stable and distinctly identifiable subcommunity level forms or types already.

The form that is popular predominantly in the Western coast of the peninsular India, that includes the coastal belt of Kerala also, is the WEST COAST TALL.

The crop is classed essentially as a crosspollinated one, and naturally, one has to expect prevalence among individuals in any population, of a comparatively higher order of heterozygosity, in respect of a considerable majority of genes. Further, being a crop that is essentially seed propagated, as a consequence, a distinctly high rate of segregation is seen to be expressed in the seedling progeny population. Of the segregants, some may prove themselves, in later life, to be superior, sometimes superior even to the maternal parent from which the seednuts were procured, or economically inferior. The predominant role that the element of chance plays in this regard, is often found to be the root cause of the apparent performance deterioration of individuals in several coconut gardens. This is indeed, felt to be a serious drawback that calls for imminent attention, and implementation of effective remedial measures. One can find out a potentially effective solution in the identification of individual palms, that could be advantageously relied upon for the recovery of a significantly advantageous proportion of vigorous progeny, that promises a later stage performance superiority. An effort is made, in this investigation, to gather informations to

make a recommendation that facilitates realisation of this felt benefit.

It has been established already, that in coconut culture, an effective enhancement in the performance standard could be induced through systematic adherence to the procedure presented in a Multiple Level Selection Schedule. Accordingly, initial selection is made in favour of motherpalms, based on accepted norms of suitability. Further, selection among the seednuts, again, based on prescribed norms, is followed, and as the final and last phase ordeal, a more severe selection is recommended among the seedling progeny in the nursery, as a consequence of which, a discrimination could be made between the promising and the less promising ones. By restricting transplantation, to the promising seedlings alone, it is found that appreciably encouraging effects, could be realised.

The performance proper, of palms belonging to the category of WEST COAST TALL, seems to manifest difference, not only from the ecogeographically diverse pocket to pocket, but among trees within the same garden and also among the progeny evolved from a common mother parent. During the study, a categorization of the 50 palms belonging to the same age group of 25 years, chosen at random,

from among those maintained in the premises of the Coconut Research Station at Balaramapuram, was made as follows. Low yielders, that gave an annual per tree nutyield of below 80, Medium yielders that represented a class characterized by a range between 80 and 120, and High yielders, consisting of palms that gave a value above 120, based on the information pertaining to records on the past five years' nutyield, formed the three categories.

The observations made use of for drawing the required conclusions were made during the period February 1981-June 1982.

A multiple criteria approach that facilitated the formulation of a value that represented numerically the seedling vigour index, was chosen for identifying the better from the poorer among the seedling progeny. Further, motherpalms that produced a relatively greater proportion of vigorous seedlings were identified, and the dependence of the motherpalm attributes to the corresponding value for the seedling vigour index was tested. So, in general, the experiment was arranged particularly for the purpose of introducing a dependable

guideline for effecting an overall improvement in the performance standard of coconutpalms of type, WEST COAST TALL belonging to different nutyield categories, as already pointed out earlier.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

In the overall improvement of the coconutpalm, the vital importance of selection made in respect of the motherpalm as well as the seedling progeny, has attained unquestionable recognition. Work done on this aspect, in the major coconut growing countries like India, Ceylon and Philippines, establish the need for a scientifically based selection procedure involving two major aspects, selection of the suited motherpalm followed by further selection among its progeny. Since, a similar approach constitutes the salient feature of the present study, a review of the reports on research already made in this context is being attempted.

1. On the Inheritance and Association of characters in coconut

Being a perennial by nature, the information available on the inheritance of characters in this crop is comparatively scanty. Further, information is available, though not in plenty, but to certain extent, on the association of characters tested at different levels as given under.

i. Among motherpalm attributes,

ii. Among seedling progeny attributes, and

iii. Between motherpalm attributes and those of the seedling progeny population.

Inheritance of characters

Lakshmanachar(1959) appears to be the first worker on coconut research, to commit a statement that the yield factor is governed largely by heredity. He attempted to compute the value for this attribute among different cultivars, and found that it varied from 0.49 to 0.62. This, according to him, is a positive evidence that substantiates the expression of variability by this estimate.

Liyanage(1962) reported the presence of varied proportion of variation, in terms of expressed and readable characters, among palms, irrespective of whether they belong to the same cultivar or not. He studied, in this context, vegetative as well as nut characters. The computed heritability values for number of bunches produced by a palm in an year, number of nuts per bunch, weight per husked nut, number of female flowers per bunch, and fruitsetting percentage were 0.47, 0.52, 0.95, 0.52 and 0.81 respectively. Further, he pointed out the possible

scope for exercising selection in favour of characters, particularly those with higher values for heritability.

Nambiar et al.(1970) resorted to a yet different approach for the computation of the heritability values among palms of the West Coast Tall variety. They employed the Parent-Progeny Regression Estimation Procedure for the purpose, and made an analysis in respect of the following ten characters.

i. Number of bunches emerged,
ii. Total number of female flowers,
iii. Total number of spikes,
iv. Number of sterile spikes,
v. Number of spikes with one female flower,
vi. Number of spikes with two female flowers,
vii. Number of spikes with more than two female flowers,
viii. Number of female flowers per spike,
ix. Number of female flowers set (yield as number of nuts), and
x. Percentage of female flowers set.

The heritability values were found to be low, for number of bunches emerged, total number of spikes, number of spikes with one female flower, number of sterile spikes, number of spikes with more than two female flowers, and

number of female flowers per spike. High heritability estimates were recorded for the remaining characters, total number of female flowers, number of spikes with two female flowers, number of female flowers set and the percentage of female flowers set. From these values obtained, it is apparent, that perceptibly distinct variation did occur between the characters. Further, they recommend, that better effectiveness of selection could be resolved through a programme, in which more weightage is purposely attributed to the variable identified as relatively more important on the basis of the values computed for heritability.

Association of characters

Patel(1938) observed significant and high positive values for correlation between yield and length of stem, and yield and number of leaves in the crown. On this basis, he proposed that the two characters, length of stem and number of leaves in the crown could be considered to serve fruitfully as dependable criteria in motherpalm selection. In addition, he observed that seednuts from bunches bearing on an average, twelve or more nuts, germinated more rapidly than those from bunches with a lesser

number of fruits. Further, seednuts that weighed 680 g and more, exhibited a statistically significant increased percentage for germination.

Liyanage(1955) reported that significantly high positive correlation existed between the earliness in the sprouting of nuts and the initiation of blooming in palms. The value for the coefficient of correlation was +0.44. In addition, that between delay in sprouting and the yield factor of the palm was found to be, though high, negative (-0.42). These observations were the basis for his making a recommendation in favour of assigning the benefit of selection exclusively to seedlings developed from seednuts germinated earlier, in the context of effecting crop improvement in coconut.

Pankajakshan and George(1961) studied the relative importance and interdependance of girth, height and number of leaves in a population of one year old seedlings of coconut, variety West Coast Tall. They found that the height and number of leaves were independent absolutely of each other. However, girth of collar was significantly and positively correlated with the two characters mentioned above. Further, they found, that the variation in the girth is influenced to the extent of 60 per cent by the

combined effect of height and number of leaves.

Liyanage(1962) found that yield of nuts and yield of copra were genetically correlated to the extent of +0.79, while the value for that between the time taken for bearing initiation, and yield of copra was as high as 0.81 but the sign was negative. Hence, earliness in flowering, and production of a greater number of nuts, were identified as effective criteria for selection for attaining superior later progeny performance in terms of copra recovery.

Satyabalan et al.(1969) reported that the production of spadices was more in palms that bear regularly. The presence of significantly positive correlation was observed between the yield, and the female flower production in palms that were classified according to their nutyield, and expressed regularity in bearing.

Nampoothiri et al.(1975) reported the results of estimation of phenotypic and genotypic correlations of yield with four seedling characters ie., time taken for germination, number of leaves of the seedling, girth of collar, and height of the seedling, and four adult palm

characters ie. time taken for flowering, the number of flowering leaf axils, spathe production and number of female flowers. Girth of collar was the only seedling character that showed a significant phenotypic correlation with yield. Among the adult palm characters, number of spathes, and female flowers, were found to be strongly and positively correlated with the yield factor. Higher positive genotypic correlations were observed between the girth and number of leaves in the seedling, spathe production and yield, and number of female flowers and yield.

Balingasa and Carpio(1977) studied six tall and two dwarf populations in coconut. They reported that an inverse relationship existed between the number of female flowers and the percentage of fruit set.

2. Selection of Motherpalms

Jack(1930) pointed out that in coconut, if carefully conducted, the method of selection can lead to appreciably noteworthy results. He estimated that by motherpalm selection alone, the first generation performance could be enhanced to the order of 25 to 35%, irrespective of any knowledge or identity of the pollen parent. In both cases,

occurrence of variation for a multitude of characters among the progeny will have to be anticipated.

Pieris(1934) from his observations, specified the following points as reliable and important for selection.

a. Stout straight stem with closely spaced leaf scars,

b. Short and well oriented fronds in the crown which itself should carry a larger number of leaves and inflorescences,

c. Short bunch stalks having no tendency to droop, and

d. Good number of female flowers in each inflorescence preferably a number ranging upto 100.

Umali(1940) observed that palms bearing on an average, 50 or more female flowers per rachilla, with a percentage value of fruitset of 35 or more, were likely to yield a relatively higher proportion of quality seedlings that germinated earlier and assured superior later stage performance.

Liyanage(1953) stated that by motherpalm selection alone an additional 50 per cent efficiency could be obtained, though this benefit could be raised even upto 90 per cent or above, by confining growth of these selected palms in isolation and by permitting natural interpollination to occur among the individuals of the selected palm

population exclusively.

Harland(1957) introduced the expression PREPOTENT, to qualify a palm capable of transmitting favourably the established increased yield potential to the progeny, even under conditions of random pollination. Further, it was proposed that palms could be of two distinct types genetically - a type consisting of virtually heterozygous palms that maintain the hybrid phase, and the other, by virtue of their possessing a relatively greater number of dominant genes favourable in this context, ensuring recovery of a satisfactory proportion of superior progeny. It was the palm belonging to the second category that was referred to as prepotent. Harland, further suggested the possibility of identification of such prepotent palms, from among individuals of a community, through a biometrically scheduled comparison incorporating an adequately large number of open pollinated progeny. Palms identified to be prepotent on the basis of the progeny analysis, as referred to as above, could be used either as recognised potent sources of seednuts through controlled pollination, or otherwise, and also, as elite sources of pollen, in making available seednuts through hybridization.

Marar(1960) recommended confining selection of motherpalms on specified norms, to gardens in reputed coconut growing areas alone. Only superior yielders, giving per tree mean nutyield of around 100 per year, with regularity in bearing, maintaining visually recognizable healthy and vigorous looks, characterized by thickset spherical crowns, short thick leafstalks and stout bunchstalks and medium sized, nearly round nuts. Trees growing in specifically favourable stray environmental pockets and those producing barren nuts should be eliminated.

Marar and Shambhu(1961) suggested a simpler method to facilitate initial screening of motherpalms by noticing the posture of seednuts floated on water. Those that remained vertically erect were found to develop into more vigorous seedlings than those that remained oblique or horizontal.

Liyanage(1962) proposed inclusion of characters like number of bunches produced per year, number of nuts per bunch, weight per husked nut, number of female flowers per bunch and setting percentage, while formulating a satisfactory complement of reliable criteria for motherpalm

selection in coconut. Earliness in bearing initiation and yield of nuts were prescribed, in addition, as valid criteria, in this regard, especially, when an increase in copra production is expected of the progeny. He was the first to rely upon a Multiple Criteria Approach for effecting selection of motherpalms in a more scientific and dependable manner. Accordingly, a schedule for the formula of the said index was arrived at as follows:

$$I = X_1 - 14.70\ X_2 - 4.47\ X_3$$ where,

X_1 = number of nuts per palm per year,

X_2 = weight per husked nut (lbs)

X_3 = flowering period of palm (months)

Pankajakshan et al.(1963) recommended selection of palms characterized by a higher value for the mean of the quantified yield factor with a low and steady value for standard deviation, as requirementally more suited, since the average annual yield and the consistency of performance of the palms were equally important and relevant under the context concerned. Further, they pointed out that a percentage increase in efficiency to 79 could be achieved in the selection of motherpalms by restricting selection to the best 10 per cent palms in a standing population.

This attained benefit, in terms of percentage, could be enhanced to even 100 per cent, if the proportion of palms selected initially was restricted to a still lower percentage of around 5. These findings were reported on the basis of a study conducted for a continuous period of four years.

Liyanage(1964) conducted mass selection on a sample of 104 individuals, in favour of nutweight, and selected the best 10 per cent, and consequently genetic gain to the extent of 12.8 per cent was attained. The total number of leaves produced during the first 40 months, and yield of nuts at the 13th to 14th year, exhibited significant positive correlations. Hence the leaf production, expressed numerically during the early growth period of the palm, is believed to serve advantageously in assessing the future yield.

Liyanage(1967) substantiated, in addition, the effectiveness of mass selection based on the observations made on the progenies of the 104 unselected seed parents. The phenotypically best 5 per cent of the parent populatio yielded progeny that gave an additional 14 per cent yield compared to the value for the overall progeny population mean.

Zuniga et al.(1969) selected potentially high yielders in three coconut plantations. They put forward recommendation in favour of a three year yield study, sufficient to predict the yield potential of parent palms, provided only 5-10 per cent of the best trees are selected.

Manthriratna(1970) recommended selection of seed parents on the basis of increased weight of husked nuts, followed by a more rigorous selection of seedlings in the nursery, so as to obtain a substantial increase in yield from the progeny.

Abeywardena(1970) suggested measures to improve the calibration of coconut experiments. A scrutiny of the pre-experimental yield of the palms was recommended as an inevitable measure. Using the information as a calibrating variate, the experimental error can be reduced by 30 to 50 per cent. Further, a survey of the pre-experimental yield pertaining to two years could enhance the degree of accuracy to greater perfection than what has been the case with a single year's data.

Nambiar et al.(1970) observed that in coconut, increased stability in yield could be brought about by practising selection for larger number of spikes with one or two female flowers since excessive number of female

flowers in the inflorescence had been noticed to lead to a serious reduction in the setting of nuts and causing irregularity in the bearing habit. Selection for high setting percentage of female flowers, that has been identified to maintain a higher value for heritability, is felt to be of utility for improving the yield of the palm to a considerably high extent.

Nambiar and Nambiar(1970) revealed, in an analysis of crosses involving parents of six different yield groups, the existence of substantial additive genetic variation for characters believed to be influencing yield. Progeny obtained from elite pollen were found to be superior in all the characters studied, to those from open pollinated or inbred crosses. Hence the possibility of upgrading low yielding groups by the use of elite pollen was justified.

Thampan(1971) enumerated the criteria for motherpalm selection as yield, nut characters, size and arrangement of the fronds, short inflorescence stalk and age of the palm.

Liyanage(1972) proposed a rapid and easy method of identifying prepotent palms based on the mean number of leaves per plant in the month following transplanting of

the seedling. According to him, prepotent palms have to have more number of leaves, as the leaf production rate was found to be closely and directly related to the yield potential of the individual.

Bavappa et al.(1973) studied genetic divergence among open pollinated progenies of West Coast Tall and its hybrids with Dwarf Green. Characters that contributed maximum towards genetic divergence were identified - setting percentage, female flower production, length of leaves, number of functioning leaves, height of stem and number of leaf scars per metre length of the stem. Hence these characters were felt to be of worth in practising selection of motherpalms.

Nampoothiri et al.(1975) suggested the time taken for flowering initiation, production of spathes, and female flowers as worthwhile characters for adult palm selection. A proper distribution of the female flowers in the inflores cence is emphasized to be desirable, since only one or two female flowers per spike, lead to successful setting of fruits.

Kannan and Nambiar(1979) conducted studies on motherpalm and seedling selection in coconut. The palms

studied belonged to three groups - high yielders represented by palms with an annual yield of 80 nuts and above, low yielders yielding 20 nuts and below, and a bulk group consisting of palms selected at random. Characters, like age at first flowering, number of female flowers, setting percentage, nutyield, weight per husked nut, copra content per nut, and annual copra yield, were studied using the adult progeny of the palms. The results showed that the progeny of high yielding and bulk parents were the superior ones in the lot. Palms giving less than 20 nuts per annum hence proved themselves to be definitely unsuitable as seed parents.

Progeny Studies in Coconut

Mendiola(1926) suggested, that overall improvement in coconut could be resolved through deliberate direction of selection in favour of seednuts for the purpose of beneficially superior later performance.

Pieris(1937) reported that horizontal planting of seednuts with the widest of the three segments placed uppermost is found to give a higher percentage of early and total germination and vigorous seedlings with thicker girth at the collar. Such seedlings are more robust and less likely to damages caused by drought and transplantation shock.

Dwyer (1938) advocated the Plant-to-Row Method of improvement in coconut. He suggested selection of seednuts from apparently superior palms identified by specified selection criteria, or previous yield records. Such seednuts should be sown in nurseries with progeny of individual palms in separate lines and the lines compared in respect of growth and vigour of seedlings. Inferior lines identified through such comparison should be rejected and vigorous seedlings selected from the retained lines. The superior effectiveness of this type of selection could be confirmed by assessing the performance standard of these individuals planted adjacently, through comparison.

John and Narayana(1942) emphasized the preservation of stacks of selected seed coconuts in fine sand for obtaining better results. Accordingly nuts were to be arranged in such a manner, that the stalk end was always pointed upwards and taken care of in that every individual was embedded in sand, wholly. They found that the seedlings sprouted from seednuts stored in this manner, possessed superiority in terms of viability and quality.

Liyanage(1953) reported that palms derived from selected seedlings gave significantly higher yields than those from unselected ones. He found that selection of

seedlings alone could induce improvement to an added 10 per cent or more. The response to selection in seedlings was observed in the form of early flowering and higher yield of nuts and copra. He proposed that early germination of seednuts should be identified as one of the important criteria for selection of seedlings in coconut.

Liyanage and Abeywardena(1958) reported, increase in size and weight of seednuts possessing a shorter sprouting period could be recognised as desirable qualities for selection in favour of seedlings. This generalization was made on the basis of the results of some trials conducted at SriLanka.

Charles(1959) reported that in New Guinea, the seedling vigour is routinely judged at the 4-leaf stage, from the girth at the base, size, spread and colour of leaves, rapidity of growth and sturdiness of the seedlings. The best seedlings were characterized by superior vigour, appreciably fast and normal development, thickness at the neck and deep green foliage.

Marar(1960) outlined the method of producing quality coconut seedlings through a programme of motherpalm selection, followed by selection of vigorous seedlings. Early germination, increased number of leaves, good collar girth

and vigorous growth were supported to form important seedling selection criteria.

Marar and Jayarajan(1960) carried out a trial at the Central Coconut Research Station, Kasargod, on the proportionate recovery of quality seedlings from nuts harvested without the use of ropes. The results showed that the practice of harvesting seednuts and grounding them without hoisting did not have any adverse influence on the percentage and rate of germination and the subsequent normal growth of seedlings. However, the practise otherwise, could be adopted, particularly, under conditions, where the trees are tall and the ground hard.

Ninan and Pankajakshan(1961) supported the scope and advantage of early identification of the prepotent palms on the basis of systematically formulated progeny analysis during which the superiority of individual progeny was assessed, in terms of its performance in the nursery. From their progeny studies in coconut, they surmised that such palms continue to maintain significantly higher progeny values irrespective of their pollen sources and hence such high yielders could be isolated as parents of superior progeny in the nursery.

Satyabalan et al.(1964) conducted a comparative study of expression of seedling vigour utilizing hybrid seedling populations of the Tall x Dwarf, Tall x Ganga-bondam, and Tall x Tall parent combinations. The number of days taken for germination, girth of collar, and number of leaves at the 8th month in the nursery, were the seedling attributes compared. The Tall x Gangabondam hybrid seedlings proved themselves significantly, the best among the lot.

Fremond and Brunin(1966) found that rapid early growth of seedlings is associated with earliness of flowering initiation. The study incorporated analysis of data on the number of leaves produced yearly, the time taken for initiation of flowering and first fruitset, and the rapidity with which height increased in populations classified into early, and late bearers. According to them, the number of leaves produced during the first two years was found to be a useful criterion to predict more or less accurately early bearing tendency in palms.

De Silva and George(1971) studied the effect of size and maturity of seednuts on the sprouting period and consequent seedling growth. Medium sized nuts of the first ripe bunch displayed the best performance with

respect to rate of sprouting and girth of seedlings. Based on the study, they suggested a stepwise selection programme, initiating with selection of motherpalms, followed first by seednut selection, giving preference to first bunch nuts with a short axis diameter of about 17.5 cm, and finally by a phase of seedling selection in the nursery. They estimated that the rejections in the nursery, in the ultimate stage of selection, did not exceed 10 per cent of the total number of seedlings found in the nursery, under conditions when the prescribed programme was adhered to strictly and in toto.

Srinivasa and Ramu(1971) reported that seedlings from nuts which germinated within 4 months had more leaves and also exhibited signs of splitting into leaflets earlier, when compared to those germinated later. This finding thus confirmed the value of earliness in nut germination as a dependable and favourable selection criterion, for seedlings in coconut.

Sundaresan et al.(1974) made a study of the collection periods and storage requirements of seed coconuts prior to planting in the nursery. The study revealed, that nuts could be collected from February to August and that they should be stored in sand under shade for

one or two months for realising a higher percentage of germination, and increased recovery proportion of quality seedlings.

Nampoothiri et al.(1974) conducted a three year study, on the number of days required for germination of seednuts counted from the date of harvest and date of sowing and also the percentage germination of seednuts. Though, intravarietal variation existed in West Coast Tall, 85 per cent of the individuals conformed to the general trend of the cultivar. When the number of days for seednut germination is counted from the date of sowing in the nursery, it led to erroneous conclusions, since the nuts harvested earlier germinated earlier, owing to the fact that during storage, they remained under conditions similar to that prevailed in the nursery. Hence it was recommended that in order to minimize the inclusion of such errors, the number of days taken for germination of seednuts should be calculated from the date of harvest itself.

Mohammad ~~et al~~.(1974) compared the germination pattern of seednuts selected from tall palms growing under dry/rainfed, semidry and irrigated conditions.

The seednuts were allowed to germinate in the same environment on raised beds. Those from the rainfed environment, germinated at the earliest(10th week) and recorded the highest percentage of germination reaching the maximum of 92.07 per cent by the 28th week. This showed that preferential enjoyment of a favourable environment by a prospective motherpalm had nothing significant to contribute towards expressed progeny superiority.

Satyabalan et al.(1975) conducted a study on 43 open pollinated progenies of 8 high yielding West Coast Tall palms. The progeny were all one year old at the time of planting. Data were collected on several characters - number of leaves at planting, girth of collar and height of seedlings, time taken for first flowering, numbers of leaves and inflorescences produced since germination, number of functional leaves, number of female flowers, and the yield of nuts. Among the seedling characters, the production of leaves was found to be the most important. Based on this progeny study, three among the eight palms were identified as prepotent, thus substantiating the usefulness of the procedure of identification of prepotent palms through progeny analysis.

Nampoothiri et al.(1975), based on their correlation studies on various seedling and adult palm attributes, emphasised the importance of girth of collar and number of leaves, as favourably potent seedling selection criteria, in view of their high correlation with ultimate yield of nuts.

Thomas(1978) studied the effects of seed size and orientation of planting of seednuts in the nursery, on the germination and subsequent growth of seedlings in coconut. Based on the findings, he recommended planting of seednuts weighing 1000 to 1300 g. and sowing them horizontally in the nursery to obtain quicker and greater germination of seednuts and faster seedling growth rate.

Wuidart(1979) conducted studies on germination of seednuts in coconut and based on his findings proposed that, the speed of germination and earliness in the appearance of the growing shoot could be relied upon as valuable criteria in seedling selection.

Kannan and Nambiar(1979) pursued studies on the need and importance of seedling selection following a programme of motherpalm selection in bettering coconut culture. Seedlings raised from high yielding palms,

randomly selected bulk palms, and low yielding palms were observed, and grouped into three categories, vigorous intermediate and poor, based on their height, collar girth and number of functioning leaves present. On each of these nine separate groups, comprising of three sub groups on seedling vigour obtained from three different motherpalm categories, data on age of the palm at the first flowering, number of female flowers, setting percentage, nutyield, weight of husked nuts, copra content per nut and annual copra yield per palm, were collected. The results of the extensive investigation, showed that the vigorous and intermediate seedlings of the high yielding and bulk palms were significantly better than the others. They grew and developed rapidly and bloomed earlier and gave the highest values for the mean yield of nuts and copra. Further, the authors suggested that, in order to facilitate better establishment, inducement of early flowering and high yield, strict seedling selection in the nursery, culling out of the inferior seedlings irrespective of the motherpalm category from which they were derived were absolutely essential.

Thus it is seen that, the above cited facts provide ample evidence, for the need and importance of a 2- level programme of selection in coconut, that should involve

necessarily an initial phenotypic screening among the motherpalms followed by a genotypic test of their superiority, established on the basis of the expressed performance of their early seedling progeny. This is apparently the spirit underlying the prepotency test.

Statistical Basis

Smith(1936) was the first to describe the application of the theory of Discriminant Function in plant selection. According to him, since the heritable differences due to the genotype, particularly for economically more important characters like yield, are obliterated to a considerable extent, by nonheritable factors such as those associated with the environment, an approach, that is known popularly as the Discriminant Function Analysis, will be of better advantage. This procedure, emphasizes on the aspects of a typically multiple criteria approach. For this a conveniently manageable number of reasonably stable and readily readable variables are to be identified distinctly. Further, when one is in a position to identify quite a large number of such variables, a further distinction must be made necessarily between the more important and the less important ones on the basis of their relative importance from the

economic point of view. The analysis calls for, essentially, an assignment of independent values as weightages for the different variables. Further, in cases where it is not that easy to make out the relative importance of the variables distinctly the author proposes an alternative method of assigning the reciprocal of the value for the mean of each character as the corresponding weightage value. This is recommended particularly in order to ensure exposing variables to an almost identical advantageous situation.

Similar approaches are found to be adopted in the arecapalm also.

Bavappa and Abraham (1961) found that in arecapalm, variation did express with regards to weight of nuts. They observed that around 25 per cent of the total nuts yielded, comprised of lighter ones. Further, heavier seednuts were found to be significantly and directly associated with higher percentage values for germination and consequent expressed vigour among the seedling progeny, particularly during their stand in the nursery. The authors recommend choice of particularly heavier seednuts to resolve superior seedling progeny performance in later years.

Bavappa et al.(1964) reported the existence of significantly negative values for the correlation between delayed germination and a multitude of diverse morphological attributes of the seedling. They put forward a recommendation, that favoured seedling progeny selection in connection with effecting overall improvement in the arecapalm. The usefulness of formulation of appropriate indices in this connection has been exposed. In this study, they followed a procedure that was in accordance with that used by Bartlett, to study germination.

Bavappa and Ramachander(1967b) felt that through a method of selection of seedlings, from a population, the proportion of uneconomically low yielders could be reduced by about 50 per cent. This method involved selection of seedlings with more than 4 leaves at planting, a collar girth exceeding 20 cm one year after planting and 4 or more nodes after two years in the field.

Bavappa and Ramachander(1967a) reported that motherpalms of uniform standards were found to possess differential transmitting ability with regards to yield. Heritability of yield was found to be comparatively

low, and unlike in coconut no relationship could be discerned between the regular bearing habit of the motherpalms and the progeny performance.

Ramachander and Bavappa (1972) computed selection indices in arecanut using 17 growth characters and 12 yield components in different combinations. The genetic advance by selection based on them as well as the relative improvement over straight selection were worked out. Based on the findings, they reported that a selection index based on all the characters enabled a genetic advance of 284.69 compared to that of 57.11 against straight selection, offering a relative improvement of 498 per cent. But a simpler index incorporating, only the number of leaves and height of seedling at the time of transplanting, could help attaining a relative improvement of 332 per cent, and hence, it was recommended for practical use in seedling selection in arecapalm.

The above reports seem to substantiate the usefulness of multilevel selection, carried out at different generations, comprised of mother parents and the progeny, to effect an overall significant improvement in performance, among seed propagated perennials.

MATERIALS AND METHODS

MATERIALS AND METHODS

MATERIAL

Fifty coconut palms belonging to the same age group of twentyfive years approximately were chosen at random and earmarked as the base material for the study. Ten seednuts per palm were collected from which the progeny was raised to facilitate Systematic Pedigree-Progeny Analysis that has been identified as the main theme of this investigation.

METHODS

The motherpalms chosen were assigned with identification numbers. They were classified into different categories on the basis of the nutyield data of the preceding five years. Accordingly, three categories were identified - Low Yielders, that gave an annual mean yield of less than 80 nuts per tree; Medium Yielders giving 80-120 nuts per tree; and High Yielders, recording per tree yield of more than 120 nuts. The particulars of trees under the above categories are given below.

Category and Code	Tree Serial Number	Farm Identification Number of palm	Five Years' average yield of nuts per tree per year
1	2	3	4
LOW (L)	1	324	77
"	2	341	66
"	3	352	61
"	4	357	74
"	5	386	59
"	6	388	53
"	7	419	67
"	8	420	65
"	9	423	64
"	10	424	48
"	11	425	54
"	12	427	62
"	13	451	79
"	14	454	64
"	15	482	53

1	2	3	4
MEDIUM (M)	16	331	85
"	17	332	84
"	18	337	107
"	19	338	114
"	20	342	102
"	21	344	98
"	22	350	83
"	23	351	100
"	24	353	90
"	25	379	117
"	26	380	111
"	27	381	108
"	28	383	83
"	29	389	109
"	30	390	85
"	31	393	83
"	32	395	114
"	33	398	91
"	34	406	87
"	35	409	80

1	2	3	4
MEDIUM (M)	36	417	87
"	37	418	81
"	38	421	102
"	39	422	101
"	40	431	90
"	41	434	88
"	42	455	119
"	43	481	113
"	44	483	97
HIGH (H)	45	304	120
"	46	349	136
"	47	368	153
"	48	384	129
"	49	394	124
"	50	585	231

Particulars of data

Three sets of data were collected.

I. Motherpalm characters

The following characters were studied during the cours of the calender year 1981.

i. The girth of the stem measured at a height of about one metre from the ground.

ii. The number of fully split fronds in the crown.

iii. The number of bunches at different stages of development in the crown ie., those in which the spathe appeared split open.

iv. The mean number of female flowers per inflorescence, calculated by dividing the total number of female flowers by the number of inflorescences on single tree basis.

v. Percentage of fruit set in the palm. The total number of female flowers in the bunches harvested during the year and the number of nuts actually produced were noted.

$$\text{Percentage fruitset (treewise)} = \frac{\text{Total number of nuts} \times 100}{\text{Total number of female flowers}}$$

vi. Annual yield of nuts per palm, and

vii. The difference between the number of nuts obtained during the peak and lean harvests during the year.

II. Seednut characters

Data recorded in respect of the seednuts harvested were as follows.

i. Fresh weight of the seednuts expressed in Kilograms
ii. Volume of the nut measured on water displacement basis and expressed in litres.

III. Seedling characters

1. Number of days for germination of the seednut counted from the date of harvest.

ii. Monthwar measurement of the height in centimetre, till the seedlings were one year old.

iii. Monthwar measurement of the girth in centimetre at the collar region, till the seedlings were one year old, and

iv. The number of split leaves when the seedlings were one year old.

Data pertaining to these observations were recorded during the period of one year from the date of sowing seednuts in the nursery.

Given below are the particulars of symbols assigned to the thirteen variables, studied during the course of the experiment.

1. Girth of stem - X_1
2. Number of fronds in the crown - X_2
3. Number of bunches in the crown - X_3
4. Number of female flowers per inflorescence - X_4
5. Percentage of fruitset - X_5
6. Total yield of nuts during the year - X_6
7. Difference between yield of peak and lean months of the year - X_7
8. Fresh weight of seednut - X_8
9. Volume of seednut - X_9
10. Number of days for germination of seednut - X_{10}
11. Height of one year old seedlings - X_{11}
12. Girth of collar of one year seedlings - X_{12}
13. Number of split leaves borne by one year old seedlings - X_{13}

Values for the variables $X_1 \ldots\ldots X_7$ were recorded on individual palmwise basis. Altogether 500 seednuts were collected from the 50 motherpalms at the rate of 10 nuts

per tree, that were marked with identification numbers. Values for the seednut characters, X_8 and X_9, were determined at the time of harvest and appropriate entries made. The seednuts collected during the months of January and April 1981 were stored and sown in June 1981 in nurseries, spaced 30 cm^2 apart. The nursery management care as per the prescribed recommendations given in the Package of Practices of the Kerala Agricultural University (1980) was adopted. Routine periodical observations were made in the nursery and the remaining characters, X_{10} ... X_{13} studied.

Thus the ungrouped data collected during the course of the study comprised of,

i. motherpalm characters - 50 x 7 = 350
ii. seednut characters - 500 x 2 = 1000, and
iii. Seedling characters - 404 x 4 = 1616

the total coming to 2966 values.

Utilization of the data

This was done according to the following schedule.

1. The Mean, Standard Deviation and Coefficient of Variation were estimated characterwise, on the basis of categorized classification of the motherpalms and also on the pooled scale. This was done for all

the 13 characters referred to earlier.

2. Formulation of an index to characterize the expressed seedling progeny vigour, and to identify the critical index value that could serve eventually as the standard criterion for the scoring of seedlings possessing significantly superior vigour.

Six variables (X_8. . . . .X_{13}) were made use of in this context. Differential weightages were attributed to the different variables. For this the scheme proposed by Smith (1936) was adopted. Using the Matrix Inversion Technique, the absolute values for the weightages for each of the variables (X_8. . . . . X_{13}) were computed and this was used for working up the actual values for the Seedling Vigour Index (SVI) for all the 404 seedling progenies that could be traced back to the corresponding motherpalms. The Seedling Vigour Index values for the 404 seedling progenies were computed using the following equation.

$$SVI = a_1X_8 + a_2X_9 + a_3 X_{10} + a_4 X_{11} + a_5 X_{12} + a_6 X_{13}$$

where a_1, a_2, a_3, a_4, a_5 and a_6 represented the weightages assigned to variables X_8, X_9, X_{10}, X_{11}, X_{12} and X_{13} respectively.

The mean of the 404 values for the indices mentioned above was fixed as the critical base value for identifying seedlings possessing significantly superior vigour. Seedlings characterized by a value higher than that of this value were scored as vigorous seedlings and the corresponding motherpalms were identified, through tracing back along the path of lineage, a record of which was maintained.

3. Identification of mother palms bearing an inherent potentiality to yield relatively more number of vigorous seedlings.

For this, the relationship, $\frac{Vg}{N}$ was used as the criterion. In this V, g and N represented the number of vigorous seedlings derived from individual motherpalms, total number of seedlings survived till the closing of the first year stand in the nursery and the total number of seednuts from each palm initially sown, respectively. In this experiment, the value for N was same in all the cases ie., 10.

Accordingly, it is apparent that the scale for this relationship showed values ranged from 0 to 10, and the middlemost value ie., 5 was arbitrarily recognised as the

critical limit, for identifying the more desirable motherpalms from the less desirable ones. Palms registering a value of 5 and above, were only considered as more desirable.

4. Finding out the degree of association between the SVI and the motherpalm attributes among the more important individuals identified on the basis of the norm detailed as above under 3.

The Mean Seedling Vigour Index (MSVI) value for the vigorous seedlings derived from each palm was estimated. The association of this value against the other 7 variables (X_1. . . . . X_7), was estimated and tested for significance. The following pairwise combinations of characters were tested.

a) X_1 - MSVI
b) X_2 - MSVI
c) X_3 - MSVI
d) X_4 - MSVI
e) X_5 - MSVI
f) X_6 - MSVI
g) X_7 - MSVI

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b) X_2 - MSVI

c) X_3 - MSVI

d) X_4 - MSVI

e) X_5 - MSVI

f) X_6 - MSVI

g) X_7 - MSVI

The information derived from the above mentioned processing of the data was used to draw conclusions that were made practical use of in the context of the objective of the study.

Further, from the data collected routinely on a periodic basis from the seedlings in the nursery during the course of the year under investigation, a search was made alongwith which was also made use of while interpreting the results and discussing the implications.

RESULTS

RESULTS

The results resolved during the course of the present investigation on Progeny Analysis in West Coast Tall coconutpalms of different yield groups are presented in Tables 1 to 6 and the Chart furnished alongwith under discussion.

The values computed on nutyield categorywise and on the pooled basis in respect of the basic statistical estimates - Mean (arithmetic mean), Standard deviation, and Coefficient of variation(phenotypic) for 13 variables are furnished as given under Table 1. Variables X_1. . . X_7 X_8 and X_9, and X_{10}. . . .X_{13} represented the motherpalm, seednuts, and seedlings that stood one year stand in the nursery, respectively.

Out of the 500 seednuts sown, only 404 seedlings survived till the end of the first year of stand in the nursery. Of these 404 seedlings, 114 developed from category L, 238 from category M and 52 from category H.

Further, of these 404 seedlings, 195 were identified to possess significantly superior vigour on comparison

Table 1. - Mean, Standard deviation and Coefficient of Variation for 13 variables in West Coast Tall coconutpalms of different yield groups

	Variable	Mean				Standard deviation				Coefficient of variation			
		L*	M*	H*	P*	L	M	H	P	L	M	H	P
1		2	3	4	5	6	7	8	9	10	11	12	13
X_1	Girth of stem	72.77	79.07	79.67	77.10	9.82	7.10	9.40	8.73	13.73	8.98	11.79	11.32
X_2	No.of fronds	27.80	28.62	30.33	28.58	3.30	2.89	8.16	2.87	11.87	9.81	26.90	10.04
X_3	No.of bunches	11.47	14.28	15.50	13.58	3.27	2.12	2.43	2.89	28.52	14.85	15.67	21.28
X_4	No.of female flowers	21.60	27.00	24.33	25.06	5.62	7.46	4.59	6.996	26.00	27.65	18.86	27.92
X_5	Percentage of fruitset	31.94	31.61	46.45	32.12	7.43	8.14	11.23	10.55	23.26	25.75	24.18	33.00
X_6	Annual nutyield	52.60	89.72	129	83.10	14.04	20.39	26.63	30.88	26.70	22.73	20.64	37.16
X_7	Difference in nutyield between peak and lean harvests	15.07	23.10	38.33	22.58	9.60	10.69	15.30	12.86	63.68	46.29	39.41	56.95

contd...

Table 1. (contd.)

1		2	3	4	5
X_8	Fresh weight of seednut	1.66	1.29	1.13	1.37
X_9	Volume of Seednut	3.08	2.397	2.06	2.55
X_{10}	No.of days for sprout initiation	209.91	208.84	218.06	210.33
X_{11}	Height of 1 year old seedlings	92.02	87.18	86.42	88.34
X_{12}	Girth of collar of 1 year old seedlings	9.87	10.13	9.88	10.02
X_{13}	No.of split leaves in 1 year old seedlings	0.26	0.32	0.19	0.29

*L - Low yielders - Medium yielders H -

6	7	8	9	10	11	12	13
0.33	0.24	0.18	0.32	19.83	18.23	16.21	23.45
0.62	0.65	0.59	0.72	20.27	26.96	28.61	28.37
34.96	35.98	34.44	35.63	16.65	17.23	15.79	16.94
31.07	36.895	19.996	33.61	33.76	42.32	23.14	38.04
1.85	1.52	1.12	1.58	18.74	14.99	11.34	15.77
0.59	0.64	0.44	0.61	226.92	199.43	228.92	210.95

High yielders P - Pooled

Table 1. (contd.)

	1	2	3	4	5	6	7	8	9	10	11	12	13
X_8	Fresh weight of seednut	1.66	1.29	1.13	1.37	0.33	0.24	0.18	0.32	19.83	18.23	16.21	23.45
X_9	Volume of Seednut	3.08	2.397	2.06	2.55	0.62	0.65	0.59	0.72	20.27	26.96	28.61	28.37
X_{10}	No.of days for sprout initiation	209.91	208.84	218.06	210.33	34.96	35.98	34.44	35.63	16.65	17.23	15.79	16.94
X_{11}	Height of 1 year old seedlings	92.02	87.18	86.42	88.34	31.07	36.895	19.996	33.61	33.76	42.32	23.14	38.04
X_{12}	Girth of collar of 1 year old seedlings	9.87	10.13	9.88	10.02	1.85	1.52	1.12	1.58	18.74	14.99	11.34	15.77
X_{13}	No.of split leaves in 1 year old seedlings	0.26	0.32	0.19	0.29	0.59	0.64	0.44	0.61	226.92	199.43	228.92	210.95

*L - Low yielders M - Medium yielders H - High yielders P - Pooled

Table 1. - Mean, Standard deviation and Coefficient of Variation for 13 variables in West Coast Tall coconutpalms of different yield groups

	Variable	Mean				Standard deviation				Coefficient of variation			
		L*	M*	H*	P*	L	M	H	P	L	M	H	P
	1	2	3	4	5	6	7	8	9	10	11	12	13
X_1	Girth of stem	72.77	79.07	79.67	77.10	9.82	7.10	9.40	8.73	13.73	8.98	11.79	11.32
X_2	No.of fronds	27.80	28.62	30.33	28.58	3.30	2.89	8.16	2.87	11.87	9.81	26.90	10.04
X_3	No.of bunches	11.47	14.28	15.50	13.58	3.27	2.12	2.43	2.89	28.52	14.85	15.67	21.28
X_4	No.of female flowers	21.60	27.00	24.33	25.06	5.62	7.46	4.59	6.996	26.00	27.65	18.86	27.92
X_5	Percentage of fruitset	31.94	31.61	46.45	32.12	7.43	8.14	11.23	10.55	23.26	25.75	24.18	33.00
X_6	Annual nutyield	52.60	89.72	129	83.10	14.04	20.39	26.63	30.88	26.70	22.73	20.64	37.16
X_7	Difference in nutyield between peak and lean harvests	15.07	23.10	38.33	22.58	9.60	10.69	15.30	12.86	63.68	46.29	39.41	56.95

contd...

against a computed base value that corresponded to the Mean Seedling Vigour Index (MSVI), the summary of the details is presented in Table 2. It was also noticed that out of the 195 vigorous seedlings 62, 118 and 15 represented categories L, M and H respectively.

Table 2. - Computed weightage values for the different seedling attributes which were included in the formulation of the Seedling Vigour Index (SVI)

Sl.No.	Attribute	Weightage value
1	X_8	-3.2603
2	X_9	+18.4787
3	X_{10}	-0.8445
4	X_{11}	-0.1233
5	X_{12}	+11.8333
6	X_{13}	+25.9379

Table 3. -- SVI for the 404 seedlings raised from the 50 West Coast Tall coconutpalms of different yield categories

Yield category	Seedling identification number	SVI
1	2	3
LOW (L)	324.1	-39.05
"	324.2	53.27*
"	324.3	-90.63
"	324.4	-2.42*
"	324.5	105.59*
"	324.6	20.25*
"	324.7	-37.71
"	324.8	-19.05*
"	324.9	-23.35
"	324.10	1.80*
"	341.1	-43.54
"	341.2	-36.33
"	341.3	21.27*
"	341.4	7.41*
"	341.5	0.60*
"	341.6	-9.96*
"	341.7	38.35*
"	341.8	-13.75*
"	341.9	21.22*

contd..

Table 3. (contd.)

1	2	3
LOW (L)	352.1	-79.03
"	352.2	-84.15
"	352.3	-43.33
"	352.4	-46.99
"	352.5	-81.05
"	352.6	-4.63*
"	352.7	14.34*
"	352.8	61.01*
"	352.9	-5.55*
"	357.1	-68.78
"	357.2	-44.47
"	357.3	27.30*
"	357.4	-54.06
"	357.5	14.99*
"	357.6	11.66*
"	357.7	29.77*
"	357.8	29.93*
"	386.1	-1.25*
"	386.2	40.28*
"	386.3	-35.56
"	386.4	-60.54
"	386.5	-67.32
"	386.6	53.25*
"	386.7	-8.83*
"	386.8	-27.87
"	386.9	-3.44*

(contd..)

Table 3. (contd.)

1	2	3
LOW (L)	388.1	-48.59
"	388.2	45.70*
"	388.3	-41.39
"	388.4	-6.46*
"	388.5	-31.86
"	388.6	-1.59*
"	388.7	-31.36
"	419.1	24.54*
"	419.2	32.63*
"	419.3	40.69*
"	419.4	79.74*
"	419.5	2.74*
"	419.6	-15.02*
"	419.7	18.26*
"	419.8	-14.92*
"	419.9	-23.34
"	420.1	73.25*
"	420.2	18.09*
"	420.3	-22.09
"	420.4	170.56*
"	420.5	5.46*
"	420.6	20.06*
"	420.7	11.10*
"	420.8	-10.61*
"	420.9	-52.06
"	420.10	-6.20*

Contd...

Table 3. (contd.)

1	2	3
LOW (L)	423.1	-48.24
"	423.2	-58.27
"	423.3	-57.49
"	423.4	-20.90
"	423.5	-21.60
"	423.6	-43.51
"	424.1	-3.16*
"	424.2	12.12*
"	424.3	72.47*
"	424.4	31.87*
"	424.5	23.79*
"	424.6	-55.21
"	424.7	-17.81*
"	425.1	23.98*
"	425.2	57.85*
"	425.3	9.56*
"	425.4	-21.77
"	425.5	-45.19
"	425.6	-54.34

contd...

Table 3. (contd.)

1	2	3
LOW (L)	427.1	-82.99
"	427.2	56.16*
"	427.3	-89.49
"	427.4	6.52*
"	427.5	-67.30
"	427.6	-70.29
"	451.1	-98.26
"	451.2	-44.35
"	451.3	-26.54
"	451.4	-51.67
"	451.5	-63.74
"	451.6	30.38*
"	451.7	-42.18
"	454.1	-9.86*
"	454.2	-6.49*
"	454.3	-61.09
"	454.4	-60.32
"	454.5	-28.14
"	482.1	-56.84
"	482.2	-23.64
"	482.3	-41.60
"	482.4	-12.64*
"	482.5	-58.67
"	482.6	-4.42*

contd...

Table 3. (contd.)

1	2	3
MEDIUM (M)	331.1	-21.11
"	331.2	77.62*
"	331.3	19.74*
"	331.4	31.31*
"	331.5	37.56*
"	331.6	51.76*
"	331.7	81.72*
"	331.8	103.03*
"	332.1	-28.91
"	332.2	-22.36
"	332.3	81.29*
"	332.4	-10.45*
"	332.5	35.49*
"	332.6	32.63*
"	332.7	111.34*
"	332.8	72.98*
"	332.9	100.43*
"	332.10	-17.58*
"	337.1	-86.57
"	337.2	-96.02
"	337.3	-7.28*
"	337.4	-38.10
"	337.5	-4.35*
"	337.6	-4.84*
"	337.7	-1.01*
"	337.8	-41.34
"	337.9	-24.19
"	337.10	-12.09*

contd...

Table 3. (contd.)

1	2	3
MEDIUM (M)	338.1	-36.79
"	338.2	16.34*
"	338.3	-8.64*
"	338.4	-76.71
"	338.5	-26.92
"	338.6	-2.61*
"	338.7	-15.26*
"	338.8	24.01*
"	338.9	19.59*
"	342.1	-46.02
"	342.2	-16.79*
"	342.3	-50.75
"	342.4	-29.51
"	342.5	-9.78*
"	342.6	-70.15
"	342.7	-51.76
"	344.1	-65.19
"	344.2	-65.93
"	344.3	-66.61
"	344.4	-64.36
"	344.5	-45.89

contd...

Table 3. (contd.)

1	2	3
MEDIUM (M)	350.1	-4.47*
"	350.2	3.56*
"	350.3	-35.95
"	350.4	3.74*
"	350.5	-64.39
"	350.6	-39.86
"	350.7	-37.49
"	350.8	-43.01
"	350.9	-54.32
"	351.1	-21.92
"	351.2	0.74*
"	351.3	-33.79
"	351.4	-18.59*
"	351.5	-27.42
"	351.6	-37.96
"	351.7	-16.66*
"	351.8	-3.26*
"	353.1	106.78*
"	353.2	-20.05*
"	353.3	-10.16*
"	353.4	63.81*
"	353.5	-18.00*
"	353.6	12.78*
"	353.7	-40.32
"	353.8	-1.69*
"	353.9	-16.78*
"	353.10	-45.33

contd...

Table 3. (contd.)

1	2	3
MEDIUM (M)	379.1	-47.68
"	379.2	-12.34*
"	379.3	-91.66
"	379.4	-4.27*
"	379.5	-60.43
"	379.6	-39.89
"	379.7	-83.53
"	379.8	-18.96*
"	379.9	-19.64*
"	380.1	-14.62*
"	380.2	-111.87
"	380.3	-14.37*
"	380.4	-114.95
"	380.5	-82.09
"	380.6	-16.74*
"	380.7	-3.48*
"	380.8	-21.62
"	381.1	-51.60
"	381.2	62.76*
"	381.3	-14.02*
"	381.4	5.93*
"	381.5	-44.07
"	381.6	-52.50
"	381.7	-36.89

contd...

Table 3. (contd.)

1	2	3
MEDIUM (M)	383.1	14.69*
"	383.2	34.24*
"	383.3	-13.77*
"	383.4	54.19*
"	383.5	22.38*
"	383.6	13.73*
"	383.7	26.15*
"	383.8	46.69*
"	383.9	-14.01*
"	389.1	21.07*
"	389.2	-23.09
"	389.3	-50.39
"	389.4	-52.45
"	389.5	-20.15*
"	389.6	32.82*
"	389.7	-9.89*
"	389.8	11.78*
"	390.1	-77.30
"	390.2	-130.06
"	390.3	-64.68
"	390.4	-107.08
"	390.5	-66.59
"	390.6	-34.92

contd...

Table 3. (contd.)

1	2	3
MEDIUM (M)	393.1	-5.45*
"	393.2	-46.01
"	393.3	-103.69
"	393.4	136.27*
"	393.5	-14.22*
"	393.6	12.77*
"	395.1	-71.14
"	395.2	-74.52
"	395.3	-74.83
"	395.4	-70.44
"	395.5	-70.45
"	395.6	-56.68
"	395.7	-21.52
"	395.8	-35.43
"	395.9	-74.14
"	395.10	-66.66
"	398.1	60.29*
"	398.2	2.79*
"	398.3	102.01*
"	398.4	125.97*
"	398.5	-19.99*
"	398.6	2.64*
"	398.7	-2.13*
"	398.8	-22.11

contd...

Table 3. (contd.)

1	2	3
MEDIUM (M)	406.1	-67.58
"	406.2	-20.18*
"	406.3	16.48*
"	406.4	4.17*
"	406.5	-84.77
"	406.6	-28.53
"	406.7	12.33*
"	406.8	19.36*
"	406.9	58.56*
"	409.1	-93.61
"	409.2	-74.06
"	409.3	-61.31
"	409.4	-81.74
"	409.5	-72.34
"	409.6	-35.53
"	409.7	-36.66
"	409.8	-51.03
"	409.9	-29.78
"	417.1	-23.19
"	417.2	-99.62
"	417.3	-97.76
"	417.4	-42.81
"	417.5	-41.43
"	417.6	-57.21
"	417.7	-37.71
"	417.8	-24.56

contd...

Table 3. (contd.)

1	2	3
MEDIUM (M)	418.1	-60.98
"	418.2	-92.21
"	418.3	-22.14
"	418.4	-11.69*
"	418.5	26.46*
"	421.1	-86.77
"	421.2	-75.25
"	421.3	-51.95
"	421.4	-53.88
"	421.5	-36.12
"	422.1	18.13*
"	422.2	5.64*
"	422.3	-58.16
"	422.4	1.33*
"	422.5	-29.49
"	422.6	-31.64
"	422.7	-40.99
"	422.8	-53.83
"	422.9	-37.14
"	422.10	16.87*
"	431.1	-91.61
"	431.2	-5.52*
"	431.3	-44.10
"	431.4	1.41*
"	431.5	-1.48*
"	431.6	-14.46*
"	431.7	-18.32*
"	431.8	68.76*

contd...

Table 3. (contd.)

1	2	3
MEDIUM (M)	434.1	-33.57
"	434.2	-46.99
"	434.3	27.84*
"	434.4	-73.84
"	434.5	-73.09
"	434.6	-14.05*
"	434.7	-14.02*
"	434.8	-20.93
"	455.1	-10.82*
"	455.2	-11.66*
"	455.3	-15.00*
"	455.4	-20.31
"	455.5	-38.58
"	455.6	52.22*
"	455.7	-40.17
"	455.8	-19.45*
"	455.9	8.22*
"	481.1	-24.72
"	481.2	-66.49
"	481.3	-112.97
"	481.4	59.79*
"	481.5	-11.07*
"	481.6	24.76*
"	481.7	0.39*
"	481.8	42.99*
"	481.9	11.53*

contd...

Table 3. (contd.)

1	2	3
MEDIUM (M)	483.1	-82.36
"	483.2	-24.06
"	483.3	10.32*
"	483.4	-60.52
"	483.5	-16.21*
"	483.6	-0.66*
"	483.7	-28.82
"	483.8	62.39*
"	483.9	0.14*
"	483.10	5.82*
HIGH (H)	304.1	-53.52
"	304.2	-8.16*
"	304.3	-23.62
"	304.4	-22.47
"	304.5	24.52*
"	304.6	-10.82*
"	304.7	6.62*
"	304.8	37.72*
"	304.9	51.33*
"	349.1	24.91*
"	349.2	-80.25
"	349.3	-89.37
"	349.4	-62.07
"	349.5	41.19*
"	349.6	-41.97
"	349.7	14.07*
"	349.8	24.45*

contd...

Table 3. (contd.)

1	2	3
HIGH (H)	368.1	-99.76
"	368.2	-84.04
"	368.3	-86.06
"	368.4	-87.71
"	368.5	-35.24
"	368.6	-64.41
"	368.7	-41.48
"	368.8	-22.34
"	384.1	-71.04
"	384.2	-73.61
"	384.3	-78.75
"	384.4	-51.17
"	384.5	-61.09
"	384.6	-51.97
"	384.7	-76.72
"	384.8	-57.70
"	384.9	-31.25
"	394.1	9.95*
"	394.2	-30.82
"	394.3	16.85*
"	394.4	-28.41
"	394.5	-69.02
"	394.6	-31.72
"	394.7	-6.56*
"	394.8	-14.16*
"	394.9	-74.49
"	394.10	-4.25*

contd...

Table 3. (contd.)

1	2	3
HIGH (H)	585.1	-20.85
"	585.2	-103.06
"	585.3	-105.96
"	585.4	-110.50
"	585.5	-65.42
"	585.6	-48.04
"	585.7	-55.02
"	585.8	-48.39

* Vigorous seedlings identified on comparison against the computed base value (-20.24)

Additional information is furnished in Table 4 so as to enable an understanding of the basis on which more desirable motherpalms were identified from the others.

Table 4. --Palmwise Vigorous Seedlings Recovery Index Values

Sl. No.	Yield category	Palm Identification Number	Vigorous seedling Recovery Index $\frac{(Vg)}{N}$
1	2	3	4
1	LOW (L)	324	6.0*
2	"	341	6.3*
3	"	352	3.6
4	"	357	4.0
5	"	386	4.5
6	"	388	2.1
7	"	419	7.2*
8	"	420	8.0*
9	"	423	0.0
10	"	424	4.2
11	"	425	1.8
12	"	427	1.2
13	"	451	0.7
14	"	454	1.0
15	"	482	1.2
16	MEDIUM (M)	331	5.6*
17	"	332	8.0*
18	"	337	5.0*
19	"	338	5.4*
20	"	342	1.4
21	"	344	0.0
22	"	350	2.7
23	"	351	3.2

contd...

Table 4. (contd.)

1	2	3	4
24	MEDIUM (M)	353	8.0*
25	"	379	3.6
26	"	380	3.2
27	"	381	2.1
28	"	383	8.1*
29	"	389	4.0
30	"	390	0.0
31	"	393	1.8
32	"	395	0.0
33	"	398	5.6*
34	"	406	5.4*
35	"	409	0.0
36	"	417	1.0
37	"	421	0.0
38	"	422	4.0
39	"	431	4.8
40	"	434	2.4
41	"	455	5.4*
42	"	481	5.4*
44	"	483	6.0*
45	HIGH (H)	304	5.4*
46	"	349	3.2
47	"	368	0.0
48	"	384	0.0
49	"	394	5.0*
50	"	585	0.0

* Desirable motherpalms identified based on the magnitude of the value for vigorous seedling recovery index (ie. for values including and above 5)

It is seen from Table 4 that of the 50 palms chosen initially for the study, only 17 identified themselves as relatively more important in that they possessed the potentiality to yield a greater proportion of seedling progeny with significant increase in vigour. Further, of the 17 palms, 4, 11 and 2 belonged to the Low, Medium and High yielding categories respectively. As has been pointed out earlier, the experiment started with a randomly selected cluster of 50 motherpalms of which 15 belonged to the Low, 29 to the Medium and 6 to the High yielding categories. It appears, in the light of the facts presented in Table-3, that of the 15 Low yielders, only 4 palms (26.67%) manifested desirable motherpalm potentiality. Of the 29 Medium yielders 11 (37.93%), and of the 6 High yielders, 2 (33.33%), proved themselves to be under the desirable category.

Further, the MSVI value was computed on a treewise basis for 17 specially identified potentially desirable motherpalms, the particulars of which are furnished in Table-5.

Table 5. --Mean SVI for vigorous seedlings for the 17 identified desirable Motherpalms.

Sl. No.	Palm identification	Mean SVI for vigorous seedlings
1	324	26.57
2	341	9.31
3	419	21.08
4	420	35.21
5	331	57.46
6	332	50.77
7	337	-5.91
8	338	5.57
9	353	14.59
10	383	20.48
11	398	38.79
12	406	15.12
13	455	0.58
14	481	21.40
15	483	10.30
16	304	16.87
17	394	0.36

As a further extension of probing into the implications, an attempt was made to assess the degree of association between the 7 motherpalm variables (X_1. . . . . X_7) on one side and the value for MSVI, and the results obtained are presented in Table-6.

Table -6. -- Association between the MSVI Values and the 7 motherpalm attributes

Variable	Correlation Coefficient
X_1	-0.2665
X_2	0.2055
X_3	-0.1153
X_4	0.00925
X_5	-0.2548
X_6	-0.3677
X_7	-0.5172*

* Significant at 5% level probability

The overall outstanding features of relevance in the context of this experiment, consisting of progeny analysis in West Coast Tall coconutpalms of different yield groups, are furnished in the Chart.

The more desirable motherpalms with the potentiality to yield relatively greater number of vigorous seedlings identified according to the methodology as detailed above, are also indicated.

Further, the data collected, routinely at regular periodical intervals, at the rate of an entry per variable per month, on the progressive development of the seedlings during their one year stand in the nursery, are represented in graphs 1 and 2. A categorywise evaluation of the progressive increase in height and collar girth of the 404 seedlings during the course of the same duration, as has been referred to above, is made.

FIG.1 GRAPH SHOWING PROGRESSIVE MONTHWAR INCREASE IN HEIGHT OF SEEDLINGS RAISED FROM WEST COAST TALL COCONUT PALMS OF THREE DIFFERENT YIELD GROUPS

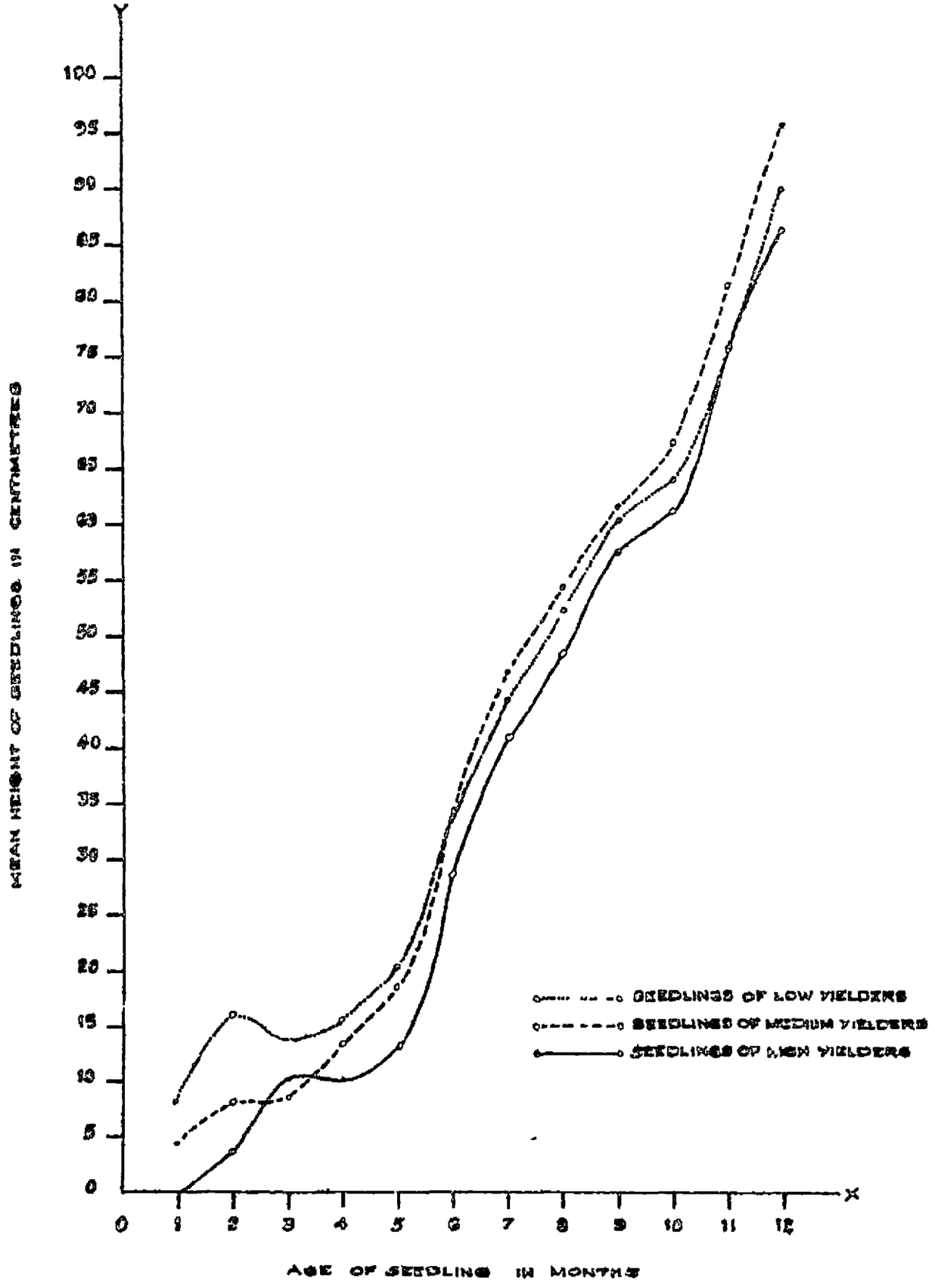
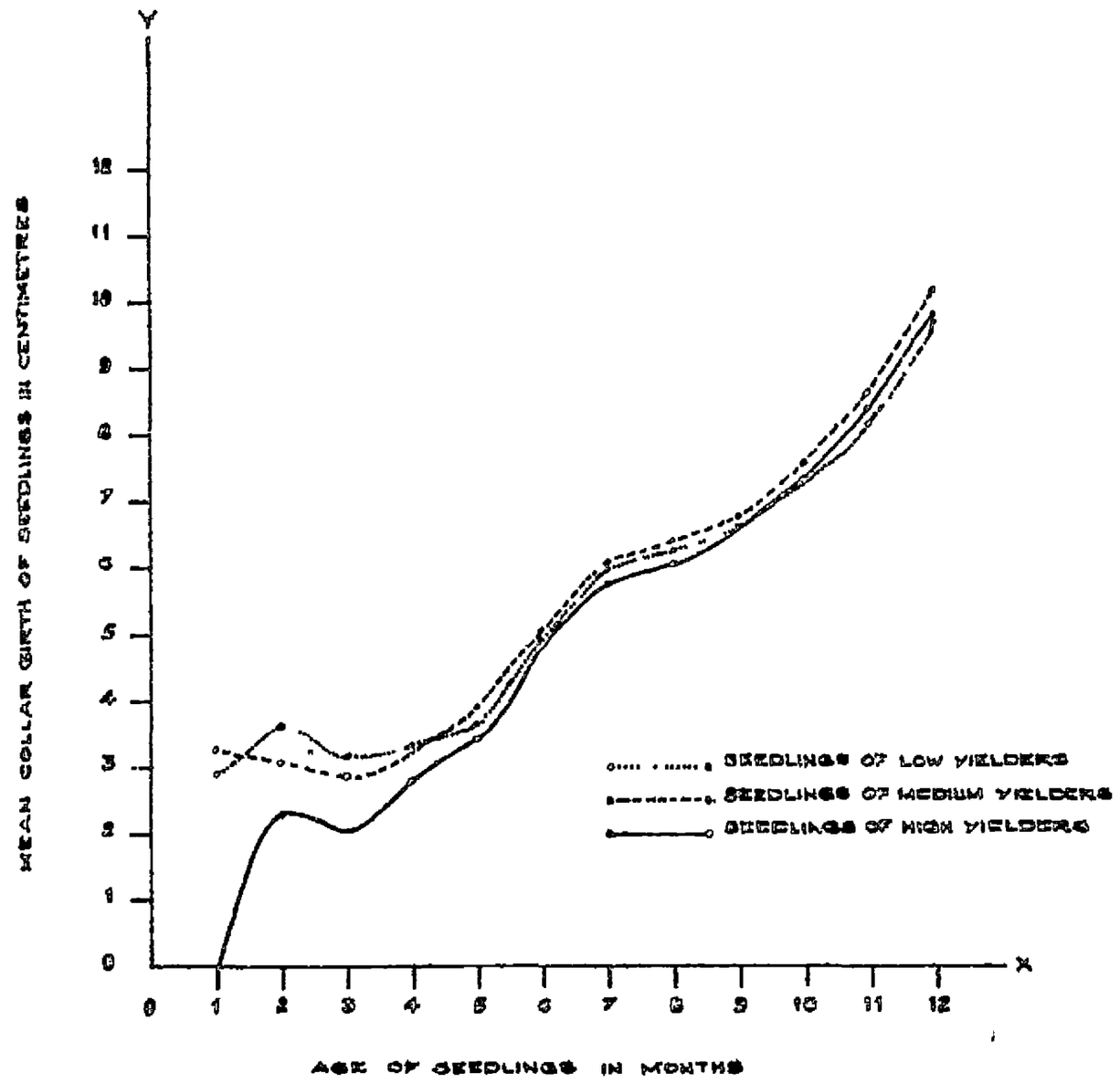


FIG 2 GRAPH SHOWING PROGRESSIVE MONTHWAR INCREASE IN GIRTH OF COLLAR OF SEEDLINGS RAISED FROM WEST COAST TALL COCONUT PALMS OF THREE DIFFERENT YIELD GROUPS



DISCUSSION

DISCUSSION

The most popular type of the coconutpalm cultivated in Kerala is the West Coast Tall. In a bulk population, one can come across, without much concern, palms belonging to the different nutyield categories- Low, Medium and High yielders.

The implications in connection with the assessment of the potentiality of individual palms, irrespective of the category to which they belong, as resolved from the trend exhibited by the results of an experiment on progeny studies conducted during 1981-82 at the Coconut Research Station, Balaramapuram, are being discussed.

The noteworthy features, made out particularly on the basis of the observations made during the conduct of a Systematic Pedigree Progeny Analysis, are represented diagrammatically in the Chart.

It is seen that, for the purpose of conducting the experiment, an initial sample consisting of 50 palms were chosen at random. Of these 50 trees, 15 (30%), 29 (58%) and 6 (12%), belonged to the Low, Medium and High yielding

FEATURES OF PROGENY ANALYSIS IN TYPE WEST COAST TALL COCONUT PALMS OF DIFFERENT YIELD CATEGORIES.

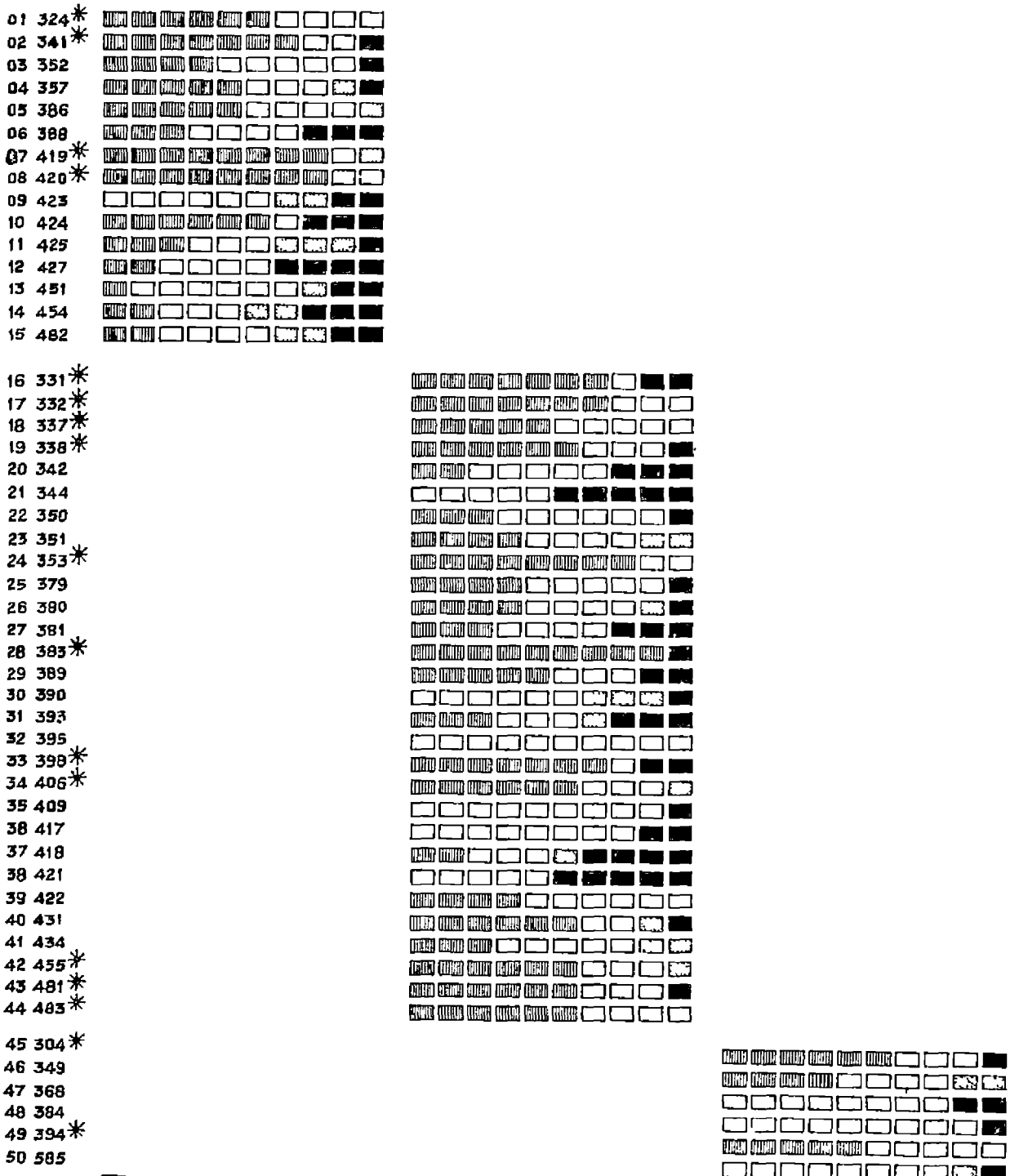
YIELD CATEGORIES OF MOTHER PALMS

SERIAL AND IDENTIFICATION NUMBER OF MOTHER PALMS

LOW

MEDIUM

HIGH



SPROUTS COUNTED

SPROUTS DRIED UP

SEED NUTS NOT GERMINATED

VIGOROUS SEEDLINGS

* HIGH POTENCY MOTHER PALMS IDENTIFIED BASED ON VIGOROUS SEEDLING RECOVERY INDEX VALUES

categories respectively. The observation seems to indicate that a greater majority of palms of the West Coast Tall type (around 60% approximately) belonged to the Medium yield category, whereas only a relative minority(approximately 10%) represented the High Yielding category. Low yielders are found to be more frequent (about 30%) compared to the High yielders.

The relative magnitude value for the percentage recovery of vigorous seedlings from the palms are being compared on the basis of the following summary table.

	NUTYIELD CATEGORY				
	L	M	H	P	L & M combined
1. Number of nuts sown	150	290	60	500	440
2. Number of seedlings obtained	114	238	52	404	352
3. Number of vigorous seedlings	62	118	15	195	180
4. Percentage germination	76.00	82.07	86.67	80.80	80.00
5. Percentage vigorous seedlings over nuts sown	41.33	40.69	25.00	39.00	40.91
6. Percentage vigorous seedlings over seedlings obtained	54.39	49.58	28.85	48.27	51.14

From the summary table, it is evident that the percentage recovery of vigorous seedlings over the number of nuts sown (item 5) gives the highest rating against Low yielders (41.33) followed by Medium yielders (40.69). Strangely enough, the value recorded against the High yielders is glaringly low (25%). It appears, from the trend, that vigorous seedlings in West Coast Tall, can be more readily recovered from palms belonging to the Low and Medium nutyielding categories that together constitute a vast majority of palms in a bulk population (90% approximately).

The maximum value for percentage germination is, however, against palms coming under the High Yielding category (86.67%). Low yielders exhibit the least value (76%) and Medium yielders occupy a position in between (82.07%). It is found, that among the High Yielding palms, in spite of the highest value, against germinability, the value against percentage recovery of vigorous seedlings is deplorably low (25%). It is true that High yielders do yield a greater number of nuts on per tree basis. However, the percentage of such trees in a community like the one

from which motherpalms were chosen for the investigation at random, was found to be as low as 12. Further, eventhough the trees under High yielders exhibited a higher percentage germination of seednuts, the percentage recovery of vigorous seedlings was very much low. Eventually, it was noticed that the values in respect of this for the different categories varied as given below.

CATEGORY	PERCENTAGE RECOVERY OF VIGOROUS SEEDLINGS
L	41.33*
M	40.69*
H	25.00
P	39.00*
L & M combined	40.91*

* nearly similar

Categorywise mean nutyield is given under Table 1. Low, Medium and High nutyield categories gave values 52.60, 89.72 and 129.00 respectively. The value against the unclassified (pooled) lot was 83.10. It is found that on consideration of the categories L & M taken together, the corresponding value becomes 77.07.

In coconut, a tree yields nuts throughout the year, of which, however, only a selected portion alone is used generally for seed propagation purpose. Taking this fact into account, it is felt that the proposed scheme of visualizing a new yield category in which L & M yielders are pooled together one can anticipate positively gainful advantage in terms of relatively greater recovery proportion of vigorous seedlings.

Therefore, in case it is felt to arrive at a working compromise by proposing to combine Low and Medium Yielders for the purpose of seed collection, it is certain to a great extent, that there is advantageous prospect of attaining an acceptable satisfactory percentage germination, approximating roughly to the extent of even 80% coupled with a percentage vigorous seedling recovery value around 40, will not turn out to be not quite an unsafe and less fruitful approach, that can be adopted, as far as palms of the West Coast Tall type are concerned.

Another interesting feature, that precipitates itself on a closer scrutiny of the Chart, is that of the 15 palms classed under category L, only 4 were identified as palms worth considering suitable, based on the criterion of proportionate recovery potential of vigorous seedlings.

Further, from among the 29 palms of the M category, 11 were identified to be suited, whereas only 2 were found to be so in the H category that contained only 6 palms. It is seen that the odds are apparently in favour of coming across trees of the L & M categories more frequently than those of the H category in a garden. In this aspect, of the 50 trees that constituted the whole of the material, 44 belonged to the integrated class of Low and Medium yielders (around 90%).

The finding seems to substantiate the proposed recommendation in favour of making a search for suited motherpalms exclusively among trees in the integrated category of Low and Medium yielders, particularly in variety West Coast Tall.

Further, the study helps to identify a standardized procedure for recognising such desirably suited motherpalms. As the foremost step, it is advised to make the search among palms that display an overall healthy disposition with a tendency for maintaining steady average yield of medium sized average weighing nuts. This should be followed up by a scheme of action formulated on the trend displayed by the results of the systematically conducted

Pedigree Progeny Analysis. Accordingly, selection must be effected, only in favour of individual palms, that record themselves, a higher order rating with regards to the expressed proportionate recovery potential of vigorous seedlings. However, the spirit and usefulness of effecting a further level selection among the seedling progeny stand in the nursery should not be overlooked in case the ultimate aim is to bring about an overall betterment in the late stage performance factor.

Understanding Motherpalms in general

The following seven variables were studied in this regard.

1. X_1 - Girth of stem
2. X_2 - Number of fronds in the crown
3. X_3 - Number of bunches in the crown
4. X_4 - Number of female flowers per inflorescence
5. X_5 - Percentage of fruitset
6. X_6 - Total yield of nuts during the year
7. X_7 - Difference between yield of peak and lean months of the year

Reference is made to the values for the mean and coefficient of variation for these variables presented in

Table 1. The following features were noticed.

Without exception, all these variables exhibited symptoms of prevalent variability, not only between variables, but between individual palms and those belonging to the different nutyield categories. Further, when the figures corresponding to these variables considered on the pooled basis, were examined, it was found that the maximum variability was expressed by X_7, the variable that indicated how far the palms maintained constancy in the number of nuts harvested through the six sessions during the twelve month period. The observation, indicates strongly that trees differed considerably from each other in this aspect. May be, one could find an explanatory reason in the genetic constitution of individual palms. The coconutpalm, is recognized already as a strictly crosspollinated one and as a consequence, majority of individuals, though may look alike phenotypically, carry large number of genes in a heterozygous condition. This condition is apparently the reason why a noticeable degree of segregation is expressed among the seedling progeny derived from the same maternal source. In this case, it is justified that, the cause of this expressed increased variability is nothing other than the expression of segregation, about which mention has been made earlier.

The observation unveils, the possibility of making advantageous use of practising selection in favour of individual palms that account themselves for a lower value for this estimate. Marar(1960) and Pankajakshan et al. (1963) did already make recommendations in favour of regularity in bearing in motherpalms. This is felt to be all the more desirable since satisfactory recovery proportion of vigorous seedlings is found to be associated directly with palms that give a relatively lower value for this estimate.

When a scrutiny was made in this connection, of the values corresponding to the individual nutyield categories, the maximum variability was expressed by category L and the minimum by H. However, one cannot directly make a recommendation in favour of confining selection of motherpalms, exclusively within the high nutyielding category, because, as has been pointed out earlier.

1. The relative proportion of palms under this category in a garden is very much low, and

2. The vigorous seedling recovery percentage for such palms is also inadequate.

A situation as this is apparently uneconomical from the point of view of commercialized coconut culture.

The attribute that exhibited the least degree of variation among the seven, is X_2, representing the number of fronds borne by individual palms. This information does not justify the proposal of a model for the selection of motherpalms based on leaf count. However, one can always look for signs of health on the leaves coupled with an appraisal of the general configuration, they attribute to the crown. Preference should be given to globose, or near blobose shapes, that ensure an ideal alignment for individual leaves in warding off of mutual shading and in accomodating conveniently, a prospective bunch of desirable features. This is in accordance with the view suggested by Marar (1960) while discussing specified norms for motherpalm selection in coconut. Pieris (1934) also pointed out the importance of size and orientation of leaves in the crown as a selection criterion for motherpalms.

The next character that exhibited drastically low expression of variation, is X_1 - the girth of stem. The figures do not permit, as such, the launching of new commitments. However, the breeder can always stick on to the principle of locating preferentially palms with healthy, strong and uniformly thick stem that bears, a neither too close, nor too much spaced array of leaf scars, before

effecting actual selection of ideal motherpalms. A similar view has been suggested by Pieris (1934) who recommended selection of palms with a stout straight stem with closely spaced leaf scars.

A second order variable, that accounts according to the figures for potentially increased variability is X_6, the yield of nuts. A groupwise consideration reveals that irrespective of the category to which they belong, trees of the West Coast Tall recorded values that did not differ much from each other.

Similar is the case with the two motherpalm attributes, that came in succession, in this order. Variable, X_5, the percentage of fruitset; and X_4, the mean number of female flowers per inflorescence, exhibited characteristically identical trends. The mean number of female flowers exhibited comparatively less variation than the setting percentage. One has to identify a stronger influence on the genetic factor associated with the number of female flowers present. Probably, this is also the reason, why, almost identical figures for the coefficient of variation in this regard, were recorded against the nutyield categories individually and under conditions

when no category distinction was accounted for. Bavappa et al. (1973) have included these two characters among others, as those contributing maximum influence towards occurrence of genetic divergence among West Coast Tall Palms. Further, Nambiar et al.(1970) observed that increased stability in yield could be attained through selection for high setting percentage. But an excessive number of female flowers in the inflorescence was suspected to lead to reduction in the setting of nuts. Nampoothiri et al.(1975) too supported this view. According to them, a proper distribution of female flowers in the inforescence has to be viewed preferably,, since only a fewer number of female flowers per spike alone develop into fruits and under the conditions, they get opportunity to enjoy the best possible condition for further development.

In the present study, it is not difficult to presume that the variable X_6 (yield of nuts) when compared to X_5 (percentage of fruitset), is more sensitive to the impulses originating from the environment. The figures estimated in this regard, seem to suggest that the Low yielders are more sensitive to the environment, than the medium yielders. On the contrary, high yielders proved themselves to be the most stable. The findings seem to

suggest the possibility of enhancing to a reasonable extent, the yield factor, and inducing more regularity in the bearing aspect during the different sessions of harvest within the year, through a deliberate administration of a suitably standardized optimum ideal management schedule, with added emphasis attributed to a higher percentage of fruitset, in an inflorescence accommodating an optimum number of female flowers spaced suitably while selecting motherpalms.

The last among the seven motherpalm attributes that warrants discussion is X_3, the number of bunches per tree. It is an undebated fact that bunches are modifications of the axillary leaf buds and in coconut, a frond can accommodate only one bunch in its axil. This, again, proves itself to be a variable with an inherently lower potentiality for variation. In this regard, a consideration similar to that given to X_2 can be made applicable here also. However, there can be conditions, when bunches turn out to be more desirable as well as otherwise. An ideal bunch should necessarily have a sturdy stalk that resists significantly the tendency for buckling, especially when it has to bear a relatively larger number of nuts. Further, a reasonably satisfactory

number of nuts could be made obtainable only when the individual nuts are not too large in size. As and when the size becomes larger, the tendency will be positively in favour of a noticeable reduction in their number. This has been supported amply by several workers like Pieris (1934), Marar(1960) and Liyanage(1962). Further, De Silva and George (1971) have pointed out that medium sized nuts are more capable of early germination and rapid seedling stage growth than others. Hence it can be safely predicted that selection for a comparatively higher number of bunches in the crown, possessing short stout bunch stalks and a large number of medium sized nuts can effectively cause an increase in the yield potential.

On Seednut attributes:

Two variables were studied individually under this context - X_8 (fresh weight) and X_9 (volume). The value for the coefficient of variation for these two characters, appears to be reasonably low, 23.45 and 28.37 respectively, and almost similar to that obtained for the other two presumably and more directly associated component characters, X_3 (number of bunches) and X_4 (number of female flowers per bunch).

Of these two seednut characters, the volume compared to the weight exhibited a slightly increased rating for variation. A logical explanation for this is not absolutely difficult to propose, since, the term seednut represents the fruit proper in coconut palm, that is, in turn, comprised of constituents that vary considerably in nature and relative proportion. It is felt that conditions are not impossible, when a large sized nut carries less of endosperm and vice versa.

Regarding the weight (X_8), a comparatively lesser order variation is seen manifested. Further, the extent of variability does not reveal much of difference between the nutyield categories. The importance of preferential selection in favour of heavy and medium nuts was reported earlier by De Silva and George (1971).

An examination of the individual values for the mean, in this regard, suggests that the heaviest nuts were yielded by trees belonging to the L category and the lightest by those belonging to the H category. Probably, the reason for the yield of comparatively fewer number of nuts by trees of the latter category may be because of the condition arising from the marked increase in the volume as well as the weight of individual nuts on a bunch, that would have effected eventually noticeable reduction in

in their number. Similarly, trees belonging to this category yielded nuts with the lowest value for the mean of the volume. On the other hand, trees of the category M, that accounted for around 60 per cent of the population, however, seem to prove themselves to be ideal with regards to the seednut characters. They produce on an average, around 90 nuts per year, on individual basis and these nuts are medium sized with an average weight. Further, these nuts gave a germination percentage of around 80, a not so low a value, a percentage recovery of seedlings around 40. As such, these observations could be depended upon to arrive at a reasonable consolation that does encourage confining, procurement of seednuts to apparently healthy motherpalms that maintain a regular bearing disposition and that yield well formed, medium sized and reasonably heavy seednuts.

On Seedling characters

Four variables were studied as follows.

i. X_{10} - number of days for sprout initiation,
ii. X_{11} - height at one year age,
iii. X_{12} - girth of collar at one year age, and
iv. X_{13} - number of split leaves at one year age.

Among these variables, the maximum variability, as expressed by the value for the coefficient of variation, was noticed against X_{13}, and the least against X_{12}. Between X_{10} and X_{11}, variation was more in respect of X_{11}. The expressed magnitude of variation for X_{10} and X_{12} are almost near.

The salient features that could be made exposed from the above findings, include, that irrespective of the nutyield category from which the seedling progeny originated, sprout initiation did express in a period of around 210 to 220 days. The observation seems to indicate that phenomenon is predominantly under genetic control. Srinivasa and Ramu (1971) found that as a rule, early germinating nuts develop into vigorous and superior seedlings. Accordingly, they substantiated the worth of considering this aspect as one of the important criteria in the selection of seedlings. X_{12}, the girth of collar seedlings at one year stage, also exhibits a trend, more or less identical, in nature and magnitude, to that of X_{10}. This is quite in support of an earlier view projected by Marar(1960), who considered this attribute as another valuable seedling selection criterion. Nampoothiri et al. (1975) found that the girth of collar

was the only seedling attribute that showed significantly positive phenotypic and genotypic correlation to the yield potential.

On the other hand, X_{13}, the number of split leaves in one year old seedlings recorded the value which is apparently folds high, when compared to those for the characters pertaining to the motherpalms, seednuts and their seedling progeny. The observation seems to initiate thinking from an entirely new philosophical but sensible vista. All plant breeding operations give necessarily the maximum weightage to the practising of selection at levels of probability felt most desirable. In order to practise selection in the most efficient and effective manner, a very high order of variation must occur in the base population matrix. Further, selection is made in favour of the best of the lot, either an individual, or a few individuals, identified through comparison against others. Mention has been made to the importance of Multi Level Selection Schedule being followed, in connection with effecting betterment in coconut culture. Accordingly, selections are made, at the levels of motherpalm populations, seednuts, and among the seedling progeny stand in the nursery. In this, the requirement is to make selection

effective in enabling recovery of an increased proportion of uniformly vigorous seedlings from the nursery. Hence, the approach has been made in such a manner as to give emphasis to distinct multiple criteria basis through the formulation of an index value that could eventually be made to serve as a reliable guideline for identifying the more vigorous from the less vigorous ones. This identification is being aimed at under the presumption that vigorous seedlings promise superior late stage performance.

Seedling Vigour Index

The formulation of the index, as has been referred to earlier, is to facilitate significant supplementation of the effectiveness, of the even otherwise accepted norms relevant to a comparatively more rigorous selection for vigorous seedlings. Further, in the formulation of SVI, weightage values were assigned to the 6 variables considered. This was accomplished through a scientifically sound computation procedure, as described by Smith(1936), instead of adopting an arbitrary weightage allotment system, which is felt to be lacking in a scientific basis. Accordingly, positive numerical values for the weightages were arrived at for three of the variables - X_9 (volume

of seednut), X_{12} (collar girth of one year old seedlings) and X_{13} (number of split leaves in one year old seedlings) and negative values were obtained for the other three attributes $-X_8$ (fresh weight of seednut), X_{10} (number of days for germination of seednut) and X_{11} (height of one year old seedlings). Particulars of the values for the assigned weightages for the different variables made use of for estimating the index value are presented under Table 2. Using these computed values for the weightages, the index (SVI) was estimated individually, for all the 404 seedlings that survived through the one year period in the nursery. The value for the overall mean was taken as the level of significance in order to make a distinction between the vigorous and the less vigorous among the seedlings (Table 3). The vigorous seedlings were found among those that had a value for the SVI, higher than that for the general mean. Altogether, 195 out of the 404 proved themselves to be vigorous and these seedlings made possible tracing back to the respective motherpalms from which they originated.

On the productivity of vigorous seedlings by the Motherpalms

Reference is again made to the Chart, showing the features of progeny analysis made on the basis of the results obtained during the course of study. The following aspects get themselves exposed.

1. Palms, irrespective of the nutyield category to which they belong, possess the ability to produce vigorous seedlings. At the same time, all the groups contained palms that did not produce any vigorous seedling at all. Such palms were more in number/proportion under High yielders.

2. Certain palms expressed the potentiality to produce greater proportion of vigorous seedlings (High Potency Motherpalms)

3. When all the nuts collected from certain palms germinated, instances were noticed, when a condition otherwise was observed in respect of others.

In the light of the above observations, a fact has become clear, that among trees in a garden, there is scope for identification of High Potency Palms, through the application of a technique that makes proper use of the

multiple criteria evaluation of seedling progeny. This, coupled with an appraisal of individual motherpalms for the expressed proportionate recovery of vigorous seedling progeny, could yield good results. The identification of High Potency palms was accomplished by estimating the numerical values for a relationship, that was felt to give a true picture of the motherpalms with regards to their ability to yield vigorous seedlings. In this approach, the Vigorous Seedling Recovery Potential was expressed numerically. Accordingly, it was seen that 4 out of 15 Low yielders, 11 out of 29 Medium yielders and 2 out of the 6 High yielders could be recognised as High Potency Palms. (Table 4)

Further, an attempt was made to test whether any significant relationship existed between the phenotypic attributes of such High Potency Palms and the extent of vigour that their seedling progeny exhibited. This was accomplished by computing the mean for the SVI values of vigorous seedlings yielded by each of these High Potency Palms (Table 5), and testing the significance of the association of the MSVI for each individual against the seven visually identifiable attributes of the same palm.

Dependence of Motherpalm attributes to the respective mean value for the SVI among High Potency Palms.

Reference is made to Table 6. Of the total 50 motherpalms subjected to progeny analysis, as already detailed earlier, 17 were identified as High Potency parents, and these 17 palms produced vigorous progeny in varying proportion. The results indicated that significant association was expressed only by X_7, the regularity in the bearing nature exhibited by the motherpalms, through the six sessions of harvest within an year. It is therefore recommended, under the context, that though, the need for computing a set of values to represent the motherpalm selection indices by adopting a multiple criteria approach, incorporating motherpalm attributes alone does not project possible scope of added importance, the identification of palms that maintain consistency with regard to this character X_7 can be considered to give beneficial effects.

On the progressive growth rate, the height and collar girth among the seedlings

It appears from Fig.1 that, an almost similar trend of progressive increase in height is expressed by the seedling

progeny from the third month onwards, irrespective of the nutyield category to which they belong. Similarly, Fig.2 is helpful to understand the progressive increase in measurement of the collar girth among the seedlings which also though exhibit a similar trend among the nutyield categories, the expressed uniformity starts from only the fifth month onwards. The observations however, do not help to resolve the desired original needs of the experiment, namely,

1. The identification of the vigorous seedlings among the seedling progeny in the nursery, through the employment of a methodology based on the multiple criteria model, and
2. to make distinction between desirably suited and less suited from among the lot of phenotypically distinct healthy palms, particularly on the basis of their individual potentiality to yield vigorous progeny in relatively superior and appreciable profusion.

Thus, it is found that, the progeny analysis carried out among coconutpalms belonging to the West Coast Tall variety, under three different nutyield categories such as Low, Medium and High yielders, has been helpful in

exposing information of practical importance in inducing an overall enhancement in the performance standard. It has been felt earlier, that in this regard, a multi-level selection schedule can be resorted to, for making available the desired effect. Accordingly, selection of phenotypically healthy motherpalms has to be given priority preference. This should be followed by a choice of well formed, medium sized, average weighing ones among the seednuts collected exclusively from these chosen motherpalms. On the belief that the expressed superior vigour of the seedling progeny is a positive and dependable indication of desirably advantageous later stage performance, emphasis has to be attributed to the practising of a more severe selection among the seedling progeny population also. This study, proposes an approach based on the multiple criteria model that could be made use of not only in identifying individual seedlings with vigour, but also in identifying more suited motherpalms based on their innate potentiality to yield such seedlings in appreciably high proportion. Further, the study reveals that such palms could be located among those that come under the category of steady average bearers. Alongwith, it is felt that, it will not be quite out of place if a recommendation is

proposed in addition in favour of confining deliberately search for such High Potency Palms among phenotypically healthier ones exclusively. Lastly, in order to ensure realization of overall late stage performance superiority among the progeny, an additional recommendation is being furnished as to restrict the transplantation strictly to established vigorous seedlings alone.

SUMMARY

SUMMARY

1. A systematically arranged Pedigree Progeny Analysis in the coconutpalm (Cocos nucifera Linn.) variety, West Coast Tall, was pursued during February 1981- June 1982, in the premises of the Coconut Research Station at Balaramapuram, as a postgraduate research programme under the Kerala Agricultural University.

2. The venture was undertaken with a view to supplement the already available norms recommended for realising the desired effects in connection with inducing an overall enhancement in the late stage seedling progeny performance standards relevant to coconut culture.

3. The material consisted of 50 trees, chosen at random, belonging to the age group of 25 years, that were subsequently classified into three categories of Low, Medium and High nutyielders. Trees that produced 80 nuts and below were classed under Low yielders, and those that recorded annually an yield of 120 nuts and above were brought under the High yielders.

4. Seednuts collected from the chosen motherpalms, at the rate of 10 per tree, were sown, eventually, in the nursery, after a period of storage, in accordance with the

procedure given in the Package of Practices of the Kerala Agricultural University.

5. Data pertaining to the following 13 variables were collected.

(1) X_1 - Girth of stem.

(2) X_2 - Number of fronds in the crown.

(3) X_3 - Number of bunches in the crown.

(4) X_4 - Number of female flowers in the inflorescence.

(5) X_5 - Percentage of fruitset .

(6) X_6 - Total yield of nuts during the year.

(7) X_7 - Difference in yields between the peak and lean harvest sessions of the year.

(8) X_8 - Fresh weight of seednut.

(9) X_9 - Volume of seednut.

(10) X_{10} - Number of days for germination of seednut.

(11) X_{11} - Height of one year old seedlings.

(12) X_{12} - Girth of collar of one year old seedlings.

(13) X_{13} - Number of split leaves borne by one year old seedlings.

6. From the seedling data, adopting a multiple criteria model of approach, a numerical expression for the Seedling

Vigour Index (SVI) was estimated individually for all the seedling progenies, that survived through the one year stand in the nursery. A standard value that could be made use of for effecting a satisfactory distinction of the vigorous, from the less vigorous seedlings was identified in the overall mean for the values for the SVI of all the seedlings.

7. It is found, that all the three nutyield categories consisted of trees that produced vigorous seedlings in varying proportion as well as those that did not produce at all, even a single such seedling.

8. The usefulness of relying upon a selection schedule, followed at the levels of the motherpalm population, seednuts and the seedling progeny stand in the nursery, is substantiated.

9. The scope for confining selection of more suited motherpalms to those displaying a general healthy outlook and maintaining a steady average bearing of nuts is stressed and justified.

10. Further, a recommendation is proposed to confine selection of motherpalms among those that express a significant positive potentiality to produce vigorous seedlings in profusion.

11. Achievements of appreciably superior standards, for late stage seedling progeny performance, could be resolved through restricting transplantation exclusively to those exhibiting superior vigour.

12. In addition, further informations were made obtainable.

Motherpalms possessing a greater proportion of expressed attributes of desirability, are more likely to transmit the characters to the progeny, than others, hence the importance of selecting motherpalms possessing the best standards of performance desirability.

The rates of increase in height and collar girth measurements in seedlings, irrespective of the nutyield category to which their parental source is located, exhibit an almost identical trend suggesting that it is the genotype that is predominantly active at this stage and not particularly the factors in the environment.

13. In conclusion, a recommendation is being proposed to seek suitable motherpalms preferably in the Medium nutyield category, since such trees cover around 60 per cent in a garden. Further, one can confine selection to such palms exclusively, so as to ensure realization of the desired beneficial effects.

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