PERFORMANCE OF CLONAL PROGENIES FROM DIFFERENT YIELD GROUPS AND IN RELATION TO SIZE OF SUCKERS IN RAINFED BANANA *Musa* (AAB GROUP) 'PALAYANKODAN'

By

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "Performance of clonal progenies from different yield groups and in relation to size of suckers in rainfed banana Musa (AAB group) 'Palayankodan'" is a record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Vellanikkara,
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CERTIFICATE

Certified that this thesis is a record of research work done independently by Smt. Prasanna, K.P., under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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Introduction

INTRODUCTION

Banana is grown in India under varying soil and seasonal conditions, exploiting the wide varietal variability that exists in the crop. In Kerala banana occupies an area of 50,000 ha (Anon., 1982) and the crop is grown both under irrigated and rainfed conditions.

Some of the prominent cultivars grown in Kerala are 'Nendran', 'Palayankodan', 'Rasthali', 'Red Banana', 'Robusta', 'Dwarf Cavendish', 'Kannan',and 'Monthan'. Among these 'Palayankodan' (AAB) syn. 'Champa' (West Bengal), 'Poovan' (Tamil Nadu), 'Karpurachakkarakeli' (Andhra Pradesh) is found to be tolerant to poor soil and drought conditions (Simmonds, 1966) and is the prominent cultivar grown in the State. Even under uniform cultural and manurial practices, variation in bunch weight is often noticed between plants within the banana cultivar 'Palayankodan'. Normally the variation in yield in banana could be attributed to the suckers used and the environmental factors. However, in a cultivar like 'Palayankodan' which has been under cultivation for hundreds of years, possible intraclonal variation due to somatic mutation cannot be ruled out. In a recent survey undertaken in the cultivar 'Nendran', at the Banana Research Station, Kannara, clonal variation was conspicuously noticed, which pointed out the possibility of clonal selection in

this cultivar. Whether clonal variation existed in the cultivar 'Palayankodan' was therefore considered as a subject matter worthy of detailed investigations.

The present studies were undertaken with the following specific objectives:-

i) to find out whether suckers selected from plants belonging to different yield groups would inherit the yield expression to their progenies through suckers in order to arrive at indications on the possibility of clonal selection.

ii) to assess the effect of the size of suckers on growth and yield of plant crop.

Investigation with the above objectives was considered essential for making any recommendation on plant selection and the type of suckers that are to be planted for obtaining higher yields in the cultivar 'Palayankodan'.

Review of Literature

REVIEW OF LITERATURE

The literature pertaining to the present studies on the planting materials of banana are reviewed hereunder.

1. PLANTING MATERIAL

Preference for planting material for banana varies widely in different parts of the world. In Jamaica, bits of large corms, maidens and sword suckers are regarded as satisfactory planting materials. In Martinique, rhizomes of flowered plants are preferred to maidens and sword suckers are regarded as a last resort. They are used as little as possible. In West Australia, spear points were the preferred planting material while in Israel well grown water suckers were recommended (Daudin, 1955).

Champion et al. (1960) compared the performance of rhizomes of flowered plants bearing a single well developed sucker and retaining about 20 cm of pseudostem with young suckers with active terminal buds and rhizomes of adult plants before flowering. The best results were obtained in respect of yield with the rhizomes of flowered plants with a sucker. When planting was unavoidably delayed growth could be hastened by using suckers, but in this case, yields were low and harvesting dates irregular. Alternatively rhizomes retaining the whole pseudostem could be used, with

much better results, but such material is very bulky and requires rapid transport and planting. The results from the various types of planting material differed more widely in the first, than in the second harvest. However, it was noted that the planting materials collected from flowered plants were more promising in respect of yield and bunch size.

Morel and Guillemot (1961) reported that sucker growth was greatly improved by leaving 1.5 m of the pseudostem attached to the rhizome. They also tried by retaining only the inflorescence stalk and removing the leaf sheaths from the rhizome. But the result was slightly inferior when compared to the former. The disadvantage of leaving attachments on the setts was the higher cost of transport. The setts with pseudostem attachments were superior in growth for the first 4 to 5 months, but after 6 months the growth was no way better than the normal ones. Storing the setts for 15 days instead of 3 days between preparation and planting was detrimental to sucker growth.

Srivastava (1963) observed that sword suckers produced bigger and heavier bunches than water suckers within 11 months.

Chattopadhyay et al. (1979) reported that suckers produced higher bunch weights compared with rhizomes and peepers.

2. SIZE OF PLANTING MATERIAL

Wright (1949) reported that sword suckers of 22 to 51 in in length, cut back 6 in above the corm and planted upright proved quite suitable under dry conditions of Jamaica. Shah and Majumdar (1950) were of the opinion that yield and number of hands per bunch were not related to height of suckers.

Oppenheimer and Gottreich (1954) stated that the sucker size should be related to planting time and weather especially in sub-tropics. When the planting was later, the sucker should be bigger in order to avoid winter chilling of bunches; but wilder the winter the smaller the sucker should be in order to avoid the prematurely shot first ratoon. Even a difference of 1 ft in height of sucker markedly affected the time of flowering of the plant crop and hence the yield. Small suckers although flowered late, gave better grades of bunches. But the yields were low. In the first ratoon the yield was lower in strong plants established from large suckers. Percentage of flowering in optimum period was more in the larger suckers in the plant crop. But this was not followed in the first ratoon crop. Ultimate yield and total duration was not much affected by sucker size. Grade hand was also not affected significantly. The major differences were noticed only in the initial stage of plant growth.

In a trial at Krishnagar, butts from fruited plants were planted as whole and cut into 2 or 4 equal bits, each possessing at least one well developed bud. At first the best growth was made by whole butts of fruited plants closely followed by butts of non-fruited plants. Quarter butts of non-fruited plants were the slowest to grow. However ultimate growth and number of hands per bunch were not affected by the type of planting material (Khan and Majumdar, 1956). In another trial conducted by them (1958) it was noted that 3 ft, 4 ft and 5 ft tall suckers made equally good growth; but the duration of crop was shortest in 5 ft suckers. Mere pruning of leaves at planting made no difference when compared with heading back of pseudostem 1 or 2 ft. Heading back caused a temporary check in growth, but it delayed fruit maturation in 5 ft suckers when headed back to 2 ft. Yield and number of hands per bunch were not related to height or heading back. It was concluded that where transport was a problem smaller suckers would be better.

Barrill (1960) observed that in Cavendish bananas pieces of corms of 1 to 6 lb in weight were better planting material than suckers of 10 to 20 in. in girth. The former type produced uniform and vigorous plants. He also found that the effect of size was more pronounced in the case of suckers than with the pieces of corm. The best sizes were pieces of corm weighing 2 to 4 lb and suckers 12 in. in girth.

Meyenhuis (1966) compared four types of planting materials namely small, well developed sword suckers along with a part of rhizome, small well developed sword suckers without rhizome, moderately large broad leaved water suckers, 2 to 3 ft tall and large suckers consisting of young stems cut off at 4 to 5 ft. All these four types began bearing at 12 to 13 months when planted in September (Spring). But the same suckers when planted in March (autumn) it was noted that only the large suckers consisting of young stems began bearing from 15th month after planting. The smaller suckers of autumn planting began bearing 19 months after planting. He concluded that large sized suckers could be planted over the whole active growing period without losing earliness and yield. Smaller planting material on the other hand could be planted only in spring.

According to Rasvi and Jagirdar (1966) large suckers (5 lb) produced taller and stouter plants which matured earlier than small suckers (2 lb). The use of large suckers as planting material increased the subsequent weight of bunches in the 'Basrai' variety. But small suckers improved bunch quality in the variety 'Philippine'. Medium (3 lb) suckers were most effective in hastening the maturity of 'Basrai'.

Trochoulias (1966) evaluated four types of planting materials namely bits ($1\frac{1}{2}$ to $2\frac{1}{2}$ lb), and large (16 oz), medium (12 to 16 oz) and small (8-12 oz) spear points. Of these the

spear points gave a higher percentage of establishment than the bits. Vegetative development was proved to be the best in the case of large spear points and least for bits. Large and medium sized spear points produced bunches more quickly than the other types of planting materials. There was a significant negative correlation between vegetative growth and bunch emergence in all cases, especially with large spear points.

Jagirdar and Ansari (1967) conducted trials with suckers cut back to 6, 12 or 18 in. above the base of the corm or left untrimmed. Cutting back to 12 in. gave plants which bore better graded bunches with a large number of fingers than cutting back to 6 in. or no trimming. They also evaluated quarter, half and whole rhizomes with suckers taken from fruited and non-fruited plants. They noted that maidens gave plants which bore bunches of higher weight with a greater number of fingers. A good percentage of plants from maidens was found to come to bearing earlier than those from quarter or half rhizomes. The total yield of plants did not significantly differ between quarter or half headed rhizomes. According to them maidens from non-fruited rhizomes were the best source of planting material.

Simmonds (1966) observed that weaker plants established from small suckers could be allowed to carry only one follower in the first ratoon. But these plants would be strong enough

to carry two followers in the second ratoon. Vigorous plants from large suckers could be allowed to carry two followers in the first ratoon, but may be thereby so weakened that they can carry only one in the second.

Alva Reyra and Carranza (1972) compared pieces of corms weighing 3.5 and 7 kg. Plants produced from corm pieces of 5 kg gave the highest yield at first harvest. The plants were not vigorous and tallest and the number of hands per bunch were the largest in this case. They also compared suckers of 0.5, 1.0 and 1.5 m in height. Of these plants raised from 1.5 m suckers were earlier yielding. When corm pieces and suckers were compared the duration of crop was shortest for the plants raised from suckers.

Assous et al. (1972) studied the performance of suckers of 4 different heights namely 224 cm, 194 cm, 167 cm and 137 cm. They found that flowering and ripening in banana were earlier with the plants raised from suckers of 224 cm height. Plants produced from suckers of 194, 167 and 137 cm had nearly the same bunch weights. But the bunches produced from suckers of 224 cm height were 11 per cent less in weight. Heading back was advantageous for taller suckers. Heading back 30 cm increased the bunch weight of the 224 cm and 194 cm groups by 11 and 6 per cent respectively. Heading back the 224 cm suckers by 60 cm raised the bunch weight by 6 per cent.

Kohli and Singh (1972) stated that bits of rhizomes with well developed bud weighing 200 to 300 g were the ideal planting material. They explained that the availability of sufficient food reserve in such suckers helped for the better establishment. The well developed bud could make use of this reserve food to sprout early and properly.

Sharma and Roy (1974) suggested that suckers of 180 cm height flowered first and gave six crops when compared with suckers of 60 cm and 120 cm height which gave only 4 to 5 crops in a period of 3 years and 7 months.

Turner (1978) found the positive influence of weight of banana planting material on the area and shape of leaves produced in the establishment phase. He also concluded that with every 0.5 kg increase in the weight of planting material there was about 75 cm^2 of extra leaf surface. The area of the first four leaves was influenced mostly by the weight of planting material and was easily controllable.

3. AGE OF PLANTING MATERIAL

According to Nagpal et al. (1958) six months old suckers were better planting material than two months old suckers.

Bartolome and Dongeuan (1958) conducted an experiment with suckers and rhizomes of different age. They found there was no significant difference in fruit yield or stooling capacity due to difference in age of planting material.

Khan and Majumdar (1961) reported that four month old suckers planted in the autumn season cropped the earliest when compared to the two months old and three month old suckers planted in monsoon and autumn season. But the bunches were the smallest in four month old suckers. The highest yield and largest number of hands and fingers per bunch was given by three month old suckers. This was noted in the variety 'Kabuli'. In another variety 'Martaman' the age of sucker did not affect the duration, yield or the number of hands and fingers.

Jagirdar and Hussain (1963) studied the performance of plants raised from $1\frac{1}{2}$, $2\frac{1}{2}$ and $3\frac{1}{2}$ months old suckers. They did not observe any significant difference in growth and fruit production of bananas due to the difference in age of planting material.

4. RAPID MULTIPLICATION

Wright (1950) reported that the number of suckers produced declined sharply as the spacing decreased. Removal of suckers as peepers instead of swords increased the total number of suckers produced per plant.

Khan and Majumdar (1956) recommended bits of rhizomes each with at least one well developed bud for producing more plants from a single parent plant. Lacatan bananas could be multiplied 16-fold in a year by splitting up and replanting

twice a year combined with adequate irrigation and manuring (Anon., 1957).

Barker (1959) reported a method of digging and planting of all suckers when they had attained a weight of more than 1.5 lb and reached a height of 2-3 ft. Stripping of the older leaf sheaths and exposing the basally located buds and covering them with soil helped the rapid production of suckers. A two week routine of sucker removal and bud exposure produced about twenty plants from a single parent. Osborne (1963) found that stripping of suckers at two monthly interval could produce large number of suckers.

Ascenco (1967) found that 9 to 30 suckers could be obtained in a period of nine months by planting suckers weighing 3 kg and earthing up. Nitrogen should be applied at the rate of 720 g ammonium sulphate and suckers were to be removed when they reached a height of 25 to 30 cm.

In a trial conducted at Alstonville tropical Fruit Research Station, Turner (1968) found that the forward eyes from the base of the corm and well developed eyes in the form of spear points were the most suitable planting material for rapid multiplication.

Azuman et al. (1977) developed a rapid multiplication technique for Giant Cavendish which included (1) planting large rhizomes in boxes filled with soil or vermiculite (in shade),

removing suitable suckers and planting them in field, nursery or cans, and (2) growing large rhizomes in a humidity chamber and removing suckers to be planted in field, nursery or cans. Both of these methods were followed by transplanting to commercial field and subsequent sucker production there. Of these two methods, the first was judged best and most practicable for a farmer. They were able to produce 3,159 rhizomes from eighteen original rhizomes within a period of sixteen months.

Materials and Methods

MATERIALS AND METHODS

The investigations to assess the performance of clonal progenies from different yield groups and in relation to size of suckers of banana was conducted in the Department of Pomology, College of Horticulture, Vellanikkara, Trichur during the year 1981-82.

Cultivar

The investigations were done in rainfed banana using the cultivar 'Palayankodan' which is one of the important commercial cultivars of Kerala.

Planting material

Suckers were selected from parent plants raised as a ratoon crop in the Horticulture College Farm, the morphological, bunch as well as fruit characters of which were recorded earlier. The plant crop as well as ratoon crop were grown under uniform cultural and manurial practices. The mother plants were grouped into four classes, based on bunch weight as given below:

B_1 = 5-7 kg/bunch

B_2 = 8-10 kg/bunch

B_3 = 11-13 kg/bunch

B_4 = 14-16 kg/bunch

From each class, suckers were collected and pooled together under that particular class. From each class the suckers of same age (three months old) were further grouped according to weight of suckers as given below:

S_1 = 1-1.5 kg/sucker

S_2 = 2-2.5 kg/sucker

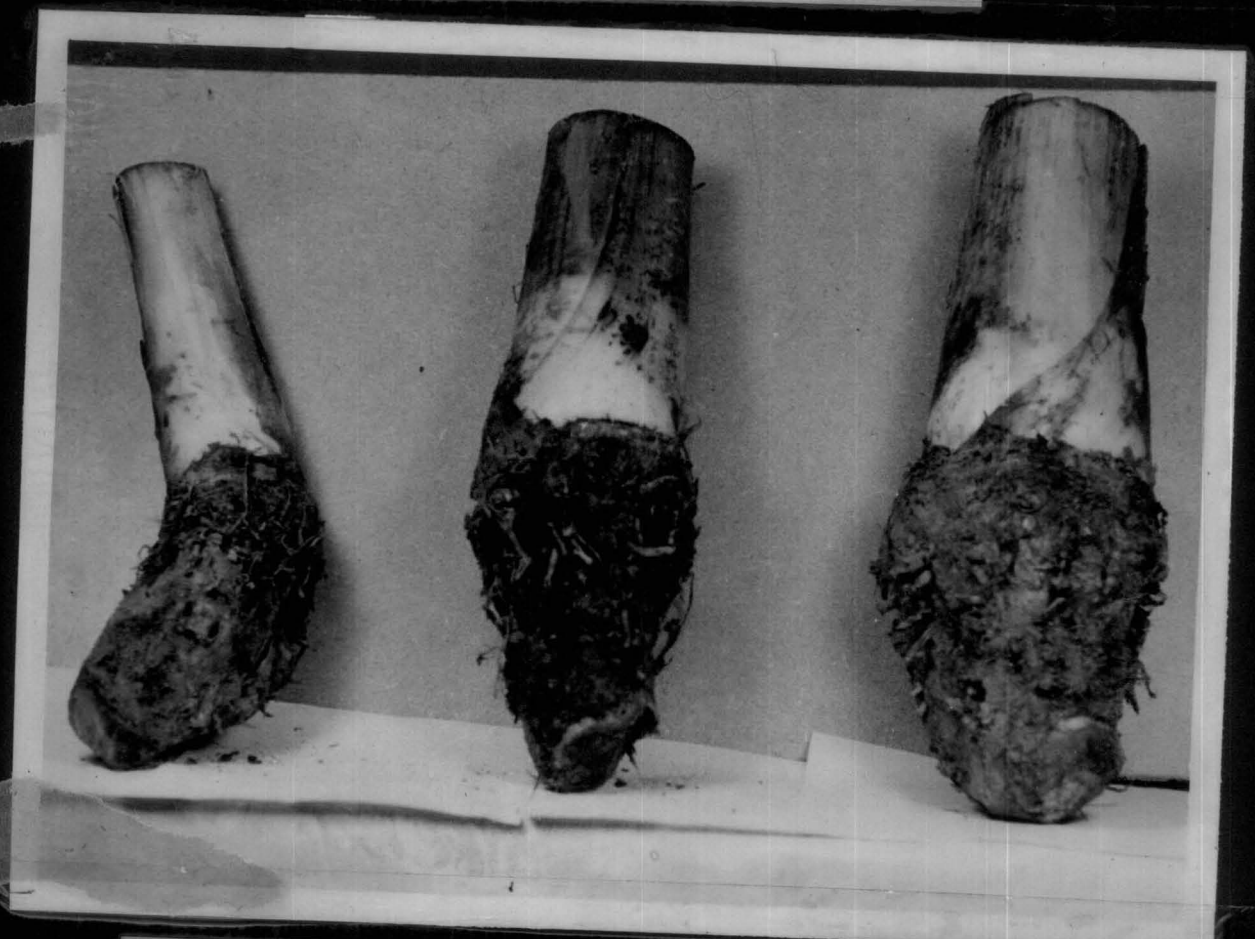
S_3 = 3-3.5 kg/sucker

In order to find the weight of suckers the pseudostems were excluded. By working out the correlation coefficient between girth and weight of suckers, significant relation was observed between these two. A regression equation could be arrived at for predicting the weight of sucker based on its girth. It was same as $y = -1.9698+0.11843x$. With this equation it was possible to identify suckers of various weights, knowing the girth at collar. This method was used for the selection of suckers coming under different weight groups. The pseudostems of suckers were headed back to a height of 25 cm before planting.

Field preparation and planting

The field was ploughed twice and levelled. Pits of 50 x 50 x 50 cm size were dug at a spacing of 2.13 x 2.13m. The suckers were planted on 3rd March 1981, one week after taking the pits. Farm yard manure at the rate of 15 kg/pit (nutrient value of 0.4 per cent nitrogen, 0.3 per cent P_2O_5

Size groups of suckers used for planting (with pseudostem)

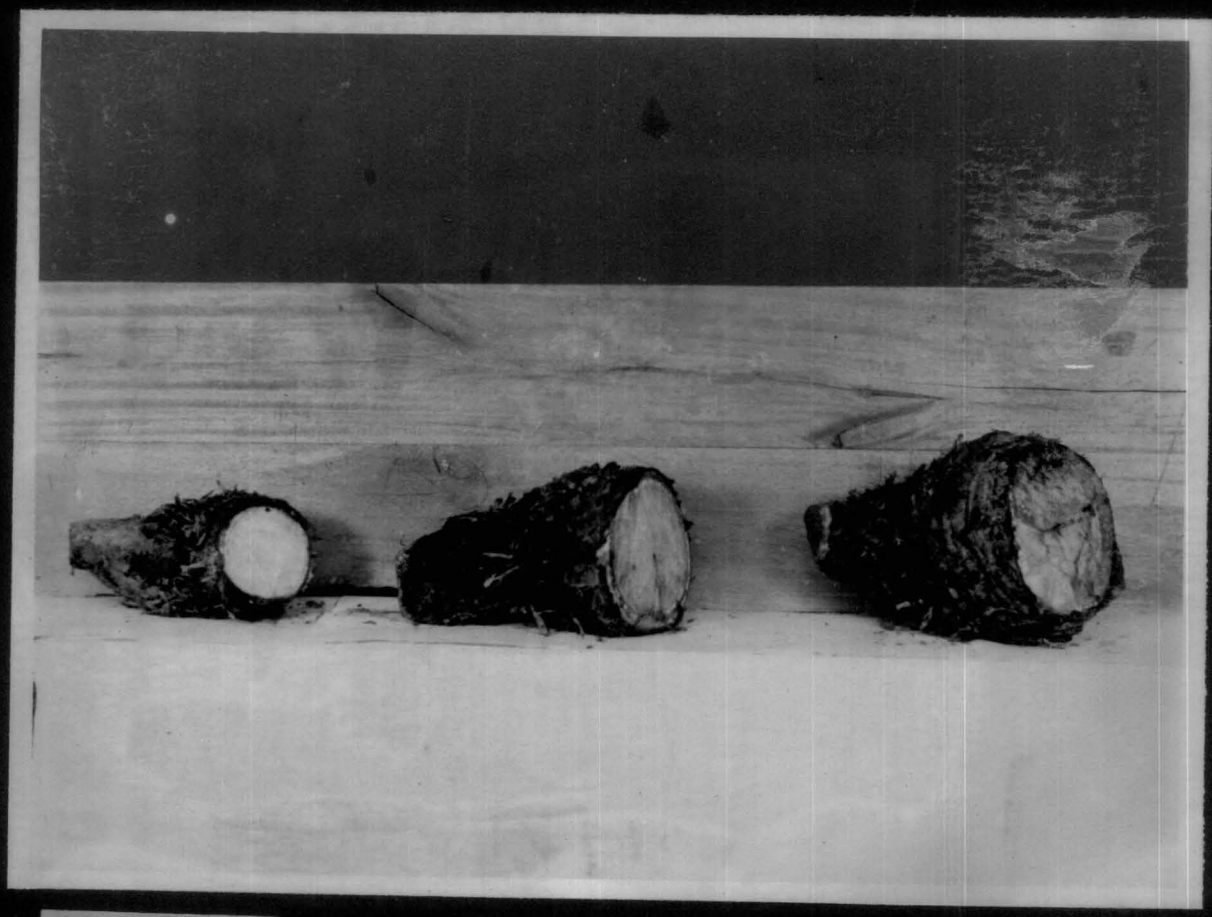


1 to 1.5 kg group

2 to 2.5 kg group

3 to 3.5 kg group

Size groups of suckers used for planting (without pseudostem)



1 to 1.5 kg group

2 to 2.5 kg group

3 to 3.5 kg group

and 0.2 per cent K_2O) was given as basal application. In addition, 25 kg of green leaf (nutrient value of 0.98 per cent nitrogen, 0.3 per cent P_2O_5 and 1.96 per cent K_2O) were also added to each pit. Thimet granules at the rate of 25 g per pit was also applied at the time of planting in each pit as a prophylatic measure against rhizome weevils and aphids.

Pot watering was done at the rate of nine litres/plant at fortnightly intervals from the first week of planting until the suckers had established. Uniform cultural operations and crop management were adopted throughout the cropping period.

Nitrogen, phosphorus and potassium were applied in the form of urea, superphosphate and muriate of potash, respectively at the rate of 200 g N, 200 g P_2O_5 and 400 g K_2O per plant. The recommendations of Kerala Agricultural University for irrigated bananas was taken as a basis for fixing the doses in the absence of any recommendations for rainfed bananas. All the fertilizers were applied in two equal split doses, the first two months after planting and the second four months after planting, taking advantage of the pre-monsoon and monsoon showers.

Experimental design and lay out

The trial was laid out as a factorial experiment in randomised block design with twelve treatments and five

replications. In each plot, there were four plants in two rows and the plants were spaced at 2.13 m x 2.13 m. From these four plants, two were marked as observational plants. The layout plan of the experiment is illustrated in Fig.1.

Treatment combinations

B_1S_1	B_2S_1	B_3S_1	B_4S_1
B_1S_2	B_2S_2	B_3S_2	B_4S_2
B_1S_3	B_2S_3	B_3S_3	B_4S_3

Fig. 1. Lay out plan

R_1	B_2S_1	B_3S_3	B_4S_2	B_1S_3	B_3S_1	B_2S_2	B_1S_1	B_3S_2	B_4S_1	B_1S_2	B_4S_3	B_2S_3
R_2	B_1S_2	B_3S_2	B_2S_1	B_1S_1	B_4S_3	B_3S_3	B_4S_1	B_4S_2	B_2S_3	B_3S_1	B_2S_2	B_1S_3
R_3	B_4S_3	B_3S_1	B_1S_2	B_2S_2	B_1S_2	B_3S_2	B_2S_3	B_3S_3	B_2S_1	B_4S_2	B_1S_1	B_4S_1
R_4	B_3S_3	B_4S_1	B_1S_3	B_4S_2	B_2S_1	B_1S_1	B_3S_1	B_2S_3	B_2S_2	B_1S_2	B_3S_2	B_4S_3
R_5	B_4S_2	B_2S_2	B_3S_2	B_1S_2	B_3S_3	B_4S_1	B_2S_1	B_4S_3	B_1S_1	B_1S_3	B_2S_3	B_3S_1

Treatments - 12 Plot size - 18.14 m^2
Spacing - 2.13 x 2.13 m

Soil

The soil of the experimental area was well drained acidic and lateritic clay loam. The chemical characteristics of the soil are presented in Table 1.

Weather data

The details of the meteorological observations for the cropping season are given in Appendix I. The daily maximum temperature during the cropping period ranged from 26.0 to 36.9°C and the minimum, from 21.3 to 27.2°C. The range of maximum and minimum relative humidity was from 57.7 to 93.7 per cent and 32.09 to 86.5 per cent, respectively. There were 109 rainy days during the period of 396 days which was the total duration of the crop. The total rainfall received during the period was 3034.9 mm. The maximum rainfall was received during the month of June, 1981.

During planting and at harvest, practically there was no rainfall and the temperature was comparatively high. The period of crop establishment (March to May) was also during hot summer when the average monthly rainfall received was only 31.27 mm. The rainfall received during June to September in the pre-shooting period was 2574.2 mm.

Observations

1. MORPHOLOGICAL CHARACTERS

The morphological characters studied were height, girth,

Table 1. Chemical characteristics of the soil

Constituents	Content in soil (%)	Analytical method used
Total nitrogen	0.13	Microkjeldahl (Jackson, 1958)
Available phosphorus	0.001	In Bray-1 extract; Chlorostannous reduced molybdophosphoric blue colour method (Jackson, 1958)
Available potassium	0.01	In IN neutral ammonium acetate extract; flame photometric (Jackson, 1958)
pH	5.3	1:2.5 soil:water ratio; using a pH meter
EC (~~Specific~~ Electrical conductivity)	0.1 millimhos/cm	1:2.5 soil:water ratio; using electrical conductivity bridge

number of leaves, petiole length, length of lamina, width of lamina, total leaf area and sucker production. The morphological characters were recorded at early vegetative phase, late vegetative phase and at shooting, adopting the method suggested by Yang and Pao (1962).

1.1. Plant characters

1.1.1. Height

The height of the plant was measured from the base of the pseudostem to the axil of the youngest leaf and recorded in cm.

1.1.2. Girth

Girth of the pseudostem was measured at 20 cm from the ground level.

1.1.3. Number of leaves

Fully opened, functional leaves present at each observation were counted.

1.1.4. Petiole length

Length of the petiole was measured from the pseudostem to the base of the lamina.

1.1.5. Length of lamina

Lamina length was measured from its base to the tip.

1.1.6. Width of lamina

Lamina width was measured at the broadest point in the middle region.

1.1.7. Total leaf area per plant

The leaf area of each functional leaf was calculated by the formula (Leaf area = Length x breadth x 0.8) given by Murray (1960). The leaf area of all the functional leaves at the time was taken to get the total leaf area per plant.

1.1.8. Duration of the crop

The number of days from planting to shooting and from shooting to harvest were noted. From these, the total number of days from planting to harvest was computed.

1.1.9. Sucker production

The number of suckers per plant was recorded as and when they were produced. However, no suckers were allowed until shooting. After the emergence of inflorescence, one sucker per plant was retained.

1.2. Bunch characters

The bunches were harvested when they were fully mature as indicated by the disappearance of angles on the fingers, that is, when the fingers were "round full" (Simmonds, 1966). The following observations were made on the bunches.

1.2.1. Weight of the bunch

Weight of the bunch including the peduncle was recorded.

1.2.2. Length of bunch

Length of bunch was measured from the point of attachment of the first hand to that of the last hand.

1.2.3. Number of hands

The number of hands per bunch was recorded.

1.2.4. Number of fingers

Number of fingers in each bunch was recorded.

1.2.5. Number of fingers per hand

Number of fingers in each hand was recorded and from this the average number of fingers per hand were computed.

1.2.6. Average weight of a hand

Weight of each hand on a bunch was recorded and the mean value calculated.

1.2.7. Average weight of a finger

The middle finger in the top row of the second hand (from the base of the bunch) was selected as the representative finger (Gottreich et al., 1964) for finding out the average weight, girth and length of the fingers. The weight of this representative finger was recorded as the average weight of a finger.

1.2.3. Girth and length of the finger

Girth of the finger was measured at the mid-portion and the length from the point of attachment to the tip, using a fine thread and a scale.

1.3. Fruit characters

The fruits collected from well ripe bunches were used for taking fruit characters. The middle fruit in the top row of the second hand was selected as the representative sample and the following observations were made.

1.3.1. Fruit weight

The weight of the selected fruit was recorded as the average weight of a fruit when it was fully ripe.

1.3.2. Pulp weight

Pulp weight of the selected fruit was recorded after removing the peel.

1.3.3. Peel weight

Peel weight was recorded after removing from the pulp.

1.3.4. Pulp/peel ratio

This was arrived at by dividing the pulp weight of the selected fruit with peel weight.

2. CHEMICAL ANALYSIS

2.1. Qualitative analysis of fruits

The fruits collected from well ripe bunches were used for quality analysis. Samples were taken from each fruit from three portions, viz., top, middle and bottom and these samples were then pooled and macerated in a waring blender. Triplicate samples from this were used for analysis of different constituents as detailed below.

2.1.1. Total soluble solids

Total soluble solids were found out by a pocket refractometer and were expressed as percentage.

2.1.2. Acidity

Distilled water was added to 10 g of the macerated sample and made upto a known volume. An aliquot of the filtered solution was titrated against 0.1 N sodium hydroxide using phenolphthalein as the indicator. The acidity was expressed as percentage of citric acid (A.O.A.C., 1960).

2.1.3. Sugars - total, reducing and non-reducing sugars

The total sugars, reducing sugars and non-reducing sugars of the samples were determined as per the method described by the A.O.A.C. (1960).

To a known quantity of macerated pulp, a small quantity of distilled water was added. The solution after thorough

mixing was clarified with neutral lead acetate and deleaded with sodium oxalate and made upto a known volume. The solution was titrated against a mixture of Fenlings A and B solutions using methylene blue as the indicator. The content of reducing sugars was expressed as percentage.

For finding the total sugars, five ml of concentrated hydrochloric acid were added to a known volume of clarified solution and the content was kept overnight. The solution was then neutralised by adding sodium hydroxide and titrated against a mixture of Fenling's A and B solutions.

Non-reducing sugars was computed by working out the difference between the total and reducing sugars.

2.1.4. Sugar/acid ratio

This was arrived at by dividing the total sugars with titrable acidity and this was reckoned as a measure of fruit quality.

3. STATISTICAL ANALYSIS

The data collected on different plant characters were analysed by applying the techniques suggested by Snedecor and Cochran (1967).

Results

RESULTS

The results of the different aspects of investigations are presented under the following sections.

1. EFFECT OF SUCKERS FROM DIFFERENT YIELD GROUPS AND THEIR SIZE ON GROWTH PARAMETERS

1.1. Height of plant

Data on the mean height of plants during early vegetative phase, late vegetative phase and at shooting are presented in the Table 2.

Plants raised from suckers of different sizes recorded significant difference in height at all the stages of growth (Table 2b). Plants from suckers weighing 1 to 1.5 kg were found to be shortest at all the stages of growth. Plants derived from the suckers weighing 2 to 2.5 kg were medium in height during the vegetative phase, but at shooting this difference levelled off and they reached on par with plants raised from 3 to 3.5 kg suckers.

1.2. Girth of pseudostem

Data furnished in Table 3 represent the girth of pseudostem at different stages of growth under different treatment combinations.

While suckers from different bunch groups did not influence the girth of pseudostem (Table 3a), the initial

Table 2. Effect of suckers from different yield groups and their size on the height of pseudostem (cm)

Treatments combinations	Early vegetative phase	Late vegetative phase	At shooting
B_1S_1	37.0	137.7	231.2
B_1S_2	57.0	161.8	234.6
B_1S_3	63.2	165.2	240.0
B_2S_1	42.1	123.0	223.1
B_2S_2	56.2	154.0	238.1
B_2S_3	64.4	167.8	236.9
B_3S_1	40.2	152.3	230.9
B_3S_2	54.4	167.9	256.1
B_3S_3	64.3	169.2	243.4
B_4S_1	40.3	143.8	243.5
B_4S_2	57.3	152.2	252.6
B_4S_3	77.2	170.8	255.2
S.Em ±	4.42	9.44	10.25
C.D (5%)	NS	NS	NS

Table 2a. Effect of suckers from different yield groups on height of pseudostem (cm)

Bunch groups	Early vegetative phase	Late vegetative phase	At shooting
B_1	52.4	154.9	235.3
B_2	54.2	148.3	232.7
B_3	52.9	163.1	243.4
B_4	56.3	155.6	250.4
S.Em ±	2.54	5.45	5.92
C.D (5%)	NS	NS	NS

Table 2b. Effect of sucker size on height of pseudostem (cm)

Sucker sizes	Early vegetative phase	Late vegetative phase	At shooting
S_1	39.9	139.2	232.2
S_2	56.2	158.9	245.4
S_3	65.0	168.2	243.9
S.Em ±	2.21	4.72	5.12
C.D (5%)	4.45	9.02	10.32

Table 3. Effect of suckers from different yield groups and their size on the girth of pseudostem (cm)

Treatments combinations	Early vegetative phase	Late vegetative phase	At shooting
B_1S_1	14.3	42.3	62.4
B_1S_2	16.9	46.1	64.2
B_1S_3	15.7	47.2	64.6
B_2S_1	15.0	42.7	61.4
B_2S_2	18.6	44.9	64.4
B_2S_3	19.7	47.5	64.6
B_3S_1	15.1	43.6	63.4
B_3S_2	17.8	48.9	64.6
B_3S_3	20.3	47.8	64.3
B_4S_1	15.7	42.2	62.1
B_4S_2	18.6	43.4	64.7
B_4S_3	21.2	46.1	65.2
S.Em ±	0.83	2.10	1.69
C.D (5%)	NS	NS	NS

Table 3a. Effect of suckers from different yield groups on girth of pseudostem (cm)

Sucker groups	Early vegetative phase	Late vegetative phase	At shooting
B_1	17.4	45.2	63.7
B_2	17.7	45.03	63.5
B_3	17.7	46.8	64.1
B_4	16.5	43.9	64.0
S.Em ±	0.48	1.21	0.95
C.D (5%)	NS	NS	NS

Table 3b. Effect of sucker size on girth of pseudostem (cm)

Sucker sizes	Early vegetative phase	Late vegetative phase	At shooting
S_1	15.2	42.7	62.3
S_2	16.5	45.8	64.5
S_3	20.0	47.2	64.7
S.Em ±	0.42	1.05	0.84
C.D (5%)	0.837	2.11	1.70

size of sucker influenced the girth of plant significantly (Table 3b). Plants from suckers weighing 1 to 1.5 kg recorded the minimum girth at all the stages of plant growth. At shooting, there was no significant difference in girth between plants from suckers of 2 to 2.5 kg and 3 to 3.5 kg.

1.3. Number of functional leaves

Data on the total number of functional leaves per plant at various stages of growth under the different treatment combinations are presented in Table 4.

Bunch groups did not influence the number of functional leaves. The sucker sizes also did not show any significant effect, except during the late vegetative phase. During the late vegetative phase, plants from suckers weighing 1 to 1.5 kg showed significantly lower leaf number compared to those of the other two groups, even though this was not observed during the early vegetative phase and at shooting.

1.4. Length of petiole

The data on the length of petiole at various stages of plant growth showed that there was no significant effect of the treatment combinations on the length of petiole (Table 5). The bunch groups also did not significantly influence the petiole length (Table 5a). But during the vegetative phase

Table 4. Effect of suckers from different yield groups and their size on the number of functional leaves

Treatments combinations	Early vegetative phase	late vegetative phase	At shooting
B_1S_1	5.6 (2.4)	9.4 (3.1)	9.6 (3.1)
B_1S_2	5.2 (2.5)	10.9 (3.3)	10.4 (3.2)
B_1S_3	5.3 (2.3)	10.5 (3.2)	10.2 (3.2)
B_2S_1	6.1 (2.5)	9.7 (3.1)	10.1 (3.2)
B_2S_2	6.3 (2.5)	10.4 (3.2)	9.6 (3.1)
B_2S_3	5.9 (2.4)	10.8 (3.3)	9.8 (3.1)
B_3S_1	5.9 (2.4)	10.4 (3.2)	10.2 (3.2)
B_3S_2	6.1 (2.5)	10.7 (3.3)	9.9 (3.2)
B_3S_3	6.6 (2.6)	10.7 (3.3)	10.2 (3.2)
B_4S_1	6.2 (2.5)	10.2 (3.2)	10.2 (3.2)
B_4S_2	6.5 (2.5)	10.4 (3.2)	10.3 (3.2)
B_4S_3	5.9 (2.4)	10.8 (3.3)	10.3 (3.2)
S.Em ±	0.05	0.06	0.05
C.D (5%)	NS	NS	NS

Figures in parentheses represent $\sqrt{x}$ transformed values

Table 4a. Effect of suckers from different yield groups on number of functional leaves

Sucker groups	Early vegetative phase	Late vegetative phase	At shooting
S_1	5.6 (2.4)	10.3 (3.2)	10.1 (3.2)
S_2	6.1 (2.5)	10.3 (3.2)	9.8 (3.1)
S_3	6.2 (2.5)	10.6 (3.3)	10.1 (3.2)
S_4	6.2 (2.5)	10.5 (3.2)	10.3 (3.2)
S.Em ±	0.05	0.04	0.03
C.D (5%)	NS	NS	NS

Figures in parentheses represent $\sqrt{x}$ transformed values

Table 4b. Effect of sucker size on number of functional leaves

Sucker sizes	Early vegetative phase	Late vegetative phase	At shooting
S_1	5.9 (2.4)	9.9 (3.1)	10.0 (3.2)
S_2	6.3 (2.5)	10.6 (3.3)	10.1 (3.2)
S_3	5.9 (2.4)	10.7 (3.3)	10.1 (3.2)
S.Em ±	0.04	0.03	0.02
C.D (5%)	NS	0.06	NS

Figures in parentheses represent $\sqrt{x}$ transformed values

Table 5. Effect of suckers from different yield groups and their size on the length of petiole (cm)

Treatments combinations	Early vegetative phase	Late vegetative phase	At shooting
B_1S_1	9.6	29.8	53.4
B_1S_2	12.2	35.0	51.4
B_1S_3	14.2	34.4	51.3
B_2S_1	10.5	32.3	51.3
B_2S_2	13.0	34.0	49.7
B_2S_3	15.2	36.0	51.6
B_3S_1	10.2	33.7	49.8
B_3S_2	14.1	36.5	52.1
B_3S_3	14.7	37.7	51.9
B_4S_1	10.5	32.6	50.3
B_4S_2	13.0	34.4	51.2
B_4S_3	15.8	36.1	52.5
SEm ±	1.34	1.13	2.35
CD (5%)	NS	NS	NS

Table 5a. Effect of suckers from different yield groups on length of petiole (cm)

Bunch groups	Early vegetative phase	Late vegetative phase	At shooting
B_1	12.0	33.1	52.1
B_2	12.8	34.1	50.8
B_3	13.0	35.9	51.3
B_4	13.1	34.3	51.3
SEm ±	0.7	0.6	1.4
CD (5%)	NS	NS	NS

Table 5b. Effect of sucker size on length of petiole (cm)

Sucker sizes	Early vegetative phase	Late vegetative phase	At shooting
S_1	10.2	32.1	51.3
S_2	13.1	34.9	51.1
S_3	14.9	36.1	51.8
SEm ±	0.67	0.55	1.17
CD (5%)	1.35	1.14	NS

the initial size of suckers influenced the petiole length significantly (Table 5b). Plants from suckers weighing 3 to 3.5 kg recorded the maximum length (36.1 cm) and plants from suckers weighing 1 to 1.5 kg the minimum (32.1 cm). This difference was levelled off at shooting time.

1.5. Length of lamina

The combined effect of yield groups and size of suckers was not significant on the length of lamina at any stage of plant growth (Table 6). Suckers from different yield groups also did not influence the lamina length (Table 6a). However, significant difference was noticed in the length of lamina between plants raised from different size of suckers during the vegetative phases (Table 6b). Plants grown from suckers weighing 3 to 3.5 kg had the maximum length of 133.1 cm and plants from 1 to 1.5 kg suckers had the minimum length of 116.3 cm. This difference was made up towards the shooting time.

1.6. Width of lamina

Data on the width of lamina at various stages of growth under the different treatment combinations are presented in Table 7.

The width of lamina was significantly influenced by the

Table 6. Effect of suckers from different yield groups and their size on the length of lamina (cm)

Treatments combinations	Early vegetative phase	Late vegetative phase	At shooting
B_1S_1	42.9	112.1	172.5
B_1S_2	49.2	126.8	172.6
B_1S_3	53.1	131.3	176.0
B_2S_1	40.3	112.8	180.1
B_2S_2	49.9	122.4	174.2
B_2S_3	58.9	135.2	175.0
B_3S_1	40.9	122.6	172.8
B_3S_2	55.3	130.3	178.5
B_3S_3	55.8	129.9	175.6
B_4S_1	46.0	117.0	167.8
B_4S_2	50.6	126.0	176.2
B_4S_3	60.2	135.8	177.5
SEm ±	3.99	4.8	6.5
CD (5%)	NS	NS	NS

Table 6a. Effect of suckers from different yield groups on length of lamina (cm)

Bunch groups	Early vegetative phase	Late vegetative phase	At shooting
B_1	48.4	123.4	173.7
B_2	49.7	123.5	176.4
B_3	50.0	127.6	175.7
B_4	52.3	126.3	173.8
SEm ±	2.31	2.79	3.73
CD (5%)	NS	NS	NS

Table 6b. Effect of sucker size on length of lamina (cm)

Sucker sizes	Early vegetative phase	Late vegetative phase	At shooting
S_1	42.6	116.3	173.3
S_2	50.7	126.4	175.4
S_3	57.0	133.1	176.1
SEm ±	1.20	2.41	3.23
CD (5%)	4.03	4.06	NS

treatment combinations during the early vegetative phase. Treatment B_4S_3 recorded the maximum width (28.4 cm). This was closely followed by the treatment B_3S_3 which recorded a lamina width of 27.1 cm. The minimum width of 19.1 cm was recorded by the treatments B_1S_1 and B_3S_1. The treatments B_4S_1 (21.1 cm) and B_2S_1 (21.3 cm) were also having significantly lower lamina width when compared to B_4S_3. Other treatments did not differ significantly between them. The differences were more noticeable during the early vegetative phase. But towards late vegetative phase and shooting, these differences were levelled off. Plants from the different bunch groups did not show significant variation with respect to width of lamina (Table 7a). Between different groups of suckers it was found that the width of lamina was significantly influenced by the size of suckers during the vegetative phase (Table 7b). Plants raised from suckers weighing 1 to 1.5 kg had the least width of lamina (20.2 cm and 57.6 cm during early and late vegetative phase respectively). This difference was levelled off at shooting stage and they came on par with the plants raised from suckers weighing 2 to 2.5 kg and 3 to 3.5 kg.

1.7. Total leaf area

Data on total leaf area per plant at different stages of growth under different treatments are furnished in Table 8.

Table 7. Effect of suckers from different yield groups and their size on the width of lamina (cm)

Treatments combinations	Early vegetative phase	Late vegetative phase	At shooting
B_1S_1	19.1	55.6	73.9
B_1S_2	22.9	60.8	74.9
B_1S_3	23.3	62.5	77.1
B_2S_1	21.3	56.5	72.5
B_2S_2	24.1	59.0	74.8
B_2S_3	25.6	62.6	74.9
B_3S_1	19.1	60.5	74.9
B_3S_2	23.8	61.8	76.4
B_3S_3	27.1	61.3	75.0
B_4S_1	21.1	57.6	72.4
B_4S_2	24.9	61.4	76.6
B_4S_3	28.4	63.2	75.2
SEm ±	2.61	2.01	2.10
CD (5%)	5.28	NS	NS

Table 7a. Effect of suckers from different yield groups on width of lamina (cm)

Bunch groups	Early vegetative phase	Late vegetative phase	At shooting
B_1	21.8	59.7	75.3
B_2	23.7	59.3	74.1
B_3	23.4	61.2	75.4
B_4	24.8	60.7	74.8
SEm ±	1.51	1.21	1.19
CD (5%)	NS	NS	NS

Table 7b. Effect of sucker size on width of lamina (cm)

Sucker sizes	Early vegetative phase	Late vegetative phase	At shooting
S_1	20.2	57.6	73.5
S_2	23.9	60.7	75.7
S_3	22.1	62.4	75.6
SEm ±	1.31	1.01	1.04
CD (5%)	2.64	2.02	NS

Table 3. Effect of suckers from different yield groups and their size on the total leaf area (cm^2)

Treatments combinations	Early vegetative phase	Late vegetative phase	At shooting
B_1S_1	3517.6	48732.6	99351.5
B_1S_2	6217.1	67102.8	111166.6
B_1S_3	5764.8	65904.8	108934.0
B_2S_1	4121.0	52265.3	99727.4
B_2S_2	6631.5	61656.4	99096.5
B_2S_3	6929.2	73144.4	108347.8
B_3S_1	3959.1	63431.1	109031.9
B_3S_2	6848.4	68230.4	111447.4
B_3S_3	7271.7	70139.9	109273.2
B_4S_1	4941.4	56290.8	100966.5
B_4S_2	7066.3	63889.4	113087.4
B_4S_3	8454.6	72659.8	110740.0
SEm ±	840.46	5379.43	6875.3
CD (5%)	1693.5	NS	NS

Table 8a. Effect of suckers from different yield groups on total leaf area (cm^2)

Bunch groups	Early vegetative phase	Late vegetative phase	At shooting
B_1	5166.5	60606.7	106484.0
B_2	5893.9	62355.4	102390.6
B_3	6026.4	67267.1	109917.5
B_4	6827.4	64279.9	108264.6
SEm ±	485.20	3105.77	3969.46
CD (5%)	NS	NS	NS

Table 8b. Effect of sucker size on total leaf area (cm^2)

Sucker sizes	Early vegetative phase	Late vegetative phase	At shooting
S_1	4134.8	55179.9	102269.3
S_2	6695.8	65219.8	108699.5
S_3	7105.1	70482.2	109323.8
SEm ±	420.23	2689.67	3437.6
CD (5%)	846.76	2419.69	NS

It is evident from the table that the total leaf area was not affected significantly by the different treatment combinations except during the early vegetative phase. During the early vegetative phase, maximum leaf area was recorded by the treatment B_4S_3 (8454.6 cm^2) followed by the treatment B_3S_3 (7271.7 cm^2). The treatment B_1S_1 showed the minimum leaf area of 3517.6 cm^2. The total leaf area of the treatments B_3S_1 (3959.1 cm^2), B_2S_1 (4121 cm^2) and B_4S_1 (4941.4 cm^2) were also significantly lower. Towards the late vegetative phase and sheeting, these differences were made up and they came along with other treatments. Suckers from different yield groups did not influence the total leaf area of the plant at any stage of growth (Table 81). The initial size of sucker influenced the total leaf area per plant during the vegetative phase. The minimum leaf area was recorded by the plants from suckers weighing 1 to 1.5 kg which was 4134.8 cm^2 during early vegetative phase and 55179.9 cm^2 during late vegetative phase. The maximum leaf area was noticed in plants raised from suckers weighing 3 to 3.5 kg (7105.1 cm^2 and 70482.2 cm^2 during early and late vegetative phase). This difference although not significant continued till sheeting time.

1.8. Sucker production

Data on the effect of different treatment combinations on sucker production are presented in Table 9.

Table 9. Effect of suckers from different yield groups and their size on production of suckers

Treatments combinations	Number of suckers produced
B_1S_1	4.3 (2.1)
B_1S_2	5.8 (2.4)
B_1S_3	4.6 (2.1)
B_2S_1	4.2 (2.04)
B_2S_2	5.2 (2.4)
B_2S_3	4.8 (2.2)
B_3S_1	3.9 (1.9)
B_3S_2	5.8 (2.4)
B_3S_3	4.9 (2.2)
B_4S_1	3.9 (1.9)
B_4S_2	5.7 (2.4)
B_4S_3	4.6 (2.1)
SEm ±	0.063
CD (5%)	NS

Figures in parentheses represent $\sqrt{x}$ transformed values

Table 9a. Effect of suckers from different yield groups on production of suckers

Bunch groups	Number of suckers produced
B_1	4.9 (2.2)
B_2	4.9 (2.2)
B_3	4.9 (2.2)
B_4	4.7 (2.2)
SEm ±	0.036
CD (5%)	NS

Figures in parentheses represent $\sqrt{x}$ transformed values

Table 9b. Effect of sucker size on production of suckers

Sucker sizes	Number of suckers produced
S_1	4.1 (2.01)
S_2	5.8 (2.4)
S_3	4.7 (2.2)
SEm ±	0.031
CD (5%)	NS

Figures in parentheses represent $\sqrt{x}$ transformed values

Data showed that there was no significant difference in the number of suckers produced by the plants due to different treatment combinations. Between plants produced from different sizes of suckers, sucker production was found to be maximum in plants from suckers weighing 2 to 2.5 kg (5.8) and minimum in plantsraised from suckers weighing 1 to 1.5 kg (4.1). Significant difference in respect of sucker production was noticed between the three sucker groups (Table 9b).

1.9. Duration of crop

Data furnished in Table 10 represent the number of days from planting to shooting, from shooting to harvest and total duration of crop.

From the Table it is evident that the duration of crop was not influenced by the treatment combinations. However, significant difference was noticed in the duration of crop between plants derived from suckers of different size (Table 10b). Maximum duration was taken by plants raised from 1 to 1.5 kg suckers (373.9 days) and minimum by plants from 3 to 3.5 kg suckers (322 days).

Treatment recorded no significant effect on the duration from planting to shooting. So also the plants from the suckers of different yield groups did not affect the duration for shooting. Between plants produced from suckers of different size groups, maximum duration from planting to shooting was

Table 10. Effect of suckers from different yield groups and their size on the duration of crop

Treatments combinations	Number of days for shooting	Days from shooting to harvest	Days from planting to harvest
B_1S_1	277.2 (16.6)	98.6 (9.9)	375.8 (19.4)
B_1S_2	240.9 (15.5)	102.3 (10.1)	343.2 (18.5)
B_1S_3	220.6 (14.8)	102.0 (10.1)	322.6 (18.0)
B_2S_1	273.4 (16.5)	98.9 (9.9)	372.3 (19.3)
B_2S_2	241.5 (15.5)	103.0 (10.1)	344.5 (18.5)
B_2S_3	222.2 (14.9)	100.6 (10.0)	322.8 (18.0)
B_3S_1	272.2 (16.5)	100.1 (10.0)	372.3 (19.3)
B_3S_2	234.9 (15.3)	100.0 (10.0)	336.8 (18.4)
B_3S_3	223.1 (14.9)	101.1 (10.1)	324.2 (18.0)
B_4S_1	276.7 (16.6)	98.5 (9.9)	375.2 (19.4)
B_4S_2	239.9 (15.5)	101.3 (10.1)	341.9 (18.5)
B_4S_3	217.2 (14.7)	101.0 (10.1)	318.3 (17.8)
SEm ±	0.094	0.070	0.076
CD (5%)	NS	NS	NS

Figures in parentheses represent $\sqrt{x}$ transformed values

Table 10a. Effect of suckers from different yield groups on the duration of crop

Bunch groups	Number of days for shooting	Days from shooting to harvest	Days from planting to harvest
B_1	245.6 (15.7)	100.9 (10.1)	347.2 (18.6)
B_2	245.2 (15.7)	100.8 (10.04)	346.5 (18.6)
B_3	243.0 (15.6)	100.4 (10.0)	344.4 (18.5)
B_4	244.0 (15.6)	100.3 (10.0)	345.1 (18.5)
SEm ±	0.054	0.040	0.044
CD (5%)	NS	NS	NS

Figures in parentheses represent $\sqrt{x}$ transformed values

Table 10b. Effect of sucker size on duration of crop

Sucker sizes	Number of days for shooting	Days from shooting to harvest	Days from planting to harvest
S_1	274.9 (16.6)	99.0 (9.9)	373.9 (19.3)
S_2	239.3 (15.5)	101.6 (10.1)	341.6 (18.5)
S_3	220.8 (14.9)	101.2 (10.1)	322.0 (17.9)
SEm ±	0.047	0.035	0.037
CD (5%)	0.095	0.079	0.074

Figures in parentheses represent $\sqrt{x}$ transformed values

taken by plants from 1 to 1.5 kg suckers (274.9 days) followed by plants derived from suckers weighing 2 to 2.5 kg (239.3 days) and minimum by plants from 3 to 3.5 kg suckers (220.8 days).

The effect of treatment combinations was not significant on the days from shooting to harvest. Same was the case with plants of suckers from different yield groups. Between different groups of suckers it was noticed that plants raised from suckers weighing 1 to 1.5 kg had significantly shorter duration from shooting to harvest (99 days) while the other two showed no significant difference (Table 10b).

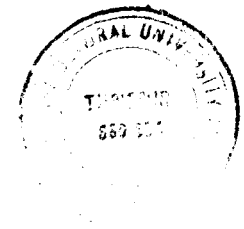
2. EFFECT OF SUCKERS FROM DIFFERENT YIELD GROUPS AND THEIR SIZE ON BUNCH CHARACTERS

2.1. Weight of bunch

Data furnished in Table 11 show that there was no significant difference in bunch weight due to treatments. Similarly the plants from different yield groups and the plants raised from suckers of different size also record no significant difference on the bunch weight.

2.2. Length of bunch

The treatments were not found to influence the length of bunch (Table 11). Suckers from different yield groups and plants derived from different sizes of suckers also were not found to affect the length of bunch.



2.3. Number of hands

Data on the number of hands produced per bunch by different treatments are presented in Table 11. There was no significant effect due to treatments.

2.4. Weight of hand

No significant difference was shown by different treatments in respect of weight of hands produced. Plants from different yield groups and different sizes of suckers when considered separately also showed that weight of hands was not influenced by these variables.

2.5. Number of fingers

Data furnished in Table 11 show that the number of fingers produced per bunch was not influenced by the treatments. Plants from different yield groups and different sized suckers also did not affect the number of fingers.

2.6. Number of fingers per hand

It is evident from Table 11 that the number of fingers produced per hand was not influenced by the treatments. Plants from different bunch groups and plants derived from suckers of different sizes when taken individually also showed no significant effect on the number of fingers produced per hand (Table 11a, 11b).

Table 11. Effect of suckers from different yield groups and their size on the bunch characters

Treatments combinations	Weight of bunch (kg)	Length of bunch (cm)	Number of hands	Weight of hand (kg)	Number of fingers	Number of fingers/hand	Length of finger (cm)	Girth of finger (cm)	Weight of finger (g)
B_1S_1	11.8	54.3	11.5 (3.4)	1.2	174.6 (13.2)	15.0 (3.9)	14.8	11.3	63.5
B_1S_2	11.6	50.8	11.7 (3.4)	1.1	184.6 (13.6)	15.8 (4.0)	15.4	11.7	63.3
B_1S_3	11.3	51.3	11.6 (3.4)	1.2	176.9 (13.4)	15.4 (3.9)	15.0	11.5	61.8
B_2S_1	11.8	51.1	11.9 (3.5)	1.1	186.0 (13.7)	15.8 (4.0)	14.9	11.6	62.9
B_2S_2	10.6	52.3	12.1 (3.5)	1.0	182.0 (13.5)	15.0 (3.9)	14.7	11.3	60.8
B_2S_3	10.8	50.1	11.6 (3.4)	1.2	179.7 (13.4)	15.2 (3.9)	15.1	11.6	63.1
B_3S_1	11.8	51.6	11.6 (3.4)	1.1	180.8 (13.4)	15.6 (4.0)	14.5	11.1	65.3
B_3S_2	11.9	52.4	11.7 (3.4)	1.1	172.3 (13.1)	14.7 (3.8)	15.2	11.6	67.0
B_3S_3	12.3	50.5	11.5 (3.4)	1.2	179.6 (13.4)	15.6 (4.0)	15.4	11.8	65.4
B_4S_1	11.1	51.5	11.8 (3.4)	1.0	183.1 (13.5)	15.6 (4.0)	14.6	11.2	62.8
B_4S_2	11.6	53.8	11.7 (3.4)	1.1	192.0 (13.7)	16.4 (4.1)	14.6	11.3	63.7
B_4S_3	11.2	50.1	11.6 (3.4)	1.1	166.6 (12.9)	14.4 (3.8)	14.9	11.3	67.9
SEm ±	0.818	2.633	0.067	0.091	0.361	0.068	0.378	0.312	3.194
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Figures in parentheses represent $\sqrt{x}$ transformed values

Table 11a. Effect of suckers from different yield groups on bunch characters

Bunch groups	Weight of bunch (kg)	Length of bunch (cm)	Number of hands	Weight of hand(g) (kg)	Number of fingers	Number of fingers/hand	Length of finger (cm)	Girth of finger (cm)	Weight of finger (g)
B_1	11.6	52.1	11.6 (3.4)	1.2	179.4 (13.4)	15.4 (3.9)	15.1	11.5	62.9
B_2	11.1	51.2	11.9 (3.4)	1.1	183.1 (13.5)	15.3 (3.9)	14.9	11.5	62.2
B_3	11.9	51.5	11.6 (3.4)	1.2	175.4 (13.3)	15.3 (3.9)	15.0	11.5	65.9
B_4	11.2	51.6	11.7 (3.4)	1.1	180.4 (13.4)	15.5 (3.9)	14.7	11.3	62.8
SEm ±	0.472	1.52	0.039	0.053	0.22	0.039	0.218	0.180	1.845
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Figures in parentheses represent $\sqrt{x}$ transformed values

Table 11b. Effect of sucker size on bunch characters

Sucker sizes	Weight of bunch (kg)	Length of bunch (cm)	Number of hands	Weight of hand (kg)	Number of fingers	Number of fingers/hand	Length of finger (cm)	Girth of finger (cm)	Weight of finger (g)
S_1	11.6	52.1	11.7 (3.4)	1.2	181.5 (13.5)	15.5 (3.9)	15.1	11.4	63.6
S_2	11.4	52.3	11.8 (3.4)	1.1	182.6 (13.5)	15.5 (3.9)	15.0	11.5	63.7
S_3	11.4	50.5	11.6 (3.4)	1.1	176.2 (13.3)	15.2 (3.9)	15.0	11.5	63.1
SEm ±	0.409	1.316	0.033	0.046	0.191	0.034	0.189	0.156	1.598
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Figures in parentheses represent $\sqrt{x}$ transformed values

2.7. Length of fingers

Length of fingers was not influenced by any of the treatments under study. When plants from different yield groups and different sucker sizes were considered separately, then also the effect of these variables were not found significant.

2.8. Girth of fingers

The combined effect of bunch groups and size of suckers was not significant. The individual effect of these factors was also not significant.

2.9. Weight of fingers

Treatments had no significant effect on the weight of fingers. Same was the case with plants from different bunch groups and different sizes of suckers.

3. EFFECT OF SUCKERS FROM DIFFERENT YIELD GROUPS AND THEIR SIZE ON FRUIT CHARACTERS

3.1. Weight of fruit

Weight of fruit was neither influenced by the size of suckers planted nor by the yield group of parents from which the suckers were obtained.

3.2. Pulp weight

Data on the pulp weight of fruit are furnished in

Table 12. Effect of suckers from different yield groups and their size on the fruit characters

Treatments combinations	Fruit weight (g)	Pulp weight (g)	Peel weight (g)	Pulp/peel ratio
B_1S_1	58.1	46.0	13.1	3.5
B_1S_2	57.8	44.9	12.9	3.5
B_1S_3	55.7	43.9	12.9	3.3
B_2S_1	57.2	44.3	12.9	3.4
B_2S_2	53.6	42.1	12.7	3.3
B_2S_3	57.7	45.0	13.0	3.5
B_3S_1	60.2	47.2	13.2	3.6
B_3S_2	61.2	47.7	13.5	3.5
B_3S_3	59.6	46.7	12.8	3.7
B_4S_1	57.5	44.3	12.8	3.5
B_4S_2	57.9	44.4	13.6	3.3
B_4S_3	54.1	43.5	12.7	3.5
SEm ±	3.336	2.308	0.448	0.182
CD (5%)	NS	NS	NS	NS

Table 12a. Effect of suckers from different yield groups on fruit characters

Bunch groups	Fruit weight (g)	Pulp weight (g)	Peel weight (g)	Pulp/peel ratio
B_1	57.2	45.0	13.0	3.4
B_2	56.2	43.8	12.9	3.4
B_3	60.3	47.2	13.2	3.6
B_4	56.5	44.1	13.0	3.4
SEm ±	1.926	1.679	0.258	0.105
CD (5%)	NS	NS	NS	NS

Table 12b. Effect of sucker size on the fruit characters

Sucker sizes	Fruit weight (g)	Pulp weight (g)	Peel weight (g)	Pulp/peel ratio
S_1	58.3	45.4	13.0	3.5
S_2	57.6	44.8	13.2	3.4
S_3	56.6	44.8	12.8	3.5
SEm ±	1.668	1.454	0.224	0.091
CD (5%)	NS	NS	NS	NS

Table 12. The treatments did not exert any significant influence on the pulp weight of fruits.

3.3. Peel weight

The combined effect of bunch groups and size of suckers was not significant with respect to the peel weight of fruits (Table 12). The individual effect of these factors was also not significant on the peel weight of fruits (Table 12a, 12b).

3.4. Pulp/peel ratio

The treatments were not found to affect the pulp/peel ratio of fruits (Table 12). So also the plants derived from different yield groups and suckers of different size did not influence the pulp/peel ratio of fruits.

4. EFFECT OF SUCKERS FROM DIFFERENT YIELD GROUPS AND THEIR SIZE ON FRUIT QUALITY

4.1. Total soluble solids

Data furnished in Table 13 show that the combined effect of yield groups and size of suckers was not significant on the total soluble solids of fruits.

4.2. Acidity

As in the case of T.S.S., the acidity of fruit was also independent of the effect of treatments.

Table 13. Effect of suckers from different yield groups and their size on fruit quality

Treatments combinations	Total soluble solids (%)	Acidity (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	Sugar/acid ratio
B_1S_1	26.6	0.47	17.1	16.7	0.4	36.8
B_1S_2	26.7	0.46	17.3	17.0	0.3	37.5
B_1S_3	26.7	0.46	17.3	17.0	0.3	37.9
B_2S_1	27.0	0.48	17.2	16.7	0.5	36.8
B_2S_2	26.9	0.46	17.1	16.7	0.4	37.3
B_2S_3	27.6	0.47	17.3	17.0	0.3	37.9
B_3S_1	26.9	0.46	17.3	17.0	0.3	37.6
B_3S_2	26.7	0.46	17.2	16.8	0.4	37.8
B_3S_3	26.5	0.48	17.2	16.9	0.3	36.4
B_4S_1	27.2	0.48	17.1	16.7	0.4	36.9
B_4S_2	27.2	0.47	17.1	16.7	0.4	36.8
B_4S_3	27.0	0.46	17.1	16.7	0.4	37.7
SEm ±	0.384	0.016	0.139	0.155	0.075	1.197
CD (5%)	NS	NS	NS	NS	NS	NS

Table 13a. Effect of suckers from different yield groups on fruit quality

Bunch groups	Total soluble solids (%)	Acidity (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugar (%)	Sugar/acid ratio
B_1	26.7	0.47	17.2	16.9	0.3	37.4
B_2	27.2	0.47	17.2	16.8	0.4	37.0
B_3	26.7	0.47	17.2	16.8	0.4	37.3
B_4	27.1	0.47	17.1	16.7	0.4	37.1
SEm ±	0.222	0.009	0.080	0.089	0.045	0.691
CD (5%)	NS	NS	NS	NS	NS	NS

Table 13b. Effect of sucker size on fruit quality

Sucker sizes	Total soluble solids (%)	Acidity (%)	Total sugars(%)	Reducing sugars (%)	Non-reducing sugar (%)	Sugar/acid ratio
S_1	26.9	0.47	17.2	16.8	0.4	37.1
S_2	26.9	0.47	17.2	16.8	0.4	37.3
S_3	26.9	0.47	17.2	16.9	0.3	37.2
SEm ±	0.192	0.008	0.069	0.077	0.039	0.598
CD (5%)	NS	NS	NS	NS	NS	NS

4.3. Total sugar

Data on total sugar of fruit are presented in Table 13. The combined effect of bunch groups and sucker sizes was not significant on the total sugar of fruit.

4.4. Reducing sugar

Reducing sugar of fruits was not influenced by different treatments. Between plants from different bunch groups and from suckers of different weights no significant difference was noticed.

4.5. Non-reducing sugar

Data furnished in Table 13 showed that the treatments, the bunch weight of parent plants or the initial size of suckers used for planting could not influence the non-reducing sugar of fruits.

4.6. Sugar/acid ratio

As acidity and total sugar were influenced by treatments, the sugar acid ratio was also not affected by different treatments under study.

Discussion

DISCUSSION

Clonal propagation as a means of multiplying selected varieties is an age old practice adopted in a variety of horticultural crops like mango (Singh, 1960), sapota (Singh, 1980), guava (Singh, 1980), citrus (Hartmann and Kester, 1976) and apple (Westwood, 1978). Banana is a crop which has been cultivated by adopting vegetative method of propagation (Simmonds, 1966). The variation noticed within a cultivar could therefore be normally assigned to somatic mutations.

Clonal variation in bananas has been reported in Red Banana (Simmonds, 1966). Selection of mother plants in clonally propagated plants also assumes importance in view of the possible variations due to somatic mutations. Mother plant selection has been well emphasised in crops like citrus (Hartmann and Kester, 1976), apple (Teskey and Shoemaker, 1978), potato (Harris, 1978) and to some extent in crops like mango (Singh, 1960) and sapota (Singh, 1980).

The studies reported in this thesis were taken up with the following two precise objectives.

i) whether the yield variation noticed between plants is inherited to the progenies and whether there is scope for selection of mother plants.

ii) whether the size of sucker has any predominant influence on the yield and duration of crop.

In order to find out whether suckers selected from plants which belonged to different yield groups would carry over this effect to their progenies, the first part of the study was conducted in detail using suckers from different yield groups. It was interesting to note that the yield expression of the mother plant was no indication of its real potential yield. In other words, sucker selection based on bunch weight of the previous crop may not serve any useful purpose in a plant like banana, and especially in the cultivar 'Palayankodan'. This would mean that whatever variations within this clone that was noticed was probably contributed by environmental and other factors. The climatic influence is such that in certain varieties the plant character and yielding ability is thoroughly altered (Simmonds, 1966).

The factors that would have influenced the bunch weight might be variable soil fertility, sucker size or other factors within a population (Azzous et al., 1972). The observations of Simmonds (1966) that "despite the enormous scale of cultivation of 'Mysore' in India only one mutant has been recorded" is noteworthy.

The fact that certain varieties like Nendran shows a high degree of clonal variation (Simmonds, 1966) in contrast

to a variety like 'Palayankodan', suggests the possibility of some degree of clonal instability in atleast certain varieties of bananas. Where such intraclonal variations are noticed selection of mother plants might yield useful results. On the other hand in a comparatively stable clone like 'Palayankodan' this may not serve any purpose. Even under the best uniform cultural conditions using uniform suckers, the bunch weight in 'Palayankodan' varies. This remains a problem to be investigated on a physiological basis. The belief that exists with atleast some farmers that selecting suckers from high yielding clones for better results in 'Palayankodan' does not appear to be valid. This means, that in order to improve the yield of banana especially in the cultivar 'Palayankodan' manipulation of cultural and manurial practices as well as selection of suckers is more important than selection of mother plants for sucker collection.

The effect of size of suckers on the morphological expression, yielding ability and crop duration is perhaps more pronounced in banana (Assous et al., 1972). In the present study it was found that the size of sucker had positive influence on the various characters like height of the plant, girth of pseudostem, length of petiole, number of functional leaves, length of lamina, width of lamina and

total leaf area. The morphological expression in terms of above characters however was only temporary in nature. The effect of the sucker size was more noticed during the early vegetative phase which to some degree extended to the late vegetative phase as well. Towards the shooting stage the differences levelled off indicating that the initial growth, while being influenced by the suckers selected, ultimately the size of sucker did not influence yield.

Shah and Majumdar (1950) reported that the size of planting material could not influence the yield attributes in the cultivar 'Palayankodan' of banana. In the present study, there was significant difference between the plants raised from suckers weighing differently, with respect to the height of pseudostem. The highest value was recorded by the plants derived from suckers weighing 3 to 3.5 kg and lowest being in plants raised from suckers weighing 1 to 1.5 kg. The same was the result with respect to the girth of pseudostem also. Turner (1976) reported that increase in weight of planting material resulted in increased growth during early stages of growth in Giant Cavendish banana. In pineapple Tan and Wee (1973) reported that larger planting material resulted in higher plants. Norman (1976) also reported that plants raised from large slips were more vigorous initially than those from small slips, but the difference in size disappeared within a year. Highest plants and largest number of

leaves were reported with largest planting material in pineapple by Cadelha and Vasconcellos (1977).

Very interestingly, in the present study it was observed that as the sucker size decreased, the duration of crop was extended. A difference of 59.9 days was noticed between plants raised from 1 to 1.5 kg suckers and 3 to 3.5 kg suckers. Oppenheimer and Gottreich (1954) suggested that the sucker size should be related to planting time in banana, since the size of sucker influenced the duration. They were of opinion that the ultimate yield and total duration were not affected significantly by sucker size when plant crop and two ratoons were considered. Rasvi and Jagirdar (1966) reported earlier maturity with larger suckers. Alva Meyra and Carranza (1972) also reported that plants raised from larger suckers were earlier yielding. In Pineapple also it was reported by Chadha et al. (1974) that largest sucker size resulted in earliest flowering (435.8 days) and smallest suckers flowered last (453.3 days).

The duration from shooting to harvest were also influenced significantly by the initial size of sucker in the present investigations. Plants from the largest suckers (3 to 3.5 kg) had taken maximum duration from shooting to harvest and plants from smallest suckers, the minimum. In pineapple Chadha et al. (1974) observed that the number of

days from flowering to fruit maturity was lowest in the case of smallest planting material. Norman (1976) reported in pineapple that smaller slips delayed both flowering and fruit maturity.

In the present investigations sucker production was found to be the lowest in plants from suckers weighing 1 to 1.5 kg. In pineapple, according to Norman (1976) large and medium slip plants produced more slips than the small slip plants.

The present studies have clearly shown that the sucker size did not influence the ultimate yield of plant, bunch characters or quality of fruit. Oppenheimer and Gottreich (1954) reported that the size of planting material could affect the yield only by affecting the flowering time. According to them small suckers although flowered late gave better grades of bunches. Khan and Majumdar (1956) had observed that planting material could not affect the yield and number of hands per bunch. Nazvi and Jagirdar (1966) reported that large suckers produced heavier bunches, and small suckers improved bunch quality. According to Azzouz et al. (1972) plants from sucker sizes of 194, 167 and 137 cm in height had nearly the same bunch weight. In pineapple Tan and Lee (1973) reported heavier fruits with larger planting material. Norman (1976) found that slip size could not influence T.S.S., acidity and T.S.S. acidity ratio. Gadelha

and Vasconcellos (1977) reported that plants from larger planting material produced best quality fruits in pineapple. According to Singh and Singh (1975), yield increased gradually with the increase in the size of sucker in respect of pineapple. Balakrishnan et al. (1981) reported that productivity of the crop was not influenced by the size of suckers in the variety 'Kew', but Nayar (1982) had seen in pineapple that suckers of uniform size (400 to 450 g) gave the best yields compared to higher and lower size categories of suckers.

From these investigations it is clear that selection of suckers in banana is necessary only for adjusting the harvesting time and has no effect on the yield. If suckers weighing 2 to 2.5 kg or above are chosen the crop can be harvested within a year. Reducing the duration of the crop is a factor to be reckoned and under such situations larger sized suckers should be preferred. Similarly if uniform harvesting is ~~as~~ intended uniform suckers should be chosen. If staggering of crop production is the aim, planting of mixed types of suckers will be preferable over the use of uniform sized suckers.

Summary

SUMMARY

The present investigations were carried out in the Department of Pomology, College of Horticulture, Kerala Agricultural University, from 1981 to 1982 to study the effect of suckers from different yield groups and their size on morphological characters, duration of crop, yield and quality attributes of rainfed banana, Musa (AAB group) 'Palayankodan'.

1. The morphological characters during the vegetative phase was influenced by the initial size of suckers used for planting.

2. The duration of the crop was significantly altered by the size of suckers. Plants raised from suckers weighing 3 to 3.5 kg recorded the minimum duration for harvest.

3. The yield was influenced neither by the parent plants from which the suckers had been selected, nor by the size of suckers used for planting.

4. The bunch characters viz., length of bunch, number of hands per bunch, weight of hand, number of fingers and length, girth and weight of finger were not influenced by the treatments.

5. Treatments did not also influence fruit weight, pulp weight, peel weight and pulp/peel ratio.

6. Quality attributes of fruits like total soluble solids, acidity, total sugars, reducing sugars and sugar/acid ratio were not altered by way of the treatments.

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* Originals not seen

Appendix I

Weather data for the period from March 1981 to April 1982

Month	Temperature °C		Relative humidity (%)		Total rainfall (mm)	Number of rainy days
	Maximum	Minimum	Maximum	Minimum		
March	36.29	24.20	81.6	46.9	2.0	1
April	36.24	25.62	77.1	52.2	16.0	1
May	33.10	24.70	88.7	53.2	225.8	6
June	28.80	21.80	93.1	86.5	1124.6	25
July	26.00	22.00	92.6	79.4	512.9	20
August	29.40	21.40	93.7	80.0	407.9	17
September	29.00	22.30	93.2	80.1	528.8	19
October	29.60	22.80	91.8	69.3	136.7	13
November	31.30	22.00	90.0	60.6	60.2	5
December	31.20	21.60	79.3	46.7	Nil	-
January	32.90	24.60	61.6	45.9	Nil	-
February	36.90	21.30	57.7	32.1	Nil	-
March	35.40	27.20	78.2	69.4	Nil	-
April	34.80	27.10	80.1	72.3	Nil	-

Appendix IV

Analysis of variance for the effect of bunch groups, sucker size and their interactions on sucker production and duration of crop

Source	df	Mean sum of squares			
		Sucker production	Days for shooting	Days from shooting to harvest	Days from planting to harvest
Blocks	4	0.0099	0.039	0.148**	0.091**
Bunch groups	3	0.0068	0.023	0.00371	0.018
Sucker sizes	2	0.769**	15.219**	0.099**	9.88**
Interactions	6	0.00688	0.045	0.014	0.031
Error	44	0.0099	0.022	0.012	0.015

* Significant at 5% level

** Significant at 1% level

Appendix V

Analysis of variance for the effect of bunch groups, sucker size and their interaction on bunch characters of banana

Source	df	Mean sum of squares								
		Weight of bunch	Length of bunch	Number of hands	Weight of hand	Number of fingers	No. of fingers/ hand	Length of fingers	Girth of fingers	Weight of fingers
Blocks	4	3.165	19.36	0.0768**	0.0216	4.285**	0.0995**	0.597	42.200**	121.319**
Bunch groups	3	2.333	2.561	0.0047	0.0208	0.115	0.0012	0.451	0.158	40.603
Sucker sizes	2	0.292	20.038	0.0052	0.0179	0.335	0.0134	0.683	0.256	2.601
Inter-actions	6	0.925	8.649	0.00128	0.0096	0.0425	0.0405	0.362	0.238	5.992
Error	44	1.672	17.331	0.0112	0.0209	0.363	0.0117	0.357	0.244	25.535

* Significant at 5% level

** Significant at 1% level

Appendix VI

Analysis of variance for the effect of bunch groups, sucker size and their interaction on fruit characters of banana

Source	df	Mean sum of squares			
		Weight of fruit	Pulp weight	Peel weight	Pulp/peel ratio
Blocks	4	150.514**	110.23**	3.016**	0.547**
Bunch groups	3	54.009	35.936	0.257	0.096
Sucker sizes	2	11.084	3.062	0.605	0.076
Interactions	6	16.027	5.335	0.476	0.049
Error	44	27.829	21.136	0.5007	0.083

** Significant at 1% level

Appendix VII

Analysis of variance for the effect of bunch groups, sucker size and their interaction on fruit quality of banana

Source	df	Mean sum of squares					
		T.S.S.	Acidity	Total sugar	Reducing sugar	Non-reducing sugar	Sugar/acid ratio
Blocks	4	0.2604	0.001	0.014	0.053	0.00831	4.848
Bunch groups	3	1.094	0.00015	0.054	0.126	0.0493	0.424
Sucker sizes	2	0.029	0.00034	0.009	0.049	0.022	0.388
Interactions	6	0.324	0.00033	0.022	0.054	0.0228	1.772
Error	44	0.3695	0.00062	0.048	0.06	0.0152	3.582

PERFORMANCE OF CLONAL PROGENIES FROM DIFFERENT YIELD GROUPS AND IN RELATION TO SIZE OF SUCKERS IN RAINFED BANANA *Musa* (AAB GROUP) 'PALAYANKODAN'

By

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ABSTRACT OF A THESIS

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ABSTRACT

The present investigation was carried out in the Department of Pomology, College of Horticulture, Vellanikkara from 1981 to 1982. The study was aimed at finding out the effect of suckers from different yield groups and their size on growth, duration, yield and quality of fruits. The four parental yield groups from which suckers were used were 5 to 7 kg, 8 to 10 kg, 11 to 13 kg and 14 to 16 kg. The size of suckers used in the study was 1 to 1.5 kg, 2 to 2.5 kg and 3 to 3.5 kg. The trial was laid out as a factorial experiment in randomised block design with twelve treatments and five replications.

Suckers from different yield groups had no effect on the morphological characters, but the size of suckers influenced the morphological characters during the vegetative phase. Towards shooting time, these differences were levelled off.

The duration of the crop was significantly reduced when the sucker used was larger. Maximum duration was taken by plants raised from suckers weighing 1 to 1.5 kg.

Yield attributes viz., weight of bunch, length of bunch, number of hands per bunch, weight of hand, number of fingers per bunch, and length, girth and weight of finger were not influenced by the treatments.

Treatments also had no effect on the fruit quality characters like total soluble solids, acidity, total sugar, reducing sugar, non-reducing sugar and sugar/acid ratio.