INTRACLONAL VARIATIONS AND NUTRITIONAL STUDIES IN BANANA cv. 'PALAYANKODAN'

By

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THESIS

Submitted in partial fulfilment of the requirement for the degree of Doctor of Philosophy in Horticulture

Faculty of Agriculture

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DECLARATION

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

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CERTIFICATE

Certified that this thesis entitled "Intraclonal variations and nutritional studies in banana cv. 'Palayankodan'" is a record of research work done independently by Mr. P.K. Rajeevan, under my guidance and supervision, and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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Introduction

INTRODUCTION

Bananas are the most important of the tropical fruits of the world. Majority of the banana growing areas in the world lies between 30° N and 30° S latitudes, indicating its ecological adaptability to tropical climate.

India, at present, has over two lakh ha. under banana. This constitutes 15 per cent of the total area under fruits. It holds second position in the world banana production. The chief banana growing states are Kerala, Tamil Nadu, Maharashtra, Andhra Pradesh, Karnataka, Orissa, Bihar and West Bengal. Kerala, Tamil Nadu and Maharashtra account for more than half of the total area. Kerala has the maximum area of 50,100 ha. and production of 16,15,227 t./year (F.I.B., 1985).

A number of banana clones are under cultivation in India. Majority are triploid hybrids belonging to the genomic groups AAB and ABB. Of these, the clones of AAB group occupy the major area. This group comprises several popular dessert types of which 'Palayankodan' is the most widely cultivated single clone because of its drought tolerance and suitability for ratooning. According to Simmonds (1959) 'Palayankodan' occupied about 70% of the area under banana in India. It is known in various parts of the country as 'Poovan', 'Mysore Poovan', 'Karpura', 'Chakarakeli', 'Champa', 'Lal Velchi', 'Mysore' etc.

Mutations in the AAB group were reported from India in the varieties 'Nendrapadathi', 'Rasthali', 'Eleri' and 'Pacha Bontha Bathess' (Simmonds, 1959). The vast differences in the agro-climatic conditions in which the clone is grown in India and the fact that India is the original home of this genomic group (Sauer, 1952), are likely to throwout numerous mutants in the clone. Despite the above facts, only one mutant of 'Palayankodan', namely, 'Motta Poovan' was reported (Jacob, 1952). In 'Nendran', the second most widely cultivated banana variety of the State, at least six mutants were reported (Nayar, 1958). These were 'Moongil', 'Nana Nendran', 'Myndoli', 'Velethan', 'Attu Nendran' and 'Nedu Nendran'. The sub-clonal identity in 'Palayankodan' is not as clearly defined as in 'Nendran', probably because, 'Palayankodan' is not cultivated in an organised manner as 'Nendran'.

Intraclonal variations were reported in the 'Majestic' variety of potato by Cockerham and Macarthur (1956). Simmonds (1959) expressed that, though there is only little scope, it could be worth trying similar studies in bananas too, which resemble potatoes in that they are rigorously vegetatively propagated. If significant variations could be obtained within a clone with regard to growth, yield and quality, it would be of great value, both in the fundamental and applied fields. In fact, the preliminary survey conducted by the Investigator indicated differences in plant and bunch characters in the clone 'Palayankodan'. This prompted the Investigator to attempt identification of superior sub-clones in 'Palayankodan' so that they could be popularised and the average productivity improved.

As regards banana nutrition, the works carried out in the world are innumerable. Specific information are still scarce with regard to the response of the crop to inorganic fertilizers under rainfed conditions as well as the exact schedule of application of fertilizers for maximum production. Based on the earlier studies, recommendations were made that the fertilizers are to be applied within five months of planting since fertilizers would exert their effect only till the flower bud initiation stage (Summerville, 1944 and Shanmugam and Velayutham, 1972). Several recommendations were later formulated, in which, although split application of fertilizers was suggested, the schedule of application was based on the earlier findings (Ho, 1969; Leigh, 1969; Champion 1970; Marques and Monteiro, 1971; Ramaswamy and Muthukrishnan, 1973a; Sharma and Roy, 1973; Veeraraghavan, 1973 and Arunachalam et al., 1976). With regard to the application of fertilizers after five months of planting, there is still controversy (Shanmugam and Velayutham, 1972 and Irizarry et al., 1981). It would be of great practical importance if the optimum proportion and the time of application of the recommended dose of fertilizers in banana are worked out.

Another aspect of interest is the possibility of translocation of the nutrients from the mother plant to suckers after harvest. It is a common belief that removal of the mother plant after harvest, in stages (mattocking), would benefit its suckers. Nayar et al. (1956) studied the effect of mattocking on the yield of the ratoon crop and obtained positive results. The assumptions on the translocation could be confirmed only with the aid of radio-tracer techniques.

The present investigations aimed at the assesement of intraclonal variation if any, in the banana clone 'Palayankodan' by surveying the important 'Palayankodan' pockets of Kerala and Tiruchirapalli of Tamil Nadu, collecting material differing in growth parameters, bunch characters, etc. and subjecting them to further detailed analysis. The differences in growth, development, yield and quality of the accessions were subjected to detailed analysis with the objective of selecting high yielding, short duration sub-clones with tolerance to pests and diseases.

Nutritional aspects in relation to yield and quality were studied in one of the accessions. The nutritional aspects included standardisation of split application of the recommended dose of inorganic fertilizers with respect to growth, yield and quality; assessment of the uptake of nutrients by the plant parts at harvest and unravelling the translocation pattern of nutrients from the mother plant to its suckers after harvest (on mattocking) with the aid of radiotracer techniques.

Review of Literature

REVIEW OF LITERATURE

Literature available on intraclonal variation in some of the vegetatively propagated crops of horticultural importance are reviewed in this chapter. With regard to the different aspects of nutrition, the review is limited to banana only.

Intraclonal variation

A clone is a group of organisms descended by vegetative propagation of a common ancestor. The progenitor and the members of a clone are genetically uniform. Uniform quantity of production and quality are expected under the same environmental conditions. If a collection of the same clone is made from different growing areas and grown under one environment, differences should not be expected theoretically. However, in practice, slight differences are recorded and explained as due to somatic variations, occurred during the long period, when the clone was grown in differing environments. Most of the variations within a clone for quantitative characters are reported to be due to the effects of environment. The longer and more widely an individual is grown as a clone, the greater would be the opportunity for somatic variations to occur.

Reports on these lines were published by Rieman *et al*. as early as in 1950. They recorded significant differences in the yielding capacity of the potato variety 'Chippewa'. They concluded that those variations were heritable and their occasional appearance was the rule and not the exception, in asexual propagation. Davidson and Lawley (1953) reported that high and low yielding clones appeared in 'King Edward' and probably in other varieties of potato. Gross and Simmonds (1954) tried to identify mutations in 'Dwarf Cavendish' group of banana with the help of differences in leaf ratios. They suggested that rather than height, leaf ratios serve better to identify the varieties. In potato Cockerham and Macarthur (1956) showed that there was significant difference in yield and disease resistance among the sub-clones of 'Majestic'. A study conducted by Shepherd (1957) reinforced the views of Gross and Simmonds (1954). He opined that leaf ratio seemed to be a character least affected by environment and therefore would be of great use for detection of intra-clonal variations. Nayar (1958) suggested that the occurrence of somatic mutations in banana offers greater and easier scope for selection of desirable types. This suggestion was based on the observation that in the clone 'Nendran' alone, at least six mutants occurred, which behaved true-to-type.

Harris et al. (1967) studied the effects of three different environments on a clone of potato and found no evidence to suggest that the different environments altered the relative expression of growth and yield parameters they studied. Clonal variation in potato was reported by

Terry et al. (1970) also. Though they could not find significant differences with regard to clone x location interactions, the clone x year x location interaction was significant for plant height and yield.

Simmonds (1959) had observed that although bananas offered little scope for the detection of such subtle changes, as were detected in potatoes, there was still a priori reason to believe that they were no less subjected to such changes. In mango, distinct clonal variations were observed when grown in different areas (Singh, 1971). In 'Dashehari' and 'Alphonso', this difference was often met with. Rootstock, soil and climate factors as well as indiscriminate multiplication were attributed as the reasons.

In genetically complex, vegetatively propagated plants like apple, dahlia, chrysanthemum and potato, conditions favourable for occurrence of variations exist (Chandrasekharan and Parthasarathy, 1975). It was pointed out that the variations in yield observed in the sub-clones were largely due to environment. Milutinovic et al. (1981), after studying the clones of the sour cherry variety 'Oblacinska' suggested that there was a possibility of improving the characteristics of this variety by clonal selection. Based on the results of clonal selection in the apricot 'Velkopavilovicka', Vachun (1981) observed that variability was high for yield; but low for vigour and fruit quality.

Fertilizer recommendations

Several suggestions are made with regard to the time and quantity of application of fertilizers to banana. Summerville (1944) opined that the time of application of fertilizers is an important factor and for better results, the fertilizers are to be applied during the early stages of growth. Later, Alexandrovitz (1955) remarked that the fertilizers are to be applied in splits. Butler (1960) conducted a study with'Gros Michel' banana and opined that only N was necessary for economic yield. Bhangoo et al. (1962) obtained contradictory results. They concluded that N alone or P and K alone did not have any effect on the yield and for significant responses, P and K are to be used in conjunction with N. In another study Bhangoo and Karon (1962) found that dolomite and minor elements enhanced the yield further.

Several workers later on recommended split application of nutrients for obtaining higher yields in banana. Osborne and Hewitt (1963) recorded the highest yield in rainfed banana when nitrogen was applied three times an year. In Taiwan the best result was obtained when N was given in five splits, P in two splits and K in three splits. N application was distributed throughout the year and P and K, in the early stages of growth (Ho, 1967, 1969). From the trial, a dose of 200 g N, 100 g P_2O_5 and 180 or 360 g K_2O/plant/year was recommended

(Ho, 1969). Based on a study conducted by Leigh (1969), it was suggested that the dose recommended for banana should be divided into three or four applications during the year. Champion (1970) suggested application of fertilizers in three splits at the total rates of 560 kg N, 224 kg P_2O_5 and 672 kg K_2O/ha. Based on another study, in Taiwan, Ho (1970) recommended an extra heavy dressing of 1000 kg K_2O/ha or more to obtain more yields. Marques and Monteiro (1971) recommended dressings of at least 200 kg N, 50 - 150 kg P_2O_5 and 100 - 600 kg K_2O/ha in three to four applications in Mozambique. Based on a study regarding the nutrient uptake in well managed plantains, Irizarry et al. (1981) observed that uptake of nutrients increased upto harvest.

According to Shanmugam and Velayutham (1972), K could be applied in three split doses during the 1st, 3rd and 5th month after planting along with N, in Tamil Nadu. They opined that fertilizers did not help in increasing the yield, if applied after the 6th month. Ramaswamy and Muthukrishnan (1973a) recommended application of nitrogen in the 3rd and 5th month after planting. In Assam, application of 900 kg N, 480 kg P_2O_5 and 480 kg K_2O/ha in three splits are recommended for 'Dwarf Cavendish' (Sharma and Roy, 1973). Veeraraghavan (1973) suggested 228 g N, 228 g P_2O_5 and 456 g K_2O/plant, in two equal splits, two and four months after planting, for banana in Kerala. For 'Palayankodan' variety, a dose of 160 - 200 g N, 160 - 200 g P_2O_5 and 320 - 400 g K_2O/plant was recommended to be applied as above (KAU, 1978). Gopimony et al. (1979) recommended the application of an additional dose of 500 g urea in five equal split doses at one week interval during the 5th month of planting for obtaining higher yields. In another study, application of N and K in equal splits 30, 60 and 150 days after planting produced maximum bunch weight (Nambiar et al., 1979). The review of the available literature indicates the need for detailed studies in 'Palayankodan' on the influence of split application of the recommended nutrients vis a vis their uptake, yield and quality.

Growth parameters as influenced by nutrient levels

The direct effects of fertilizers are first manifested on the morphology and growth, which in turn reflect on the yield. In a trial conducted on Musa cavendishii, application of phosphorus did not bring about any effect on the growth. In the very early stages of growth, significant increase was seen associated with the presence of added potash (Summerville, 1944). According to Bhan and Majumdar (1956), heavy application of N induced earliness in the variety 'Martaman'. However, no response was observed for P and K. In fertilizer trials on different soil types, high levels of N alone reduced sucker germination and the highest rate of sucker development was recorded in plots receiving N, P and K. With regard to the rate of leaf development, there was no effect (Segars, 1963). On the other hand Venkatesam et al. (1965) reported a stimulative effect of N, the effective leaf area being increased with rising levels of N in the variety 'Karpoora Chakarakeli'. In his studies, Martin-Prevel (1969) found that N sometimes stimulated growth or induced earliness, depending upon the ratio of N to the other major elements in the leaf. A significant positive correlation between K concentration in the 3rd leaf and stem circumference and height was established by Ho (1969).

Melin (1970) reported that application of S at 0.5 Kg/plant increased the growth and earliness, particularly in the presence of supplementary N. He observed that Mg tended to cause early flowering. K in combination with N increased the growth and earliness. A positive correlation was obtained by Fernandez and Garcia (1972) between the percentage of N in the 1st and 3rd leaves at floral differentiation, and flowering. In the studies by Jambulingam et al. (1975), higher K_2O rates were required to increase the pseudostem height, girth, leaf area, sucker production and early flowering. In an experiment with 'Cavendish' clones, Arunachalam et al. (1976) observed promotive effects for plant characters to the level of 170 g

N/plant. Early flowering was obtained by the use of P_2O_5 also upto 60 g/plant in 'Robusta' (Ramaswamy, 1976). While conducting investigations on the effects of NPK fertilization on banana variety 'Basrai Dwarf', Singh et al. (1977) observed that NPK @ 150, 90 and 170 g/plant gave the best growth and induced earliness. Significant differences in respect of height and girth of pseudostem were obtained with N and K split at 30 and 150 days after planting (Nambiar et al., 1979). Turner and Barkus (1980) reported that low K supply reduced the leaf area in banana variety 'Williams' by 20 per cent. Low K levels had no effect on the rate of appearance of new leaves and relative leaf area production rate. An experiment to study the effects of N on rainfed 'Palayankodan' (Mathew, 1980) indicated that the height and girth of the pseudostem as well as the length of the petiole increased significantly with increasing levels of N. She observed no effect of N on the number of functional leaves and leaf area. Another experiment on the same variety (Sheela, 1982) indicated that only the plant height was increased by the supply of K. The highest level of K induced early harvest of the bunches.

Bunch and fruit characters as influenced by nutrient levels

A positive relation between the applied nutrients (fertilizers) and yield was observed by several workers. Studies dating back to 1933 conducted by Baillon et al. established that increased yields could be obtained by the application of nitrogen and potash to banana. Bhan and Majumdar (1956) opined that yields were better with heavy applications of N; but there was no response to P and K. Application of N had a significant effect on the number of hands and fingers also. The findings of Butler (1960) are also on similar lines. Bhangoo et al. (1962) observed that N alone or PK alone did not exhibit any effect on the yield of 'Giant Cavendish' banana. Based on a study in the same variety, Bhangoo and Karon (1962) opined that dolomite lime and minor elements in conjunction with NPK fertilizer mixture were necessary for optimum banana production. Hagin et al. (1964) obtained no response to P fertilization. Venkatesam et al. (1965) observed that the variety 'Karpoora Chakarakeli' did not respond to the application of P and K.

Ho (1967) obtained yields of more than 30 t./ha by maintaining leaf K at 5 per cent throughout the growth and development. The highest yield and the largest number of fingers per hand were obtained with the above concentration of K (Ho, 1969). Ho (1970) opined that yield and quality response to K was substantial if N and P supply were adequate. Contrary to this, Melin (1970) reported that K responses were not normally significant with regard to yield. According to him, S application at 0.5 Kg/plant increased the bunch yield, particularly in the presence of supplementary N. Moreau and Robin (1972) opined that the higher dose of K_2O tried (1350 Kg/ha), resulted in the greatest increase of 93 per cent in yield. Ramaswamy and Muthukrishnan (1973a) investigated the effects of N on fruit development in 'Robusta' banana and obtained the best result with 170 g N/plant which increased the length and circumference of the fruit at harvest. After a four year NPKCa trial with 'Nendran' banana, Veeraraghavan (1973) reported that both fruit weight and number were markedly increased by an NPK combination of 228 : 228 : 456 g/plant. Twyford and Walmsley (1974b), after conducting extensive studies with regard to the mineral composition of 'Robusta' banana, concluded that very high yields were always associated with high uptake of K, than that of other elements. Jambulingam et al. (1975) also observed that potash had significant effects on the grade of the bunch and on the acidity and T.S.S. of the fruits.

Bunch characters were seen influenced favourably upto 170 g N per plant (Arunachalam et al., 1976). In a trial with 'Robusta' banana, the number of hands/bunch, the bunch weight and the fruit size were seen increased with P_2O_5 upto 60 g per plant. However, the fruit quality was not influenced (Ramaswamy, 1976). Kohli et al. (1976), based on a study in the same variety, obtained maximum yields with 180 g N, 15.5 g P and 186.75 g K/plant/year. Pillai et al. (1977), studied the response of 'Nendran' banana to different levels of NPK.

They observed that yields were greater with N and K_2O at 191 and 301 g/plant/year. There was, however, little or no response to P_2O_5. On the contrary, Singh et al. (1977) observed that N, P and K at the rate of 150, 90 and 170 g/plant gave the best yield and excellent fruit quality. According to Vadivel and Shanmugavelu (1978), increase in the levels of K_2O significantly increased the reducing, non-reducing and total sugars as well as T.S.S. in the variety 'Robusta'. Acidity was decreased while sugar/acid ratio was enhanced.

Gopimony et al. (1979) studied the effects of top dressing urea at the 5th month in 'Zanzibar' variety. They obtained a significant increase in the bunch weight and number of fingers per bunch as a result of the treatment. In another study on the split application of nutrients, Nambiar et al. (1979) found that N and K in equal splits at 30 and 150 days after planting recorded the maximum bunch weight. Studying the effects of nitrogen nutrition on rainfed 'Palayankodan', Mathew (1980) observed that the optimum and economic levels of N were 204.6 and 96.0 g/plant respectively. Sheela (1982) obtained increased yields with increasing levels of K and established the optimum level of K to be 600 g/plant for 'Palayankodan'. Turner and Barkus (1982) observed that low K supply considerably reduced the bunch weight and the various yield components in banana.

Dry matter production

In crop plants, utilisation of the nutrients depends upon the varietal efficiency and also on the agro-climatic conditions. Dry matter production is influenced by the variety, soil, climatic conditions and the supply of nutrients. These factors which cause wide differences in the dry matter production were subjected to detailed investigations by several workers. Baillon et al. (1933) conducted studies with special reference to banana in the Cannaries and obtained a dry matter content of 18 Kg/plant. A content of 6.5 Kg/per plant was reported by Martin-Prevel (1962). Twyford and Walmsley (1973) conducted extensive studies on the dry matter production in Musa cavandishii grown in six different localities. The average total dry matter content of the plants varied with localities and the range was from 5.520 to 15.205 Kg/plant. Turner and Barkus (1980) estimated the dry matter production in 'Williams' banana as related to the supply of K, Mg and Mn in sand culture. They found that low K supply reduced the dry matter production. Mathew (1980) observed nitrogen to have a positive effect on the dry matter production in rainfed 'Palayankodan'. She found the total dry matter production to be the highest at the highest level tried (400 g N/plant) and the lowest, at zero level. The range was from 4.59 to 5.88 Kg/plant. At harvest, maximum dry matter was found in the fruits. Sheela (1982) reported that the total dry matter production increased with increasing levels of K. The range of dry matter production for zero to 600 g K_2O/plant was from 4.58 to 5.32 Kg/plant. Here too, the highest accumulation of dry matter was found in the fruits at harvest.

Correlations during growth and development

Information on the inter relationships among the yield, growth parameters and other economic traits would immensely help manipulate these parameters so as to result in increased yields. According to Murray (1961), the length x breadth of the third leaf at the 6th month and the final weight of the bunches were highly correlated in 'Dwarf Cavendish'. Hasselo (1962) obtained a close correlation between the bunch weight and the circumference of the pseudostem at the time of shooting. Extensive statistical studies carried out by Lossois (1963) on banana plantations of different ages showed a strong correlation between the yield and the circumference of the pseudostem (1.0 m above the soil surface) at flowering time. Simple, partial and multiple correlation studies conducted by Teaotia et al. (1970) led to the conclusion that bunch yield was strongly correlated to the pseudostem circumference. Turner (1970) reported that 'leaf length duration' (leaf length x longevity) was positively related to bunch weight. Correlation between circumference of the pseudostem, and weight and number of hands was observed by Fernandez and Garcia (1972) also. Lassoudiere et al. (1974) established a relationship between bunch weight and grade (measure of finger thickness) of the second hand. Studies of Warner et al. (1974) showed a direct relation between yield, height of pseudostem and girth. From a regression equation, Obiefuna and Ndubizu (1979) worked out a coefficient (0.8) for estimating the true leaf area of plantains from length x width measurements. Girth and weight of fingers were identified as the attributes responsible for increased yield in 'Palayankodan' (Mathew, 1980). According to Hernadez (1983), finger number was the most important variable and had an r value of 0.86 with bunch weight.

Nutrient concentration

In banana, as in other crops, several workers have attempted to work out meaningful correlations between the status of nutrients in the plant parts and the yield. Such information is useful in developing crop logging techniques, in crops like sugarcane (Clements, 1960). The possibility of utilizing the leaf analysis data for ensuring successful production in banana was first investigated in Jamaica by Hewitt (1955). Based on this study, the 3rd leaf was taken as the standard leaf and the concentration below which the yields were diminished were found to be 2.6% for N, 0.45% for P_2O_5 and 3.3% for K_2O. Bidner and Ravikovitch (1958) found that the mineral composition of the mature leaves differed only slightly; but that of the young leaves differed markedly. There was a lack of balance with regard to Ca, Mg and K which accounted for the poor growth of the plants. Boland (1960) conducted leaf analysis in banana and the optimum levels were found to be 2.8 to 3.0% for N, 0.40 to 0.55% for P_2O_5 and 3.8 to 4.0% for K_2O. He recommended that the middle lamina halves of the second leaf before shooting was the best for conducting analysis. Based on studies conducted on 'Gros Michel' in the Cameroons, 'Poyo' in the Ivory Coast and 'Petite Naine' in Guinea, Dumas (1960) stressed that potash content of the plants should be approximately 5.8%, 4.0% and 3.6%, respectively for the above varieties. Murray (1960) conducted studies in 'Dwarf Cavendish' under glass house conditions and observed that 1.4% Ca and 0.6% Mg in the third leaf were adequate. Brzesowsky and Biesen (1962) conducted foliar analysis in 'Lacatan' banana and reported that increased potash application positively influenced the leaf K; but the effect with regard to N was not significant. Hewitt and Osborne (1962) also conducted leaf analysis of 'Lacatan' banana. They observed that N and P_2O_5 in the leaves were in the order 2.60% and 0.40 to 0.45%, respectively. With regard to potassium, 4.00% was regarded as adequate. Twyford and Coulter (1964) recommended the adequacy levels for N, P_2O_5 and K_2O to be 2.00 - 2.29%, 0.48% and 3.80% respectively. Ho (1969) examined the correlation between banana fruit yield and leaf potassium content, and obtained the highest yield and the largest number of fingers per hand at a K value of 5.0% or more at three months before harvest. Investigations conducted by Lahav (1972) in Israel proved that for determining the K level in banana, the stalk of the 7th leaf was the most appropriate part.

Ramaswamy and Muthukrishnan (1973b) found 3.29% N, 0.44% P_2O_5 and 3.11% K_2O in the 'Robusta' leaf tissue with the application of 170.0 kg N, 85.0 kg P_2O_5 and 283.5 kg K_2O/acre. The importance of maintaining high N in the leaves throughout the life of the 'Robusta' plants was stressed by Twyford and Walmsley (1973). They further opined (1974a) that the rapidly differentiating tissues (throughout the life cycle of banana) are always associated with high concentrations of specific nutrients; but these nutrients were not always the same. Shawky et al. (1974) studied the distribution of N, P and K in different parts of banana plants and found that lamina had the highest N and P content. The K contents of midrib and petiole were thrice that of lamina. The nutrient concentrations (per cent) in the leaf tissues of 'Cavendish' clones ranged from 3.18 to 3.43 for N, 0.46 to 0.54 for P, 3.36 to 3.76 for K, 2.30 to 2.40 for Ca and 0.25 to 0.28 for Mg (Arunachalam et al., 1976).

Veerannah et al. (1976a) conducted nutrient uptake studies in 'Robusta' and 'Poovan'. They suggested that leaf was the specific tissue for diagnosing N and P whereas K could be the best diagnosed in the sheath. They further reported (1976b) that sheath, petiole, leaf and midrib were the best parts for the analysis of Ca. Any organ was found to be good for Mg. In South Africa, nutritional status of 'Dwarf Cavandish' banana was determined by Langenegger and Plessis (1977). They suggested that the two most promising tissues for foliar analysis were a section of the midrib and also the corresponding laminae from the leaf in position III, sampled after flowering at a stage when two hands were visible. The midrib gave better indications of N and K as compared to the other tissues. Warner and Fox (1977) sampled the 3rd full sized leaf below the inflorescence in order to study the effects of nitrogen and potassium nutrition in 'Giant Cavendish' banana in Hawaii. Leaf N levels were found to be associated with yield which approached the maximum at about 2.8% N. Heavy application of K was required to maintain leaf K at 3.2% in the control. It was reported by Garcia et al. (1980) that as the plants developed, the N and K concentration in leaf III decreased, while Ca increased and P and Mg remained constant. Guijarro et al. (1980) compared the various leaf sampling methods in banana and recommended a 10 cm transverse band from the middle portion of the leaf blade. The N, P, K, Ca and Mg contents in this band were similar to those in the middle portion of the 3rd leaf used in the traditional analysis. According to Mathew (1980), the nutrient status of the 3rd leaf at shooting ranged from 1.33 to 2.08% for N, 0.14 to

0.17% for P and 2.05 to 2.76% for K. Lahav et al. (1981) tested the suitability of different organs for determination of nutrients in banana. They found that N, Cl, B, Fe and Ca could be best sampled in the blade of leaf III and P, Mg and Mn in the petiole of leaf VII. No differences between the organs were observed with respect to K, Na or Zn contents.

Nutrient removal

The quantity of nutrients removed by a plant, the quantity removed from an unit area, the quantity required to produce unit weight of produce etc. serve as guidelines to the nutrient requirement of the crop. The requirement varies with the variety and the agroclimatic conditions of growth. Jacob and Uexkull (1960) found that the nutrient removal by a 30 t. crop of banana was to the tune of 50 - 75 Kg N, 15 - 20 Kg P_2O_5 and 175 - 220 Kg K_2O. Martin-Prevel (1962) found that 600 Kg N, 250 Kg P_2O_5, 1000 Kg K_2O, 125 Kg CaO and 30 Kg MgO were required per hectare for a high yielding crop. He further reported in 1964 that a crop of 40 t./ha required 80 Kg N, 20 Kg P_2O_5 and 240 Kg K_2O/ha under Guinea and Guadeloupe conditions. Martin-Prevel et al. (1968) reported that 250 Kg N, 90 Kg P_2O_5, 1350 Kg K_2O, 300 Kg CaO and 90 Kg MgO had been taken up per hectare by a crop of 'Gros Michel' banana grown on a fertile soil at the Cameroons. Based on total nutrient uptake by a banana crop in Malaysia, Joseph (1971) reported that a crop producing 16.25 t. fresh fruits per hectare removed

38 kg N, 8 kg P, 285 kg K, 30 kg Ca and 49 kg Mg.

Jauhari et al. (1974) revealed that in the first few months of planting, there was rapid uptake of N, P_2O_5 and K_2O. K content in the leaves and roots decreased with age; but that in the rhizome and pseudostem increased. Twyford and Walmsley (1974b), after an elaborate study on the mineral composition of 'Robusta' banana at four locations, postulated that the content of nutrients varied very much as influenced by site. A very high yield was always found to be associated with a higher uptake of K than that of other nutrients. After conducting studies on the nutrient uptake of 'Robusta' and 'Poovan' banana, Veerannah et al. (1976a) reported that 'Robusta' required N, P_2O_5 and K_2O at the rate of 325, 75 and 1195 kg/ha, respectively, while the requirement for 'Poovan' was 408, 35 and 1285 kg/ha, respectively. N and K were absorbed more in the pre-flowering stage in 'Robusta' whereas it was continuous and steady and quantities were almost equal before and after flowering in 'Poovan'. They further reported (1976b) that the uptake of K was remarkably high as compared to that of the other nutrients. 'Poovan' required more K than 'Robusta'. Chattopadhyay and Mallik (1977) conducted uptake studies in 'Dwarf Cavendish' banana and reported that P uptake increased with frequent heavy irrigation. The leaves contained the highest quantity of N, followed by the petiole. Mathew (1980) found that uptake of

N and P were maximum in the lamina during the vegetative phase and in the fruits during the reproductive phase. K was found to be the maximum in the pseudostem. Irizarry et al. (1981) studied the nutrient uptake in intensively managed plantain cv. 'Maricongo' growing on two soil types. It was found that an average of 249, 21, 585, 60 and 147 kg/ha of N, P, K, Mg and Ca, respectively, were taken up during the crop cycle. Nutrient uptake increased upto the harvest. The role of K in the mineral nutrition of banana was studied by Jaramillo and Garita (1982) who found that one tonne of banana fruits contained 1.25 to 2.00 kg N, 0.50 kg P_2O_5, 6.00 kg K_2O, 0.23 kg Ca and 0.33 kg Mg. Sheela (1982) also studied the effects of K in the rainfed banana, 'Palayankodan' and reported that at harvest, the highest uptake of N was found in the lamina, P in the fruits and K in the pseudostem.

Inter relationships among nutrients

Many workers reported that plant growth and yield generally depended upon the balance that existed between certain nutrients and that for optimum yields this balance should be maintained. Dumas and Martin-Prevel (1958), after studying the nutritional aspects of banana plantations in Guinea, reported that the yields depended largely on the balance between K and N as well as between Ca and Mg. It was generally held that optimum yields were obtained if the major nutrients were supplied adequately in appropriate proportion. Butler (1960) reported that economic response to fertilization could be expected only from the use of N. He found that K, P or a combination of them alone or in conjunction with N produced no significant increase in the production, over N used alone. After carrying out an investigation in 'Giant Cavendish' banana, Bhangoo et al. (1962) reported that significant responses were obtained from the use of phosphorus and potash in conjunction with nitrogen. N alone or PK alone did not have any effect on the yield. Hewitt and Osborne (1962) also reported that in the presence of adequate N and P, it was possible to double the weight of fruits by the application of K.

Brzesowsky and Biesen (1962) reported that K in the leaf had a depressing effect on the leaf Mg. Ho (1969) studied the effect of K and reported that K application lowered the leaf Ca, Mg and N contents. Martin-Prevel (1969) reported that the growth and yield depended upon the ratio of N to the other major nutrient elements in the soil. The relationship of S and N was studied by Melin (1970). He reported that S application increased the growth and yield, particularly in the presence of supplementary N. The content of K was negatively correlated with Ca + Mg at all the stages, according to Fernandez et al. (1973). They also reported that the Mg percentage in the cation sum always remained a constant. Antagonism between K and Mg, K and Ca, and K and N were observed by Lahav (1973-74). He reported that the antagonism between K and Mg was greater than that between K and Ca. Synergism existed between K and P. Increased K uptake was correlated to decreased Ca and Mg uptake (Veerannah, et al., 1976b). Lahav et al. (1978) found antagonistic relationship at the initial stages of sucker growth between K and Ca + Mg, between N and P, between P and Zn, and between N and Cl. Garcia et al. (1980) reported negative correlation between leaf K and leaf Ca, between leaf K and leaf Mg, and between each of the ratios K/N, K/Ca and K/Mg. As the plants developed, the N and K concentration in leaf III decreased, Ca increased, and P and Mg remained constant. Turner and Barkus (1982) reported that low K supply increased the concentration of N, P, Ca, Mg, Cu and Zn; K and Mn were unaffected in 'Williams' banana. High levels of Mn significantly decreased the concentration of N and Mg, and raised that of Mn. Low Mg decreased Mg; but did not affect the other elements. Sheela (1982), on the other hand, found an increased uptake of P with an increase in the level of K under Vellanikkara conditions.

Relative importance of nutrients

Several investigations were undertaken to judge the relative importance, especially of the major nutrients. Manurial experiments as early as in 1921 conducted by Fawcett revealed that N and K were required in large amounts for banana.

The results obtained by Baillon *et al*. (1933) were also on similar lines. Norris and Ayyar (1942), on the other hand, opined that K alone was required in large quantities. According to them, N was required in moderate quantities and P, in relatively little quantities for optimum production. The profound effect caused by K was also reported by Hewitt and Osborne (1962). Osborne and Hewitt (1963) found no response of banana to the application of phosphatic fertilizers. They stressed the importance of potash for higher production in banana. Hagin *et al*. (1964) also could not find any response to P fertilization in their experiments conducted in Israeli banana plantations.

Twyford (1967) observed that the amount of potash was always the highest among the nutrients analysed, being between 2.3 to 4.6 times the content of N. He recommended a ratio of 4 : 1 : 14 for N, P and K respectively, which indicated the greater importance of K and the much lesser need for P. Ho (1969) established significant positive correlation between fruit yield and leaf K content in banana. Turner (1969) also suggested that banana requires high N low P and high K. The poor response to P was obtained by Melin (1970) also. He could not find significant positive response with K; but in combination with N, K increased the yield markedly. Ramaswamy and Muthukrishnan (1973b) also suggested that for maximising yield, the quantity of N and K required was more as compared to that of P. They suggested a dose of 420 kg N, 210 kg P_2O_5 and 700 kg K_2O/ha. The observations made by Pillai et al. (1977) in 'Nendran' were also on similar lines. They reported that there was little or no response to P, and yields were greater with N and K at 191 and 301 g/plant/year, respectively.

Nutrient translocation between mother plant and suckers

On the belief that there was translocation of nutrients from the portions of the mother plant after harvest to the suckers in the clump, the practice of 'mattocking' was developed. After the harvest, the whole or a part of the mother plant was retained so as to nurse the followers. Nayar et al. (1956) examined this practice and found that the yield of the ratoon crop was significantly higher when the parent pseudostem was half-removed or untouched after harvest. According to Martin-Prevel (1964), the banana growers believed that one plant in a clump obtained water and nutrients from another to varying extents and that the young developing plants were nourished by the older plants of the clump. This nursing continued until the young plants reached a certain stage of development, after which they became independent. He further added that this belief was never proved. Walmsley and Twyford (1968) carried out preliminary experiments in a 'Robusta' banana nursery using ^{32}P. The results showed that there was a transfer from the mother plant to the followers and vice versa. Based on the translocation studies using radio isotopes, Teisson (1970) showed that the suckers could contribute to the mineral nutrition of the mother plants. Leaving a portion of the pseudostem attached to the sett resulted in fewer but longer and stouter shoot with 26 per cent more leaf surface 3 months after planting (Morez, 1961). It was also reported by Morez and Guillemot (1962) that sucker growth was greatly improved by leaving 1.5 m of the pseudostem attached to the sett. Turner and Barkus (1973) monitored the weekly loss of mineral nutrients from banana pseudostems after the harvest. They opined that if the lost nutrients were translocated to a young growing sucker, as is likely when mattocking is practiced, they would contribute more than 40 per cent of its requirements for all the elements, except Mg and Zn. Best results regarding increase of hands per bunch and bunch weight in the succeeding crop were obtained by Ferraz et al. (1976) when the plants were cut down completely 30 days after harvest in cv. 'Prata'. Balakrishnan (1980), after conducting mattocking studies in 'Robusta', observed that intact pseudostem after harvest continued to translocate nutrients to the developing sucker.

Materials and Methods

MATERIALS AND METHODS

The present investigations aimed at assessing in detail the differences in growth and development of the twenty four accessions of _Musa_ (AAB group) 'Palayankodan' collected from different growing areas. The nutritional aspects with regard to growth, dry matter production and uptake of nutrients _vis a vis_ yield and quality were studied in one of the accessions. The field experiments were laid out at the Banana Research Station, Kannara, Trichur during three cropping seasons (1981-1984). Translocation of nutrients from the mother plant (after harvest) to the sucker(s) was another aspect of study. The radiotracer studies were conducted using the facilities available at the Radiotracer Laboratory, College of Horticulture, Vellanikkara. The soil of the experimental area is a well drained, acidic lateritic loam. The chemical characteristics of the soil are presented in Table 1. The weather data for the period from 1-3-81 to 31-8-84 are given in Appendix-I.

A. Intraclonal variation studies

1. Survey and collection

A survey was conducted during 1981 covering all the districts of Kerala (23 locations) and the Tiruchirapalli district of Tamil Nadu (one location) (Fig.1). Particulars

Table 1. Chemical characteristics of the soil

Constituent	Content in the soil	Analytical method used
Total nitrogen	0.160%	Micro Kjeldahl (Jackson, 1958)
Available phosphorus	0.005%	In Bray I extract; chlorostannous reduced molybdophosphoric blue colour method using a Spectronic 20 spectrophotometer at 410 nm (Jackson, 1958)
Available potassium	0.023%	In I N neutral ammonium acetate extract; flame photometric (Jackson, 1958)
p^H	5.4	1 : 2.5 soil : water ratio; using a p^H meter

FIG.1.MAP SHOWING THE LOCATIONS OF THE ACCESSIONS

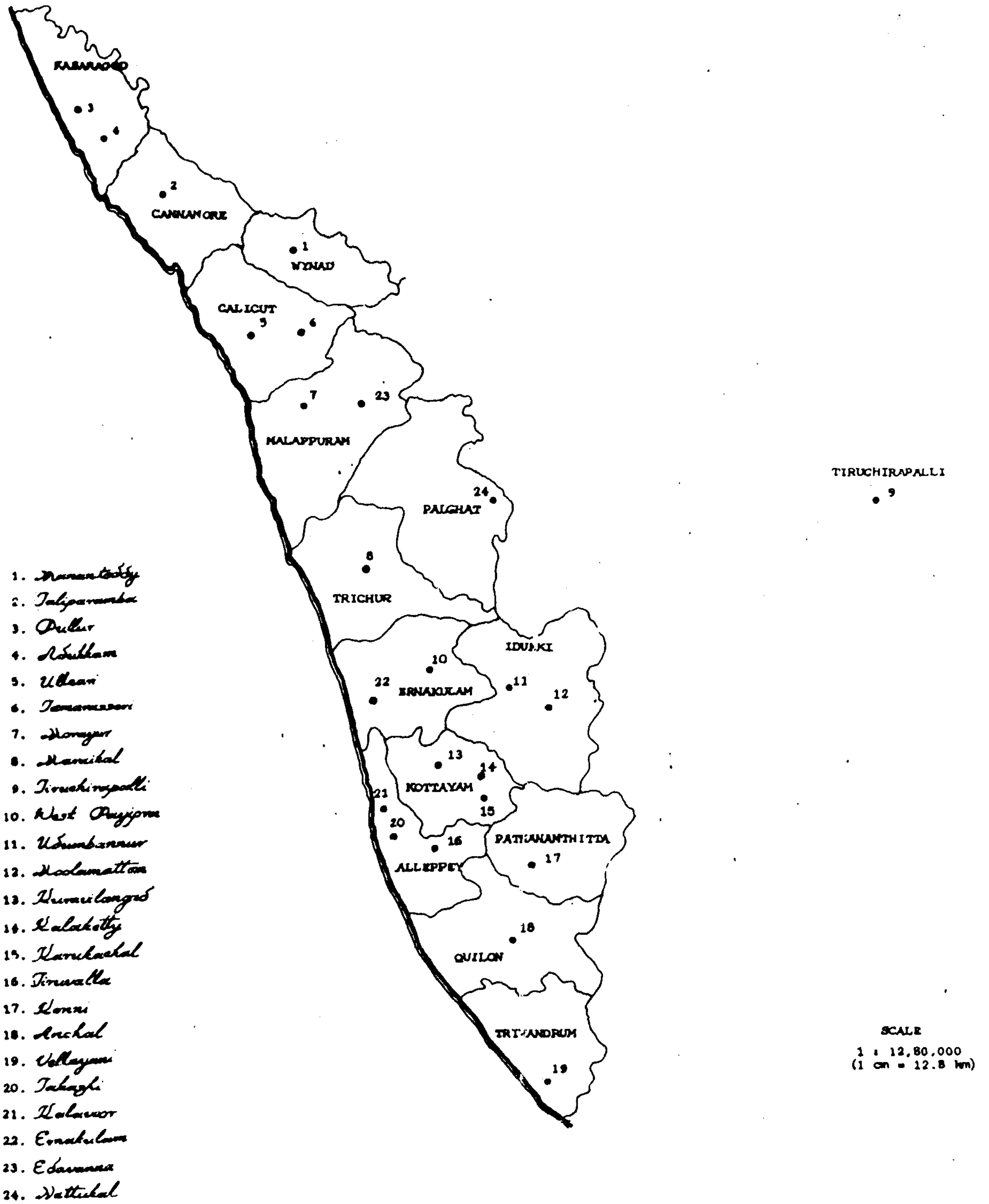


Table 1. Particulars of the accessions

Details	Accessions			
Accession Number	1	2	3	4
Location	Manantoddy	Taliparambe	Pullur	Adukkam
Name and address of the farmer/institute	V. Kunhumon, Vallimadathil Veedu, P.O. Arattuthara, Wynad.	District Agricultural Farm, Taliparamba.	State Seed Farm, Pullur.	P.K. Mohammed Kunhi, Anapetti House, P.O. Kalichanadukkam, Via. Nileshwar.
District	Wynad	Cannanore	Kasaragod	Kasaragod
Local name of the clone	Mysore Poovan	Mysore Poovan	Mysore Poovan	Mysore Poovan
Soil type	Clay loam	Sandy loam	Clay loam	Lateritic loam
Mode of cultivation				
Whether pure crop/ intercrop	Intercrop	Intercrop	Intercrop	Intercrop
If intercrop, main crop(s)	Coffee, arecanut, coconut, pepper	Coconut, arecanut	Coconut	Coconut, arecanut
Whether homestead garden/ commercial cultivation	Homestead garden	Commercial cultivation	Commercial cultivation	Homestead garden
Cultivation practices				
Whether plant crop/ratoon	1st ratoon	1st ratoon	1st ratoon	5th ratoon
Number of ratoons generally taken	5	2	Several	Several
From where the suckers were procured	Local	Local	Local	Local
Main season of planting	May-June	May-June	June-July	May-June
Organic manure applied		Nil		Nil
Name	Green leaves	-	Farmyard manure	-
Quantity	10 kg	-	10 kg	-
Time	At planting	-	One month after planting	-
Fertilisers applied	Nil	For plant crop only	Nil	Nil
Name	-	N P K	-	-
Quantity	-	160 g 160 g 320 g	-	-
Time	-	2 and 4 months after planting in equal splits	-	-
Soil amendments used	Nil	Nil	Nil	Nil
Name	-	-	-	-
Quantity	-	-	-	-
Time	-	-	-	-
Water management				
Whether rainfed/ irrigated	Irrigated	Irrigated	Irrigated	Irrigated
If irrigated, interval (days)	10 - 14	3 - 4	3 - 4	7
Incidence of pests and diseases				
Diseases/pests	Bunchytop	Bunchytop	Bunchytop	Bunchytop
Intensity	Severe	Mild	Moderate	Moderate
Plant protection measures adopted	Nil	Nil	Nil	Nil
Main season of harvest	Spread over the year	April-May	January-May	March-April
Whether male bud removed/ retained	Retained	Retained	Removed	Removed
If removed, at what stage	-	-	One month after shooting	One month after shooting
Number of suckers retained	All	3 - 4	All	3 - 4
Mattocking details	Cut off at about 60-70 cm from ground level	Cut off at half	Cut off at half	Cut off at the base
Morphological characters of the plant				
Height (cm)	360	425	375	360
Girth (cm)	65	84	70	75
Number of functional leaves	9	10	11	10
Bunch characters				
Weight (kg)	12	14	10	16
Number of hands	10	10	9	10
Number of fingers	225	200	165	225

(contd.)

Table .. (contd.)

Details	Accessions			
Accession Number	5	6	7	8
Location	Ulleari	Tamarasserry	Morayur	Maraikal
Name and address of the farmer/institute	O. Narayanan Nair, Othayoth House, P.O. Ulleari, Via. Quilandy,	Pounoor Estate, Tamarasserry, P.O.	Alavi, [illegible], Mathrubhoomi Agent, Kavode House, P.O. Morayur.	Banana Research Station, Maraikal, P.O. Kannara.
District	Calicut	Calicut	Malappuram	Trichur
Local name of the clone	Mysore Poovan	Mysore Poovan	Mysore Poovan	Palayankodan
Soil type	Clay loam	Lateritic loam	Lateritic loam	Sandy loam
Mode of cultivation				
Whether pure crop/intercrop	Pure crop	Pure crop	Intercrop	Pure crop
If intercrop, main crop(s)	-	-	Coconut, wild trees	-
Whether homestead garden/commercial cultivation	Homestead garden	Commercial cultivation	Homestead garden	Commercial cultivation
Cultivation practices				
Whether plant crop/ratoon	2nd ratoon	1st ratoon	Plant crop	1st ratoon
Number of ratoons generally taken	3	3-4	4-5	2
From where the suckers were procured	Local	Local	Local	Local
Main season of planting	May-June	April-May	April-May	Jan-Feb, Sept-Oct
Organic manure applied	Nil			
Name	-	Green leaves	Cowdung	Green leaves
Quantity	-	5 kg	5 kg	5 kg
Time	-	At planting	At planting	At planting
Fertilizers applied	Nil	Nil	Nil	
Name	-	-	-	N P K
Quantity	-	-	-	160g 160g 320g
Time	-	-	-	2 and 4 months after planting in equal splits
Soil amendments used	Nil	Nil	Nil	Nil
Name	-	-	-	-
Quantity	-	-	-	-
Time	-	-	-	-
Water management				
Whether rainfed/irrigated	Rainfed	Rainfed	Irrigated	Irrigated
If irrigated, interval (days)	-	-	7	10-14
Incidence of pests and diseases				
Diseases/pests	Bunchytop	Bunchytop	Bunchytop	Bunchytop, Kokkan, leaf spot
Intensity	Moderate	Mild	Mild	Moderate
Plant protection measures adopted	Nil	Nil	Nil	Carbofuran against bunchytop and Bordeaux mixture against leaf-spot
Main season of harvest	May-June	April-May	March-May	Jan-April, Sept-Nov
Whether male bud removed/retained	Retained	Retained	Removed	Removed
If removed, at what stage	-	-	After completion of female phase	One week after completion of female phase
Number of suckers retained	2	2-3	2	1-2
Mattocking details	Cut off at half	Cut off at half	Cut off at the base	Only the crown cut off with the bunch
Morphological characters of the plant				
Height (cm)	315	335	330	325
Girth (cm)	70	75	65	75
Number of functional leaves	9	10	8	10
Bunch characters				
Weight (kg)	19	18	15	13
Number of hands	1[illegible]	11	11	10
Number of fingers	215	215	225	175

(contd.)

Table 2. (contd.)

Details	Accessions			
Accession Number	9	10	11	12
Location	Tiruchirapalli	West Payipra	Udumbannur	Moolamattom
Name and address of the farmer/institute	Elite Banana Garden, Mudalai Patty, Thiruchirapalli.	K.M. Hydrose, Kotta Parambil, P.O. Trikalathur,	V.V. Varghese, Ambakat House, P.O. Udumbannur.	M.A. Raman, Maintenance Division, Telephone Exchange, P.O. Moolamattom
District	Tiruchirapalli	Ernakulam	Idukki	Idukki
Local name of the clone	Poovan	Palayankodan	Palayankodan	Palayankodan
Soil type	Red loam	Clay loam	Sandy loam	Sandy loam
Mode of cultivation				
Whether pure crop/ intercrop	Pure crop	Intercrop	Intercrop	Mixed crop with tapioca
If intercrop, main crop(s)	-	Coconut	Coconut	-
Whether homestead garden/ commercial cultivation	Commercial cultivation	Homestead garden	Homestead garden	Homestead garden
Cultivation practices				
Whether plant crop/ratoon	1st ratoon	1st ratoon	9th ratoon	1st ratoon
Number of ratoons generally taken	2	2-3	Several	3
From where the suckers were procured	Local	Local	Local	Arakulam
Main season of planting	April	May-June	May	May-June
Organic manure applied				
Name	Farmyard manure	Farmyard manure	Cowdung	Cowdung
Quantity	10 kg	10 kg	5 kg	2-3 kg
Time	At planting	At planting	At planting	At planting
Fertilisers applied		Nil	Nil	
Name	N P K	-	-	17 : 17 : 17 complex
Quantity	113g 113g 113g	-	-	1 kg
Time	At planting 3 and 5 months after planting in equal splits	-	-	2 and 5 months after planting in equal splits
Soil amendments used	Nil	Nil		
Name	-	-	Lime	Lime
Quantity	-	-	1 kg	½ kg
Time	-	-	At planting	2 months after planting
Water management				
Whether rainfed/ irrigated	Irrigated	Irrigated	Rainfed	Rainfed
If irrigated, interval (days)	7	3-4	-	-
Incidence of pests and diseases		Nil		
Diseases/pests	Bunchytop	-	Bunchytop	Bunchytop
Intensity	Mild	-	Moderate	Moderate
Plant protection measures adopted	Nil	-	Nil.	Nil
Main season of harvest	March-May	April-May	Jan-May	July-Dec
Whether male bud removed/ retained	Removed	Removed	Retained	Removed
If removed, at what stage	After completion of female phase	1 month after shooting	-	1 week after completion of female phase
Number of suckers retained	1-2	1-2	3-4	2
Mattocking details	Cut off at half	Only bunch removed	Cut off at the base	Cut off at about 30 cm from ground level
Morphological characters of the plant				
Height (cm)	300	330	330	360
Girth (cm)	70	70	65	80
Number of functional leaves	11	8	8	9
Bunch characters				
Weight (kg)	15	15	14	15
Number of hands	11	10	12	11
Number of fingers	190	225	200	175

(contd.)

Table 2. (contd.)

Details	Accessions			
Accession Number	13	14	15	16
Location	Kuravilangad	Kalaketty	Karukachal	Tiruvalla
Name and address of the farmer/institute	P.K. Augustine, Pallathanath House, P.O. Mannakkanad,	C.M. Thomas, Chemmanappallil, P.O. Kalaketty	George Varghese, Modayil, P.O. Karukachal	V.K. Sarojini, Thottakkat House, P.O. Thirumoolapuram
District	Kottayam	Kottayam	Kottayam	Alleppey
Local name of the clone	Palayankodan	Palayankodan	Palayankodan	Palayankodan
Soil type	Sandy loam	Lateritic loam	Lateritic loam	Clay loam
Mode of cultivation				
Whether pure crop/ intercrop	Pure crop	Intercrop	Intercrop	Intercrop
If intercrop, main crop(s)	-	Cocoa	Coconut, cocoa, cloves	Coconut, arecanut
Whether homestead garden/ commercial cultivation	Commercial cultivation	Homestead garden	Homestead garden	Homestead garden
Cultivation practices				
Whether plant crop/ratoon	1st ratoon	2nd ratoon	2nd ratoon	10th ratoon
Number of ratoons generally taken	Several	Several	3	Several
From where the suckers were procured	Local	Local	Local	Local
Main season of planting	May-June	April-May	May-June	May
Organic manure applied	Nil		Nil	
Name	-	Farmyard manure	-	Wood ash, green leaves
Quantity	-	5 kg	-	5 kg
Time	-	At planting	-	At planting
Fertilizers applied		Nil		Nil
Name	Super phosphate and muriate of potash mix	-	17 : 17 : 17 complex	-
Quantity	½ kg	-	100 g	-
Time	2 months after planting	-	2 months after planting	-
Soil amendments used		Nil		
Name	Lime	-	Lime	Lime
Quantity	2 kg	-	250 g	500 g
Time	3 months after planting	-	At planting	Occasional
Water management				
Whether rainfed/ irrigated	Rainfed	Irrigated (After shooting only)	Irrigated	Rainfed
If irrigated, interval (days)	-	3-4	3-4	-
Incidence of pests and diseases				
Diseases/pests	Bunchytop	Bunchytop	Bunchytop	Bunchytop, rhizome weevil
Intensity	Mild	Moderate	Mild	Mild
Plant protection measures adopted	Nil	Nil	Furadan applied	Nil
Main season of harvest	July-Aug	May-June	Sept-Oct	May
Whether male bud removed/ retained	Removed	Removed	Removed	Retained
If removed, at what stage	One week after completion of female phase	After completion of female phase	After completion of female phase	-
Number of suckers retained	1-2	2-3	1	2
Mattocking details	Cut off at about 30 cm from ground level	Cut off at about 60 cm from ground level	Cut off at the base	Cut off at the base
Morphological characters of the plant				
Height (cm)	350	330	360	330
Girth (cm)	80	73	75	68
Number of functional leaves	11	8	8	7
Bunch characters				
Weight (kg)	20	20	20	17
Number of hands	11	12	12	11
Number of fingers	200	275	250	225

(contd.)

Table 2. (contd.)

Details	Accessions			
Accession Number	17	18	19	20
Location	Konni	Anchal	Vellayani	Takazhi
Name and address of the farmer/institute	M.K. George, Malancneru Puthenveedu, P.O. Ilakollur.	District Agricultural Farm, Anchal	Instructional Farm, College of Agriculture, P.O. Vellayani.	K. Sankara Pillai, Kottarathil House, P.O. Takazhi.
District	Pathanamthitta	Quilon	Trivandrum	Alleppey
Local name of the clone	Palayankodan	Palayankodan	Palayankodan	Palayankodan
Soil type	Sandy loam	Loam	Red loam	Reclaimed sandy loam
Mode of cultivation				
Whether pure crop/ intercrop	Pure crop	Intercrop	Pure crop	Intercrop
If intercrop, main crop(s)	-	Pepper	-	Coconut
Whether homestead garden/ commercial cultivation	Commercial cultivation	Commercial cultivation	Commercial cultivation	Commercial cultivation
Cultivation practices				
Whether plant crop/ratoon	Plant crop	Plant crop	Plant crop	Plant crop
Number of ratoons generally taken	2	3	2	3-4
From where the suckers were procured	Local	Peringamala	Local	Local
Main season of planting	May	May	May	June-July
Organic manure applied				Nil
Name	Farmyard manure	Farmyard manure	Farmyard manure/ green leaves	-
Quantity	10 kg	20-25 kg	10 kg	-
Time	2 months after planting	1½ months after planting	2 months after planting	-
Fertilizers applied				Nil
Name	Urea and muriate of potash mix	N P K	N P K	-
Quantity	500 g	160g 160g 320g	80g 80g 160g	-
Time	4 months after planting	1½, 3 and 4½ months after planting	3 months after planting	-
Soil amendments used	Nil	Nil	Nil	Nil
Name	-	-	-	-
Quantity	-	-	-	-
Time	-	-	-	-
Water management				
Whether rainfed/ irrigated	Irrigated	Irrigated	Irrigated	Rainfed
If irrigated, interval (days)	7	7	3-4	-
Incidence of pests and diseases	Nil			Nil
Diseases/pests	-	Bunchytop	Bunchytop	-
Intensity	-	Mild	Mild	-
Plant protection measures adopted	-	Nil	Nil	-
Main season of harvest	May	April-May	May	April-May
Whether male bud removed/ retained	Removed	Removed	Removed	Removed
If removed, at what stage	After completion of female phase	Within 2 weeks after completion of female phase	After completion of female phase	After completion of female phase
Number of suckers retained	2	2	2	2
Mattocking details	Cut off at the base	Only bunch removed	Cut off at the base	Cut off at the base
Morphological characters of the plant				
Height (cm)	330	240	285	285
Girth (cm)	75	65	70	45
Number of functional leaves	8	5	6	7
Bunch characters				
Weight (kg)	15	15	18	11
Number of hands	11	12	13	10
Number of fingers	200	15	275	165

Table 3. (concl.)

Details	Accessions			
Accession Number	21	22	23	24
Location	Kalavoor	Ernakulam	Edavanna	Nattukal
Name and address of the farmer/institute	N. Sadanandan, Nediyanil Puthen Veedu, P.O. Kalavoor.	Baso Thomas, Arapulikal House, 27/482, Perumannoor.	M. Ebrahim, Madari Haris, Edavanna	Mariappa Geunter, Valara, P.O. Nattukal
District	Alleppey	Ernakulam	Malappuram	Palghat
Local name of the clone	Palayankodan	Palayankodan	Mysore Poovan	Pulichi
Soil type	Sandy	Clay loam	Sandy loam	Sandy loam
Mode of cultivation				
Whether pure crop/ intercrop	Pure crop	Pure crop	Pure crop	Pure crop
If intercrop, main crop(s)	-	-	-	-
Whether homestead garden/ commercial cultivation	Homestead garden	Homestead garden	Commercial cultivation	Commercial cultivation
Cultivation practices				
Whether plant crop/ratoon	Plant crop	2nd ratoon	1st ratoon	Plant crop
Number of ratoons generally taken	2-3	Several	3	3
From where the suckers were procured	Local	Local	Chunkathara	Local
Main season of planting	May	May	May-June	May
Organic manure applied		Nil		Nil
Name	Cowdung	-	Farmyard manure	-
Quantity	10 kg	-	2 kg	-
Time	At planting	-	1 month after planting	-
Fertilisers applied	Nil	Nil	Nil	
Name	-	-	-	17 : 17 : 17 complex + urea
Quantity	-	-	-	1 kg ½ kg
Time	-	-	-	2 months after planting
Soil amendments used	Nil	Nil	Nil	Nil
Name	-	-	-	-
Quantity	-	-	-	-
Time	-	-	-	-
Water management				
Whether rainfed/ irrigated	Irrigated	Rainfed	Irrigated	Irrigated
If irrigated, interval (days)	2-3	-	7	7
Incidence of pests and diseases	Nil			
Diseases/pests	-	Bunchytop	Bunchytop	Leaf spot
Intensity	-	Mild	Mild	Moderate
Plant protection measures adopted	-	Nil	Nil	Nil
Main season of harvest	May-June	May-June	May-June	May-June
Whether male bud removed/ retained	Removed	Removed	Removed	Removed
If removed, at what stage	After completion of female phase	After completion of female phase	After completion of female phase	Within one week after completion of female phase
Number of suckers retained	2	4-5	3-4	2
Mattocking details	Cut off at the base	Cut off at the base	Cut off at the base	Cut off at the base
Morphological characters of the plant				
Height (cm)	190	285	360	200
Girth (cm)	54	61	75	65
Number of functional leaves	9	11	8	7
Bunch characters				
Weight (kg)	14	17	12	19
Number of hands	8	13	11	13
Number of fingers	165	225	185	175

regarding the soil conditions, cultivation practices, crop performance etc. with respect to the accessions are presented separately (Table 2). Twelve suckers each of the accessions were brought to Kannara for further studies.

2. Evaluation of the accessions

a. Experimental design and layout

The accessions were evaluated over three cropping seasons (one plant crop and two ratoons). The experiment was laid out on 15-6-1981 with 24 entries and three replications in RBD. Planting was done in pits 50 cm^3 at a spacing of 2.13 m either way. Out of the five plants per row, two on either end were kept as border plants, thus giving three treatment plants per plot.

The list of the accessions of 'Palayankodan' is presented below:

Accession	Location	District
1	2	3
1.	Manantoddy	Wynad
2.	Taliparamba	Cannanore
3.	Pullur	Kasaragod
4.	Adukkam	Kasaragod
5.	Ulleari	Calicut
6.	Tamarasseri	Calicut

(contd.)

1	2	3
7	Morayur	Malappuram
8	Maraikal	Trichur
9	Tiruchirapalli	Tiruchirapalli
10	West Payipra	Ernakulam
11	Udumbannur	Idukki
12	Moolamattom	Idukki
13	Kuravilangad	Kottayam
14	Kalaketty	Kottayam
15	Karukachal	Kottayam
16	Tiruvalla	Pathanamthitta
17	Konni	Pathanamthitta
18	Anchal	Quilon
19	Vellayani	Trivandrum
20	Takazhi	Alleppey
21	Kalavoor	Alleppey
22	Ernakulam	Ernakulam
23	Edavanna	Malappuram
24	Nattukal	Palghat

Crop management practices were adopted as per the package of practice recommendations (KAU, 1978). Urea, Factamfos and muriate of potash were applied to supply N, P_2O_5 and K_2O at the rate of 200 : 200 : 400 g per plant in two equal splits, the first at two months after planting and the second, after another two months. To conduct ratoon studies, one sucker per plant was marked at the peeper stage and retained after the shooting of the mother plant, such that it was about two months old by the time the harvest of the mother plant was over.

b. Observations

The various observations recorded and the procedure adopted are furnished below:

i) Growth parameters

The observations were made on all the treatment plants in the three replications.

Height of the pseudostem

The height of the pseudostem, measured from the ground level to the axil of the youngest leaf, was expressed in cm.

Girth of the pseudostem

The girth of the pseudostem was measured at 20 cm above the ground level and expressed in cm.

Leaves per plant

Fully opened, functional (more than 50 per cent area green) leaves, present at the time of each observation, were counted and recorded.

Functional life of the leaves

At the active vegetative growth period, one 'just unfurled leaf' per plant was marked and the time taken for it to become non-functional (less than 50% area green) was recorded in days.

Phylacron

In the observational plants, the 'just unfurled leaves' were tagged by paint marking on their petioles. After about six weeks the 'just unfurled leaves' were marked again as before. The number of leaves unfurled during the time interval was recorded. From this the number of days taken for producing one new leaf (Phylacron) was computed.

Total leaves per plant

The number of leaves produced by the observational plants from planting to shooting was recorded.

The following observations were carried out on the third fully opened youngest leaf (Leaf III) at the time of shooting.

Length of the lamina

Length of the lamina was measured from the point of attachment to the tip and expressed in m.

Width of the lamina

Width of the lamina was measured at the middle of the lamina and expressed in m.

Leaf area

Leaf area was computed using the formula given by Murray (1960) in which the product of length and width of lamina was multiplied by the factor 0.8 to give the area. The leaf area was expressed in m^2.

Length of the petiole

Length of the petiole was measured from its point of attachment with the pseudostem to the base of the lamina and expressed in cm.

Width of the petiolar canal

Width of the petiolar canal was measured at the middle portion of the petiole and expressed in cm.

Girth of the petiole

Girth of the petiole was measured at the middle portion of the petiole by passing a thread around from one wing to the other.

Stomatal density

Impressions of both the surfaces of the middle portion of the third leaf lamina were taken using the adhesive 'Quickfix'. The carefully peeled impressions were examined under a compound microscope. The area of the microscopic field was determined with the aid of a stage micrometer. The number of stomata was counted in three random fields, averaged and then the number per mm^2 worked out.

Duration of the crop

The number of days taken from planting to shooting and from shooting to harvest were recorded. The total duration of the crop was arrived at by adding the two.

ii) Bunch characters

The bunches were harvested when they were fully mature (fingers plump). The following observations were made on the bunches harvested from the treatment plants to give the plot means.

Weight of the bunch

Weight of the bunch, including the portion of the peduncle (exposed outside the plant), was recorded in kg.

Number of hands per bunch

The number of hands on each bunch was counted.

Number of fingers per bunch

The total number of fingers per bunch was counted.

Length of the bunch

Length of the bunch was measured from the point of origin of the first hand to that of the last hand and expressed in cm.

Weight of the hand

. The hands were removed carefully from the peduncle and their total weight recorded. This was divided by the number of hands to give the average weight of the hand.

Mean weight of a green finger

The weight of the hands was divided by the number of fingers to give the mean weight of a green finger.

From each bunch of the treatment plants, the second hand was ripened and the middle fruit in the top row was selected as the representative finger (Gottreich *et al*., 1964) for recording the fruit characters.

iii) Physical characters of the fruit (ripe finger)

Length of the pedicel (stalk)

Length of the pedicel was measured from the point of attachment of the fruit with the hand to the base of the edible portion and expressed in cm.

Length of the edible portion

Length of the edible portion was measured from the point of attachment of the pedicel to the fruit to the point of attachment of apex and expressed in cm.

Length of the apex

Length of the apex was measured from the tip of the fruit to the junction of apex and edible portion and expressed in cm.

Total length of the fruit

Length of the fruit was computed by adding up the above three values and expressed in cm.

Girth of the fruit

Girth of the fruit was measured at its mid portion using a thread and scale and expressed in cm.

Weight of the fruit

The fruit was weighed in a top loading balance and the weight was expressed in g.

Weight of the pulp

The fruit was skinned and the edible portion was weighed in a top loading balance and the weight was expressed in g.

Pulp/peel ratio

This value was arrived at by dividing the weight of the pulp by the weight of the peel.

$$ie = \frac{\text{Weight of pulp}}{\text{Weight of (fruit - pulp)}}$$

iv) Grading of fruits

After studying a large number of fruits, the ripe fruits were graded and classified. The grades fixed as per classification are furnished below:

Sl. no.	Character	Grading		
		Desirable level	Inter-mediate level	Undesirable level
i)	Disposition of the fingers	Compact	-	Spreading
ii)	Presence of blotches/speckles on the skin	Absent	-	A few
iii)	Curvature	Straight	-	Curved
iv)	Angularity	Round	-	Angular
v)	Colour of the skin	Bright yellow	-	Dull or deep yellow

v) Scoring for pests and diseases

The accessions were evaluated for the resistance/tolerance against rhizome weevil, sigatoka and bunchytop which are economically important to the state. The scoring was made during ratoon 2. Scoring for leaf spot was made at the time of shooting following the scale for estimating the leaf spot in banana suggested by Stover (1971). From this the disease index was worked out by the equation suggested by Mc Kinney (1923). As regards the bunchytop disease, the number of plants dead through the three year cycle was expressed as the percentage of the total plants after the harvest of the ratoon 2. The estimation of rhizome weevil infection was also made after the harvest. The rhizomes were uprooted, the infected portion scooped out and the infection was expressed as the ratio of the weight of the infected tissue to the total weight of the rhizome (B.R.S., 1982).

B. Nutritional studies

The studies were carried out in the accession 'Tiruchirapalli', one of the best clones in the preliminary study and in which sufficient number of uniform suckers were available. The following experiments were carried out:

1. Influence of split application of nutrients on the growth, yield and quality

a. Experimental design and layout

The land was cleared, ploughed and levelled. Pits 50 cm^3 were dug at a spacing of 2.13 m either way. The experiment was laid out adopting the randomised block design with fifteen treatments and three replications. In each plot, there were four rows of plants and each row in turn contained four plants. Out of the total sixteen plants in a plot, the central four plants comprised the tagged plants. All the observations were carried out in the tagged plants.

b. Treatments

To assess the effect of split application of fertilizers on the uptake of nutrients, yield, quality etc. the recommended dosage (200 g N, 200 g P and 400 g K/plant) was split as follows:

Treatment	Months from planting			
	2	4	6	8
T_1	½	½	0	0
T_2	½	0	½	0
T_3	½	¼	¼	0
T_4	½	0	¼	¼
T_5	½	¼	0	¼
T_6	¼	¼	¼	¼
T_7	¼	½	0	¼
T_8	¼	½	¼	0
T_9	¼	0	½	¼
T_{10}	¼	¼	½	0
T_{11}	¼	¼	0	0
T_{12}	¼	0	¼	0
T_{13}	¼	¼	0	0
T_{14}	¼	0	¼	0
T_{15}	¼	0	0	¼

In the schedule, T_1, which conformed to the Package of Practices Recommendations (KAU, 1978) in quantity as well as splitting, served as the control. The splits with no fertilizer application in the second month as well as those where more than a fourth of the recommended dose was to be applied at the eighth month were excluded from the rest of the treatments.

The nutrients nitrogen, phosphorus and potassium were supplied in the form of ammonium sulphate (20.5% N), super phosphate (16.0% P) and muriate of potash (58.0% K) respectively. Irrigation was given at fortnightly intervals during summer and also immediately after the application of fertilizers if the soil moisture level was found to be low. Uniform cultural operations and management practices were adopted during the cropping period (KAU, 1978).

c. Observations

In order to assess the influence of split application of nutrients on the growth, yield and quality, the growth parameters (height and girth of pseudostem, number of leaves, leaf area and duration of the crop), the bunch characters (weight of the bunch, number of hands per bunch and number of fingers per bunch) and fruit characters (length of the pedicel, apex and edible portion; girth of the fruit, weight of the fruit and pulp; volume of the fruit and pulp, pulp/peel ratio, total, reducing and non-reducing sugars, total soluble solids, acidity and sugar/acid ratio) were estimated.

2. Influence of split application of nutrients on the dry matter production and uptake of elements

To estimate the uptake of elements, the samples were collected at the time of harvest from the plants of experiment 1. One plant per treatment per replication was uprooted and the aerial parts were grouped into pseudostem, leaves, peduncle and fruits. All the leaves produced by the plant from the time of planting were collected, dried, weighed, finely chopped and composite samples drawn. The leaves which became non-functional before harvest were collected then and there and at the time of harvest the leaves that were borne by the plants were collected. With regard to the other parts, samples were taken after the harvest of the bunches. Fresh weight was recorded separately, random samples of a known fresh weight were dried in an oven at 70°C and the total dry weight computed. After grinding in a mill with stainless steel blades, the samples were stored in polythene bottles until chemical analysis. The samples were analysed separately for N, P, K, Ca, Mg, S, Cu, Fe, Mn and Zn. Total uptake as well as distribution of the elements in the different parts were computed from the values of concentration of elements and the dry weight of parts sampled.

3. Influence of mattocking on the translocation of phospherus-32

The treatments used for the study are given below:

T_1 - Pseudostem injection of ^{32}P 15 days prior to harvest. Only the bunch removed at the time of harvest.

T_2 - Pseudostem injection of ^{32}P 15 days prior to harvest. Pseudostem (along with the bunch) cut off at about half the height at the time of harvest.

T_3 - Pseudostem injection of ^{32}P at harvest. Only the bunch removed.

T_4 - Pseudostem injection of ^{32}P at harvest. Pseudostem (along with the bunch) cut off at half the height.

Using a 5-ml hypodermic syringe, 0.5 ml of ^{32}P solution (carrier-free) with an activity of 0.5 mCi was injected into the pseudostem at about 125 cm above ground level (Plate 1). Middle portions of the third fully opened leaves including midribs were collected (IAEA, 1975) from the suckers and also mother plants (in the case of T_1 and T_3) at fortnightly intervals for a period of two months. The leaf samples were dried in a hot air oven at 75°C. The samples were subsequently cut into small bits for radioactivity determination.

Plate-1. Inoculation of ^{32}P in the pseudostem of the mother plant

Plate -1.

C. Analytical methods

1. Quality analysis

Samples were taken from the pedicel end, middle portion and apical end of the edible portion and these were pooled and macerated in a Warring blender. Triplicate estimations were made on each of the fruits as detailed below and the mean worked out.

a. Total solube solids

Total soluble solids were estimated using a pocket refractometer and expressed in percentage.

b. Acidity

Ten grams of the macerated sample were mixed with distilled water and made upto a known volume. A known quantity of the filtered solution was titrated against 0.1 N sodium hydroxide using phenolphthalein as the indicator. The acidity was expressed as a percentage of the citric acid (A.O.A.C., 1960).

c. Reducing sugars

To a known quantity of the macerated pulp, about 10 ml of distilled water was added. The solution, after thorough mixing, was clarified with neutral lead acetate. This was de-leaded with sodium oxalate and made up to a known volume. Finally it was titrated against a mixture of Fehlings A and B solutions using methylene blue as the indicator. The content of the reducing sugar was expressed in percentage (A.O.A.C., 1960).

d. Total sugars

Total sugars were estimated as per the standard method (A.O.A.C., 1960). Concentrated hydrochloric acid (5.0 ml) was 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 Fehlings A and B solutions. The content was expressed in percentage.

e. Non-reducing sugars

This was computed by subtracting the value for the reducing sugars from that of the total sugars.

f. Sugar/acid ratio

This was arrived at by dividing the value for the total sugars by that of the titrable acidity.

2. Nutrient analysis

Cross sections, 2.5 cm wide, including the midrib, from the middle portion of the 3rd fully opened leaves (Hewitt, 1955) of the observational plants were taken, dried and powdered. The powdered samples were used for chemical analysis of the nutrients, viz., N, P, K, Ca, Mg, S, Cu, Fe, Mn and Zn.

a. Nitrogen

Hundred mg of the leaf sample were digested with 2.0 ml of concentrated sulphuric acid and oxidised with hydrogen peroxide until a clear solution was obtained. This was then made up to 100 ml and an aliquot of 1.0 ml was taken from this. To this was added 1.0 ml sodium hydroxide (10%) and 0.5 ml sodium silicate and made up to 25 ml. Nessler's reagent (0.8 ml) was added to this to develop the colour which was read in a Spectronic 20 spectrophotometer at 410 nm (A.O.A.C., 1960).

b. Other nutrient elements

For the estimation of the other elements, the samples were digested with 15 ml of a 1 : 1 mixture of nitric acid and perchloric acid. When the quantity was reduced to 2 - 3 ml, it was cooled and made up to 100 ml. Aliquots from the digest were taken and estimations of the various nutrients were made as follows:

i) Phosphorus

Ten ml of the aliquot was taken to which was added 5.0 ml of Barton's reagent. This was made up to 25 ml and read at 470 nm in a Spectronic 20 spectrophotometer (Jackson, 1958).

ii) Potassium

One ml of the aliquot was taken and made up to the required volume, depending upon the probable concentration of the element, and read in a flame photometer (Jackson, 1958).

iii) Sulphur

To an aliquot of the extract, barium chloride and gum acasia were added and made up to the required volume depending upon the probable concentration of the element and the reading was taken within 20 to 30 minutes at 490 nm in a Spectronic 20 spectrophotometer.

iv) Calcium and magnesium

From the extract, an aliquot was taken and strontium chloride was added so as to give a Sr concentration of 1000 ppm in the final solution. Strontium was used as a releasing agent. It was made up to the required volume depending upon the probable concentration of the element and analysed using an atomic absorption spectrophotometer.

v) Copper, iron, manganese and zinc

The digest was analysed for copper, iron, manganese and zinc using an atomic absorption spectrophotometer.

3. Radioassay

The radioactivity of the leaf samples was determined as follows. One gram of leaf sample was digested in a conical flask on a hot plate using 15 ml of 1 : 1 nitric-perchloric acid mixture until the digest became clear and the volume of the contents was reduced to 2 - 3 ml. The digest was then transferred into 20 ml scintillation counting vial. The conical flask was washed two to three times with about five ml of distilled water each time. Finally, the volume of the vial was made upto 20 ml by visual comparison with the 20 ml water level in another vial. The vials were kept undisturbed for four hours for settling of the silica and then the radioactivity was determined in a liquid scintillation system (LKB Wallac OY, Finland) employing Cerenkov technique (Wahid *et al*., 1985).

D. Statistical methods

The data generated in the studies were subjected to statistical analysis. The analysis of variance technique for Randomised Block Design was employed to test the accessions. The extent of association among characters was measured by correlation coefficients. Path coefficient analysis was used for estimating the direct and indirect effects of various characters on yield. A selection index was worked out using discriminant function technique. D^2 analysis was carried out to calculate the genetic distance among the accessions. The contribution of characters towards divergence was also worked out. The details of the statistical analysis followed in the studies are as follows:

1. Analysis of variance

The model utilised in the analysis of this design is

$$Y_{ij} = \bar{Y} + b_i + t_j + e_{ij}$$

i = 1.......3

j = 1......24

Where Y_{ij} = Performance of jth genotype in the ith block

$\bar{Y}$ = General means

b_i = True effect of ith block

t_j = True effect of jth genotype

and e_{ij} = random error associated with the jth treatment in the ith block.

2. Estimation of variability

Estimates of variance components were obtained by using the formula suggested by Burton (1952). The formulae used in the estimation of genotypic, phenotypic and environmental variances are given below:

a. Phenotypic variance (Vp) = (Vg) + (Ve)

Where (Vg) = Genotypic variance

(Ve) = Environmental variance

b. Genotypic variance (Vg) $= \frac{MSa - MSe}{r}$

Where MSa = Accession mean square

MSe = Environmental mean square

r = Number of replications

c. Environmental variance (Ve) = MSe

d. Environmental coefficient of variation

$$(ECV) = \frac{\sqrt{(Ve)} \times 100}{\bar{X}}$$

e. Genotypic coefficient of variation

$$(GCV) = \frac{\sqrt{(Vg)} \times 100}{\bar{X}}$$

f. Phenotypic coefficient of variation

$$(PCV) = \frac{\sqrt{(Vp)} \times 100}{\bar{X}}$$

3. Estimation of heritability

The formula suggested by Burton and Devane (1953) was used to estimate the heritability in the broad sense.

$$\text{Heritability } (h^2) = \frac{(Vg) \times 100}{(Vp)}$$

4. Estimation of expected genetic advance

The expected genetic advance (GA) of the available germplasm was measured by using the formula suggested by

Lush (1949) and Johnson *et al*. (1955a)

$$GA = h^2 . i . \sigma_p$$

Where $i = 2.06$

$$\sigma_p = (Vp)^{1/2}$$

5. **Estimation of expected genetic gain**

The expected genetic advance expressed as percentage of mean is the expected genetic gain.

$$\text{ie. Expected genetic gain (GG)} = \frac{GA \times 100}{\bar{X}}$$

6. **Estimation of correlations**

Phenotypic and genotypic covariances were worked out in the same way as variances were calculated. The different covariance estimates were calculated by the method suggested by Fisher (1954). Phenotypic and genotypic correlation coefficients among the various characters were worked out in all possible combinations according to the formula suggested by Johnson *et al*. (1955b).

7. **Path coefficient analysis**

The characters which exhibited strong correlation ($r > 0.70$) with yield were considered for the path coefficient analysis. The principles and techniques suggested by Wright (1921), Li (1955) and Duvey and Lu (1959) for cause and effect system were adopted for the analysis.

8. Estimation of selection indices

The selection indices were obtained by discriminant function analysis. The component characters used were selected based on the relative magnitude of direct effects on yield per plant. The method suggested by Robinson *et al*. (1951) was used for constructing selection indices. The relative efficiency of selection through discriminant function over straight selection was calculated as suggested by Paroda and Joshi (1970).

9. D^2 analysis

The overall significance of the differences among the different accessions with regard to the mean value of the selected characters was tested using Wilk's Lamda criterion (Wilks, 1932). Since the value was significant, further analysis to estimate the genetic distance (D^2 of Mahalanobis) among the 24 accessions was done (Mahalanobis, 1936; Rao, 1952; Singh and Choudhary, 1979). Considering 24 accessions, two at a time, 276 ($24C_2$) squares of differences (D^2 values) were obtained. The D^2 values for each combination were ranked in the descending order of magnitude. After arranging the D^2 values in this manner, a method suggested by Tocher (Rao, 1952) was used for cluster formation.

10. Contribution of characters towards divergence

The contribution of characters towards divergence was estimated following the method suggested by Singh and Choudhary (1979). A modification of this method (Unnithan, 1985) was also tried, in which, instead of considering the number of times a character had secured first rank, the actual contribution of each character towards D^2 was considered.

Results

RESULTS

Studies were conducted at the Banana Research Station, Kannara, Trichur during 1981-84 to assess the intraclonal variations in the accessions of *Musa* (AAB Group) 'Palayankodan' made from different growing areas. Nutritional studies were conducted in one of the accessions. The results generated in the studies are presented in this chapter under two major heads, intraclonal variation studies and nutritional studies.

A. Intraclonal variation studies

1. Survey and collection

A survey was conducted covering 24 locations inside and outside Kerala. Particulars of the accessions are given in Table 2. Further works to study the variations were carried out on these accessions.

2. Evaluation of the accessions

a. Growth parameters

i) Height of the plants

Data on the mean height of the plants from the 4th to 10th months after planting in the plant crop and from 4th to 7th months after planting in ratoon 1 are presented in Tables 3 and 4 respectively.

Table 3. Height of the plants belonging to the accessions at different stages of growth (plant crop)

Accession	Mean height of plants (cm)						
	4th month	5th month	6th month	7th month	8th month	9th month	10th month
1	124.56	148.00	160.33	191.00	198.78	216.90	238.89
2	119.50	142.87	169.72	190.28	199.44	213.78	231.50
3	106.89	136.45	149.10	173.30	183.50	196.50	220.22
4	122.22	149.34	162.56	181.78	193.45	208.33	233.89
5	117.11	140.00	150.89	169.94	179.39	189.89	222.61
6	125.17	145.51	166.43	196.67	212.11	218.89	239.28
7	126.17	146.39	161.78	181.78	191.67	206.89	237.33
8	138.44	162.33	192.14	210.27	216.33	230.00	245.00
9	121.73	144.22	155.33	185.11	193.22	210.11	232.78
10	138.11	164.00	193.67	209.45	217.78	230.89	249.11
11	131.33	148.17	167.55	186.45	196.94	214.33	240.83
12	127.44	160.67	168.33	181.67	190.11	198.17	223.11
13	114.78	138.28	149.39	173.39	179.00	192.45	217.72
14	129.56	149.11	172.22	202.33	216.11	223.33	242.22
15	91.39	119.22	130.00	151.61	165.11	184.11	214.67
16	114.00	141.23	157.22	171.55	186.78	196.44	216.33
17	133.56	164.33	178.45	197.11	205.22	214.78	232.22
18	120.22	152.67	165.11	179.00	192.22	206.56	234.89
19	125.78	145.56	172.94	201.83	213.45	222.00	240.78
20	122.45	137.44	162.33	179.45	186.06	196.22	217.33
21	137.33	155.39	179.67	195.89	225.33	234.44	253.56
22	136.83	176.94	197.89	217.11	226.33	233.00	255.44
23	88.39	109.95	120.39	137.61	144.61	156.56	190.45
24	111.78	130.33	149.89	166.28	181.33	198.78	227.72
CD (5%)	NS	NS	32.00	31.39	30.07	29.07	25.62
SEm ±	11.56	11.12	11.24	11.03	10.56	10.21	9.00

Table 4. Height of the plants belonging to the accessions at different stages of growth (ratoon 1)

Accession	Mean height of plants (cm)			
	4th month	5th month	6th month	7th month
1	188.17	214.83	235.00	253.00
2	177.28	191.61	214.00	237.89
3	168.11	196.06	223.44	257.39
4	169.33	185.67	211.00	242.56
5	176.50	190.89	211.65	237.11
6	188.33	203.00	230.50	256.33
7	162.33	171.89	190.67	227.45
8	189.89	208.89	239.22	269.00
9	157.06	198.05	223.67	253.89
10	170.33	189.00	212.22	245.00
11	187.78	201.89	228.34	256.11
12	158.72	175.50	196.94	227.72
13	175.11	191.00	215.89	243.22
14	174.50	191.72	219.94	249.55
15	180.00	194.83	221.69	252.22
16	198.05	210.83	232.72	261.83
17	187.44	205.89	230.44	258.78
18	198.11	216.89	245.89	273.56
19	182.78	192.11	231.67	260.11
20	164.44	182.22	211.11	245.11
21	177.33	191.44	217.22	254.78
22	190.00	206.67	229.56	260.45
23	194.17	208.28	241.83	271.44
24	220.44	238.11	261.83	285.46
CD (5%)	33.61	30.53	32.00	29.01
SEm ±	11.74	10.72	11.24	10.19

In the plant crop, during the 4th and 5th months of growth, the differences due to the accessions were not statistically significant. Thereafter significant differences were obtained in the height of the plants. The plants of the accession 22 (Ernakulam) were the tallest in the months 6th, 7th, 8th and 10th. In the 9th month, the accession 21 (Kalavoor) had the tallest plants, closely followed by 22 (Ernakulam). The plants of the accession 23 (Edavanna) recorded the minimum height in all the months.

The differences were significant in ratoon 1 in all the months. The accession 24 (Nattukal) was the tallest in all the cases, followed by the accession 18 (Anchal). The least height was recorded by the accession 9 (Tiruchirapalli) in the 4th month and by the accession 7 (Morayur) in the subsequent months under report.

ii) Girth of the pseudostem

Data on the mean girth of the pseudostem from 4th to 10th months after planting in the plant crop and from 4th to 7th months after planting in ratoon 1 are presented in Tables 5 and 6 respectively.

In the plant crop the differences due to the accessions were significant in the months from the 5th to 10th. In the

Table 5. Girth of the plants belonging to the accessions at different stages of growth (plant crop)

Accession	Mean girth of plants (cm)						
	4th month	5th month	6th month	7th month	8th month	9th month	10th month
1	33.45	42.22	45.67	51.28	53.33	55.67	59.67
2	31.83	39.86	46.77	50.94	53.67	57.33	61.28
3	30.44	36.86	40.97	46.78	50.50	53.44	56.61
4	32.66	39.94	44.22	48.78	51.94	55.22	59.22
5	31.61	36.78	40.61	45.56	47.78	50.78	53.56
6	34.17	44.33	48.00	53.56	56.44	58.61	62.78
7	31.44	40.47	43.28	48.28	52.67	54.50	59.39
8	37.44	45.03	49.39	53.11	55.67	57.89	59.67
9	31.33	39.44	43.67	49.67	52.77	55.89	60.11
10	37.55	42.44	47.61	52.33	54.67	56.00	59.11
11	32.22	41.67	45.34	50.78	54.89	58.06	62.05
12	35.11	41.08	46.42	50.00	51.11	53.67	56.17
13	33.00	40.19	44.17	47.61	50.00	53.22	55.78
14	37.67	46.95	49.78	55.83	58.17	60.72	63.00
15	26.83	31.58	35.83	43.17	46.28	49.56	57.00
16	31.11	39.39	42.78	47.56	49.22	52.00	55.89
17	35.22	44.33	47.72	54.11	55.95	58.44	62.89
18	30.89	40.84	44.42	49.22	53.67	58.44	62.56
19	36.67	45.14	49.61	54.72	59.22	62.44	64.33
20	33.11	40.33	42.75	47.11	49.56	51.67	54.67
21	35.50	45.53	50.00	57.78	59.33	61.72	64.78
22	41.61	48.39	52.89	55.89	57.67	60.06	62.89
23	26.67	31.25	34.33	38.33	41.00	43.78	48.67
24	33.55	37.55	42.22	49.56	52.67	54.44	57.67
CD (5%)	NS	8.29	8.57	7.98	7.95	7.67	6.63
SEm ±	2.73	2.91	3.01	2.80	2.79	2.69	2.33

Table 6. Girth of the plants belonging to the accessions at different stages of growth (ratoon 1)

Accession	Mean girth of plants (cm)			
	4th month	5th month	6th3 month	7th month
1	50.56	53.94	56.78	60.61
2	47.44	51.72	55.11	59.39
3	48.78	54.17	57.12	62.56
4	44.67	48.22	51.78	58.33
5	46.72	52.28	53.61	60.28
6	55.33	59.56	61.50	63.17
7	42.28	47.78	56.61	60.33
8	50.44	56.33	58.22	62.78
9	49.83	53.94	58.28	62.78
10	46.00	50.11	54.22	59.67
11	49.44	54.67	57.22	62.11
12	42.33	47.39	49.39	54.44
13	48.11	52.00	53.67	59.44
14	46.56	52.17	55.89	61.11
15	47.33	52.94	57.00	60.72
16	53.17	58.78	61.89	68.06
17	50.78	56.11	58.00	62.89
18	54.00	60.56	63.78	69.22
19	49.44	53.94	59.67	63.33
20	44.33	49.06	52.50	62.00
21	48.67	52.67	55.33	62.33
22	52.44	56.22	58.33	61.00
23	45.06	54.00	61.72	66.94
24	60.83	65.45	69.55	74.11
CD (5%)	NS	NS	8.26	7.86
SEm ±	3.50	3.32	2.90	2.76

months 7th, 8th and 10th, the accession 21 (Kalavoor) emerged first. In the 6th and 9th months it was second to the accessions 22 (Ernakulam) and 19 (Vellayani) respectively. In the 5th month, the accession 22 (Ernakulam) led the other accessions followed by the accessions 14 (Kalaketty) and 21 (Kalavoor). In all the months accession 23 (Edavanna) recorded the minimum value.

Though the differences were not significant during the early stages in the ratoon 1, in the 6th and 7th months there were significant differences. During these months, the accession 24 (Nattukal) had the maximum girth, followed by the accession 18(Anchal). The accession 12 (Moolamattom) exhibited the least girth in both the months.

iii) Number of functional leaves

Data on the mean number of functional leaves from 4th to 10th months after planting in the plant crop and from 4th to 7th months after planting in ratoon 1 are presented in Tables 7 and 8 respectively.

It may be seen that in the plant crop the differences due to the accessions were significant in the 4th, 8th and 9th months only. In the 4th month, the accession 14 (Kalaketty) was superior to others. The accession 19 (Vellayani) emerged first both in the 8th and 9th months. In the 4th month, accession 23 (Edavanna) recorded the minimum value. In the 8th and 9th months, the accession 20 (Takazhi) had the

Table 7. Number of functional leaves of the plants belonging to the accessions at different stages of growth (plant crop)

Accession	Mean number of functional leaves						
	4th month	5th month	6th month	7th month	8th month	9th month	10th month
1	7.89	7.67	7.56	7.39	7.56	8.89	11.45
2	6.78	7.61	7.39	7.60	7.44	9.11	11.39
3	7.39	7.39	7.33	7.83	8.33	8.83	11.11
4	7.22	7.66	7.89	7.56	7.89	9.00	11.28
5	7.28	7.56	6.83	6.61	7.11	8.56	11.06
6	7.33	7.83	7.72	7.72	7.44	8.78	11.17
7	7.72	7.44	7.00	7.33	7.39	8.67	11.83
8	7.00	7.78	7.50	7.50	7.44	8.89	11.00
9	7.22	7.56	7.22	7.33	7.56	8.77	11.67
10	7.22	7.89	6.89	7.00	6.56	8.00	10.33
11	7.95	7.44	6.78	6.78	7.00	8.11	10.50
12	6.83	7.67	6.67	6.11	6.27	7.22	9.67
13	6.72	6.83	6.89	6.61	6.67	7.89	9.94
14	8.22	8.00	7.33	7.50	7.17	8.27	10.11
15	6.72	6.61	6.11	6.50	6.67	7.67	10.83
16	7.11	7.00	6.89	6.89	6.56	7.55	9.55
17	8.00	8.44	7.67	6.78	7.44	8.45	9.89
18	7.67	7.89	6.67	6.78	7.55	7.89	10.67
19	8.00	8.44	7.89	7.06	8.45	9.44	10.89
20	7.00	7.11	6.77	6.78	6.11	7.00	9.11
21	8.00	8.28	7.55	7.56	6.78	8.67	11.44
22	7.39	8.11	7.88	7.11	6.89	8.33	10.55
23	5.28	8.39	6.50	6.22	7.44	7.72	10.11
24	7.00	8.11	7.67	7.83	7.39	8.72	10.67
CD (5%)	1.12	NS	NS	NS	0.90	1.20	NS
SEm ±	1.25	0.53	0.39	0.39	0.32	0.42	0.60

Table 8. Number of functional leaves of the plants belonging to the accessions at different stages of growth (ratoon 1)

Accession	Mean number of functional leaves			
	4th month	5th month	6th month	7th month
1	7.55	8.78	8.17	10.78
2	7.56	8.39	8.56	10.50
3	7.83	8.06	8.39	10.78
4	7.11	8.11	8.56	10.78
5	7.17	8.22	8.22	9.83
6	7.56	8.06	8.67	10.83
7	6.83	7.17	7.83	10.00
8	7.67	8.33	8.44	10.56
9	7.11	8.11	8.72	10.67
10	7.34	7.44	8.33	9.78
11	7.22	8.22	8.33	10.22
12	6.33	6.94	7.56	9.61
13	6.22	7.00	7.78	9.78
14	7.28	8.00	8.33	10.33
15	7.56	8.00	8.28	10.06
16	7.56	8.00	8.44	10.22
17	7.33	8.67	9.00	11.33
18	7.78	8.67	9.00	10.56
19	7.44	8.11	8.89	11.00
20	6.67	7.50	7.61	9.61
21	7.33	8.11	8.22	10.11
22	7.50	7.39	7.83	9.89
23	7.72	8.33	8.78	10.78
24	7.94	8.78	9.06	11.00
CD (5%)	NS	1.04	NS	NS
SEm ±	0.33	1.16	0.36	0.42

least value.

In the ratoon 1 the differences were significant only in the 5th month. The accessions 1 (Manantoddy) and 24 (Nattukal) recorded the maximum number of leaves during this month. The least value was recorded by the accession 12 (Moolamattom).

iv) Plant characters at shooting

Data on the height of the plants, girth of the pseudostem, number of functional leaves and the area of 3rd leaf, taken at the time of shooting in the plant crop, ratoon 1 and ratoon 2, are presented in Tables 9, 10 and 11 respectively.

In the plant crop the accessions differed significantly in the girth of the pseudostem and the area of 3rd leaf. The accession 21 (Kalavoor) recorded the maximum girth (67.56 cm) and the accession 3 (Pullur), the minimum (59.33 cm). As regards the area of 3rd leaf, the accession 15 (Karukachal) had the maximum area (1.46 m^2), followed by (1.35 m^2) in the accession 18 (Anchal). The accession 22 (Ernakulam) had the least leaf area (1.01 m^2).

The differences with regard to the girth of the pseudostem and the area of 3rd leaf were significant in ratoon 1. As regards the girth, the accession 24 (Nattukal)

Table 9. Characters of the plants belonging to the accessions at shooting (plant crop)

Accession	Mean height (cm)	Mean girth (cm)	Mean number of functional leaves	Mean area of third leaf (m^2)
1	266.00	63.95	14.89	1.24
2	276.33	63.22	12.28	1.19
3	267.83	59.33	14.44	1.12
4	281.44	62.00	15.52	1.19
5	279.06	59.39	15.00	1.18
6	297.17	66.83	14.33	1.33
7	305.77	64.94	13.83	1.34
8	268.95	63.33	14.17	1.15
9	272.90	62.44	15.22	1.12
10	282.33	62.89	11.11	1.14
11	283.72	65.00	14.78	1.26
12	274.83	61.67	14.00	1.10
13	269.00	60.17	12.83	1.29
14	280.00	66.83	13.00	1.17
15	299.17	64.00	14.67	1.46
16	284.94	61.72	12.94	1.22
17	294.33	64.22	14.00	1.08
18	295.33	65.22	15.89	1.35
19	277.56	66.67	14.22	1.32
20	276.12	61.00	13.39	1.21
21	283.89	67.56	14.33	1.30
22	271.72	65.05	12.67	1.01
23	284.33	62.83	13.33	1.23
24	289.22	65.11	14.56	1.19
CD(5%)	NS	4.63	NS	0.17
SEm ±	11.52	1.62	1.21	0.06

Table 10. Characters of the plants belonging to the accessions at shooting (ratoon 1)

Accession	Mean height (cm)	Mean girth (cm)	Mean number of functional leaves	Mean area of third leaf (m^2)
1	304.22	66.89	14.56	1.34
2	284.28	66.17	13.89	1.21
3	311.33	68.33	14.28	1.27
4	295.33	64.00	14.83	1.09
5	302.00	69.83	13.67	1.25
6	318.17	69.00	15.00	1.23
7	285.61	62.11	13.89	1.23
8	305.00	64.33	14.11	1.22
9	209.00	65.17	14.50	1.05
10	309.89	66.33	13.78	1.04
11	294.50	64.83	12.67	1.11
12	296.17	61.50	14.33	1.10
13	309.33	70.50	13.67	1.23
14	308.00	65.50	14.17	1.29
15	296.78	66.33	12.89	1.26
16	311.00	75.17	13.33	1.39
17	285.67	65.00	14.89	1.14
18	306.00	72.61	14.22	1.35
19	302.72	68.61	14.39	1.29
20	273.33	64.50	12.67	1.15
21	295.33	68.89	14.78	1.30
22	282.44	65.06	12.50	1.07
23	306.50	69.83	13.50	1.34
24	323.89	76.22	13.33	1.37
CD(5%)	NS	5.79	NS	0.22
SEm ±	11.27	2.03	0.58	0.10

Table 11. Characters of the plants belonging to the accessions at shooting (ratoon 2)

Accession	Mean height (cm)	Mean girth (cm)	Mean number of functional leaves	Mean area of third leaf (m^2)
1	319.67	68.00	13.33	1.44
2	286.50	70.70	13.17	1.24
3	279.72	71.93	12.00	1.11
4	303.83	71.77	12.67	1.11
5	299.50	70.60	11.33	1.26
6	313.33	73.10	10.50	1.36
7	327.00	67.77	12.67	1.75
8	301.00	70.60	12.00	1.29
9	296.33	69.07	12.17	1.28
10	309.33	69.60	10.50	1.26
11	312.83	70.77	10.17	1.21
12	310.67	74.53	11.17	1.23
13	319.50	72.10	11.67	1.40
14	320.00	68.77	11.67	1.45
15	306.00	70.80	11.67	1.34
16	325.33	71.60	11.00	1.43
17	287.83	67.13	10.83	1.02
18	300.17	71.93	11.00	1.39
19	317.33	69.37	11.00	1.56
20	303.83	68.00	11.33	1.14
21	324.00	67.90	11.67	1.56
22	283.00	69.67	11.67	1.28
23	304.00	67.53	11.67	1.26
24	313.83	71.20	12.00	1.46
CD(5%)	NS	NS	NS	0.27
SEm ±	38.30	2.20	0.67	0.09

recorded the maximum value (76.22 cm). The girth was 61.50 cm in the accession 12 ('Moolamattom'), which was the minimum value. Leaf area was maximum (1.39 m^2) in the accession 16 (Tiruvalla) and minimum (1.04 m^2) in the accession 10 (West Payipra).

In ratoon 2, the differences in the area of 3rd leaf alone was found to be statistically significant. The accession 7 (Morayur) recorded the maximum leaf area of 1.75 m^2. This was followed by the accessions 19 (Vellayani) and 21 (Kalavoor) with the leaf area of 1.56 m^2 each. The accession 17 (Konni) had the least leaf area (1.02 m^2).

v) Duration of the crop

Data relating to the mean duration of the crop from planting to shooting, from shooting to harvest and from planting to harvest in the plant crop, ratoon 1 and ratoon 2 are furnished in Tables 12, 13 and 14 respectively (Fig. 2).

Differences due to the accessions were not statistically significant in the plant crop.

In ratoon 1 the differences were statistically significant only in the duration from starting to shooting. Accession 15 (Karukachal) recorded the maximum duration (302.67 days) whereas the accession 22 (Ernakulam) had the minimum duration (249.44 days).

Table 12. Duration of the plants belonging to the accessions (plant crop)

Accession	Duration, days		
	Planting to shooting	Shooting to harvest	Planting to harvest
1	340.17	79.78	419.95
2	347.78	80.44	428.22
3	351.28	78.78	430.06
4	352.28	78.55	430.83
5	366.67	80.44	446.11
6	346.50	82.17	428.67
7	344.89	89.11	434.00
8	368.00	84.28	452.28
9	347.83	87.11	434.94
10	365.61	78.11	443.72
11	357.17	85.11	442.28
12	336.67	84.00	420.67
13	371.94	83.27	455.21
14	344.50	77.67	422.17
15	377.50	82.89	460.39
16	373.83	75.67	449.50
17	363.33	79.67	443.00
18	368.22	79.05	447.27
19	336.61	73.67	410.28
20	364.78	81.11	445.89
21	358.45	75.00	433.45
22	328.61	83.95	412.56
23	373.67	78.28	451.95
24	349.78	87.33	437.11
CD(5%)	NS	NS	NS
SEm ±	13.82	3.13	14.52

Table 13. Duration of the plants belonging to the accessions (ratoon 1)

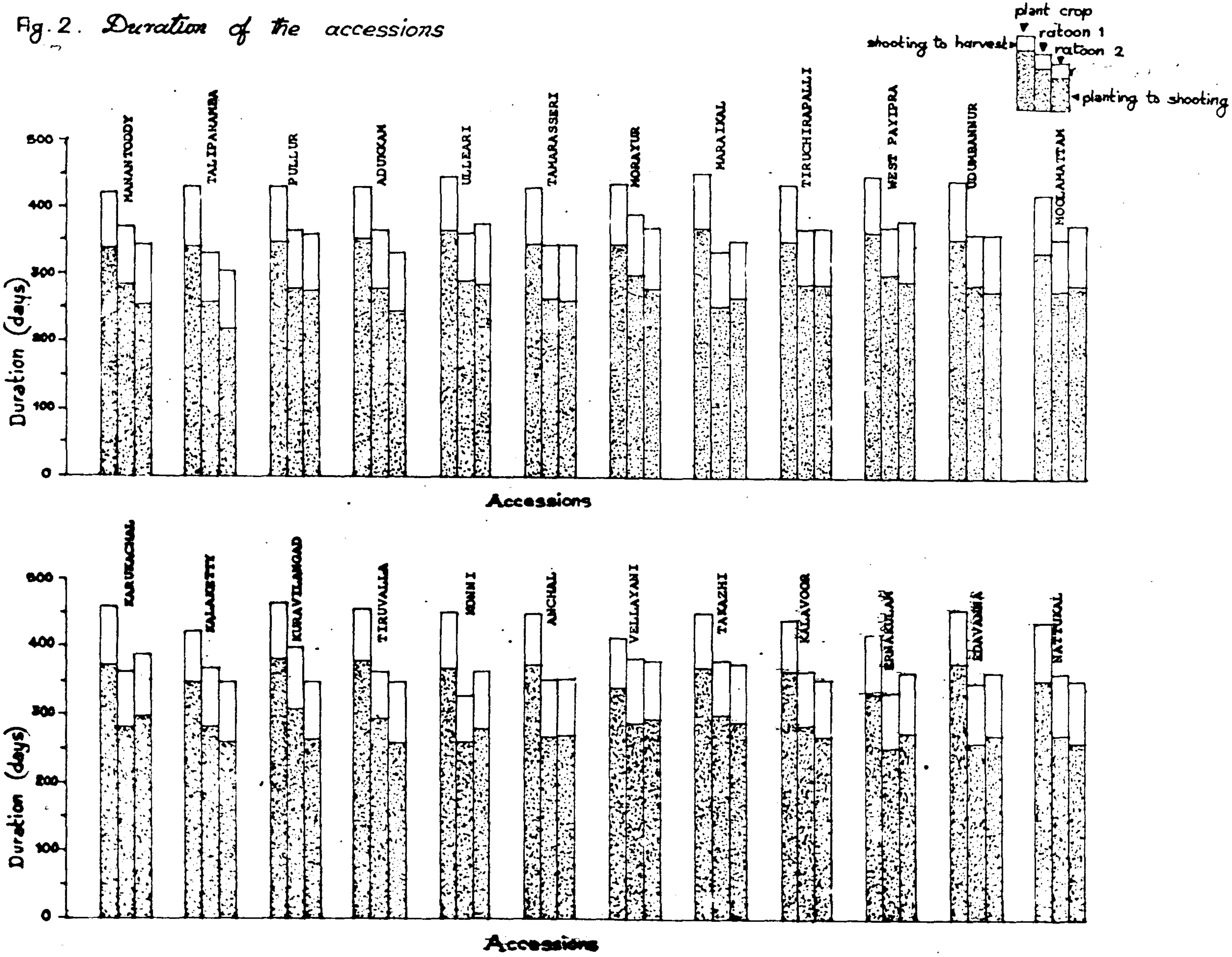
Accession	Duration, days		
	Starting to shooting	Shooting to harvest	Starting to harvest*
1	285.78	85.50	371.67
2	257.50	81.50	332.25
3	277.44	83.25	362.92
4	281.50	83.25	366.50
5	289.50	80.00	358.25
6	264.67	82.00	345.50
7	301.44	82.75	392.25
8	255.67	84.00	333.17
9	282.50	79.50	356.25
10	298.39	81.25	370.84
11	283.33	84.50	361.25
12	276.33	79.50	354.25
13	277.67	81.50	359.50
14	278.00	85.50	366.00
15	302.67	83.25	392.75
16	288.83	83.50	361.75
17	257.44	77.50	326.50
18	266.50	80.00	347.75
19	285.06	81.25	379.83
20	293.00	78.50	376.25
21	279.33	80.50	359.50
22	249.44	84.00	330.67
23	256.00	81.50	346.00
24	270.22	80.50	358.67
CD (5%)	30.02	NS	NS
SEm ±	10.55	2.93	14.40

*The data presented in this column is not a sum of those in the preceeding two columns since the number of replications maintained for the study have been reduced from three to two due to wind damage after flowering

Table 14. Duration of the plants belonging to the accessions (ratoon 2)

Accession	Duration, days		
	Starting to shooting	Shooting to harvest	Starting to harvest
1	257.00	88.33	345.33
2	219.83	85.50	305.33
3	276.83	84.67	361.50
4	247.17	83.67	330.83
5	287.33	87.17	374.50
6	258.33	85.67	344.00
7	282.00	87.33	369.33
8	264.50	87.33	351.83
9	282.67	87.33	370.00
10	290.33	88.17	378.50
11	273.50	86.83	360.33
12	287.00	89.50	376.50
13	294.83	92.17	387.00
14	257.33	89.33	346.67
15	259.67	86.67	346.33
16	254.50	89.67	344.17
17	276.33	84.77	361.10
18	265.17	85.00	350.17
19	288.67	88.00	376.67
20	286.50	84.33	370.33
21	264.67	85.67	350.83
22	271.00	89.67	360.67
23	269.67	91.00	360.67
24	261.23	88.33	349.57
CD(5%)	NS	NS	NS
SEm ±	15.01	2.62	14.99

Fig. 2. Duration of the accessions



In ratoon 2 the differences observed in the plants belonging to the accessions in respect of the above characters were not statistically significant.

b. Leaf characters

Data pertaining to characters of leaf, namely, phylacron, life of a leaf, total number of leaves produced by the plant,leaf ratio and the stomatal density in the upper and lower surfaces of the leaf are furnished in Table 15.

The differences were statistically significant with regard to the phylacron, total number of leaves and the stomatal density in the upper surface of the leaf. Phylacron was the maximum (17.20 days) in accession 12 (Moolamattom) and the minimum in accession 19 (12.23 days). As regards the total number of leaves produced, the accession 3 (Pullur) and 6 (Tamarasseri) recorded the maximum number (31.83 each). The minimum number (27.50) was recorded by the accession 22 (Ernakulam). The density of stomata in the upper surface of the leaf was the highest (181.21 per mm^2) in the accession 4 (Adukkam) and the lowest (95.37 per mm^2) in the accession 14 (Kalaketty).

c. Petiole characters

Data relating to the length of the petiole, girth

Table 15. Leaf characters of the plants belonging to the accessions

Accession	Mean phylacron (days)	Mean life of a leaf (days)	Mean number of total leaves	Mean leaf ratio	Mean stomatal density (per mm^2)	
					Upper epidermis	Lower epidermis
1	14.10	76.67	31.33	2.76	139.60	311.00
2	12.43	75.67	30.50	2.93	105.66	247.56
3	11.90	69.67	31.83	2.82	128.55	289.86
4	13.73	74.43	31.50	2.84	181.21	287.36
5	14.60	75.23	30.83	2.79	134.35	313.49
6	13.50	74.17	31.83	2.97	118.59	284.46
7	15.07	73.83	30.83	2.96	149.28	272.44
8	14.33	76.37	29.50	2.90	101.18	262.48
9	12.67	70.83	31.67	2.89	127.34	279.62
10	16.60	69.90	29.17	2.90	98.28	271.22
11	13.67	74.00	29.67	2.92	117.35	294.41
12	17.20	73.67	30.00	2.97	117.35	270.78
13	16.07	73.83	31.50	3.03	97.03	295.66
14	14.13	78.00	31.00	2.94	95.37	268.29
15	15.23	75.00	29.67	2.83	114.45	323.02
16	12.57	72.77	30.67	3.01	125.64	347.08
17	15.40	76.83	29.83	2.94	99.52	277.38
18	15.40	78.23	29.50	2.83	99.52	302.67
19	12.23	81.50	31.17	2.71	125.64	311.00
20	15.57	77.17	30.67	2.97	121.50	301.31
21	13.13	75.50	30.00	3.06	120.25	281.97
22	14.47	74.40	27.50	2.89	111.96	323.44
23	14.07	77.17	31.67	2.96	122.74	251.70
24	12.90	78.33	31.50	2.82	122.49	274.92
CD(5%)	2.96	NS	2.02	NS	33.24	NS
SEm ±	1.04	2.91	0.71	0.08	11.68	24.95

of the petiole, width of the petiolar canal and depth of the petiolar canal are presented in Table 16.

The differences observed in the accessions were not statistically significant in any of the characters.

d. Nutrient content of the index leaf

Data furnished in Table 17 relates to the content of nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, copper, iron, manganese and zinc in the index leaf at the time of shooting.

None of the accessions exhibited significant differences in the content of any of the above nutrient elements.

e. Incidence of pests and diseases

Data on the reaction of the accessions to the important pest (rhizome weevil) and diseases (bunchytop and Sigatoka leaf spot) are presented in Table 18.

i) Rhizome weevil

Accessions 1 (Taliparamba), 23 (Edavanna) and 24 (Nattukal) were totally free from the weevil infection even after the third crop (ratoon 2). The accessions 7, 11, 18, 19 and 21 (Morayur, Udumbannur, Anchal, Vellayani and Kalavoor respectively) were moderately infected. The

Table 16. Petiole characters of the plants belonging to the accessions

Accession	Length (cm)	Girth (cm)	Width of canal (cm)	Depth of canal (cm)
1	48.83	11.00	1.67	2.07
2	50.77	9.23	1.10	1.53
3	51.93	10.83	1.43	2.10
4	55.33	10.57	1.07	1.80
5	45.27	10.67	1.80	1.90
6	52.83	10.13	1.23	1.90
7	52.50	12.00	1.80	2.43
8	51.83	11.00	1.53	1.93
9	50.83	10.60	1.50	1.97
10	50.50	10.83	1.60	2.00
11	55.83	10.83	1.30	1.53
12	48.30	10.67	1.27	2.00
13	54.17	10.67	1.17	2.00
14	44.00	10.00	1.67	1.83
15	46.67	11.00	1.50	2.07
16	46.53	9.83	1.00	1.63
17	46.17	10.50	1.40	2.17
18	50.83	11.33	1.43	1.83
19	45.73	12.50	2.00	2.43
20	49.33	9.00	0.90	1.53
21	58.33	10.00	1.30	1.93
22	50.33	10.73	1.20	1.80
23	47.33	11.27	1.27	2.20
24	50.67	11.50	1.60	1.97
CD(5%)	NS	NS	NS	NS
SEm ±	3.33	0.66	0.24	0.20

Table 17. Nutrient composition of the index leaf of the plants belonging to the accessions

Accession	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)
1	2.55	0.198	3.53	0.28	0.26	0.067	75.6	300.6	1257.7	40.5
2	2.68	0.196	3.53	0.33	0.32	0.083	54.0	150.1	1225.0	29.0
3	2.80	0.179	3.42	0.45	0.46	0.080	46.9	254.7	1229.3	38.2
4	3.03	0.192	3.43	0.31	0.27	0.082	41.9	165.3	1247.0	32.5
5	2.48	0.190	3.53	0.25	0.26	0.090	55.1	221.2	1348.0	38.9
6	2.61	0.175	3.42	0.29	0.25	0.068	44.2	196.7	1559.7	47.5
7	2.89	0.183	3.62	0.32	0.34	0.082	69.8	168.1	1101.7	29.8
8	2.62	0.193	3.48	0.21	0.29	0.077	42.1	189.8	791.0	30.3
9	3.10	0.198	3.52	0.30	0.27	0.084	52.3	280.9	1190.0	42.3
10	2.64	0.196	3.62	0.33	0.32	0.080	49.6	184.6	1021.7	26.9
11	2.80	0.187	3.70	0.36	0.42	0.087	77.4	280.7	1329.7	31.6
12	2.41	0.213	3.43	0.22	0.25	0.076	45.6	176.1	931.0	26.9
13	2.96	0.177	3.17	0.31	0.28	0.083	58.1	290.4	1493.7	55.3
14	3.14	0.158	3.97	0.32	0.29	0.081	52.6	198.5	1073.0	25.0
15	3.14	0.190	3.47	0.20	0.24	0.080	60.4	201.3	1143.0	39.0
16	2.59	0.171	3.48	0.35	0.34	0.079	47.7	205.3	1124.0	29.5
17	3.09	0.192	3.57	0.24	0.24	0.080	51.2	218.0	1250.0	40.2
18	2.84	0.180	3.75	0.25	0.28	0.073	48.6	255.7	924.3	46.6
19	2.70	0.175	3.38	0.34	0.44	0.080	45.8	119.2	1109.3	31.9
20	2.59	0.188	3.42	0.23	0.27	0.071	64.1	147.1	872.7	19.6
21	2.47	0.177	3.48	0.26	0.42	0.076	70.8	232.9	1151.0	27.8
22	2.96	0.181	3.98	0.32	0.32	0.091	75.0	277.2	1270.3	44.8
23	2.48	0.192	3.70	0.27	0.26	0.073	56.8	210.4	1196.3	26.4
24	3.09	0.194	3.70	0.32	0.40	0.081	36.0	317.8	1142.7	28.3
CD(5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SEm ±	0.22	0.01	0.20	0.57	0.05	0.01	9.69	42.4	192.1	8.7

Table 18. Incidence of pests and diseases in the plants belonging to the accessions

Accession	Incidence of pest/diseases		
	Rhizome weevil*	Bunchytop (mortality %)	Sigatoka leaf spot (Disease index)
1	0.00	11.00	5.66
2	4.19	22.00	5.17
3	0.88	22.00	4.89
4	3.33	0.00	5.70
5	1.21	11.00	3.32
6	0.55	33.00	4.52
7	1.44	11.00	5.69
8	1.60	0.00	2.78
9	0.67	11.00	4.63
10	4.36	0.00	3.74
11	1.76	0.00	3.03
12	0.42	22.00	4.31
13	1.88	0.00	4.22
14	1.21	33.00	6.00
15	0.42	33.00	3.58
16	3.75	11.00	5.03
17	1.19	0.00	6.93
18	1.10	0.00	2.48
19	1.48	33.00	4.13
20	1.99	22.00	3.13
21	1.35	0.00	2.52
22	0.74	11.00	5.25
23	0.00	33.00	4.02
24	0.00	11.00	4.98

*The data presented is the ratio of the infected rhizome to total rhizome ratio of infected to total rhizome (by weight) in these accessions were 1.44, 1.76, 1.10, 1.48 and 1.35 respectively. The maximum ratio (4.36) was recorded in the accession 10 (West Payipra).

ii) Bunchytop

Mortality due to bunchytop ranged from 0 to 33 per cent in the accessions during the course of the three crops. There was no incidence of bunchytop disease in the accessions 4 (Adukkam), 8 (Maraikal), 10 (West Payipra), 11 (Udumbannur), 13 (Kuravilangad), 17 (Konni), 18 (Anchal) and 21 (Kalavoor). In the accession 7 (Morayur) the mortality per cent was 11. The accessions 6 (Tamarasseri), 14 (Kalaketty), 15 (Karukachal), 19 (Vellayani) and 23 (Edavanna) exhibited 33 per cent mortality.

iii) Sigatoka leaf spot

The disease index ranged from 2.48 in the accession 18 (Anchal) to 6.93 in the accession 17 (Konni). In the accession 21 (Kalavoor) the index was low (2.52). In the accession 7 (Morayoor), 11 (Udumbannur) and 19 (Vellayani) the indices were 5.69, 3.03 and 4.13 respectively.

f. Bunch characters

i) Plant crop

Data pertaining to the bunch characters such as weight of the bunch, number of hands, weight of hands, mean weight of a hand, number of fingers, mean weight of a finger and length of the bunch are presented in Table 19.

Weight of the bunch

There were significant differences among the accessions with regard to the bunch weight. Maximum bunch weight (16.33 kg) was recorded by the accession 21 (Kalavoor). This was on par with the accessions 18 (Anchal), 15 (Karukachal), 11(Udumbannur), 7 (Morayur), 19 (Vellayani) and 1 (Manantoddy). These accessions recorded the bunch weight of 16.02 kg, 15.17 kg 14.87 kg, 14.46 kg, 14.42 kg and 13.77 kg, respectively. The accession 21 (Kalavoor) and 18 (Anchal) were significantly superior to the local accession, Maraikal (8) which recorded a bunch weight of 12.60 kg. Accession 12 (Moolamattom) recorded the least bunch weight (9.78 kg).

Number of hands

Statistically significant differences among the accessions were obtained for this character. Accessions 7 (Morayur) and 15 (Karukachal) recorded the maximum number of hands (12.00 each). This was followed by the accession 21 (Kalavoor) with 11.67 hands. These were on par with

Table 19. Bunch characters of the plants belonging to the accessions (plant crop)

Accession	Weight of bunch (Kg)	Number of hands	Weight of hands (Kg)	Mean weight of a hand (Kg)	Number of fingers	Mean weight of a finger (g)	Length of bunch (cm)
1	13.77	11.17	11.02	0.99	159.17	70.73	45.83
2	11.38	10.33	9.52	0.92	161.00	58.87	41.50
3	10.95	10.17	9.32	0.91	155.83	59.23	41.17
4	13.50	10.83	10.88	1.00	165.83	65.43	46.50
5	11.75	10.17	9.00	0.96	162.33	59.37	41.67
6	12.65	11.17	10.11	0.91	176.00	57.43	46.33
7	14.46	12.00	11.75	0.97	190.60	61.83	42.00
8	12.60	11.00	10.49	0.95	169.50	61.83	44.08
9	11.88	10.50	9.46	0.90	163.37	57.67	44.67
10	10.22	10.00	8.51	0.85	142.67	59.63	38.89
11	14.87	10.17	12.40	1.11	177.17	70.07	45.67
12	9.78	10.33	7.89	0.77	151.33	52.37	39.06
13	12.92	10.50	10.90	1.04	160.50	67.70	46.50
14	11.92	10.92	9.55	0.94	146.50	65.10	43.78
15	15.17	12.00	12.85	1.07	195.33	65.50	50.67
16	12.95	10.33	10.30	1.00	168.00	61.73	45.67
17	10.00	10.17	8.80	0.86	150.50	58.20	40.25
18	16.02	11.00	12.80	1.17	173.83	73.77	47.50
19	14.42	11.17	11.87	1.06	174.17	68.10	47.00
20	11.42	10.00	9.21	0.91	151.17	60.37	40.67
21	16.33	11.67	13.64	1.17	179.17	76.60	50.33
22	11.15	10.50	9.17	0.87	155.67	58.57	46.08
23	10.72	10.33	8.72	0.84	165.17	52.80	43.75
24	13.57	11.33	11.17	0.99	176.50	64.50	45.00
CD(5%)	2.68	1.22	2.65	0.20	26.40	12.23	6.32
SEm ±	0.94	0.44	0.93	0.02	9.27	4.30	2.22

the local accession, Maraikal (8), that had produced 11.00 hands. Minimum number of hands (10.00) was recorded by both West Payipra and Takazhi (accessions 10 and 20, respectively).

Weight of hands

Statistically significant differences among the accessions were obtained in this character. Maximum weight of 13.64 kg was recorded by the accession 21 (Kalavoor). This was significantly superior to the local accession, Maraikal (8), which had a weight of 10.49 kg. The accession 12 (Moolamattom) had the minimum weight, of 7.89 kg. The trend of variation among the accessions was almost in line with that of the bunch weight.

Mean weight of a hand

The differences among the various accessions were statistically significant. Maximum weight (1.17 kg each) was obtained in the accessions 18 (Anchal) and 21 (Kalavoor). These were followed by the accessions 11 (Udumbannur), 15 (Karukachal) and 19 (Vellayani) which had recorded the mean weight of 1.11 kg, 1.07 kg and 1.06 kg respectively. The accession 12 (Moolamattom) had the minimum weight (0.77 kg).

Number of fingers

The differences among the accessions were statistically significant. Maximum number of fingers (195.33) was produced by the accession 15 (Karukachal). This was closely followed by the accession 7 (Morayur) with 190.60 fingers. The accession 21 (Kalavoor), which had produced the heaviest bunches, emerged third by producing 179.17 fingers. These were on par with that of the accession 8 (Maraikal), the local accession, with 169.50 fingers. Accession 10 (West Payipra) recorded the minimum number of fingers (142.67).

Mean weight of a finger

The differences among the accessions were statistically significant. The accession 21 (Kalavoor) recorded the highest finger weight of 76.60 g. This was significantly superior to the local accession, 8 (Maraikal), with 61.83 g. The accession 18 (Anchal) emerged second in finger weight (73.77 g). The lowest finger weight (52.80 g) was that of the accession 23 (Edavanna).

Length of the bunch

Length of the bunch differed significantly among the different accessions. It was maximum (50.67 cm) in the accession 15 (Karukachal). This was on par with 12 other accessions but significantly different from the local accession, 8 (Maraikal), which had a bunch length of 44.08 cm. Accession 10 (West Payipra) had the minimum length (38.89 cm).

ii) Ratoon 1

Data relating to the mean bunch characters such as bunch weight, number of hands and number of fingers are given in Table 20.

Weight of the bunch

There were significant differences with regard to the bunch weight. Accession 21 (Kalavoor) produced the heaviest bunches with a mean weight of 14.82 kg. This was closely followed (14.63 kg) by the accession 18 (Anchal). These accessions were on par with eight other accessions and significantly superior to the local accession, Maraikal (8), which had a bunch weight of 11.19 kg. Accession 3 (Pullur) produced bunches of the minimum weight (9.88 kg).

Number of hands

The differences among the accessions were statistically significant. Maximum number of hands (13.50) was

Table 20. Bunch characters of the plants belonging to the accessions (ratoon 1)

Accession	Weight of bunch (kg)	Number of hands	Number of fingers
1	12.63	11.50	160.25
2	10.63	11.00	164.50
3	9.88	11.25	161.50
4	12.75	12.50	164.75
5	11.25	11.25	168.50
6	10.75	11.50	158.50
7	13.31	12.25	190.50
8	11.19	11.50	171.00
9	12.13	11.50	168.50
10	10.88	11.25	166.75
11	13.50	13.50	183.00
12	10.13	12.50	169.50
13	13.88	12.50	183.50
14	10.25	11.00	157.50
15	13.25	11.75	166.75
16	13.38	11.75	179.75
17	10.63	10.25	168.75
18	14.63	13.00	192.25
19	13.38	11.75	198.75
20	11.25	12.50	176.50
21	14.81	13.00	182.75
22	10.38	11.50	161.50
23	10.88	11.75	170.75
24	12.19	11.25	176.75
CD(5%)	2.40	1.45	24.58
SEm ±	0.82	0.49	8.40

produced by the accession 11 (Udumbannur). Accessions 18 (Anchal) and 21 (Kalavoor) followed this with 13.00 hands each. These three accessions were significantly superior to the accession 8 (Maraikal), the local one, which had 11.50 hands. Accession 17 (Konni) produced the minimum number of hands (10.25).

Number of fingers

Statistically significant differences were obtained in the number of fingers. Accession 19 (Vellayani) produced the maximum number of fingers (198.75). This was significantly superior to the local accession, Maraikal (8), that had produced 171.00 fingers. The accessions 18 (Anchal), 7 (Morayur), 13 (Kuravilangad), 11 (Udumbannur) and 21 (Kalavoor) took the positions from 2nd to 6th. These had the finger number of 192.25, 190.50, 183.50, 183.00 and 182.75 respectively. The accession 14 (Kalaketty) recorded the least number of fingers (157.50).

iii) Ratoon 2

Data relating to the weight of the bunch, number of hands and number of fingers are presented in Table 21.

The differences observed among the accessions in respect of the above characters were not statistically

Table 21. Bunch characters of the plants belonging to the accessions (ratoon 2)

Accession	Weight of bunch (kg)	Number of hands	Number of fingers
1	10.67	12.00	186.67
2	10.58	12.33	188.33
3	9.92	10.67	188.67
4	10.67	11.33	188.00
5	10.25	11.33	168.33
6	10.58	11.00	175.33
7	13.42	12.67	188.67
8	9.75	11.33	163.33
9	10.92	11.33	182.67
10	9.50	10.33	159.33
11	12.42	12.00	166.67
12	9.25	10.33	168.33
13	12.83	12.33	174.33
14	10.17	10.67	160.33
15	10.75	11.00	177.00
16	11.08	11.33	169.67
17	8.50	10.33	161.33
18	12.58	12.00	182.33
19	12.67	11.33	163.33
20	10.25	11.00	171.33
21	12.83	11.00	171.33
22	9.33	10.67	163.33
23	10.33	12.33	188.67
24	10.67	11.67	191.00
CD(5%)	NS	NS	NS
SEm ±	1.19	0.69	11.43

significant. However, the heaviest bunches (13.42 kg) were produced by the accession 7 (Morayur). This was closely followed by the accessions 21 (Kalavoor) and 13 (Karukachal). These two accessions produced bunches of 12.83 kg each. As regards the number of hands too the accession 7 (Morayur) emerged first by producing 12.67 hands. The accession 24 (Nattukal), on the other hand, produced the maximum number of fingers (191.00).

iv) Pooled bunch characters for the three crops

Data pertaining to the bunch weight, number of hands and number of fingers of the three crops (the plant crop and the two ratoons) were pooled and the mean values were subjected to statistical analysis. The data obtained are furnished in Table 22. Bunch weight of the accessions in the three crops is presented in Fig.3. Photographs of the bunches and hands of certain accessions are presented in Plates 2, 3, 4, 5, 6 and 7.

Weight of the bunch

There were significant differences with regard to the bunch weight. The heaviest bunches (14.872 kg) were produced by the accession 21 (Kalavoor). This was on par with the accessions 18 (Anchal), 11 (Udumbannur), 7 (Morayur),

Table 22. Pooled mean of the bunch characters of the plants belonging to the accessions

Accession	Mean weight (kg)	Mean number of hands	Mean number of fingers
1	12.182	11.50	169.06
2	10.683	11.17	171.22
3	10.586	10.70	170.28
4	12.103	11.45	175.31
5	10.903	10.81	164.39
6	11.652	11.22	172.58
7	13.567	12.08	187.44
8	11.050	11.19	165.50
9	11.656	11.14	171.99
10	10.147	10.44	154.86
11	13.608	11.97	173.97
12	9.767	10.86	162.03
13	13.167	11.67	169.67
14	10.889	10.55	152.44
15	13.028	11.61	181.33
16	12.228	10.97	170.42
17	9.933	10.36	158.50
18	14.378	11.70	191.47
19	13.436	11.33	176.28
20	10.986	10.92	163.64
21	14.872	11.61	177.00
22	10.203	10.67	159.14
23	10.722	11.56	181.28
24	12.326	11.50	183.92
CD(5%)	3.014	NS	17.05
SEm ±	1.058	0.38	5.98

Fig. 3. Bunch weight of the accessions

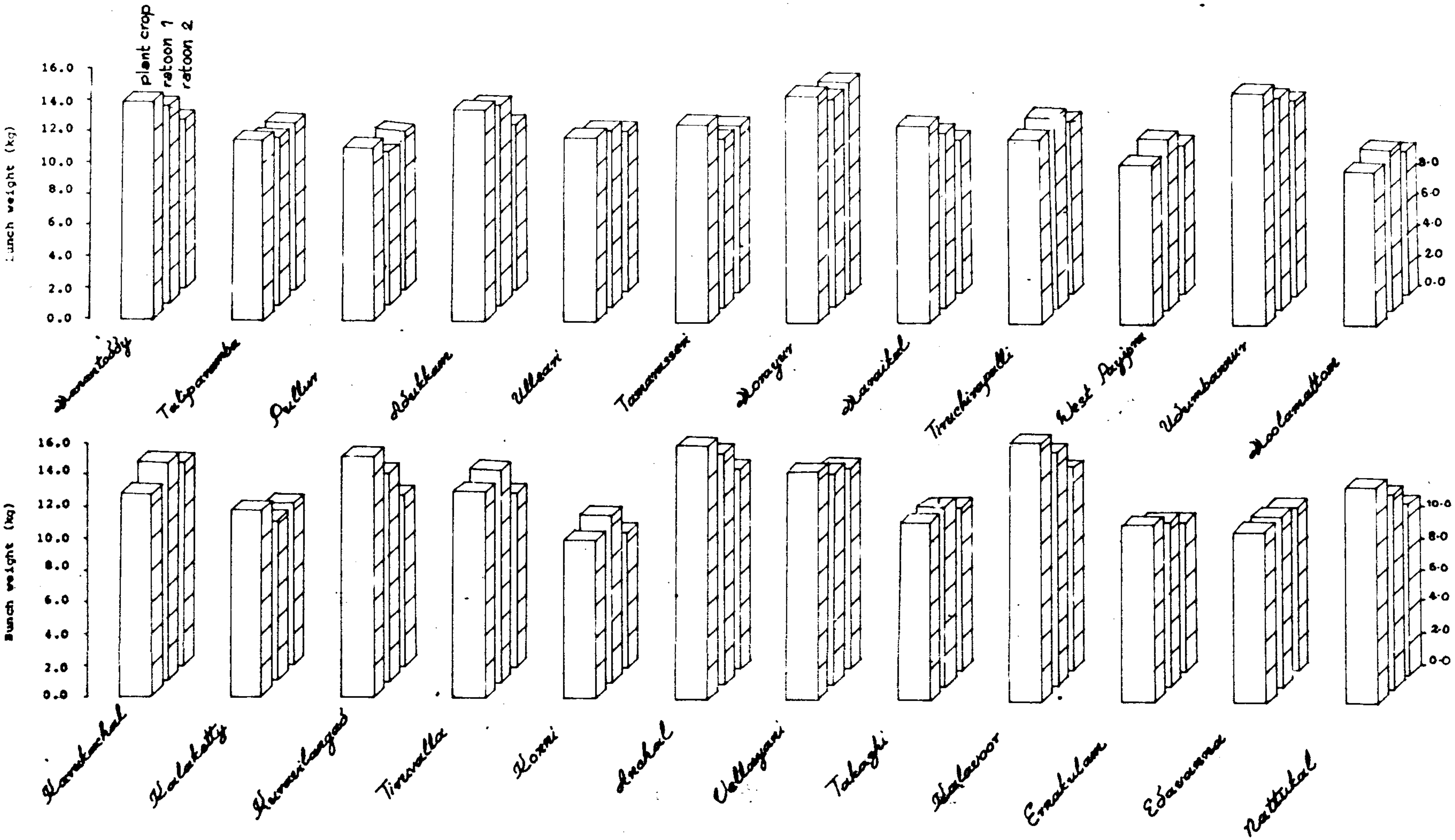


Plate-2. Bunches of the accessions Vellayani, Kalavoor, Kuravilangad and Adukkam

Plate-3. Hands of the accessions Vellayani, Kalavoor, Kuravilangad and Adukkam

Plate - 2.

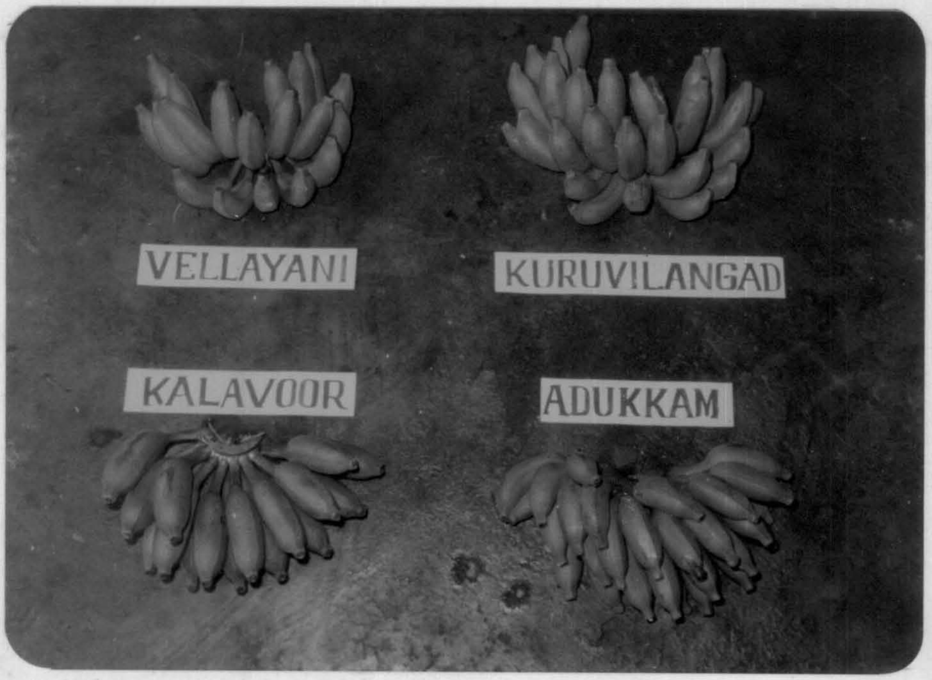


Plate - 3.

Plate-4. Bunches of the accessions Nattukal, Morayur and Udumbannur

Plate-5. Hands of the accessions Nattukal, Morayur and Udumbannur

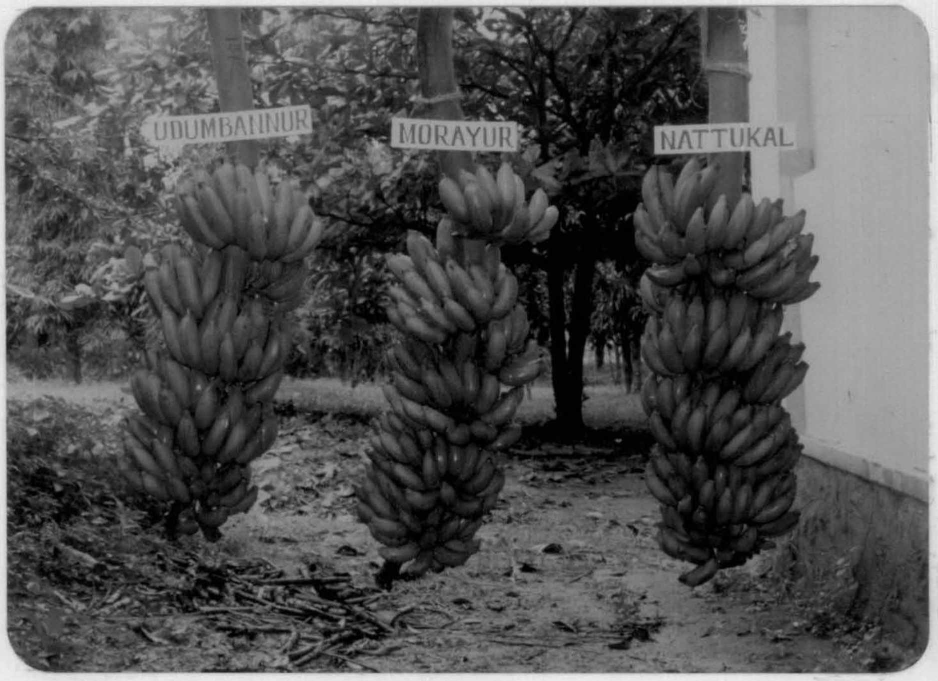


Plate-4.

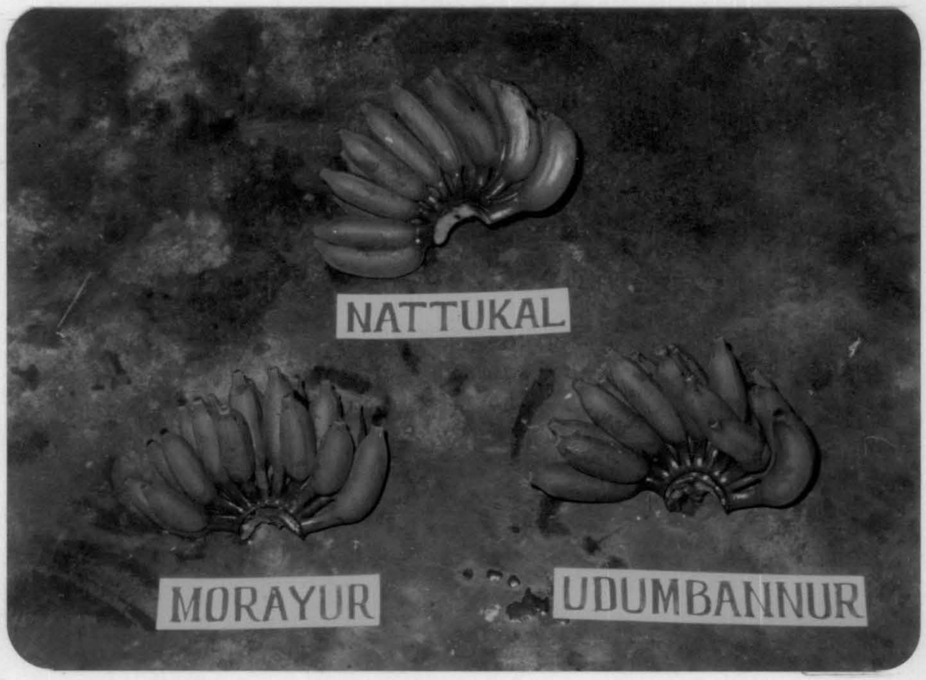


Plate-5.

Plate-6. Bunches of the accessions Karukachal, Manantoddy and Maraikal

Plate-7. Hands of the accessions Karukachal, Manantoddy and Maraikal

Plate-6.

Plate-7.

19 (Vellayani), 13 (Karukachal) and 15 (Kuravilangad). These accessions produced bunches weighing 14.378 kg, 13.608 kg, 13.567 kg, 13.436 kg, 13.167 kg and 13.028 kg respectively. The accession 12 (Moolamattom) produced bunches with the lowest weight of 9.767 kg.

Number of hands

The differences among the accessions were not statistically significant. However, the accession 7 (Morayur) had the maximum number of hands (12.08). Minimum number (10.36) was recorded by the accession 17 (Konni).

Number of fingers

Significant differences were obtained with regard to the number of fingers. The accession 7 (Morayur) recorded the maximum number (187.44) which was on par with 12 other accessions. The accession 21 (Kalavoor), which had produced the heaviest bunches, emerged sixth by producing 177.00 fingers. Minimum number of fingers (152.44) was recorded in the accession 14 (Kalaketty).

g. Fruit characters

i) Physical characters

Data on the physical characters of the ripe fruits such as weight of the fruit and pulp; pulp/peel ratio; length of the stalk, edible portion, apex and total length; as well as girth are given in Table 23.

Weight of the fruit

The differences obtained were statistically significant. Maximum weight (99.00 g) was recorded by the accession 21 (Kalavoor). This was on par with the accessions 13 (Kuravilangad) and 18 (Anchal) which recorded the fruit weight of 86.67 g and 86.33 g respectively. The above three accessions were significantly superior to the local accession, Maraikal (8), that had a value of 63.33 g. The accession 22 (Ernakulam) recorded the minimum weight (48.33 g).

Weight of the pulp

This character also exhibited significant differences among the accessions almost in accordance with the fruit weight. Accession 21 (Kalavoor), which had the maximum weight of 82.67 g, was significantly superior to all others. This was followed by the accession 18 (Anchal) with a value of 67.00 g. This accession was significantly superior to the local accession, Maraikal (8), which had a pulp weight of 52.00 g. Minimum weight (39.67 g) was recorded by the accession 22 (Ernakulam).

Table 23. Fruit characters (physical) of the plants belonging to the accessions

Accession	Weight of fruit (g)	Weight of pulp (g)	Pulp/peel ratio	Length of stalk (cm)	Length of edible portion (cm)	Length of apex (cm)	Total length (cm)	Girth (cm)
1	73.33	56.33	3.39	2.93	11.07	0.73	14.73	11.07
2	59.00	49.00	5.50	2.13	10.17	0.70	13.00	10.27
3	57.33	45.00	3.80	2.77	9.33	0.70	12.80	10.40
4	60.67	47.00	3.60	2.63	10.50	0.53	13.66	10.33
5	58.00	46.00	3.85	2.77	9.80	0.83	13.40	10.30
6	67.67	52.67	3.63	2.43	11.27	0.80	14.50	10.90
7	70.33	55.33	3.72	3.00	11.33	0.87	15.20	10.70
8	63.33	52.00	4.68	2.50	10.60	0.67	13.77	10.70
9	63.67	49.67	3.71	2.53	10.30	0.77	13.60	10.83
10	59.00	47.33	4.12	2.17	10.13	0.83	13.13	10.27
11	75.33	59.33	3.75	3.00	10.57	0.70	14.27	11.80
12	57.67	47.33	4.58	2.33	10.43	0.73	13.49	10.27
13	86.67	65.67	3.14	2.90	11.30	0.87	14.17	11.37
14	63.33	49.00	3.57	2.40	11.37	0.67	14.44	11.10
15	68.67	54.33	4.30	2.57	11.03	0.80	14.40	10.10
16	73.67	57.33	3.51	3.27	10.93	0.80	15.00	11.17
17	61.33	49.00	4.90	2.20	10.20	0.60	13.00	10.53
18	86.33	67.00	3.46	3.27	11.87	0.90	16.04	11.40
19	80.67	48.67	4.17	2.13	10.50	0.70	13.33	10.47
20	72.00	54.67	3.16	2.60	10.83	0.80	14.23	10.83
21	99.00	82.67	6.06	3.37	12.00	0.87	16.24	11.83
22	48.33	39.67	4.63	1.97	9.60	0.83	12.40	9.87
23	54.33	41.67	3.42	2.57	10.63	0.83	14.03	10.07
24	63.33	48.33	3.24	2.77	10.37	0.80	13.94	10.43
CD(5%)	14.32	10.16	NS	0.72	NS	NS	NS	0.96
SEm ±	5.03	3.33	0.55	0.25	0.54	0.10	0.72	0.34

Pulp/peel ratio

The differences obtained among the accessions were not statistically significant for the pulp/peel ratio by weight.

Length of the stalk

Statistically significant differences were obtained in the accessions for this character. The accession 21 (Kalavoor) had the longest stalk (3.37 cm). This was significantly superior to the local accession, Maraikal (8), that had a stalk of 2.50 cm long. The shortest (1.97 cm) stalk was produced by the accession 22 (Ernakulam).

Length of the edible portion

The differences among the accessions were not statistically significant.

Length of the apex

The accessions did not exhibit statistically significant differences.

Total length of the fruit

The differences obtained among the accessions were not statistically significant.

Girth of the fruit

The data showed statistically significant differences. The girth was maximum (11.83 cm) in the accession 21 (Kalavoor). This was closely followed by the accession 11 (Udumbannur), that had a girth of 11.80 cm. The above two accessions were significantly superior to the local accession, Maraikal (8), that had a girth of 10.70 cm. Minimum girth (9.87 cm) was observed in the accession 22 (Ernakulam).

ii) Chemical characters

Data on the chemical (qualitative) characters of the fruits produced by the plants belonging to the different accessions are presented in Table 24.

Total soluble solids

The differences obtained were statistically significant. Maximum value of 26.17 per cent was recorded in the accession 15 (Karukachal) whereas that of 14 (Kalaketty) was the minimum (22.00 per cent).

Reducing sugars

The data revealed significant differences among the accessions. The accession 20 (Takazhi) had the highest value (17.18%) and the accession 7 (Morayur), the lowest (16.18%).

Table 24. Fruit characters (chemical) of the plants belonging to the accessions

Accession	T.S.S. (%)	Sugars (%) Reducing	Non-reducing	Total	Acidity (%)	Sugar/acid ratio	Ascorbic acid (mg/100 g)
1	23.67	16.50	0.18	16.68	0.36	46.33	8.92
2	22.67	16.43	0.18	16.61	0.44	37.75	8.53
3	23.33	16.34	0.26	16.60	0.44	37.73	8.73
4	22.67	16.34	0.19	16.53	0.38	43.50	9.12
5	23.50	16.41	0.22	16.63	0.40	41.58	8.13
6	24.33	16.68	0.14	16.82	0.44	38.23	8.72
7	23.00	16.18	0.23	16.41	0.38	43.18	8.52
8	25.00	17.06	0.18	17.24	0.30	57.47	8.33
9	22.83	16.63	0.20	16.83	0.44	38.25	8.52
10	23.17	16.68	0.22	16.90	0.40	42.45	8.53
11	22.83	16.63	0.27	16.90	0.32	52.81	8.13
12	24.17	16.97	0.18	17.15	0.38	45.13	8.52
13	24.17	17.03	0.19	17.22	0.34	50.65	8.53
14	22.00	16.63	0.24	16.87	0.46	36.67	7.73
15	26.17	17.15	0.25	17.40	0.36	48.33	9.12
16	24.33	17.15	0.20	17.35	0.40	43.38	8.33
17	22.83	16.63	0.22	16.85	0.42	40.12	7.93
18	23.17	16.64	0.17	16.81	0.40	42.03	8.53
19	23.83	16.92	0.18	17.10	0.48	35.63	8.92
20	24.67	17.18	0.24	17.42	0.36	48.39	8.72
21	22.33	17.03	0.27	17.30	0.38	45.53	8.33
22	23.67	17.11	0.20	17.31	0.40	43.28	8.33
23	25.00	17.11	0.20	17.31	0.40	43.28	8.53
24	26.00	17.16	0.22	17.38	0.36	48.28	8.53
CD(5%)	1.91	0.23	NS	0.23	NS	NS	NS
SEm ±	0.67	0.08	0.03	0.08	0.04	5.14	0.61

Non-reducing sugars

The differences obtained among the accessions were not statistically significant.

Total sugars

Significant differences were obtained with regard to the total sugar content. The accession 20 (Takazhi) gave the highest percentage of total sugars (17.42). The lowest value (16.41%) was recorded in the accession 7 (Morayur).

Acidity

Acidity of the fruits did not differ significantly among the accessions studied.

Sugar/acid ratio

The differences obtained among the accessions were not statistically significant.

Ascorbic acid

The differences obtained among the accessions were not statistically significant.

iii) Grading of the fruits

Results of the grading of the fruits produced by the plants belonging to the different accessions are given below:

Disposition of the fingers

The accession 1 and 2 (Manantoddy and Taliparamba respectively) produced compact fingers. The accessions 7 (Morayur), 11 (Udumbannur) and 21 (Kalavoor) had moderately compact fingers. In the accessions 18 and 19 (Anchal and Vellayani respectively) the fingers were rather spreading. Fingers of the accession 6 (Tamarasseri) were of highly spreading nature (Plate 8).

Presence of blotches/speckles on the skin

The blotches/speckles were very few in the accessions 7 (Morayur), 14 (Kalaketty) and 23 (Edavanna). Accessions 18 (Anchal) and 21 (Kalavoor) had a few blotches/speckles. In the accession 4 (Adukkam) and 24 (Nattukal), the blotches/speckles were rather heavy.

Curvature

In the accessions 1 (Manantoddy), 8 (Maraikal) and 21 (Kalavoor), the fruits were almost straight. More curvature was observed in the accessions 12 (Moolamattom) and 2 (Taliparamba) (Plate 9).

Plate-8. Hands showing disposition of fingers

Plate-9. Fingers showing curvature

Plate_8.

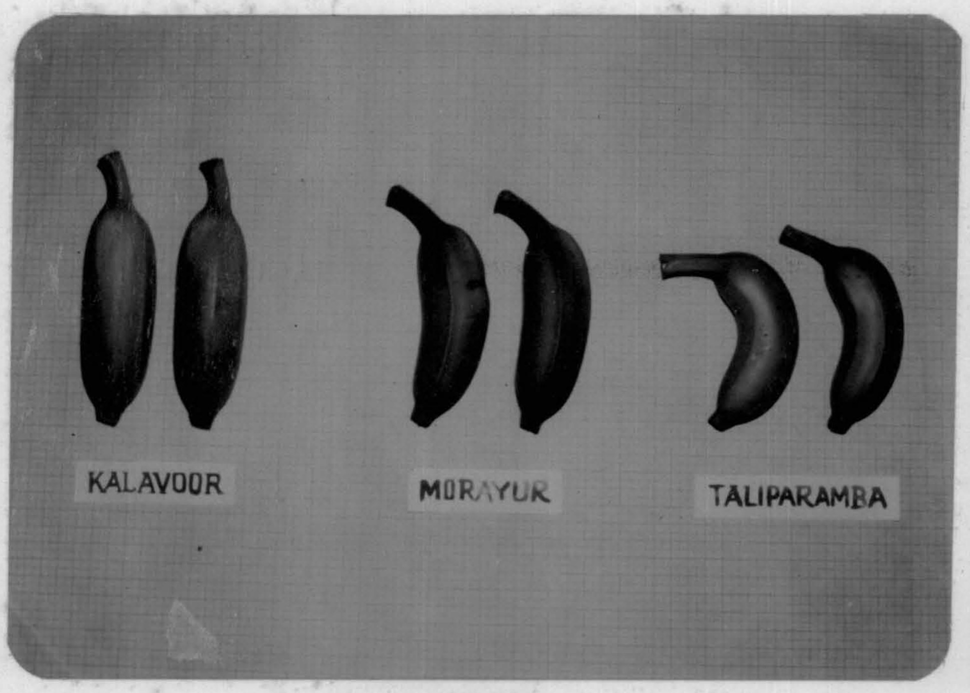


Plate_9.

Angularity

Angularity was absent in the accession 21 (Kalavoor). The accession 9 (Tiruchirapalli) had slight angularity whereas it was prominent in the accession 20 (Takazhi).

Colour of the skin

In the skin colour, the accession 21 (Kalavoor) turned to be the most appealing one with uniform bright yellow skin. The accession 17 (Konni), 22 (Ernakulam) and 24 (Nattukal) secured the least grade.

Overall grade of the fruits

In the total grade of the fruits, the accession 21 (Kalavoor) excelled all the other accessions. This was closely followed by the accession 1 (Taliparamba). The least grade was secured by the accession 10 (West Payipra).

h. Variability

For the estimation of variability, data pertaining to 24 characters were made use of. The range, mean and standard error of mean for the characters are presented in Table 25. The phenotypic, genotypic and environmental variances for the different characters are given in Table 26. Table 27 contains the phenotypic, genotypic and environmental coefficients of variation for the characters. Heritability,

Table 25. Range, mean and standard error of mean for different characters of the plants belonging to the accessions

Sl. no.	Character	Range		Mean	Standard error
		From	To		
1.	Height of pseudostem at shooting (cm)	235.67	347.33	281.75	11.52
2.	Girth of pseudostem at shooting (cm)	56.33	70.00	63.56	1.62
3.	Number of leaves at shooting	7.33	19.00	14.06	1.21
4.	Leaf production interval (days)	10.00	19.8	14.2	1.04
5.	Total number of leaves produced	27.0	34.0	30.6	0.71
6.	Life of a leaf (days)	64.5	86.0	75.2	2.91
7.	Leaf ratio	2.62	3.25	2.90	0.08
8.	Area of 3rd leaf at shooting (m^2)	0.97	1.55	1.22	0.06
9.	Stomatal density of upper surface (no./mm^2)	70.91	207.75	119.62	11.68
10.	Length of petiole (cm)	31.0	59.5	50.3	3.33
11.	Duration from planting to shooting (days)	302.00	422.00	355.68	13.82
12.	Duration from planting to harvest (days)	376.00	503.00	436.60	14.52
13.	Weight of bunch (kg)	8.75	18.00	12.71	0.94
14.	Number of hands	9.50	14.00	10.75	0.44
15.	Weight of hands (kg)	7.23	15.30	10.42	0.93
16.	Average weight of a hand (kg)	0.68	1.30	0.97	0.02
17.	Number of fingers	124.0	221.5	165.5	9.27
18.	Average weight of a green finger (g)	45.3	89.3	62.8	4.30
19.	Length of bunch (cm)	34.25	55.00	44.36	2.22
20.	Weight of ripe finger (g)	45.0	105.0	66.8	5.03
21.	Weight of pulp (g)	37.0	88.0	57.7	3.33
22.	Length of fruit (cm)	11.2	17.2	14.1	0.72
23.	Length of pedicel (cm)	1.5	3.8	2.6	0.25
24.	Girth of finger (cm)	9.3	12.4	10.7	0.34

Table 26. Phenotypic variance (Vp), genotypic variance (Vg) and environmental variance (Ve) for different characters of the plants belonging to the accessions

Sl. no.	Character	Vp	Vg	Ve
1.	Height of pseudostem at shooting (cm)	379.507	-18.449	397.956
2.	Girth of pseudostem at shooting (cm)	10.702	2.781	7.921
3.	Number of leaves at shooting	4.055	-0.359	4.414
4.	Leaf production interval (days)	4.169	0.933	3.236
5.	Total number of leaves produced	2.137	0.626	1.511
6.	Life of a leaf (days)	24.463	-0.961	26.424
7.	Leaf ratio	0.019	0.002	0.017
8.	Area of 3rd leaf at shooting (m^2)	0.018	0.006	0.012
9.	Stomatal density of upper surface (no./mm^2)	636.645	227.551	409.094
10.	Length of petiole (cm)	34.263	0.896	33.367
11.	Duration from planting to shooting (days)	568.609	-4.370	572.979
12.	Duration from planting to harvest (days)	602.275	-29.746	632.021
13.	Weight of bunch (kg)	5.141	2.477	2.664
14.	Number of hands	0.751	0.179	0.572
15.	Weight of hands (kg)	4.077	1.480	2.597
16.	Average weight of a hand (kg)	0.020	0.006	0.014
17.	Number of fingers	347.821	89.883	257.938
18.	Average weight of a green finger (g)	74.239	18.891	55.348
19.	Length of bunch (cm)	20.010	5.251	14.759
20.	Weight of ripe finger (g)	182.772	106.814	75.958
21.	Weight of pulp (g)	109.618	71.369	38.249
22.	Length of fruit (cm)	1.915	0.337	1.578
23.	Length of pedicel (cm)	0.274	0.084	0.190
24.	Girth of finger (cm)	0.512	0.173	0.339

Table 27. Phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV) and environmental coefficient of variation (ECV) for different characters of the plants belonging to the accessions

Sl. no.	Character	PCV	GCV	ECV
1.	Height of pseudostem at shooting (cm)	6.91	1.52	0.69
2.	Girth of pseudostem at shooting (cm)	5.15	2.62	4.43
3.	Number of leaves at shooting	14.32	4.26	14.94
4.	Leaf production interval (days)	14.38	6.80	12.67
5.	Total number of leaves produced	4.78	2.59	4.02
6.	Life of a leaf (days)	6.58	1.30	6.84
7.	Leaf ratio	4.75	1.54	4.50
8.	Area of 3rd leaf at shooting (m^2)	11.00	6.35	8.98
9.	Stomatal density of upper surface (no./mm^2)	21.09	12.61	16.91
10.	Length of petiole (cm)	11.64	1.88	3.65
11.	Duration from planting to shooting (days)	6.70	0.59	6.73
12.	Duration from planting to harvest (days)	5.62	1.25	5.76
13.	Weight of bunch (kg)	17.84	12.38	12.84
14.	Number of hands	8.06	3.94	7.04
15.	Weight of hands (kg)	19.38	11.68	15.47
16.	Average weight of a hand (kg)	14.58	7.99	12.20
17.	Number of fingers	11.27	5.73	9.70
18.	Average weight of a green finger (g)	13.72	6.92	11.85
19.	Length of bunch (cm)	10.08	5.17	8.66
20.	Weight of ripe finger (g)	20.24	15.47	13.05
21.	Weight of pulp (g)	18.15	14.64	10.72
22.	Length of fruit (cm)	9.81	4.12	8.91
23.	Length of pedicel (cm)	20.13	11.14	16.76
24.	Girth of finger (cm)	6.69	3.89	5.44

genetic advance and genetic gain are presented in Table 28.

Of the different characters studied, the environmental component of variance was high for all the characters, except for the weight of ripe finger (Vg = 106.814 and Ve = 75.958) and the weight of pulp (Vg = 71.369 and Ve = 38.249). For the weight of bunch, the genotypic and environmental variances were almost equal (Vg = 2.477 and Ve = 2.664). With regard to the number of hands and number of fingers, the genotypic component of variance showed lower values (Vg = 0.179, Ve = 0.572 and Vg = 89.883, Ve = 257.938 respectively).

With regard to heritability (h^2), maximum value (0.651) was recorded in the weight of pulp, followed by (0.584) weight of ripe finger. The number of leaves at flowering had the value of -0.089. Weight of the bunch, number of hands and number of fingers had the values 0.482, 0.238 and 0.258 respectively. As regards genetic advance, the highest value was recorded in the stomatal density of the upper leaf surface (18.758) and the lowest in leaf ratio (0.030). Weight of the bunch recorded the value of 2.272. The values for the number of hands and the number of fingers were 0.430 and 10.025 respectively. Weight of the ripe finger and weight of the pulp showed high genetic gain (24.602 and 24.574 respectively). Weight of the bunch and number of fingers recorded the values of 17.876 and

Table 28. Heritability in the broad sense (h^2), genetic advance and genetic gain for different characters of the plants belonging to the accessions

Sl. no.	Character	h^2	Genetic advance	Genetic gain
1.	Height of pseudostem at shooting (cm)	-0.049	1.970	0.699
2.	Girth of pseudostem at shooting (cm)	0.260	1.768	2.782
3.	Number of leaves at shooting	-0.089	0.371	2.639
4.	Leaf production interval (days)	0.224	0.950	6.690
5.	Total number of leaves produced	0.293	0.891	2.912
6.	Life of a leaf (days)	-0.039	0.404	0.537
7.	Leaf ratio	0.099	0.030	1.034
8.	Area of 3rd leaf at shooting (m^2)	0.318	0.093	7.623
9.	Stomatal density of upper surface (no./mm^2)	0.357	18.758	15.681
10.	Length of petiole (cm)	0.026	0.318	0.632
11.	Duration from planting to shooting (days)	-0.008	0.381	0.107
12.	Duration from planting to harvest (days)	-0.049	2.521	0.577
13.	Weight of bunch (kg)	0.482	2.272	17.876
14.	Number of hands	0.238	0.430	0.040
15.	Weight of hands (kg)	0.363	1.525	14.635
16.	Average weight of a hand (kg)	0.276	0.088	9.072
17.	Number of fingers	0.258	10.025	6.057
18.	Average weight of a green finger (g)	0.254	4.543	7.234
19.	Length of bunch (cm)	0.262	2.442	5.505
20.	Weight of ripe finger (g)	0.584	16.434	24.602
21.	Weight of pulp (g)	0.651	14.179	24.574
22.	Length of fruit (cm)	0.176	0.507	3.596
23.	Length of pedicel (cm)	0.308	0.334	12.846
24.	Girth of finger (cm)	0.339	0.503	4.701

and 6.057 respectively. Genetic gain for the number of hands was the minimum (0.040).

i. Correlations

i) Correlation between yield and selected characters

For the estimation of correlation with yield (bunch weight), the data of 23 characters were used. The genotypic and the phenotypic correlations were estimated and are presented in Table 29.

Of the 23 characters studied, maximum phenotypic correlation was obtained with the weight of hands (rp = 0.979). The phylacron, leaf ratio, total number of leaves produced, stomatal density of upper leaf surface, duration from planting to shooting, duration from planting to harvest, life of a leaf and length of petiole failed to establish significant phenotypic correlations with the bunch weight. As regards the genotypic correlations, the total number of leaves produced as well as the duration from planting to harvest did not have significant correlations with the bunch weight. Of the vegetative characters, maximum correlation was exhibited by the area of 3rd leaf at shooting (rp = 0.635 and rg = 0.971).

ii) Correlation coefficients among selected characters

Data presented in Table 30 relates to the correlation

Table 29. Phenotypic correlation and genotypic correlation between bunch weight and different characters of the plants belonging to the accessions

Sl. no.	Character	Phenotypic correlation	Genotypic correlation
1.	Height of pseudostem at shooting (cm)	0.243*	0.911**
2.	Girth of pseudostem at shooting (cm)	0.448**	0.605**
3.	Number of leaves at shooting	0.523**	0.258*
4.	Leaf production interval (days)	-0.206	-0.273*
5.	Total number of leaves produced	0.055	-0.082
6.	Life of a leaf (days)	0.194	0.948**
7.	Leaf ratio	-0.013	-0.454**
8.	Area of 3rd leaf at shooting (m^2)	0.635**	0.971**
9.	Stomatal density of upper surface (no./mm^2)	0.141	0.249*
10.	Length of petiole (cm)	0.229	1.426**
11.	Duration from planting to shooting (days)	0.133	0.333**
12.	Duration from planting to harvest (days)	0.133	0.084
13.	Number of hands	0.725**	0.996**
14.	Weight of hands (kg)	0.979**	1.007**
15.	Average weight of a hand (kg)	0.901**	1.026**
16.	Number of fingers	0.731**	0.897**
17.	Average weight of a green finger (g)	0.798**	0.986**
18.	Length of bunch (cm)	0.637**	1.056**
19.	Weight of ripe finger (g)	0.618**	0.822**
20.	Weight of pulp (g)	0.617**	0.813**
21.	Length of fruit (cm)	0.507**	1.138**
22.	Length of pedicel (cm)	0.529**	0.817**
23.	Girth of finger (cm)	0.405**	0.779**

*Significant at 5% level

**Significant at 1% level

Table 30. Genotypic and phenotypic correlation coefficients among sixteen selected characters

Characters	Girth of the pseudo-stem at shooting	Area of the third leaf at shooting	Interval of leaf production	Total number of leaves produced	Stomatal density of upper leaf surface	Weight of the bunch	Number of hands	Weight of hands	Mean weight of a hand	Number of fingers
Girth of the pseudostem at shooting	1.000	0.327** (0.352)**	0.156 (-0.258)*	-0.346** (-0.106)	-0.299* (-0.150)	0.605** (0.448)**	0.992** (0.448)**	0.513** (0.432)**	0.253* (0.388)**	0.544** (0.238)*
Area of the third leaf at shooting		1.000	-0.082 (0.011)	0.400** (0.034)	0.133 (0.050)	0.971** (0.635)	1.016** (0.569)**	1.012** (0.620)**	1.025** (0.510)**	1.091** (0.616)**
Interval of leaf production			1.000	-0.887** (-0.176)	-0.674** (-0.085)	-0.273* (-0.206)	-0.137 (-0.136)	-0.318** (-0.173)	-0.419** (-0.160)	-0.501** (-0.144)
Total number of leaves produced				1.000	0.653** (0.273)*	-0.082 (0.055)	-0.076 (0.018)	-0.187 (0.063)	-0.220 (0.077)	0.159 (0.029)
Stomatal density of upper leaf surface					1.000	0.249* (0.141)	0.454** (0.161)	0.199 (0.115)	0.073 (0.068)	0.400** (0.226)
Weight of the bunch						1.000	0.996** (0.725)**	1.007** (0.979)**	1.026** (0.901)**	0.897** (0.731)**
Number of hands							1.000	1.015** (0.725)**	1.020** (0.417)**	1.022** (0.843)**
Weight of hands								1.000	1.000** (0.926)**	0.909** (0.738)**
Mean weight of a hand									1.000	0.859** (0.519)**
Number of fingers										1.000

contd..

Table 30 (concl.)

Characters	Average weight of a finger	Length of the bunch	Weight of the ripe finger	Weight of the pulp	Length of the pedicel	Girth of the finger
Girth of the pseudostem at shooting	0.437** (0.426)**	0.688** (0.298)*	0.185 (0.247)*	0.261* (0.281)*	0.275* (0.112)	0.097 (0.169)
Area of the third leaf at shooting	0.818** (0.383)**	0.869** (0.519)**	0.796** (0.423)**	0.776** (0.380)**	-0.029 (0.319)**	0.431** (0.177)
Interval of leaf production	0.180 (-0.131)	-0.682** (-0.149)	0.019 (-0.088)	0.034 (-0.046)	0.490** (-0.008)	-0.218 (-0.064)
Total number of leaves produced	-0.372** (0.090)	-0.118 (0.047)	-0.031 (0.065)	0.116 (0.025)	-1.665** (0.203	0.020 (0.139)
Stomatal density of upper leaf surface	0.064 (-0.023)	0.223 (0.037)	-0.224 (-0.024)	-0.233* (-0.024)	-0.908** (0.220)	-0.204 (-0.020)
Weight of the bunch	0.986** (0.798)**	1.056** (0.637)**	0.822** (0.618)**	0.813** (0.617)**	0.817** (0.529)**	0.779** (0.405)**
Number of hands	0.909** (0.351)**	0.818** (0.593)**	0.620** (0.311)**	0.654** (0.332)**	1.378** (0.282)*	0.427** (0.086)
Weight of hands	0.954** (0.818)**	1.066** (0.637)**	0.865** (0.581)**	0.878** (0.588!)**	0.749** (0.500)**	0.773** (0.399)**
Mean weight of a hand	0.983** (0.891)**	1.205** (0.529)**	0.993** (0.600)**	0.988** (0.596)**	0.496** (0.510)**	0.941** (0.492)**
Number of fingers	0.739** (0.225)	0.873** (0.553)**	0.550** (0.273)*	0.592** (0.264)*	1.099** (0.362)**	0.398** (0.027)
Average weight of a finger	1.000	1.056** (0.478)**	1.017** (0.607)**	0.991** (0.622)**	0.455** (0.414)**	0.977** (0.563)**
Length of the bunch		1.000	0.713** (0.404)**	0.747** (0.384)**	1.146** (0.304)**	0.393** (0.257)*
Weight of the ripe finger			1.000	0.995** (0.976)**	0.733** (0.700)**	0.967** (0.730)**
Weight of the pulp				1.000	0.958** (0.659)**	0.950** (0.706)**
Length of the pedicel					1.000	0.676** (0.536)**
Girth of the finger						1.000

Figures in parentheses indicate phenotypic correlation coefficients

* Significant at 5% level

** Significant at 1% level

coefficients among the sixteen selected characters.

It may be seen that, of the vegetative characters, area of 3rd leaf had the greatest correlation with the bunch characters, viz., weight of the bunch, number of hands, weight of the hands, mean weight of a hand, number of fingers, length of the bunch and weight of the ripe finger. This was followed by the girth of the pseudostem. Of the bunch characters, the number of hands had the greatest correlation with the number of fingers. Length of the bunch showed high correlation with the weight of the bunch and the hands, number of hands and fingers as well as average weight of the green finger and weight of the ripe finger. Length of the pedicel also showed high correlation with the weight of the bunch, weight of the hands and mean weight of a hand. The finger characters like the average weight of a finger, weight of the ripe finger, weight of the pulp and girth of the finger also were highly correlated with the length of the pedicel. Girth of the finger recorded higher correlation with the bunch characters as well as the finger characters.

j. Path coefficient analysis

In order to find out the direct and indirect effects of components which showed significant differences among the accessions, path coefficient analysis was carried out. The genotypic correlations of bunch weight with its

15 components were partitioned into direct and indirect contributions. Data on these estimates are presented in Table 31.

The results revealed that weight of hands exerted the maximum positive direct effect (1.6045) followed by the mean weight of green finger (0.6649) and the weight of ripe finger (0.5885). The value for the number of fingers was 0.2292. The component characters such as mean weight of a hand, weight of the pulp, number of hands, total number of leaves and length of the bunch had negative direct effects (-0.8968, -0.7671, -0.2451, -0.1550 and -0.1416 respectively).

As regards the indirect effects, considerable effects could be observed through the characters such as the area of the 3rd leaf, number of hands, weight of the hands, mean weight of a hand, number of fingers, mean weight of a green finger, weight of the ripe finger, length of the pedicel, girth of the fruit and length of the bunch. The indirect effects of most of the characters on yield were high through the weight of hands, mean weight of a green finger and weight of ripe finger. On the other hand, most of the characters had very low indirect effects on yield through the mean weight of a hand and weight of the pulp.

Table 31. Direct and indirect genotypic effect of fifteen component characters on yield

Characters	rg	Area of the third leaf at shooting	Interval of leaf production	Total number of leaves produced	Stomatal density of upper leaf surface	Girth of the pseudo stem at shooting	Number of hands	Weight of hands	Mean weight of a hand	Number of fingers	Mean weight of a finger	Length of the bunch	Weight of the ripe finger	Weight of the pulp	Length of the pedicel	Girth of the fruit
Area of the third leaf at shooting	0.97	0.0590	0.0879	-0.0620	0.0052	-0.0262	-0.2490	1.6238	-0.9192	0.2501	0.5439	-0.1231	0.4684	-0.5952	0.0014	-0.0140
Interval of leaf production	-0.273	-0.0048	-0.0964	0.1375	-0.0263	-0.0125	0.0336	-0.5102	0.3758	-0.1148	-0.1197	0.0966	0.0112	-0.0261	-0.023?	0.0071
Total number of leaves produced	-0.082	0.0236	0.0855	-0.1550	0.0255	0.0277	0.0186	-0.3000	0.1973	0.0364	-0.2473	0.0167	0.0182	0.0890	0.0824	-0.0006
Stomatal density of upper leaf surface	0.249	0.0078	0.0650	-0.1012	0.0390	0.0239	-0.1113	0.1909	-0.0664	0.0917	0.0426	-0.0316	-0.1318	0.1707	0.0449	0.0066
Girth of the pseudo-stem at shooting	0.529	0.0193	-0.0150	0.0536	-0.0117	-0.0800	-0.2432	0.8231	-0.2269	0.1247	0.2906	-0.0974	0.1089	-0.2002	-0.0136	-0.0031
Number of hands	0.996	0.0690	0.0132	0.0118	0.0177	-0.0794	-0.2451	1.6286	-0.9148	0.2343	0.6044	-0.1159	0.3649	-0.5017	-0.0682	-0.0138
Weight of hands	1.007	0.0597	0.0307	0.0290	0.0046	-0.0110	-0.2488	1.6045	-0.8968	0.2084	0.6343	-0.1518	0.5090	-0.6735	-0.0371	-0.0251
Mean weight of a hand	1.026	0.0605	0.0804	0.0341	0.0029	-0.0202	-0.2500	1.6045	-0.8968	0.1969	0.6536	-0.1707	0.5830	-0.7579	-0.0245	-0.0305
Number of fingers	0.897	0.0644	0.0483	-0.0246	0.0156	-0.0435	-0.2505	1.4585	-0.7704	0.2292	0.4914	-0.1236	0.3237	-0.4541	-0.0544	-0.0139
Mean weight of a finger	0.986	0.0483	0.0174	0.0576	0.0025	-0.0350	-0.2228	1.5307	-0.8816	0.1694	0.6649	-0.1496	0.5985	-0.7602	-0.0225	-0.0317
Length of the bunch	1.056	0.0518	0.0658	0.0183	0.0087	-0.0550	-0.2009	1.7109	-1.0807	0.2001	0.7021	-0.1416	0.4196	-0.5738	-0.0567	-0.0127
Weight of the ripe finger	0.822	0.0470	-0.0018	-0.0048	-0.0087	-0.0148	-0.1520	1.3879	-0.8897	0.1261	0.6762	-0.1010	0.5885	-0.7632	-0.0363	-0.0314
Weight of the pulp	0.822	0.0458	-0.0033	0.0180	-0.0091	-0.0209	-0.1603	1.4088	-0.8861	0.1357	0.6589	-0.1058	0.5855	-0.7671	-0.0474	-0.0308
Length of the pedicel	0.589	-0.0017	-0.0063	0.2580	-0.0354	-0.0220	-0.3378	1.2018	-0.4448	0.2519	0.3025	-0.1623	0.4313	-0.7348	-0.0495	-0.0219
Girth of the fruit	0.779	0.0254	0.0210	-0.0031	-0.0080	-0.0078	-0.1047	1.2403	-0.8439	0.0912	0.6496	-0.0557	0.5691	-0.7287	-0.0334	-0.0324

rg = Genotypic correlation coefficients between bunch weight and the component characters

Figures underlined represent direct effect

Residual effect = 0.026

k. **Fixing selection criterion**

i) **Testing selection indices**

From the data obtained in the path coefficient analysis (Table 31) four selection indices were formulated. In the first case, three characters having high direct and indirect effects on bunch weight, viz., number of hands, number of fingers and mean weight of a green finger were considered. Selection index including the weight of bunch with the above three characters were considered in the second case. In the third selection index, seven characters, viz., weight of the hands, mean weight of a hand, weight of the ripe finger, weight of the pulp, number of hands and mean weight of a green finger were taken into account. A fourth selection index was also formed including the weight of the bunch with the above seven characters. Particulars regarding the four selection indices are presented in Table 32.

Minimum efficiency (0.9194) was obtained in I_1 (selection index 1) wherein three characters alone were considered. When the bunch weight also was included with this (I_2), the efficiency, as compared to the direct selection, was 1.3419. When seven characters were considered (I_3), which included the characters in I_1 too, the efficiency was 1.1990. To this when bunch weight was also added the

Table 32. Selection indices with different sets of characters

Character	Selection Indices			
	I_1	I_2	I_3	I_4
Weight of bunch (X_1)	-	1.5399	-	1.2659
Number of hands per bunch (X_2)	0.2381	0.2103	1.3908	3.3952
Weight of hands (X_3)	-	-	-1.0846	-2.9734
Mean weight of a hand (X_4)	-	-	13.8147	36.5651
Number of fingers per bunch (X_5)	0.0271	-0.0859	0.0067	-0.0944
Mean weight of a green finger (X_6)	0.0719	-0.1979	-0.0133	-0.2553
Weight of ripe finger (X_7)	-	-	-0.0362	-0.0689
Weight of pulp (X_8)	-	-	0.1210	0.1397
Expected response*	1.0059	1.4682	1.3114	1.6408
Efficiency over direct selection	0.9194	1.3419	1.199	1.4997
Efficiency over direct selection (%)	-8.06	34.19	19.86	49.97

*The expected response for direct selection was 1.0941 efficiency was raised to 1.4997. These results indicated that the selection through discriminant function, considering only three characters which had high effect on bunch weight, was inferior to the direct selection. However, when the bunch weight was also taken along with this, the effectiveness was 34.19 per cent more than direct selection. Selection based on eight characters (including the bunch weight) showed 49.97 per cent more effectiveness.

ii) Determination of selection criteria and selection

Using the function denoted by I_2 above, which was found to be the most effective selection index based on comparative efficiency, the selection criterion for each accession was worked out. Of these, the first two accessions, viz., Anchal and Kalavoor were selected.

1. D^2 analysis

i) D^2 values

Considering 24 accessions, two at a time, 276 ($24C_2$) squares of differences (D^2 values) were obtained. These values are presented in Table 33. Serial numbers 1 to 24 were assigned to the accessions in order to present the data precisely.

Table 33. D^2 values for 24 accessions of Musa (AAB group) 'Palayankodan' considering 16 characters simultaneously

	1	2	3	4	5	6	7	8	9	10	11	12
1.	0											
2.	16233.12	0										
3.	794.30	10120.79	0									
4.	39976.93	107051.56	51405.79	0								
5.	41.72	15401.12	670.33	41392.80	0							
6.	5611.45	2783.08	2367.63	75480.25	5160.88	0						
7.	3692.71	35309.98	7779.89	19548.81	4093.11	18364.75	0					
8.	20262.00	403.95	13487.47	116899.13	19246.45	4713.57	40947.03	0				
9.	1285.47	8479.31	93.08	55336.42	1113.50	1577.09	9301.24	11614.94	0			
10.	26421.30	1512.88	18728.60	131224.03	25239.15	7873.48	49520.03	593.18	16421.22	0		
11.	6235.84	2370.48	2802.55	77751.66	5725.54	43.81	19433.54	4119.28	1951.03	7088.64	0	
12.	6607.22	2593.69	3325.52	78632.45	5983.98	327.21	19800.82	4042.68	2402.19	6732.89	222.83	0

contd.

Table 33. (contd.)

	13	14	15	16	17	18	19	20	21	22	23	24
1.	30035.33	30594.03	8575.83	1913.88	24612.15	25548.24	1711.84	4039.36	5012.61	10051.53	3029.62	2978.57
2.	2368.76	2316.34	1340.34	7159.07	1011.65	1213.46	7545.77	4277.03	3351.25	831.00	5267.52	5331.41
3.	21725.87	22046.70	4514.24	315.78	17124.78	17920.08	214.97	1560.01	2021.12	5535.68	869.05	789.30
4.	139209.55	140492.44	85505.70	59047.04	127266.87	129399.46	57824.91	69279.95	73088.18	90009.66	64956.83	64627.03
5.	28857.86	29423.13	7929.00	1681.75	23511.55	24454.90	1499.94	3596.45	4638.58	9347.64	2670.38	2649.98
6.	9801.68	10044.62	396.54	1059.39	6821.15	7304.27	1230.62	241.60	69.26	733.15	414.90	448.54
7.	54582.51	55386.92	23339.50	10861.79	47132.96	48453.41	10329.36	15294.09	17265.63	25731.75	13342.26	13232.08
8.	1381.98	1240.31	2581.33	10117.21	361.12	550.85	10464.47	6415.08	5538.03	1838.48	7684.91	7799.66
9.	19180.73	19551.19	3407.61	79.41	14919.77	15636.87	68.88	932.92	1278.64	4332.34	428.85	392.17
10.	274.90	315.78	4910.48	14557.05	61.21	83.31	15160.35	9852.75	8815.99	3929.28	11634.96	11883.02
11.	9004.33	9234.66	225.34	1358.95	6116.52	6580.57	1540.98	320.07	150.32	468.79	598.19	634.10
12.	8770.15	9189.45	232.11	1789.00	5933.54	6434.13	2024.09	358.77	526.12	523.83	825.80	994.77

contd.

Table 33. (concl.)

	13	14	15	16	17	18	19	20	21	22	23	24
13	0	157.33	6587.23	17090.02	369.66	225.76	17923.60	12097.79	10717.95	5525.22	14070.60	14355.81
14		0	6849.38	17510.34	376.32	294.34	18136.00	12561.06	11054.15	5645.11	14402.07	14578.27
15			0	2609.94	4148.47	4546.40	2871.29	881.04	662.91	88.62	1446.19	1554.61
16				0	13138.88	13751.68	110.83	557.71	791.77	3441.70	218.18	208.90
17					0	35.49	13713.93	8782.88	7685.48	3239.53	10412.78	10615.51
18						0	14434.90	9335.53	8129.98	3632.26	11043.06	11254.90
19							0	756.43	1021.07	3670.85	282.94	203.21
20								0	213.24	1435.66	129.25	234.04
21									0	1100.22	348.43	370.68
22										0	2078.71	2162.99
23											0	30.69
24												0

From the data it can be seen that the minimum genetic distance of 30.69 was obtained between the accessions 23 (Edavanna) and 24 (Nattukal). The distance was maximum between the accessions 4 (Adukkam) and 7 (Morayur).

ii) Cluster formation

Using D^2 values, the 24 accessions were grouped into five clusters as detailed below:

Cluster 1 (13 accessions)

Pullur, Tamarasseri, Tiruchirapalli, Udumbannur, Moolamattom, Karukachal, Tiruvalla, Vellayani, Takazhi, Kalavoor, Ernakulam, Edavanna and Nattukal.

Cluster 2 (2 accessions)

Manantoddy and Ulleari.

Cluster 3 (7 accessions)

Taliparamba, Maraikal, West Payipra, Kuravilangad, Kalaketty, Konni and Anchal.

Cluster 4 (1 accession)

Morayur.

Cluster 5 (1 accession)

Adukkam.

iii) Average intra and inter-cluster D^2 and D values

The intra and inter-cluster D^2 values were calculated and presented in Tables 34(a) and 34(b) and Fig.4. It was observed that the intra-cluster D^2 values were lesser than the inter-cluster D^2 values. So the clusters can be considered more or less homogenous within themselves and heterogenous between themselves.

The maximum average inter-cluster distance was between clusters 3 and 5 (127363.3). The minimum distance was between the clusters 2 and 4 (3872.9). The maximum average intra-cluster distance was in cluster 1 (1075.8) and the minimum in cluster 4 and cluster 5 (0.05 each).

m. Contribution of characters towards divergence

Data relating to the contribution of characters towards divergence using two different methods are presented in Table 35. Weight of the bunch contributed the maximum towards divergence in both the methods (87.319% and 37.373% respectively). This was followed by the girth of the fruit (9.420% and 22.055% respectively). Since the contribution was based on the number of times each of the characters having secured first rank, 10 out of 16 characters recorded zero per cent contribution in the first method. In the second method, none of the characters showed zero per cent

Table 34(a). Average intra and inter-cluster D^2 values

Cluster	1	2	3	4	5
1	1075.8	3890.7	9664.1	15698.2	69547.4
2		41.7	24274.3	3872.9	40684.9
3			706.2	47333.3	127363.3
4				0.0	19548.8
5					0.0

Table 34(b). Average intra and inter-cluster distance (D values)

Cluster	1	2	3	4	5
1	32.8	62.4	98.3	125.3	263.5
2		6.5	155.8	62.4	201.7
3			26.6	217.6	356.9
4				0.0	139.8
5					0.0

FIG.4. CLUSTER DIAGRAM SHOWING INTRA AND INTER-CLUSTER DISTANCES

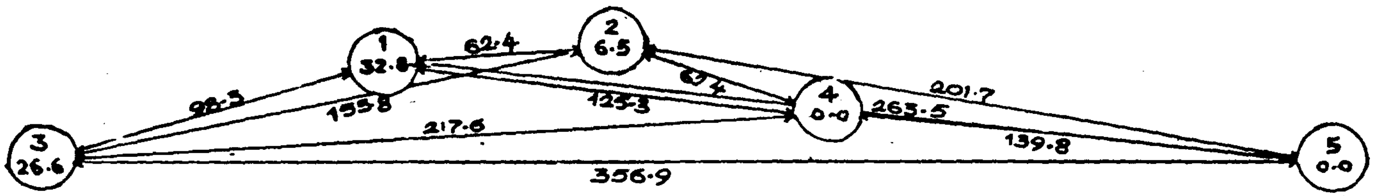


Table 35. Contribution of characters towards divergence

Character	Per cent contribution*	
	1	2
Girth of pseudostem at shooting	0	0.010
Area of third leaf at shooting	0	0.012
Leaf production interval	0.725	0.206
Total number of leaves produced	1.449	0.217
Stomatal density of upper surface	0	10.337
Weight of bunch	87.319	37.373
Number of hands	0	18.534
Weight of hands	0	0.608
Average weight of a hand	0	0.094
Number of fingers	0	0.005
Average weight of a green finger	0	0.208
Length of bunch	0	0.360
Weight of ripe finger	0.362	1.798
Weight of pulp	0	0.521
Length of pedicel	0.725	7.661
Girth of finger	9.420	22.055

* The estimations were made following two methods:

1. As given by Singh and Choudhary (1979)
2. As suggested by Unnithan (1985)

contribution, since due weightage was given to the D^2 values of each character while estimating the contribution. Hence, in the second method, the number of hands and stomatal density of the upper surface also recorded high values (18.534% and 10.337% respectively) whereas these characters had recorded zero per cent contribution based on the first method.

B. Nutritional studies

1. Influence of split application of NPK fertilizers on growth, yield and quality

a. Growth parameters

i) Height of the plants

Data on the mean height of the plants from the 4th to 8th months after planting in the plant crop and from the 4th to 6th months after starting in ratoon 1 are presented in Table 36 and 37 respectively.

In the plant crop, from the initial stages of growth till the 6th month, differences due to the treatments were not statistically significant. Thereafter, significant differences were obtained in the height of the plants. Plants receiving T_{11} (¼, ¾, 0, 0) were the tallest, followed by T_6 (¼, ¼, ¼, ¼). Plants of T_5 (½, ¼, 0, ¼) recorded the minimum height.

Table 36. Effect of split application of NPK on plant height (plant crop)

Treatment		Mean height of plants (cm)				
Code	Splitting*	4th month	5th month	6th month	7th month	8th month
T_1	½ ½ 0 0	102.08	157.08	216.17	268.75	290.33
T_2	½ 0 ½ 0	114.17	160.33	197.00	240.17	261.50
T_3	½ ¼ ¼ 0	107.33	163.67	206.92	264.25	289.67
T_4	½ 0 ¼ ¼	111.42	155.00	193.50	237.58	270.25
T_5	½ ¼ 0 ¼	94.50	143.83	190.00	232.50	249.92
T_6	¼ ¼ ¼ ¼	112.25	168.67	219.75	274.17	296.92
T_7	¼ ½ 0 ¼	122.00	179.08	226.33	267.33	285.33
T_8	¼ ½ ¼ 0	110.91	169.92	206.83	261.33	287.58
T_9	¼ 0 ½ ¼	133.83	158.33	204.75	249.17	255.25
T_{10}	¼ ¼ ½ 0	126.91	181.58	230.08	265.92	287.75
T_{11}	¼ ¾ 0 0	122.08	172.25	230.75	281.67	297.67
T_{12}	¼ 0 ¼ 0	117.92	160.17	188.39	239.89	267.89
T_{13}	¼ ¼ 0 0	117.50	174.17	222.58	270.00	284.33
T_{14}	¼ 0 ¼ 0	120.50	168.75	208.67	261.83	283.33
T_{15}	¼ 0 0 ¼	106.83	157.00	197.25	237.67	260.00
CD (5%)		NS	NS	NS	26.59	31.28
SEm ±		9.26	10.22	10.80	9.18	10.80

* ½, ½, 0, 0 indicates that the recommended dose has been split as ½ at the second month, and ½ at the fourth month after planting. ¼, ¼, ¼, ¼ indicates that the recommended dose has been evenly split at the second, fourth, sixth and eighth months.

Table 37. Effect of split application of NPK on plant height (ratoon 1)

Treatment					Mean height of plants (cm)		
Code	Splitting				4th month	5th month	6th month
T_1	½	½	0	0	231.08	272.58	319.33
T_2	½	0	½	0	226.33	266.08	305.61
T_3	½	¼	¼	0	230.33	269.50	304.25
T_4	½	0	¼	¼	211.58	252.64	287.50
T_5	½	¼	0	¼	185.83	259.83	304.53
T_6	¼	¼	¼	¼	228.08	264.58	296.33
T_7	¼	½	0	¼	224.50	267.08	308.83
T_8	¼	½	¼	0	232.00	273.00	309.75
T_9	¼	0	½	¼	204.83	255.19	286.83
T_{10}	¼	¼	½	0	215.42	253.83	294.17
T_{11}	¾	¼	0	0	240.25	265.33	309.50
T_{12}	¾	0	¼	0	221.67	261.78	299.33
T_{13}	¾	¼	0	0	236.08	277.67	317.67
T_{14}	¾	0	¼	0	247.83	286.92	319.50
T_{15}	¾	0	0	¼	236.92	281.75	319.67
CD (5%)					NS	NS	19.54
SEm ±					14.22	9.14	6.75

In ratoon 1, though the differences were not significant during the early stages of growth, in the 6th month there were significant differences. T_{15} (¼, 0, 0, ¼), which recorded the maximum height, was closely followed by T_{14} (¼, 0, ¼, 0) and T_1 (½, ½, 0, 0) during this month. Minimum height was recorded by T_9 (¼, 0, ½, ¼).

ii) Girth of the pseudostem

Data relating to the girth of the pseudostem in the plant crop and in ratoon 1 are presented in Tables 38 and and 39 respectively.

In the plant crop the effects of the different treatments showed significant differences only when the plants were eight months old. In this month T_{11} (¼, ¼, 0, 0) recorded the maximum girth (65.75 cm) and T_{15} (¼, 0, 0, ¼), the minimum girth (56.92 cm).

The differences were not statistically significant in any of the months in ratoon 1.

iii) Number of functional leaves

Data on the mean number of functional leaves under the different treatments in the plant crop and in ratoon 1 are presented in Tables 40 and 41 respectively.

Table 38. Effect of split application of NPK on plant girth (plant crop)

Treatment		Mean girth of plants (cm)				
Code	Splitting	4th month	5th month	6th month	7th month	8th month
T_1	½ ½ 0 0	28.13	41.17	49.58	60.58	64.00
T_2	½ 0 ½ 0	30.46	42.17	45.75	56.50	61.25
T_3	½ ¼ ¼ 0	30.80	41.21	50.17	61.75	64.50
T_4	½ 0 ¼ ¼	29.67	40.79	46.08	56.17	60.83
T_5	½ ¼ 0 ¼	26.63	39.42	44.83	53.83	57.00
T_6	¼ ¼ ¼ ¼	29.54	42.96	49.17	60.17	63.67
T_7	¼ ½ 0 ¼	33.38	46.54	51.25	61.17	64.92
T_8	¼ ½ ¼ 0	29.96	45.17	48.92	58.67	63.25
T_9	¼ 0 ½ ¼	36.08	42.46	48.00	58.42	62.52
T_{10}	¼ ¼ ½ 0	33.96	46.42	50.75	59.67	63.50
T_{11}	¼ ¾ 0 0	33.29	46.54	53.67	62.17	65.75
T_{12}	¼ 0 ¾ 0	31.58	42.01	45.58	55.56	60.02
T_{13}	¾ ¼ 0 0	31.00	46.29	52.25	60.08	62.83
T_{14}	¾ 0 ¼ 0	32.67	44.58	49.33	59.08	63.17
T_{15}	¾ 0 0 ¼	30.08	41.42	46.08	53.83	56.92
CD (5%)		NS	NS	NS	NS	4.93
SEm ±		2.11	2.23	2.39	2.04	1.70

Table 39. Effect of split application of NPK on plant girth (ratoon 1)

Treatment		Mean girth of plants (cm)		
Code	Splitting	4th month	5th month	6th month
T_1	½ ½ 0 0	55.50	59.58	68.58
T_2	½ 0 ½ 0	53.33	58.00	63.81
T_3	½ ¼ ¼ 0	53.75	57.75	63.08
T_4	½ 0 ¼ ¼	47.67	52.94	58.00
T_5	½ ¼ 0 ¼	50.17	54.17	64.92
T_6	¼ ¼ ¼ ¼	53.08	59.42	63.17
T_7	¼ ½ ¼ 0	54.25	58.50	64.58
T_8	¼ 0 ½ ¼	54.08	59.83	64.33
T_9	¼ ¼ ½ 0	47.33	53.50	58.00
T_{10}	¼ ¼ ½ 0	50.33	55.75	60.92
T_{11}	¼ ¼ 0 0	56.42	59.33	65.00
T_{12}	¼ 0 ¼ 0	50.92	57.14	62.17
T_{13}	¼ ¼ 0 0	53.33	61.18	66.58
T_{14}	¼ 0 ¼ 0	57.17	62.25	66.08
T_{15}	¼ 0 0 ¼	54.17	61.25	67.03
CD (5%)		NS	NS	NS
SEm ±		2.80	2.37	2.27

Table 40. Effect of split application of NPK on number of functional leaves (plant crop)

Treatment					Mean number of functional leaves				
Code	Splitting				4th month	5th month	6th month	7th month	8th month
T_1	½	½	0	0	7.58	8.42	9.58	8.50	8.42
T_2	½	0	½	0	8.08	8.00	9.17	8.50	8.25
T_3	½	¼	¼	0	7.67	9.25	9.17	8.92	9.25
T_4	½	0	¼	¼	7.25	8.58	8.58	7.83	8.50
T_5	½	¼	0	¼	7.50	8.50	8.50	7.67	7.67
T_6	¼	¼	¼	¼	8.00	8.58	9.25	8.33	8.83
T_7	¼	½	0	¼	8.42	9.08	9.17	8.33	8.33
T_8	¼	½	¼	0	7.42	8.42	9.25	8.17	8.91
T_9	¼	0	½	¼	8.42	8.42	8.25	8.25	8.06
T_{10}	¼	¼	½	0	8.25	9.00	9.08	8.75	8.08
T_{11}	¼	¾	0	0	8.50	8.83	10.25	8.83	8.50
T_{12}	¼	0	¾	0	8.08	8.47	8.50	8.42	8.33
T_{13}	¾	¼	0	0	7.83	8.67	9.92	8.11	8.08
T_{14}	¾	0	¼	0	8.33	8.50	9.08	8.58	8.33
T_{15}	¾	0	0	¼	8.08	8.58	8.67	8.33	7.41
CD (5%)					NS	NS	NS	NS	0.58
SEm ±					0.32	0.28	0.38	0.27	0.20

Table 41. Effect of split application of NPK on the number of functional leaves (ratoon 1)

Treatment		Mean number of functional leaves		
Code	Splitting	4th month	5th month	6th month
T_1	½ ½ 0 0	14.33	13.75	10.83
T_2	½ 0 ½ 0	14.08	13.25	10.56
T_3	½ ¼ ¼ 0	13.42	13.33	10.50
T_4	½ 0 ¼ ¼	13.08	12.67	9.41
T_5	½ ¼ 0 ¼	13.25	13.00	10.19
T_6	¼ ¼ ¼ ¼	13.67	12.83	10.67
T_7	¼ ½ 0 ¼	14.08	13.58	10.92
T_8	¼ ½ ¼ 0	13.92	13.67	10.67
T_9	¼ 0 ½ ¼	12.50	12.67	10.17
T_{10}	¼ ¼ ½ 0	14.00	13.83	10.58
T_{11}	¼ ¾ 0 0	14.00	14.67	12.00
T_{12}	¼ 0 ¾ 0	14.67	13.64	10.17
T_{13}	¾ ¼ 0 0	14.92	14.58	12.67
T_{14}	¾ 0 ¼ 0	14.92	14.08	11.25
T_{15}	¾ 0 0 ¼	14.17	13.42	11.25
CD (5%)		NS	NS	NS
SEm ±		0.64	0.73	0.60

In the plant crop significant differences among the treatment effects could be observed only in the 8th month. At this stage, T_3 (½, ¼, ¼, 0) produced the maximum number of functional leaves (9.25) and T_{15} (¼, 0, 0, ¼), the minimum number (7.41).

The treatments failed to establish statistically significant differences in ratoon 1.

iv) Plant characters at shooting

Data on the height of the plants, girth of the pseudostem and the number of functional leaves at the time of shooting, both in the plant crop and in ratoon 1, are presented in Tables 42 and 43 respectively.

The differences due to the treatments with regard to the plant characters at shooting were not significant both in the plant crop and in ratoon 1.

v) Duration of the crop

Data relating to the duration of the crop from planting to shooting and from planting to harvest in the plant crop and in ratoon 1 are presented in Tables 44 and 45 respectively (Fig.5).

There were significant differences with regard to the duration from planting to shooting in the plant crop.

Table 42. Effect of split application of NPK on plant characters at shooting (plant crop)

Treatment Code	Splitting				Mean height (cm)	Mean girth (cm)	Mean number of functional leaves
T_1	½	½	0	0	310.83	68.41	7.58
T_2	½	0	½	0	303.11	71.64	8.08
T_3	½	¼	¼	0	302.83	68.94	7.67
T_4	½	0	¼	¼	298.83	66.75	7.25
T_5	½	¼	0	¼	283.75	62.00	7.50
T_6	¼	¼	¼	¼	306.42	66.17	8.00
T_7	¼	½	0	¼	289.50	66.75	8.42
T_8	¼	½	¼	0	299.00	64.92	7.42
T_9	¼	0	½	¼	305.00	66.58	8.42
T_{10}	¼	¼	½	0	291.92	67.58	8.25
T_{11}	¼	¾	0	0	302.42	67.50	8.50
T_{12}	¼	0	¾	0	313.19	66.54	8.08
T_{13}	¾	¼	0	0	293.50	65.00	7.83
T_{14}	¾	0	¼	0	304.00	67.25	8.33
T_{15}	¾	0	0	¼	277.00	63.08	8.08
CD (5%)					NS	NS	NS
SEm ±					8.49	1.90	0.61

Table 43. **Effect of split application of NPK on plant characters at shooting (ratoon 1)**

Treatment Code	Splitting				Mean height (cm)	Mean girth (cm)	Mean number of functional leaves	Mean area of third leaf (m^2)
T_1	½	½	0	0	332.83	70.00	11.17	1.45
T_2	½	0	½	0	324.00	67.17	10.83	1.39
T_3	½	¼	¼	0	333.83	67.17	11.00	1.50
T_4	½	0	¼	¼	322.33	65.17	9.83	1.37
T_5	½	¼	0	¼	326.33	69.67	10.50	1.21
T_6	¼	¼	¼	¼	333.83	69.67	10.83	1.34
T_7	¼	½	0	¼	315.83	67.50	12.33	1.47
T_8	¼	½	¼	0	334.17	67.83	11.50	1.26
T_9	¼	0	½	¼	304.67	60.58	10.33	1.24
T_{10}	¼	¼	½	0	312.83	63.50	11.17	1.49
T_{11}	¼	¼	0	0	318.33	67.50	11.50	1.36
T_{12}	¼	0	¼	0	333.83	67.17	10.50	1.40
T_{13}	¼	¼	0	0	326.83	68.33	11.67	1.39
T_{14}	¼	0	¼	0	337.67	68.50	12.17	1.38
T_{15}	¼	0	0	¼	343.33	68.67	11.00	1.37
CD (5%)					NS	NS	NS	NS
SEm ±					11.59	2.37	0.52	0.27

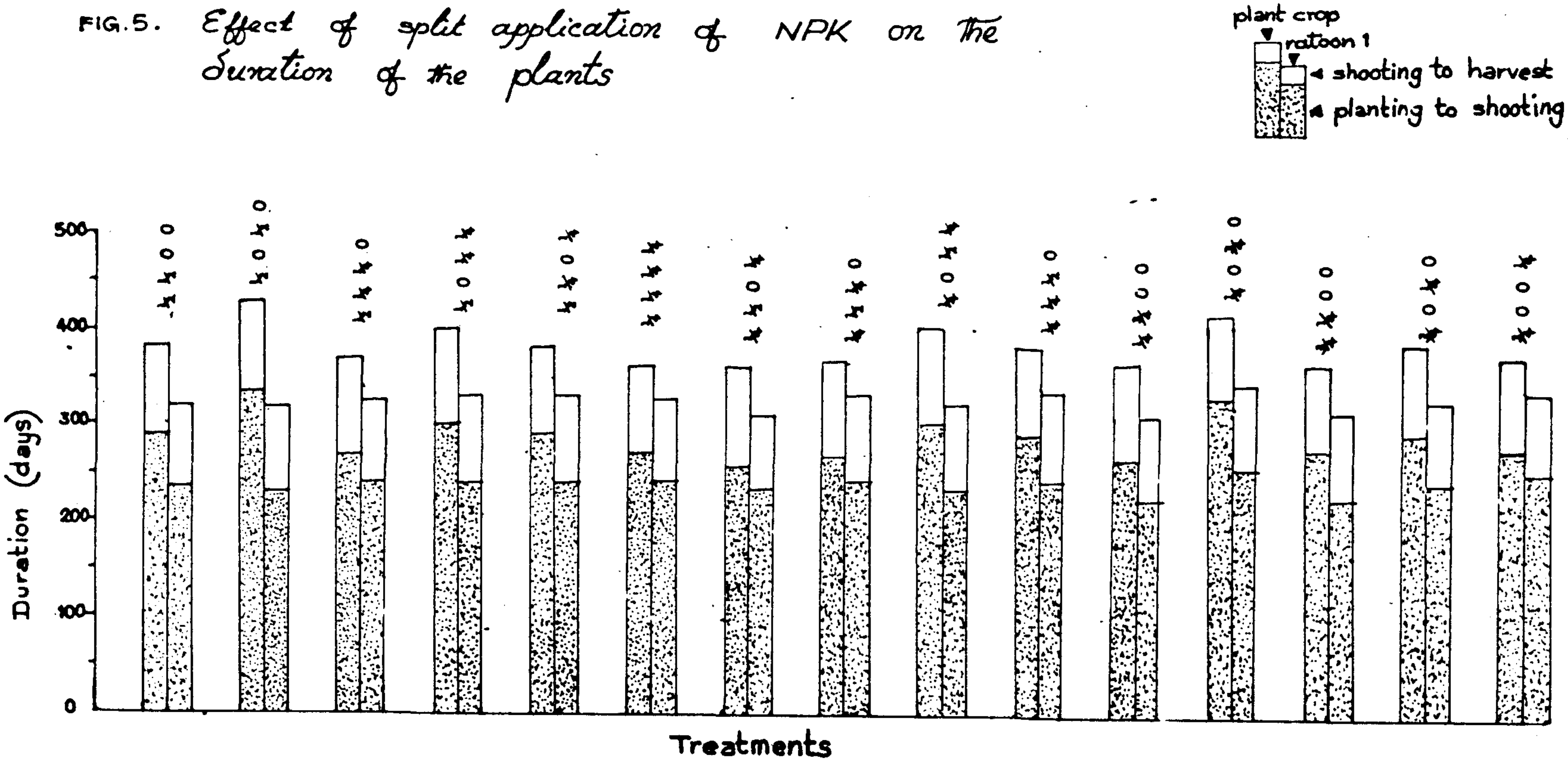
Table 44. Effect of split application of NPK on duration of the crop (plant crop)

Treatment		Mean duration (days)		
Code	Splitting	Planting to shooting	Shooting to harvest	Planting to harvest
T_1	½ ½ 0 0	290.50	91.33	381.83
T_2	½ 0 ½ 0	334.00	96.00	430.00
T_3	½ ¼ ¼ 0	270.33	101.00	371.33
T_4	½ 0 ¼ ¼	298.83	102.83	401.66
T_5	½ ¼ 0 ¼	290.50	93.00	383.50
T_6	¼ ¼ ¼ ¼	268.67	95.17	363.84
T_7	¼ ½ 0 ¼	255.50	103.00	358.50
T_8	¼ ½ ¼ 0	269.00	95.83	364.83
T_9	¼ 0 ½ ¼	299.67	102.50	402.17
T_{10}	¼ ¼ ½ 0	282.00	99.33	381.33
T_{11}	¼ ¾ 0 0	262.17	93.00	355.17
T_{12}	¼ 0 ¾ 0	326.83	90.50	417.33
T_{13}	¾ ¼ 0 0	268.17	94.50	362.67
T_{14}	¾ 0 ¼ 0	284.17	98.17	382.34
T_{15}	¾ 0 0 ¼	276.83	88.50	365.33
CD(5%)		35.15	NS	34.99
SEm ±		22.13	3.75	12.08

Table 45. **Effect of split application of NPK on duration of the crop (ratoon 1)**

Treatment		Mean duration (days)		
Code	Splitting	Starting to shooting	Shooting to harvest	Starting to harvest
T_1	½ ½ 0 0	233.83	87.50	321.33
T_2	½ 0 ½ 0	231.83	86.67	318.50
T_3	½ ¼ ¼ 0	236.33	85.83	322.16
T_4	½ 0 ¼ ¼	240.50	90.00	330.50
T_5	½ ¼ 0 ¼	239.50	87.83	327.33
T_6	¼ ¼ ¼ ¼	238.17	87.50	325.67
T_7	¼ ½ 0 ¼	227.50	82.17	309.67
T_8	¼ ½ ¼ 0	237.50	89.50	327.00
T_9	¼ 0 ½ ¼	232.00	84.17	316:17
T_{10}	¼ ¼ ½ 0	237.00	89.33	326.33
T_{11}	¼ ¾ 0 0	218.83	86.67	305.50
T_{12}	¼ 0 ¾ 0	249.83	87.33	337.16
T_{13}	¼ ¼ 0 0	217.83	89.50	307.33
T_{14}	¼ 0 ¼ 0	232.67	85.67	318.34
T_{15}	¼ 0 0 ¼	242.33	86.33	328.66
CD (5%)		NS	NS	NS
SEm ±		11.14	2.35	11.03

FIG. 5. Effect of split application of NPK on the duration of the plants



Earliest shooting (255.50 days) was observed in T_7 (¼, ½, 0, ¼) followed by T_{11} (¼, ¼, 0, 0) which shot in 262.17 days. Longest duration (334.00 days) was recorded in T_2 (½, 0, ½, 0). The differences were not significant with regard to the duration from shooting to harvest. The duration from planting to harvest also recorded significant differences wherein T_{11} (¼, ¼, 0, 0) gave the earliest crop in 355.17 days, followed by T_7 (¼, ½, 0, ¼) giving the crop in 358.50 days. T_2 (½, 0, ½, 0) recorded the maximum duration and came to harvest in 430.00 days.

The differences with regard to the above observations were not statistically significant in ratoon 1.

b. Dry matter production

i) Contribution of different parts

Data relating to the dry matter content of the different parts and the total dry matter content of the plants, as influenced by the different treatments, are presented in Table 46 and Fig.6.

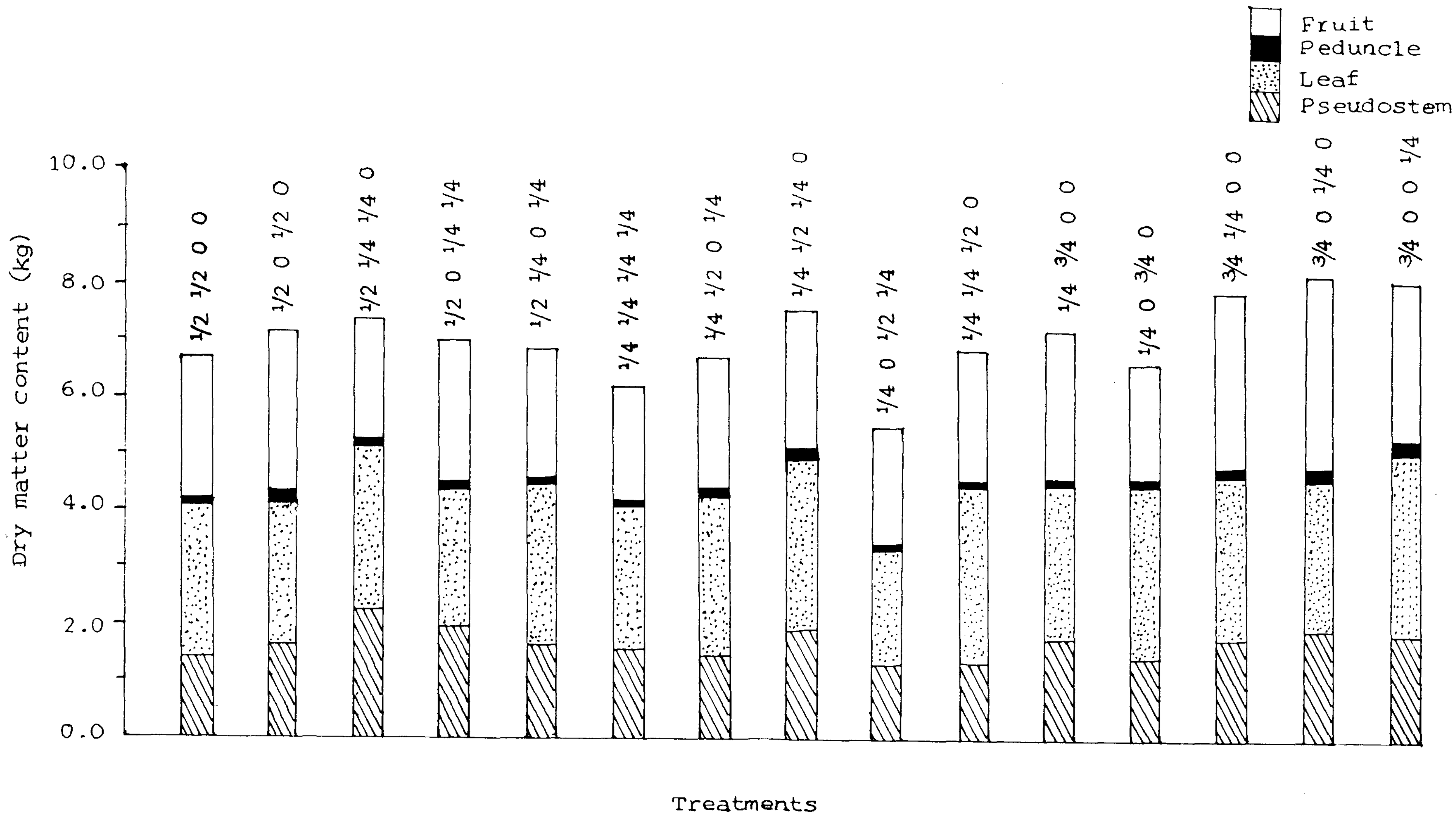
Significant differences were not obtained with respect to any of the organs. However, the total dry matter content recorded significant differences. The highest value of 8.207 kg was recorded by T_{14} (¼, 0, ¼, 0).

Table 46. Effect of split application of NPK on dry matter content of different plant parts at harvest

Treatment		Mean dry matter content (kg)				
Code	Splitting	Pseudo-stem	Leaves	Peduncle	Fruits	Total
T_1	½ ½ 0 0	1.409 (21.12)	2.665 (39.94)	0.105 (1.57)	2.494 (37.37)	6.673
T_2	½ 0 ½ 0	1.637 (22.96)	2.551 (35.78)	0.143 (2.01)	2.798 (39.25)	7.129
T_3	½ ¼ ¼ 0	2.241 (30.45)	2.871 (39.00)	0.124 (1.68)	2.125 (28.87)	7.361
T_4	½ 0 ¼ ¼	1.941 (27.80)	2.422 (34.69)	0.111 (1.59)	2.508 (35.92)	6.982
T_5	½ ¼ 0 ¼	1.689 (24.80)	2.767 (40.63)	0.118 (1.73)	2.237 (32.84)	6.811
T_6	¼ ¼ ¼ ¼	1.512 (24.25)	2.551 (40.92)	0.125 (2.01)	2.046 (32.82)	6.234
T_7	¼ ½ 0 ¼	1.487 (22.14)	2.789 (41.53)	0.124 (1.85)	2.315 (34.48)	6.715
T_8	¼ ½ ¼ 0	1.935 (25.50)	3.024 (39.84)	0.145 (1.91)	2.486 (32.75)	7.590
T_9	¼ 0 ½ ¼	1.342 (24.40)	1.991 (36.20)	0.116 (2.11)	2.051 (37.29)	5.500
T_{10}	¼ ¼ ½ 0	1.376 (20.09)	3.056 (44.61)	0.109 (1.59)	2.309 (33.71)	6.850
T_{11}	¼ ¾ 0 0	1.790 (24.85)	2.706 (37.57)	0.117 (1.62)	2.590 (35.96)	7.203
T_{12}	¼ 0 ¾ 0	1.411 (21.38)	3.072 (46.54)	0.121 (1.83)	1.997 (30.25)	6.601
T_{13}	¾ ¼ 0 0	1.788 (22.70)	2.874 (36.50)	0.138 (1.75)	3.075 (39.05)	7.875
T_{14}	¾ 0 ¼ 0	1.952 (23.78)	2.648 (32.27)	0.156 (1.90)	3.451 (42.05)	8.207
T_{15}	¾ 0 0 ¼	1.853 (22.70)	3.221 (39.47)	0.145 (1.78)	2.942 (36.05)	8.161
CD (5%)		NS	NS	NS	NS	1.380
SEm ±		0.20	0.23	0.02	0.30	0.48

Note: Figures in parentheses indicate the percentage to the total

FIG.6. EFFECT OF SPLIT APPLICATION OF NPK ON THE DRY MATTER CONTENT OF DIFFERENT PLANT PARTS AT HARVEST



This treatment was significantly superior to T_6 (¼, ¼, ¼, ¼) and T_9 (¼, 0, ½, ¼) which recorded 6.234 kg and 5.500 kg respectively. The control, T_1 (½, ½, 0, 0), had recorded a total dry matter content of 6.673 kg.

ii) Relative contribution by different parts

The dry matter production was partitioned into the various plant parts and the data are furnished in Table 47. These values were obtained by pooling all the treatments.

It can be seen from the Table that the total dry weight ranged from 5.500 to 8.207 kg/plant, the maximum percentage being contributed by the leaves (39.03 ± 3.71). The fruits (35.24 ± 3.52%) and the pseudostem (23.93 ± 2.65%) also contributed appreciably. The contribution of the peduncle (1.80 ± 0.70%) was the least.

iii) Rate of production

Data relating to the per day dry matter production, as calculated from the total dry matter production and the total duration, are given in Table 48.

The per day production was maximum (25.78 g) in T_{14} (¾, 0, ¼, 0) which was 24.12% more than that of the control. This was closely followed by T_{13} (¾, ¼, 0, 0) with a per day production of 25.62 g (23.35% more than the control). Minimum

Table 47. Effect of split application of NPK on the mean, standard deviation and range values of dry matter production in different plant parts at harvest

Particulars	Pseudostem	Leaves	Peduncle	Fruits	Total
Dry matter production (kg)	1.691* ± 0.266** (1.342 - 2.241)***	2.747 ± 0.305 (1.991 - 3.221)	0.126 ± 0.015 (0.105 - 0.156)	2.495 ± 0.420 (1.997 - 3.451)	7.059 ± 0.722 (5.500 - 8.207)
% to total	22.93 ± 2.65 (20.09 -30.45)	39.03 ± 3.71 (32.27 -46.54)	1.80 ± 0.70 (1.57 - 2.11)	35.24 ± 3.52 (28.87 -42.05)	

* Mean

** Standard deviation

*** Range

Table 48. Effect of split application of NPK on the rate of dry matter production

Treatment					Duration (days)	Dry matter production (g)		
Code	Splitting					Total	Rate (per day)	Deviation from control (%)
T_1	½	½	0	0	321.33	6673	20.77	-
T_2	½	0	½	0	318.50	7129	22.38	+ 7.75
T_3	½	¼	¼	0	322.16	7361	22.85	+10.01
T_4	½	0	¼	¼	330.50	6982	21.13	+ 1.73
T_5	½	¼	0	¼	327.33	6811	20.81	+ 0.19
T_6	¼	¼	¼	¼	325.67	6234	19.14	- 7.85
T_7	¼	½	0	¼	309.67	6715	21.68	+ 4.38
T_8	¼	½	¼	0	327.00	7590	23.21	+11.75
T_9	¼	0	½	¼	316.17	5500	17.40	-16.23
T_{10}	¼	¼	½	0	326.33	6850	20.99	+ 1.06
T_{11}	¼	¾	0	0	305.50	7203	23.58	+13.53
T_{12}	¼	0	¾	0	337.16	6601	19.58	- 5.73
T_{13}	¾	¼	0	0	307.33	7875	25.62	+23.35
T_{14}	¾	0	¼	0	318.34	8207	25.78	+24.12
T_{15}	¾	0	0	¼	328.66	8161	24.83	+19.55

rate was that of T_9 (¼, 0, ½, ¼) which had a dry matter production of 17.40 g/day and was 16.23% less than the control. The control, T_1 (½, ½, 0, 0), had produced 20.77 g dry matter per day.

c. Bunch characters

i) Plant crop

Data pertaining to the weight of the bunch, number of hands and number of fingers, as influenced by the different treatments, in the plant crop, are presented in Table 49.

The differences observed among the treatments in respect of the above characters were not statistically significant.

ii) Ratoon 1

Data pertaining to the effect of the various treatments on the yield in ratoon 1 are presented in Table 50.

There were significant differences with regard to the weight of the bunch. Maximum bunch weight (16.63 kg) was recorded by T_{14} (¼, 0, ¼, 0) and was on par with T_{13} (¼, ¼, 0, 0), T_6 (¼, ¼, ¼, ¼) and T_{11} (¼, ¼, 0, 0) which had recorded bunch weight of 16.50 kg, 15.50 kg and 14.42 kg respectively. These treatments were significantly superior

Table 49. Effect of split application of NPK on bunch characters (plant crop)

Treatment		Mean weight (kg)	Mean number of hands	Mean number of fingers
Code	Splitting			
T_1	½ ½ 0 0	10.50	10.67	168.67
T_2	½ 0 ½ 0	11.00	10.67	152.67
T_3	½ ¼ ¼ 0	11.83	11.83	167.83
T_4	½ 0 ¼ ¼	11.50	11.33	180.33
T_5	½ ¼ 0 ¼	11.33	10.00	149.83
T_6	¼ ¼ ¼ ¼	12.00	11.50	156.00
T_7	¼ ½ 0 ¼	11.42	10.33	167.67
T_8	¼ ½ ¼ 0	11.92	11.00	173.00
T_9	¼ 0 ½ ¼	11.58	10.67	159.17
T_{10}	¼ ¼ ½ 0	11.92	11.00	169.50
T_{11}	¼ ¾ 0 0	13.33	11.67	196.00
T_{12}	¼ 0 ¾ 0	10.92	11.00	165.17
T_{13}	¾ ¼ 0 0	12.00	10.67	165.50
T_{14}	¾ 0 ¼ 0	11.75	11.33	169.83
T_{15}	¾ 0 0 ¼	12.17	11.00	187.33
CD (5%)		NS	NS	NS
SEm ±		0.73	0.37	10.46

Table 50. Effect of split application of NPK on the bunch characters (ratoon 1)

Treatment		Mean weight (kg)	Mean number of hands	Mean number of fingers
Code	Splitting			
T_1	½ ½ 0 0	13.67	12.33	199.67
T_2	½ 0 ½ 0	13.58	12.00	198.67
T_3	½ ¼ ¼ 0	11.08	11.00	180.17
T_4	½ 0 ¼ ¼	12.58	11.33	174.83
T_5	½ ¼ 0 ¼	11.33	11.67	197.67
T_6	¼ ¼ ¼ ¼	15.50	11.50	195.00
T_7	¼ ½ 0 ¼	13.58	10.67	163.33
T_8	¼ ½ ¼ 0	12.83	11.33	183.83
T_9	¼ 0 ½ ¼	11.25	9.67	157.67
T_{10}	¼ ¼ ½ 0	13.25	10.67	191.33
T_{11}	¼ ¾ 0 0	14.42	11.17	192.33
T_{12}	¼ 0 ¾ 0	13.17	11.67	188.33
T_{13}	¾ ¼ 0 0	16.50	12.00	204.50
T_{14}	¾ 0 ¼ 0	16.63	12.50	207.00
T_{15}	¾ 0 0 ¼	13,45	12.17	196.33
CD(5%)		2.88	NS	NS
SEm ±		0.99	0.54	12.77

to the control, T_1 (½, ½, 0, 0), which had recorded a bunch weight of 13.67 kg. T_3 (½, ¼, ¼, 0) recorded the minimum bunch weight (11.08 kg). The data presented on the number of hands and the number of fingers revealed that the treatment differences were not statistically significant.

iii) Ratoon 2

Data relating to the bunch characters as influenced by the different treatments in ratoon 2 are presented in Table 51.

Weight of the bunch differed significantly with regard to the treatments tried. T_{14} (¼, 0, ¼, 0) which recorded the maximum (14.50 kg) bunch weight, was on par (12.25 kg) with the control, T_1 (½, ½, 0, 0). The minimum bunch weight (9.50 kg) was recorded by T_5 (½, ¼, 0, ¼). Significant differences were observed with regard to the number of hands. It was maximum (10.83) in T_{11} (¼, ¼, 0, 0), which was on par with the control, T_1 (½, ½, 0, 0), and minimum (8.67) in T_9 (¼, 0, ½, ¼) and T_{15} (¼, 0, 0, ¼). With respect to the number of fingers, the differences among the treatments were not statistically significant.

iv) Pooled bunch characters for the three crops

Data on the bunch characters of the three crops

Table 51. Effect of split application of NPK on bunch characters (ratoon 2)

Treatment Code	Splitting				Mean weight (kg)	Mean number of hands	Mean number of fingers
T_1	½	½	0	0	12.25	10.50	165.83
T_2	½	0	½	0	11.83	9.67	156.33
T_3	½	¼	¼	0	11.75	9.83	153.67
T_4	½	0	¼	¼	10.00	9.17	136.33
T_5	½	¼	0	¼	9.50	8.83	140.50
T_6	¼	¼	¼	¼	13.08	10.00	161.83
T_7	¼	½	0	¼	12.25	10.50	156.17
T_8	¼	½	¼	0	9.92	9.50	146.43
T_9	¼	0	½	¼	9.75	8.67	131.33
T_{10}	¼	¼	½	0	11.50	9.33	145.00
T_{11}	¾	¼	0	0	13.83	10.83	162.40
T_{12}	¾	0	¼	0	13.00	9.83	157.00
T_{13}	¼	¾	0	0	14.25	10.33	187.17
T_{14}	¼	0	¾	0	14.50	10.33	178.83
T_{15}	¾	0	0	¼	11.33	8.67	138.67
CD (5%)					2.77	1.23	NS
SEm ±					0.96	0.42	11.27

(the plant crop and the two ratoons) were pooled and subjected to statistical analysis. The results are furnished in Table 52. Bunch weight of the plants of the treatments in the three crops is presented in Fig.7. Photographs of the bunches and hands of representative treatments are presented in Plates 10 and 11 respectively.

The maximum bunch weight (14.295 kg) recorded by T_{14} (¾, 0, ¼, 0) was on par with T_{13} (¾, ¼, 0, 0), which recorded a bunch weight of 14.250 kg. These treatments were significantly superior to the control, T_1 (½, ½, 0,0), which recorded 12.139 kg bunch weight. Data on the number of hands and the number of fingers showed no significant differences.

d. Fruit characters

i) Physical characters

Data on the physical characters of the fruit, as influenced by the different treatments, are presented in Table 53.

There were no significant differences with regard to the length of the stalk, length of the edible portion, length of the apex, total length, girth and weight of the fruit, weight of pulp, volume of fruit or volume of pulp. With regard to the pulp/peel ratio (by weight), significant

Table 52. Effect of split application of NPK on bunch characters (pooled data for the three crops)

Treatment: Code	Treatment: Splitting				Mean weight (kg)	Mean number of hands	Mean number of fingers
T_1	½	½	0	0	12.139	11.17	178.39
T_2	½	0	½	0	12.139	10.78	169.22
T_3	½	¼	¼	0	11.556	10.89	156.50
T_4	½	0	¼	¼	11.361	10.61	163.83
T_5	½	¼	0	¼	10.722	10.17	162.67
T_6	¼	¼	¼	¼	13.528	11.00	170.95
T_7	¼	½	0	¼	12.417	10.50	162.39
T_8	¼	½	¼	0	11.556	10.61	167.75
T_9	¼	0	½	¼	10.861	9.67	149.39
T_{10}	¼	¼	½	0	12.222	10.33	168.61
T_{11}	¼	¾	0	0	13.861	11.22	183.58
T_{12}	¼	0	¾	0	12.361	10.83	170.17
T_{13}	¾	¼	0	0	14.250	11.00	185.72
T_{14}	¾	0	¼	0	14.295	11.39	185.05
T_{15}	¾	0	0	¼	12.317	10.61	167.61
CD (5%)					1.945	NS	NS
SEm ±					0.930	0.31	7.36

Fig. 7. Effect of split application of NPK on the bunch weight of the plants

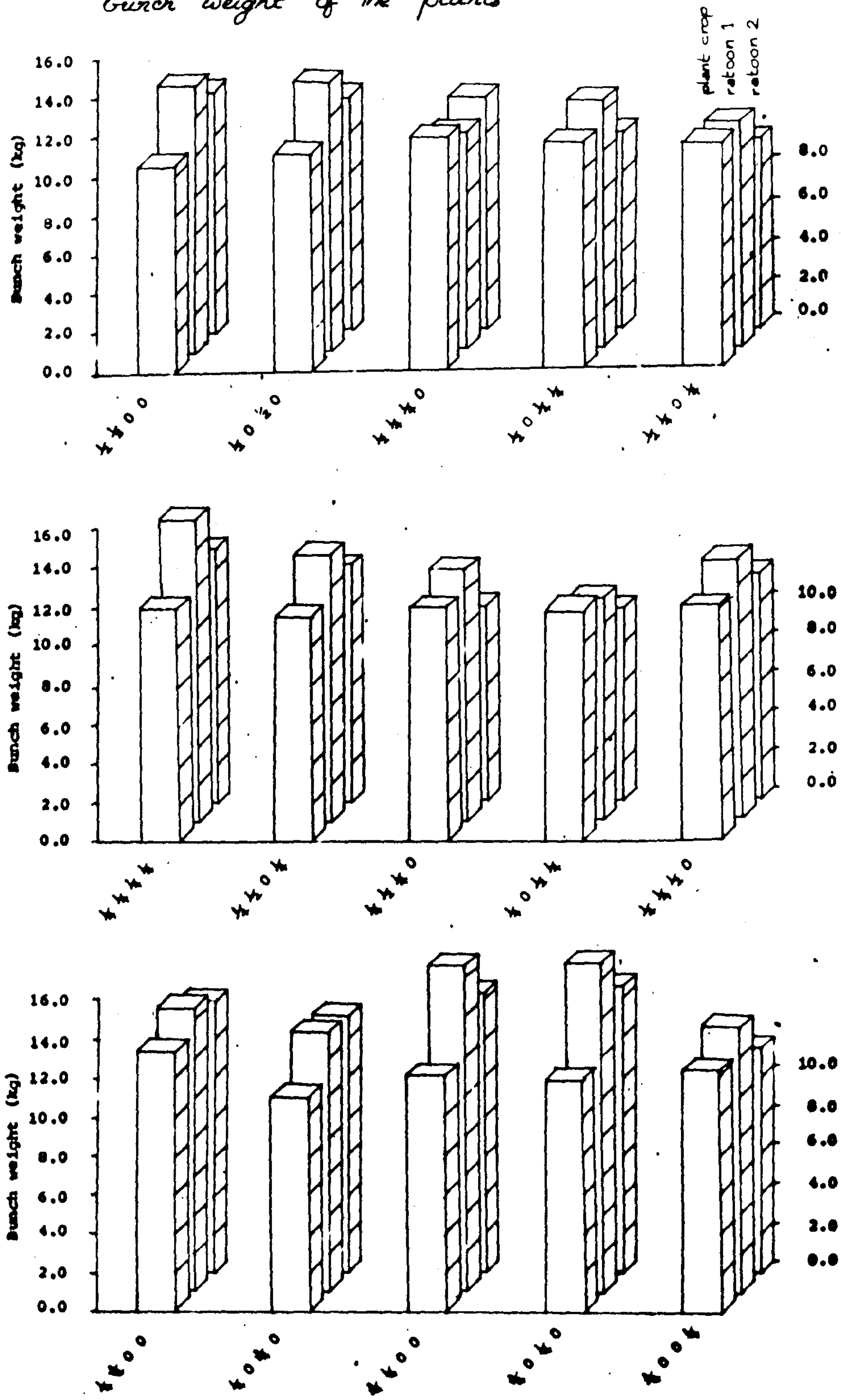


Plate-10. Bunches of T_1, T_6, T_{11}, T_{13} and T_{14}

Plate-11. Hands of T_1, T_6, T_{11}, T_{13} and T_{14}

Plate - 10.

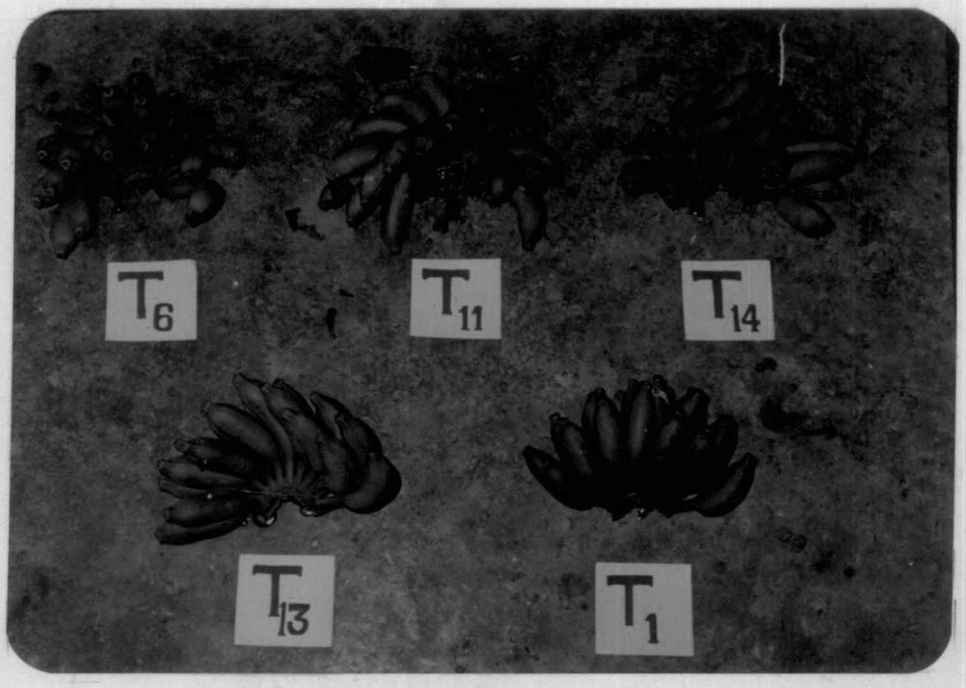


Plate - 11.

Table 53. Effect of split application of NPK on the physical characters of the fruit

Treatment Code	Splitting				Mean length (cm) Stalk	Edible portion	Apex	Total	Mean girth (cm)	Mean weight (g) Fruit	Pulp	Mean volume (cc) Fruit	Pulp	Mean pulp/peel ratio (by weight)
T_1	½	½	0	0	2.77	11.07	0.73	14.57	9.50	69.67	56.60	60.33	51.00	4.29
T_2	½	0	½	0	3.17	10.50	0.77	14.44	9.57	66.33	54.33	62.17	51.83	4.55
T_3	½	¼	¼	0	2.87	11.67	0.87	15.41	10.63	81.67	65.50	77.33	57.67	4.18
T_4	½	0	¼	¼	3.03	9.90	0.77	13.70	9.67	64.33	53.67	57.00	46.17	5.48
T_5	½	¼	0	¼	2.67	10.10	0.77	13.54	9.43	62.50	46.83	54.33	42.00	3.28
T_6	¼	¼	¼	¼	2.87	11.43	0.77	15.07	10.23	81.00	64.50	77.00	61.67	3.88
T_7	¼	½	0	¼	3.13	10.33	0.80	14.26	9.27	63.50	51.33	56.00	47.33	4.20
T_8	¼	½	¼	0	3.00	11.20	0.87	15.07	9.30	69.67	57.17	61.00	49.33	4.80
T_9	¼	0	½	¼	2.73	10.80	0.73	14.26	9.53	67.83	55.67	60;83	51.27	4.57
T_{10}	¼	¼	½	0	2.83	11.03	0.80	14.66	10.10	70.67	59.33	65.00	52.50	5.31
T_{11}	¼	¾	0	0	2.67	10.50	0.73	13.90	9.53	65.83	51.50	59.50	47.17	3.75
T_{12}	¼	0	¾	0	2.63	9.77	0.83	13.23	8.97	54.33	42.17	48.50	37.17	3.54
T_{13}	¾	¼	0	0	3.07	11.30	0.67	15.04	9.87	70.67	54.00	64.50	46.33	3.29
T_{14}	¾	0	¼	0	2.80	10.40	0.77	13.97	9.50	65.50	52.83	56.17	43.83	4.32
T_{15}	¾	0	0	¼	2.83	10.17	0.70	13.70	10.13	68.00	57.67	62.00	45.00	5.64
CD (5%)					NS	NS	NS	NS	NS	NS	NS	NS	NS	1.42
SEm ±					0.16	0.59	0.06	0.62	0.35	5.76	4.49	6.10	4.69	0.49

differences were obtained. T_{15} (¾, 0, 0, ¼) excelled all the other treatments with a ratio of 5.64 whereas the minimum ratio (3.28) was recorded in T_5 (½, ¼, 0, ¼).

ii) Chemical characters

Data on the chemical (qualitative) characters of the fruit as influenced by the different treatments are presented in Table 54.

There were no significant differences with regard to total soluble solids, non-reducing sugars, acidity or sugar/acid ratio. However, significant differences were observed with regard to reducing and total sugars. In the content of reducing sugars, T_{15} (¾, 0, 0, ¼), which recorded the highest percentage (17.30), was significantly superior to the control, T_1 (½, ½, 0, 0), with a content of 16.52 per cent. T_3 (½, ¼, ¼, 0) had the lowest value (15.97 per cent). In the total sugar content also, T_{15} (¾, 0, 0, ¼) had the highest value (17.43 per cent) which was significantly superior to that (16.71 per cent) of the control, T_1 (½, ½, 0, 0). Lowest percentage (16.28) was obtained in T_5 (½, ¼, 0, ¼).

2. Influence of split application of NPK fertilizers on the uptake of elements

a. Nutrient content

i) Nitrogen

Data on the percentage of N in the different plant

Table 54. Effect of split application of NPK on the chemical characters (quality) of the fruit

Treatment		T.S.S. (%)	Sugars (%)			Acidity (%)	Sugar/ Acid ratio
Code	Splitting		Reducing	Non-Reducing	Total		
T_1	½ ½ 0 0	27.33	16.52	0.19	16.71	0.46	36.43
T_2	½ 0 ½ 0	28.00	16.45	0.38	16.83	0.48	35.42
T_3	½ ¼ ¼ 0	26.50	15.97	0.39	16.36	0.50	32.82
T_4	½ 0 ¼ ¼	25.83	16.33	0.29	16.62	0.50	33.36
T_5	½ ¼ 0 ¼	27.00	16.11	0.17	16.28	0.46	35.85
T_6	¼ ¼ ¼ ¼	28.00	16.48	0.45	16.93	0.52	32.68
T_7	¼ ½ 0 ¼	28.33	16.92	0.18	17.10	0.52	33.28
T_8	¼ ½ ¼ 0	27.67	16.53	0.18	16.71	0.48	35.21
T_9	¼ 0 ½ ¼	27.83	16.68	0.21	16.89	0.50	33.88
T_{10}	¼ ¼ ½ 0	27.00	17.08	0.19	17.27	0.52	33.31
T_{11}	¼ ¾ 0 0	28.67	17.17	0.16	17.33	0.50	34.77
T_{12}	¼ 0 ¾ 0	28.33	17.20	0.19	17.39	0.50	34.89
T_{13}	¾ ¼ 0 0	28.67	17.08	0.22	17.30	0.54	32.31
T_{14}	¾ 0 ¼ 0	28.17	17.08	0.25	17.33	0.50	34.77
T_{15}	¾ 0 0 ¼	29.00	17.30	0.13	17.43	0.52	33.61
CD (5%)		NS	0.32	NS	0.30	NS	NS
SEm ±		0.82	0.12	0.12	0.10	0.03	1.69

parts are presented in Table 55. Significant differences were evident only in the peduncle. The highest percentage (2.98) was recorded in T_{10} (¼, ¼, ¼, 0) which was significantly superior to the control T_1 (½, ½, 0, 0) which had a value of 2.16%. The lowest value (1.31%) was in T_{14} (¾, 0, ¼, 0).

ii) Phosphorus

Data pertaining to the concentration of P in the different plant parts as influenced by the different treatments are given in Table 56. The differences due to the treatments were not statistically significant.

iii) Potassium

The percentage of K in the different plant parts as influenced by the different treatments are given in Table 57. The differences were significant only in the pseudostem and the peduncle. In the pseudostem, the maximum percentage (2.53) was recorded in T_4 (½, 0, ¼, ¼). This was significantly superior to the control, T_1 (½, ½, 0, 0) which recorded 1.82%. The percentage was the lowest (1.42) in T_3 (½, ¼, ¼, 0). In the peduncle, T_2 (½, 0, ½, 0) recorded the maximum percentage (7.30). This was on par with T_{11} (¼, ¾, 0, 0) with 6.00% and T_{14}

Table 55. **Effect of split application of NPK on the N content of the different plant parts at harvest**

Treatment					Mean content of N (%)			
Code	Splitting				Pseudo-stem	Leaves	Peduncle	Fruits
T_1	½	½	0	0	1.28	1.93	2.16	1.28
T_2	½	0	½	0	1.42	1.88	1.58	1.12
T_3	½	¼	¼	0	1.63	1.72	2.34	0.96
T_4	½	0	¼	¼	1.46	2.34	1.93	1.26
T_5	½	¼	0	¼	1.42	2.00	2.09	1.08
T_6	¼	¼	¼	¼	1.58	1.88	1.79	1.01
T_7	¼	½	0	¼	1.83	1.81	1.83	1.38
T_8	¼	½	¼	0	1.65	1.86	2.43	0.94
T_9	¼	0	½	¼	1.56	2.34	1.88	1.01
T_{10}	¼	¼	½	0	1.42	1.93	2.98	1.05
T_{11}	¼	¼	0	0	1.35	1.93	2.16	1.45
T_{12}	¼	0	¾	0	1.72	2.11	2.20	1.15
T_{13}	¾	¼	0	0	1.51	2.07	2.16	1.03
T_{14}	¾	0	¼	0	1.47	2.02	1.31	1.08
T_{15}	¾	0	0	¼	1.38	2.22	2.80	1.56
CD (5%)					NS	NS	0.73	NS
SEm ±					0.15	0.22	0.25	0.47

Table 56. Effect of split application of NPK on the P content of the different plant parts at harvest

Treatment		Mean content of P (%)			
Code	Splitting	Pseudo-stem	Leaves	Peduncle	Fruits
T_1	½ ½ 0 0	0.096	0.083	0.204	0.117
T_2	½ 0 ½ 0	0.100	0.085	0.219	0.129
T_3	½ ¼ ¼ 0	0.077	0.086	0.169	0.127
T_4	½ 0 ¼ ¼	0.079	0.090	0.183	0.125
T_5	½ ¼ 0 ¼	0.102	0.084	0.229	0.110
T_6	¼ ¼ ¼ ¼	0.086	0.075	0.225	0.121
T_7	¼ ½ 0 ¼	0.073	0.073	0.196	0.115
T_8	¼ ½ ¼ 0	0.094	0.075	0.195	0.129
T_9	¼ 0 ½ ¼	0.098	0.096	0.169	0.110
T_{10}	¼ ¼ ½ 0	0.100	0.071	0.192	0.113
T_{11}	¼ ¼ 0 0	0.100	0.077	0.255	0.129
T_{12}	¼ 0 ¼ 0	0.129	0.096	0.198	0.113
T_{13}	¼ ¼ 0 0	0.100	0.090	0.192	0.123
T_{14}	¼ 0 ¼ 0	0.094	0.079	0.244	0.121
T_{15}	¼ 0 0 ¼	0.106	0.072	0.213	0.119
CD (5%)		NS	NS	NS	NS
SEm ±		0.01	0.01	0.03	0.01

Table 57. Effect of split application of NPK on the K content of the different plant parts at harvest

Treatment					Content of K (%)			
Code	Splitting				Pseudo-stem	Leaves	Peduncle	Fruits
T_1	½	½	0	0	1.82	2.20	5.30	2.09
T_2	½	0	½	0	2.25	2.50	7.30	2.35
T_3	½	¼	¼	0	1.42	1.90	4.70	2.13
T_4	½	0	¼	¼	2.53	2.20	5.60	2.27
T_5	½	¼	0	¼	1.74	1.70	4.30	2.08
T_6	¼	¼	¼	¼	2.02	2.50	5.00	2.33
T_7	¼	½	0	¼	1.80	2.30	5.10	2.12
T_8	¼	½	¼	0	1.96	3.30	5.30	2.03
T_9	¼	0	½	¼	1.77	2.10	2.90	2.08
T_{10}	¼	¼	½	0	1.87	2.40	5.10	1.90
T_{11}	¼	¾	0	0	1.52	1.90	6.00	2.25
T_{12}	¼	0	¾	0	2.44	2.10	5.30	2.18
T_{13}	¾	¼	0	0	1.95	2.20	5.20	2.52
T_{14}	¾	0	¼	0	1.66	3.10	5.80	2.32
T_{15}	¾	0	0	¼	2.23	1.80	5.50	2.10
CD (5%)					0.45	NS	1.61	NS
SEM ±					0.16	0.42	0.56	0.24

(¼, 0, ¼, 0) with 5.80%,and significantly superior to the control, T_1 (½, ½, 0, 0), with 5.30%. T_9 (¼, 0, ½, ¼) had the lowest percentage (2.90).

iv) Calcium

Data pertaining to the percentage of Ca in the different plant parts as influenced by the various treatments are given in Table 58. The pseudostem and the leaves showed significant differences. In the pseudostem, T_9 (¼, 0, ½, ¼) recorded the highest (1.09%) and T_6 (¼, ¼, ¼, ¼) the lowest (0.47%) values. With regard to the leaves, T_9 (¼, 0, ½, ¼) had the highest percentage (1.21). This was significantly superior to T_1 (½, ½, 0, 0) with 0.91%. T_{15} (¼, 0, 0, ¼) had the lowest percentage (0.75).

v) Magnesium

Data with regard to the percentage of Mg in the different plant parts are given in Table 59. The differences obtained were not statistically significant in any of the parts.

vi) Sulphur

Data pertaining to the concentration of S in the different plant parts are given in Table 60. The pseudostem alone showed significant differences with regard to the concentration of S. T_{12} (¼, 0, ¼, 0), which had the

Table 58. **Effect of split application of NPK on the Ca content of the different plant parts at harvest**

Treatment		Content of Ca (%)			
Code	Splitting	Pseudo-stem	Leaves	Peduncle	Fruits
T_1	½ ½ 0 0	0.68	0.91	0.38	0.16
T_2	½ 0 ½ 0	0.91	1.15	0.33	0.24
T_3	½ ¼ ¼ 0	0.89	0.98	0.34	0.39
T_4	½ 0 ¼ ¼	0.79	0.89	0.51	0.15
T_5	½ ¼ 0 ¼	0.71	0.80	0.49	0.19
T_6	¼ ¼ ¼ ¼	0.47	0.77	0.37	0.09
T_7	¼ ½ 0 ¼	1.03	1.20	0.31	0.13
T_8	¼ ½ ¼ 0	0.86	0.95	0.32	0.23
T_9	¼ 0 ½ ¼	1.09	1.21	0.42	0.33
T_{10}	¼ ¼ ½ 0	0;70	0.98	0.50	0.17
T_{11}	¼ ¾ 0 0	1.05	0.92	0.25	0.20
T_{12}	¼ 0 ¾ 0	0.61	0.93	0.47	0.19
T_{13}	¾ ¼ 0 0	0.67	0.84	0.33	0.34
T_{14}	¾ 0 ¼ 0	0.80	0.85	0.43	0.26
T_{15}	¾ 0 0 ¼	0.69	0.75	0.28	0.21
CD (5%)		0.35	0.28	NS	NS
SEm ±		0.12	0.09	0.09	0.08

Table 59. Effect of split application of NPK on the Mg content of the different plant parts at harvest

Treatment					Content of Mg (%)			
Code	Splitting				Pseudo-stem	Leaves	Peduncle	Fruits
T_1	½	½	0	0	0.33	0.37	0.39	0.26
T_2	½	0	½	0	0.28	0.40	0.29	0.17
T_3	½	¼	¼	0	0.35	0.35	0.18	0.40
T_4	½	0	¼	¼	0.28	0.42	0.22	0.22
T_5	½	¼	0	¼	0.32	0.44	0.31	0.17
T_6	¼	¼	¼	¼	0.24	0.30	0.30	0.19
T_7	¼	½	0	¼	0.49	0.44	0.30	0.28
T_8	¼	½	¼	0	0.37	0.38	0.26	0.33
T_9	¼	0	½	¼	0.50	0.42	0.31	0.36
T_{10}	¼	¼	½	0	0.24	0.31	0.28	0.28
T_{11}	¼	¾	0	0	0.47	0.36	0.13	0.33
T_{12}	¼	0	¾	0	0.24	0.35	0.28	0.26
T_{13}	¾	¼	0	0	0.25	0.30	0.22	0.33
T_{14}	¾	0	¼	0	0.21	0.32	0.22	0.40
T_{15}	¾	0	0	¼	0.27	0.31	0.16	0.33
CD (5%)					NS	NS	NS	NS
SEm ±					0.08	0.05	0.08	0.26

Table 60. Effect of split application of NPK on the S content of the different plant parts at harvest

Treatment					Content of S (%)			
Code	Splitting				Pseudo-stem	Leaves	Peduncle	Fruits
T_1	½	½	0	0	0.052	0.086	0.176	0.029
T_2	½	0	½	0	0.054	0.111	0.207	0.030
T_3	½	¼	¼	0	0.046	0.106	0.144	0.031
T_4	½	0	¼	¼	0.036	0.093	0.215	0.034
T_5	½	¼	0	¼	0.065	0.100	0.164	0.034
T_6	¼	¼	¼	¼	0.054	0.118	0.158	0.032
T_7	¼	½	0	¼	0.056	0.086	0.145	0.028
T_8	¼	½	¼	0	0.043	0.090	0.151	0.032
T_9	¼	0	½	¼	0.085	0.102	0.167	0.032
T_{10}	¼	¼	½	0	0.058	0.100	0.140	0.029
T_{11}	¼	¼	0	0	0.047	0.089	0.149	0.035
T_{12}	¼	0	¼	0	0.106	0.084	0.195	0.031
T_{13}	¼	¼	0	0	0.052	0.098	0.187	0.030
T_{14}	¼	0	¼	0	0.047	0.109	0.167	0.033
T_{15}	¼	0	0	¼	0.080	0.104	0.140	0.029
CD (5%)					0.029	NS	NS	NS
SEm ±					0.01	0.01	0.02	0.003

highest percentage (0.106), was significantly superior to the control T_1 (½, ½, 0, 0) with 0.052%. Lowest percentage (0.036) was recorded in T_4 (½, 0, ¼, ¼).

vii) Copper

Data relating to the concentration of Cu in the different plant parts as influenced by the different treatments are presented in Table 61. The treatment differences were not found to be statistically significant.

viii) Iron

Data pertaining to the Fe content of the different plant parts as influenced by the different treatments are presented in Table 62. The treatments exhibited significant differences only in the peduncle. T_5 (½, ¼, 0, ¼) had the highest content (1352.0 ppm) and was significantly superior to the control T_1 (½, ½, 0, 0) with 574.4 ppm. T_2 (½, 0, ½, 0) recorded the lowest content (307.7 ppm).

ix) Manganese

Data on the Mn content of the different plant parts are presented in Table 63. Significant differences were obtained only in the case of the pseudostem, wherein, the maximum content (1262.7 ppm) was observed in T_9 (¼, 0, ½, ¼). This was significantly superior to the control, T_1 (½, ½, 0, 0), with 807.3 ppm and the lowest value (666.7 ppm) was recorded in T_7 (¼, ½, 0, ¼).

Table 61. **Effect of split application of NPK on the Cu content of the different plant parts at harvest**

Treatment					Content of Cu (ppm)			
Code	Splitting				Pseudo-stem	Leaves	Peduncle	Fruits
T_1	½	½	0	0	37.8	33.3	32.9	16.6
T_2	½	0	½	0	38.4	34.3	25.3	17.0
T_3	½	¼	¼	0	37.3	38.1	26.0	15.4
T_4	½	0	¼	¼	39.3	29.8	24.1	15.4
T_5	½	¼	0	¼	42.6	36.8	29.1	15.3
T_6	¼	¼	¼	¼	41.8	33.4	29.5	17.3
T_7	¼	½	0	¼	33.7	44.3	26.8	17.1
T_8	¼	½	¼	0	36.8	35.5	23.8	19.1
T_9	¼	0	½	¼	35.0	37.0	48.9	16.8
T_{10}	¼	¼	½	0	38.8	32.4	23.4	18.4
T_{11}	¼	¾	0	0	31.9	31.9	32.1	18.2
T_{12}	¼	0	¾	0	37.9	40.1	23.8	16.0
T_{13}	¾	¼	0	0	43.3	31.9	23.3	16.5
T_{14}	¾	0	¼	0	40.9	35.2	43.8	19.0
T_{15}	¾	0	0	¼	42.3	36.8	18.4	16.1
CD (5%)					NS	NS	NS	NS
SEm ±					4.89	3.68	6.52	1.15

Table 62. Effect of split application of NPK on the Fe content of the different plant parts at harvest

Treatment		Content of Fe (ppm)			
Code	Splitting	Pseudo-stem	Leaves	Peduncle	Fruits
T_1	½ ½ 0 0	578.4	725.7	574.4	137.8
T_2	½ 0 ½ 0	807.5	1116.2	307.7	132.5
T_3	½ ¼ ¼ 0	1069.9	1064.8	628.5	90.1
T_4	½ 0 ¼ ¼	598.0	1009.9	493.7	101.1
T_5	½ ¼ 0 ¼	1433.0	665.7	1352.0	126.0
T_6	¼ ¼ ¼ ¼	1185.7	759.5	956.4	133.6
T_7	¼ ½ 0 ¼	1085.8	843.7	509.0	96.7
T_8	¼ ½ ¼ 0	673.9	1063.5	327.6	110.8
T_9	¼ 0 ½ ¼	543.4	1200.8	1070.7	197.9
T_{10}	¼ ¼ ½ 0	877.7	1157.1	609.9	126.5
T_{11}	¼ ¼ 0 0	346.1	926.0	527.9	88.2
T_{12}	¼ 0 ¼ 0	866.1	1046.6	881.0	99.9
T_{13}	¼ ¼ 0 0	518.1	894.6	430.6	114.3
T_{14}	¼ 0 ¼ 0	763.5	961.6	490.2	66.6
T_{15}	¼ 0 0 ¼	814.2	836.8	654.8	120.3
CD (5%)		NS	NS	566.65	NS
SEm ±		250.20	185.32	195.65	31.11

Table 63. Effect of split application of NPK on the Mn content of the different plant parts at harvest

Treatment					Content of Mn (ppm)			
Code	Splitting				Pseudo-stem	Leaves	Peduncle	Fruits
T_1	½	½	0	0	807.3	5745.3	311.7	138.0
T_2	½	0	½	0	1055.0	5418.3	482.7	262.7
T_3	½	¼	¼	0	1046.3	4463.7	376.7	211.3
T_4	½	0	¼	¼	870.7	3665.7	445.0	203.0
T_5	½	¼	0	¼	904.3	4760.0	394.0	170.0
T_6	¼	¼	¼	¼	686.7	6230.7	440.0	272.0
T_7	¼	½	0	¼	666.7	4530.7	362.7	154.3
T_8	¼	½	¼	0	876.7	3502.3	394.7	167.7
T_9	¼	0	½	¼	1262.7	6644.0	543.3	194.3
T_{10}	¼	¼	½	0	929.3	6736.0	453.7	210.3
T_{11}	¼	¼	0	0	1022.3	5323.3	382.0	165.0
T_{12}	¼	0	¼	0	805.0	5048.0	520.0	276.0
T_{13}	¼	¼	0	0	696.7	6573.3	391.7	151.0
T_{14}	¼	0	¼	0	1005.3	7359.0	458.7	225.0
T_{15}	¼	0	0	¼	117.7	6665.0	389.5	212.0
CD (5%)					335.20	NS	NS	NS
SEm ±					115.73	1107.12	48.67	36.94

x) Zinc

Data relating to the concentration of Zn in the various plant parts as influenced by the different treatments are presented in Table 64. Significant differences with regard to the different treatments were obtained only in the fruits. Highest content (54.2 ppm) was recorded in T_{13} (¼, ¼, 0, 0). This treatment was significantly superior to the control, T_1 (½, ½, 0, 0), with 24.6 ppm. Lowest content (11.6 ppm) was recorded in T_{11} (¼, ¼, 0, 0).

b. Range of nutrient content

Data pertaining to the mean, standard deviation and range values of nutrient content in the different plant parts as influenced by the treatments are given in Table 65. The values were calculated by pooling the data for all the treatments.

The pseudostem had the maximum content of Cu (38.5 ppm), and the leaves, the maximum content of Ca (0.94%), Mg (0.36%), Fe (951.5 ppm) and Mn (5511.1 ppm). Content of N, P, K, S and Zn were maximum in the peduncle (2.11%, 0.206%, 5.23%, 0.167% and 45.2 ppm, respectively). Minimum content of K (1.93%) and Zn (28.2 ppm) were recorded in the pseudostem, P (0.082%) in the leaves, N (1.16%), Ca (0.22%), S (0.031%), Cu (17.0 ppm), Fe (116.2 ppm) and Mn (200.8 ppm) in the fruits and Mg (0.26%) in the peduncle.

Table 64. Effect of split application of NPK on the Zn content of the different plant parts at harvest

Treatment					Content of Zn (ppm)			
Code	Splitting				Pseudo-stem	Leaves	Peduncle	Fruits
T_1	½	½	0	0	19.2	24.2	42.8	24.6
T_2	½	0	½	0	47.7	37.4	34.2	27.9
T_3	½	¼	¼	0	22.8	36.4	22.4	34.5
T_4	½	0	¼	¼	34.8	37.7	35.1	31.6
T_5	½	¼	0	¼	25.2	52.3	53.8	39.5
T_6	¼	¼	¼	¼	19.9	36.1	65.6	38.5
T_7	¼	½	0	¼	31.7	24.3	48.8	30.1
T_8	¼	½	¼	0	37.3	55.2	46.8	43.6
T_9	¼	0	½	¼	12.7	47.4	72.7	45.1
T_{10}	¼	¼	½	0	29.4	71.1	51.1	20.2
T_{11}	¼	¾	0	0	25.8	35.1	29.0	11.6
T_{12}	¼	0	¾	0	30.1	67.1	61.8	26.1
T_{13}	¾	¼	0	0	26.7	23.0	23.7	54.2
T_{14}	¾	0	¼	0	29.8	60.6	55.7	16.6
T_{15}	¾	0	0	¼	29.1	42.2	34.0	16.5
CD (5%)					NS	NS	NS	19.86
SEm ±					6.58	13.31	17.57	6.86

Table 65. Effect of split application of NPK on the mean, standard deviation and range of the content of elements in the different plant parts at harvest

Nutrient	Pseudostem	Leaves	Peduncle	Fruits
N (%)	1.51* ± 0.15** (1.28 - 1.82)***	2.00 ± 0.18 (1.72 - 2.34)	2.11 ± 0.43 (1.31 - 2.98)	1.16 ± 0.19 (0.94 - 1.96)
P (%)	0.096 ± 0.014 (0.073 - 0.129)	0.082 ± 0.010 (0.071 - 0.096)	0.206 ± 0.025 (0.169 - 0.255)	0.120 ± 0.010 (0.110 - 0.129)
K (%)	1.93 ± 0.32 (1.42 - 2.53)	2.28 ± 0.44 (1.70 - 3.30)	5.23 ± 0.93 (2.90 - 7.30)	2.18 ± 0.16 (1.90 - 2.52)
Ca (%)	0.80 ± 0.18 (0.47 - 1.09)	0.94 ± 0.14 (0.75 - 1.21)	0.38 ± 0.08 (0.25 - 0.51)	0.22 ± 0.08 (0.09 - 0.39)
Mg (%)	0.32 ± 0.10 (0.21 - 0.50)	0.36 ± 0.05 (0.30 - 0.44)	0.26 ± 0.07 (0.13 - 0.39)	0.29 ± 0.08 (0.17 - 0.40)
S (%)	0.059 ± 0.017 (0.036 - 0.106)	0.098 ± 0.010 (0.084 - 0.118)	0.167 ± 0.025 (0.140 - 0.215)	0.031 ± 0.001 (0.028 - 0.035)
Cu (ppm)	38.5 ± 3.3 (31.9 - 43.3)	35.4 ± 3.7 (29.8 - 44.3)	28.8 ± 8.1 (18.4 - 48.9)	17.0 ± 1.3 (15.3 - 19.1)
Fe (ppm)	810.8 ± 289.3 (346.1 - 1433.0)	951.5 ± 162.1 (665.7 - 1200.8)	634.3 ± 302.1 (307.7 - 1352.0)	116.2 ± 30.2 (66.6 - 197.9)
Mn (ppm)	914.9 ± 173.6 (666.7 - 1262.7)	5511.1 ± 1181.7 (3502.3 - 7359.0)	423.1 ± 62.1 (311.7 - 543.3)	200.8 ± 44.3 (138.0 - 276.0)
Zn (ppm)	28.2 ± 8.3 (12.7 - 47.7)	43.3 ± 15.2 (23.0 - 71.1)	45.2 ± 15.3 (22.4 - 72.7)	30.7 ± 12.0 (11.6 - 54.2)

* Mean

** Standard deviation

*** Range

c. **Nutrient uptake**

i) **Nitrogen**

Data pertaining to the uptake and the percentage contribution of N by the different plant parts as well as the total N uptake are given in Table 66. Significant differences in the uptake were observed only in the fruits. T_{15} (¼, 0, 0, ¼), which recorded the highest uptake (42.70 g), was on par (32.37 g) with the control, T_1 (½, ½, 0, 0). Lowest uptake (18.81 g) was obtained in T_6 (¼, ¼, ¼, ¼).

ii) **Phosphorus**

Data pertaining to the uptake and the percentage contribution of P by the different plant parts as well as the total P uptake, as influenced by the different treatments, are presented in Table 67. The differences were significant only in the fruits. Maximum uptake (4.18 g) was recorded in T_{14} (¼, 0, ¼, 0). This was significantly superior to the control, T_1 (½, ½, 0, 0), with 2.92 g. The lowest uptake (2.26 g) was obtained in T_{12} (¼, 0, ¼, 0).

iii) **Potassium**

Data on the uptake and the percentage contribution of K by the different plant parts as well as the total K

Table 66. Effect of split application of NPK on the N uptake of the different plant parts at harvest

Treatment		Uptake of N (g)				
Code	Splitting	Pseudo-stem	Leaves	Peduncle	Fruits	Total
T_1	½ ½ 0 0	17.69 (17.14)	50.97 (49.40)	2.16 (2.09)	32.37 (31.37)	103.19
T_2	½ 0 ½ 0	23.29 (22.39)	48.05 (46.20)	2.30 (2.21)	30.37 (29.20)	104.01
T_3	½ ¼ ¼ 0	35.95 (32.81)	50.13 (45.75)	2.96 (2.70)	20.54 (18.74)	109.58
T_4	½ 0 ¼ ¼	28.46 (23.96)	56.43 (47.52)	2.15 (1.81)	31.72 (26.71)	118.76
T_5	½ ¼ 0 ¼	23.99 (22.72)	55.44 (52.51)	2.55 (2.41)	23.61 (22.36)	105.59
T_6	¼ ¼ ¼ ¼	24.09 (25.84)	48.12 (51.61)	2.21 (2.37)	18.81 (20.18)	93.23
T_7	¼ ½ ¼ 0	26.85 (24.03)	50.04 (44.78)	2.18 (1.95)	32.67 (29.24)	111.74
T_8	¼ ½ ¼ 0	31.93 (28.02)	55.27 (48.50)	3.53 (3.10)	23.23 (20.38)	113.96
T_9	¼ 0 ½ ¼	20.64 (23.04)	45.94 (51.28)	2.21 (2.47)	20.79 (23.21)	89.58
T_{10}	¼ ¼ ½ 0	19.46 (18.18)	59.97 (56.03)	3.35 (3.13)	24.25 (22.66)	107.03
T_{11}	¼ ¼ 0 0	24.00 (20.53)	52.23 (44.68)	2.53 (2.17)	38.14 (32.62)	116.90
T_{12}	¼ 0 ¼ 0	24.53 (21.35)	65.05 (56.62)	2.64 (2.30)	22.67 (19.73)	114.89
T_{13}	¼ ¼ 0 0	27.66 (22.26)	62.03 (29.91)	2.92 (2.35)	31.67 (25.48)	124.28
T_{14}	¼ 0 ¼ 0	28.99 (23.87)	53.31 (43.90)	2.04 (1.68)	37.09 (30.55)	121.43
T_{15}	¼ 0 0 ¼	24.70 (17.25)	71.81 (50.14)	3.99 (2.79)	42.70 (29.82)	143.20
CD (5%)		NS	NS	NS	12.54	NS
SEm ±		3.88	8.28	0.47	4.33	10.86

Note: Figures in parentheses indicate the percentage to the total

Table 67. Effect of split application of NPK on the P uptake of the different plant parts at harvest

Treatment		Uptake of P (g)				
Code	Splitting	Pseudo-stem	Leaves	Peduncle	Fruits	Total
T_1	½ ½ 0 0	1.37 (20.42)	2.20 (32.79)	0.216 (3.27)	2.92 (43.52)	6.71
T_2	½ 0 ½ 0	1.63 (21.17)	2.17 (28.18)	0.306 (4.03)	3.59 (46.62)	7.70
T_3	½ ¼ ¼ 0	1.77 (24.82)	2.44 (34.22)	0.209 (2.95)	2.71 (38.01)	7.13
T_4	½ 0 ¼ ¼	1.52 (21.32)	2.27 (31.84)	0.204 (2.80)	3.14 (44.04)	7.13
T_5	½ ¼ 0 ¼	1.73 (25.37)	2.31 (33.87)	0.280 (4.10)	2.50 (36.66)	6.82
T_6	¼ ¼ ¼ ¼	1.33 (22.17)	1.93 (32.17)	0.316 (5.33)	2.42 (40.33)	6.00
T_7	¼ ½ 0 ½	1.10 (18.30)	2.03 (33.78)	0.234 (3.83)	2.65 (44.09)	6.01
T_8	¼ ½ ¼ 0	1.89 (24.67)	2.27 (29.63)	0.277 (3.66)	3.22 (42.04)	7.66
T_9	¼ 0 ½ ¼	1.32 (22.60)	1.92 (32.88)	0.196 (3.42)	2.40 (41.10)	5.84
T_{10}	¼ ¼ ½ 0	1.36 (21.32)	2.19 (34.33)	0.220 (3.44)	2.61 (40.91)	6.38
T_{11}	¼ ¾ 0 0	1.74 (23.17)	2.10 (27.96)	0.299 (3.99)	3.37 (44.88)	7.51
T_{12}	¼ 0 ¾ 0	1.85 (25.31)	2.96 (40.49)	0.241 (3.28)	2.26 (30.92)	7.81
T_{13}	¾ ¼ 0 0	1.80 (21.28)	2.65 (31.32)	0.254 (2.96)	3.76 (44.44)	8.46
T_{14}	¾ 0 ¼ 0	1.84 (21.85)	2.04 (24.23)	0.359 (4.28)	4.18 (49.64)	8.42
T_{15}	¾ 0 0 ¼	2.00 (24.78)	2.29 (28.38)	0.308 (3.84)	3.47 (43.00)	8.07
CD (5%)		NS	NS	NS	1.10	NS
SEm ±		0.29	0.37	0.06	0.38	0.70

Note: Figures in parentheses indicate the percentage to the total

uptake in the plant are presented in Table 68. Uptake of K in the pseudostem as well as the total K uptake in the plant were significant. The pseudostem contained the maximum quantity (48.43 g) in T_4, which was significantly superior to the control, T_1 (½, ½, 0, 0), with 25.73 g. T_9 (¼, 0, ½, ¼) recorded the lowest quantity (23.80 g). With regard to the total uptake, T_{14} (¼, 0, ¼, 0) had the maximum (206.63 g) and was significantly superior to the control, T_1 (½, ½, 0, 0), with a value of 139.71 g. Minimum uptake (111.07 g) was recorded by T_9 (¼, 0, ½, ¼).

iv) Calcium

Data pertaining to the effect of the different treatments on the Ca uptake and the percentage contribution by the different plant organs as well as the total Ca uptake in the plant are presented in Table 69. Neither the uptake in the different plant organs nor the total uptake recorded statistically significant differences.

v) Magnesium

Data pertaining to the effect of different treatments on the uptake and the percentage contribution of Mg by the different plant parts as well as the total Mg uptake in the plant are presented in Table 70. The differences obtained were not statistically significant either in the plant parts or in the whole plant.

Table 68. Effect of split application of NPK on the K uptake of the different plant parts at harvest

Treatment		Uptake of K (g)				
Code	Splitting	Pseudo-stem	Leaves	Peduncle	Fruits	Total
T_1	½ ½ 0 0	25.73 (18.42)	58.26 (41.70)	5.43 (3.89)	50.29 (35.99)	139.71
T_2	½ 0 ½ 0	36.75 (20.71)	64.59 (36.39)	10.58 (5.96)	65.57 (36.94)	177.49
T_3	½ ¼ ¼ 0	31.32 (22.99)	53.72 (39.43)	5.85 (4.29)	45.35 (33.29)	136.24
T_4	½ 0 ¼ ¼	48.43 (29.04)	55.25 (33.12)	6.19 (3.71)	56.94 (34.13)	166.81
T_5	½ ¼ 0 ¼	29.45 (23.25)	45.54 (35.96)	5.16 (4.08)	46.49 (36.71)	126.64
T_6	¼ ¼ ¼ ¼	29.65 (20.46)	63.94 (44.12)	6.42 (4.43)	44.90 (30.99)	144.91
T_7	¼ ½ 0 ¼	26.25 (18.00)	65.00 (44.58)	6.31 (4.33)	48.24 (33.09)	145.80
T_8	¼ ½ ¼ 0	39.64 (20.61)	94.57 (49.18)	7.65 (3.98)	50.44 (26.23)	192.30
T_9	¼ 0 ½ ¼	23.80 (21.43)	40.97 (36.89)	3.59 (3.23)	42.71 (38.45)	111.07
T_{10}	¼ ¼ ½ 0	24.72 (16.88)	72.26 (49.34)	5.66 (3.87)	43.80 (29.91)	146.44
T_{11}	¼ ¼ 0 0	26.54 (18.57)	51.59 (36.09)	6.93 (4.85)	57.88 (40.49)	142.94
T_{12}	¼ 0 ¼ 0	34.43 (23.22)	64.43 (43.45)	6.54 (4.41)	42.89 (28.92)	148.29
T_{13}	¼ ¼ 0 0	34.17 (18.49)	64.59 (34.96)	7.24 (3.92)	78.77 (42.63)	184.77
T_{14}	¼ 0 ¼ 0	32.41 (15.68)	85.29 (41.28)	9.03 (4.37)	79.90 (38.67)	206.63
T_{15}	¼ 0 0 ¼	41.21 (24.70)	57.29 (34.33)	8.03 (4.81)	60.35 (36.16)	166.88
CD (5%)		13.39	NS	NS	NS	50.94
SEm ±		4.62	12.04	1.25	8.84	17.59

Note: Figures in parentheses indicate the percentage to the total

Table 69. Effect of split application of NPK on the Ca uptake of the different plant parts at harvest

Treatment					Uptake of Ca (g)				
Code	Splitting				Pseudo-stem	Leaves	Peduncle	Fruits	Total
T_1	½	½	0	0	9.61 (24.84)	24.39 (63.04)	0.399 (1.03)	4.29 (11.09)	38.69
T_2	½	0	½	0	14.70 (28.55)	28.92 (56.18)	0.431 (0.84)	7.43 (14.43)	51.48
T_3	½	¼	¼	0	19.82 (34.87)	28.37 (49.91)	0.434 (0.76)	8.22 (14.46)	56.84
T_4	½	0	¼	¼	15.22 (37.50)	20.96 (51.64)	0.570 (1.40)	3.84 (9.46)	40.59
T_5	½	¼	0	¼	12.03 (31.62)	22.02 (57.89)	0.554 (1.45)	3.44 (9.04)	38.04
T_6	¼	¼	¼	¼	7.35 (24.81)	19.82 (66.91)	0.487 (1.66)	1.96 (6.62)	29.62
T_7	¼	½	0	¼	14.32 (28.13)	33.36 (65.54)	0.382 (0.75)	2.84 (5.58)	50.90
T_8	¼	½	¼	0	17.48 (33.35)	28.87 (55.07)	0.466 (0.90)	5.60 (10.68)	52.42
T_9	¼	0	½	¼	14.91 (32.64)	23.72 (51.93)	0.506 (1.11)	6.54 (14.32)	45.68
T_{10}	¼	¼	½	0	9.50 (21.53)	30.04 (68.09)	0.530 (1.20)	4.05 (9.18)	44.12
T_{11}	¼	¾	0	0	18.93 (38.75)	24.95 (51.08)	0.293 (0.59)	4.68 (9.58)	48.85
T_{12}	¼	0	¾	0	8.66 (20.96)	28.71 (69.50)	0.539 (1.31)	3.40 (8.23)	41.31
T_{13}	¾	¼	0	0	12.35 (25.64)	24.97 (51.84)	0.431 (0.89)	10.42 (21.63)	48.17
T_{14}	¾	0	¼	0	15.70 (32.77)	22.53 (47.02)	0.665 (1.40)	9.01 (18.81)	47.91
T_{15}	¾	0	0	¼	12.86 (29.89)	24.04 (55.87)	0.409 (0.95)	5.72 (13.29)	43.03
CD (5%)					NS	NS	NS	NS	NS
SEm ±					2.73	3.26	0.13	2.08	5.05

Note: Figures in parentheses indicate the percentage to the total

Table 70. Effect of split application of NPK on the Mg uptake of the different plant parts at harvest

Treatment					Uptake of Mg (g)				
Code	Splitting				Pseudo-stem	Leaves	Peduncle	Fruits	Total
T_1	½	½	0	0	4.76 (21.90)	9.83 (45.22)	0.394 (1.79)	6.76 (31.09)	21.74
T_2	½	0	½	0	4.67 (23.46)	10.15 (50.98)	0.417 (2.10)	4.67 (23.46)	19.91
T_3	½	¼	¼	0	7.93 (29.62)	10.15 (37.92)	0.226 (0.86)	8.46 (31.60)	26.97
T_4	½	0	¼	¼	5.52 (25.68)	10.08 (46.88)	0.290 (1.35)	5.61 (26.09)	21.50
T_5	½	¼	0	¼	5.45 (25.65)	11.89 (55.95)	0.342 (1.60)	3.57 (16.80)	21.25
T_6	¼	¼	¼	¼	3.77 (23.62)	7.72 (48.37)	0.434 (2.70)	4.04 (25.31)	15.96
T_7	¼	½	0	¼	7.06 (27.43)	12.38 (48.10)	0.378 (1.47)	5.92 (23.00)	25.74
T_8	¼	½	¼	0	7.70 (27.68)	11.64 (41.84)	0.369 (1.33)	8.11 (29.15)	27.82
T_9	¼	0	½	¼	6.76 (29.91)	8.10 (35.84)	0.358 (1.59)	7.38 (32.66)	22.60
T_{10}	¼	¼	½	0	3.44 (17.21)	9.76 (48.82)	0.333 (1.65)	6.46 (32.32)	19.99
T_{11}	¼	¾	0	0	7.88 (30.64)	9.61 (37.36)	0.147 (0.58)	8.08 (31.42)	25.72
T_{12}	¼	0	¾	0	3.44 (17.85)	10.85 (56.31)	0.332 (1.71)	4.65 (24.13)	19.27
T_{13}	¾	¼	0	0	4.26 (18.65)	8.95 (39.19)	0.275 (1.22)	9.35 (40.94)	22.84
T_{14}	¾	0	¼	0	4.23 (15.73)	8.45 (31.41)	0.347 (1.30)	13.87 (51.56)	26.90
T_{15}	¾	0	0	¼	5.22 (21.81)	9.90 (41.37)	0.228 (0.96)	8.58 (35.86)	23.93
CD (5%)					NS	NS	NS	NS	NS
SEm ±					1.59	1.77	0.12	2.14	3.56

Note: Figures in parentheses indicate the percentage to the total

vi) Sulphur

Data relating to the uptake and the percentage contribution of S by the different plant organs as well as the total S uptake in the plant are presented in Table 71. Significant differences in the S uptake could be obtained only in the fruits. Highest uptake (1.127 g) was found in T_{14} (¼, 0, ¼, 0). This was significantly superior to the control, T_1 (½, ½, 0, 0), with an uptake of 0.702 g. Lowest uptake (0.600 g) was recorded by T_{12} (¼, 0, ¼, 0).

vii) Copper

Data relating to the uptake of Cu and the percentage contribution by the different plant parts as well as total Cu uptake in the plant are presented in Table 72. The various treatments exhibited significant effects only in the leaves, in which T_7 (¼, ½, 0, ¼) recorded the highest value (123.6 mg). This was on par with T_{14} (¼, 0, ¼, 0) with a Cu uptake of 93.2 mg. T_7 (¼, ½, 0, ¼) was significantly superior to the control, T_1 (½, ½, 0, 0), with an uptake of 88.7 mg. The lowest uptake (72.2 mg) was recorded in T_4 (½, 0, ¼, ¼).

viii) Iron

Table 73 shows the data regarding the uptake and the percentage contribution of Fe by the different plant

Table 71. Effect of split application of NPK on the S uptake of the different plant parts at harvest

Treatment		Uptake of S (g)				
Code	Splitting	Pseudo-stem	Leaves	Peduncle	Fruits	Total
T_1	½ ½ 0 0	0.743 (18.96)	2.29 (58.45)	0.183 (4.67)	0.702 (17.92)	3.92
T_2	½ 0 ½ 0	0.897 (18.51)	2.83 (58.39)	0.294 (6.06)	0.826 (17.04)	4.85
T_3	½ ¼ ¼ 0	1.025 (20.70)	3.09 (62.40)	0.178 (3.60)	0.659 (13.30)	4.95
T_4	½ 0 ¼ ¼	0.714 (17.61)	2.25 (55.49)	0.238 (5.87)	0.853 (21.03)	4.06
T_5	½ ¼ 0 ¼	1.095 (23.02)	2.74 (57.61)	0.195 (4.10)	0.726 (15.27)	4.76
T_6	¼ ¼ ¼ ¼	0.844 (17.90)	3.06 (64.88)	0.200 (4.24)	0.612 (12.98)	4.72
T_7	¼ ½ 0 ¼	0.832 (20.47)	2.39 (58.81)	0.182 (4.48)	0.660 (16.24)	4.06
T_8	¼ ½ ¼ 0	0.808 (17.72)	2.74 (60.10)	0.216 (4.74)	0.795 (17.44)	4.56
T_9	¼ 0 ½ ¼	1.143 (28.40)	2.03 (50.45)	0.199 (4.95)	0.652 (16.20)	4.02
T_{10}	¼ ¼ ½ 0	0.815 (17.28)	3.08 (65.31)	0.144 (3.05)	0.677 (14.36)	4.72
T_{11}	¼ ¾ 0 0	0.781 (18.41)	2.39 (56.33)	0.171 (4.03)	0.901 (21.23)	4.24
T_{12}	¼ 0 ¾ 0	1.419 (29.32)	2.58 (53.32)	0.240 (4.96)	0.600 (12.40)	4.84
T_{13}	¾ ¼ 0 0	0.898 (18.38)	2.82 (57.72)	0.254 (5.20)	0.914 (18.70)	4.89
T_{14}	¾ 0 ¼ 0	0.936 (16.91)	3.21 (58.00)	0.261 (4.72)	1.127 (20.37)	5.53
T_{15}	¾ 0 0 ¼	1.474 (25.05)	3.35 (56.92)	0.203 (3.45)	0.858 (14.58)	5.89
CD (5%)		NS	NS	NS	0.240	NS
SEm ±		0.19	0.37	0.03	0.08	0.48

Note: Figures in parentheses indicate the percentage to the total

Table 72. Effect of split application of NPK on the Cu uptake of the different plant parts at harvest

Treatment		Uptake of Cu (mg)				
Code	Splitting	Pseudo-stem	Leaves	Peduncle	Fruits	Total
T_1	½ ½ 0 0	53.3 (28.52)	88.7 (47.46)	3.5 (1.87)	41.4 (22.15)	186.9
T_2	½ 0 ½ 0	62.9 (31.20)	87.5 (43.40)	3.6 (1.79)	47.6 (23.61)	201.6
T_3	½ ¼ ¼ 0	83.6 (36.52)	109.4 (47.9)	3.2 (1.40)	32.7 (14.29)	228.9
T_4	½ 0 ¼ ¼	76.3 (40.20)	72.2 (38.04)	2.7 (1.42)	38.6 (20.34)	189.8
T_5	½ ¼ 0 ¼	72.0 (34.06)	101.8 (48.15)	3.4 (1.61)	34.2 (16.18)	211.4
T_6	¼ ¼ ¼ ¼	63.2 (33.71)	85.2 (45.44)	3.7 (1.97)	35.4 (18.88)	187.5
T_7	¼ ½ 0 ¼	50.1 (23.13)	123.6 (57.07)	3.33 (1.52)	39.6 (18.28)	216.6
T_8	¼ ½ ¼ 0	71.2 (31.01)	107.4 (46.78)	3.5 (1.52)	47.5 (20.69)	229.6
T_9	¼ 0 ½ ¼	47.3 (29.34)	73.7 (45.72)	5.7 (3.54)	34.5 (21.40)	161.2
T_{10}	¼ ¼ ½ 0	53.4 (27.04)	99.0 (50.12)	2.6 (1.32)	42.5 (21.52)	197.5
T_{11}	¼ ¼ 0 0	57.1 (29.39)	86.3 (44.41)	3.8 (1.96)	47.1 (24.24)	194.3
T_{12}	¼ 0 ¼ 0	53.5 (25.28)	123.2 (58.23)	2.9 (1.37)	32.0 (15.12)	211.6
T_{13}	¾ ¼ 0 0	77.4 (34.71)	91.7 (41.12)	3.2 (1.43)	50.7 (22.74)	223.0
T_{14}	¾ 0 ¼ 0	79.8 (32.52)	93.2 (37.98)	6.8 (2.77)	65.6 (26.73)	245.4
T_{15}	¾ 0 0 ¼	78.4 (31.74)	118.5 (47.98)	2.7 (1.09)	47.4 (19.19)	247.0
CD (5%)		NS	31.6	NS	NS	NS
SEm ±		12.26	10.91	0.96	6.79	18.24

Note: Figures in parentheses indicate the percentage to the total

Table 73. Effect of split application of NPK on the Fe uptake of the different plant parts at harvest

Treatment		Uptake of Fe (g)				
Code	Splitting	Pseudo-stem	Leaves	Peduncle	Fruits	Total
T_1	½ ½ 0 0	0.83 (28.43)	1.68 (57.53)	0.061 (2.05)	0.353 (12.09)	2.92
T_2	½ 0 ½ 0	1.38 (30.21)	2.81 (61.49)	0.045 (0.98)	0.330 (7.22)	4.57
T_3	½ ¼ ¼ 0	2.34 (41.34)	3.05 (53.89)	0.077 (1.36)	0.193 (3.41)	5.66
T_4	½ 0 ¼ ¼	1.16 (30.14)	2.38 (61.83)	0.055 (1.43)	0.254 (6.60)	3.85
T_5	½ ¼ 0 ¼	2.42 (51.93)	1.81 (38.84)	0.161 (3.46)	0.269 (5.77)	4.66
T_6	¼ ¼ ¼ ¼	1.67 (41.81)	1.98 (49.58)	0.102 (2.55)	2.242 (6.06)	3.99
T_7	¼ ½ 0 ¼	1.56 (37.45)	2.32 (55.69)	0.062 (1.49)	0.224 (5.37)	4.17
T_8	¼ ½ ¼ 0	1.33 (27.65)	3.15 (65.49)	0.049 (1.02)	0.281 (5.84)	4.81
T_9	¼ 0 ½ ¼	0.74 (19.87)	2.46 (66.06)	0.116 (3.11)	0.408 (10.96)	3.72
T_{10}	¼ ¼ ½ 0	1.23 (24.35)	3.46 (68.49)	0.070 (1.38)	0.292 (5.78)	5.05
T_{11}	¼ ¼ 0 0	0.68 (19.71)	2.49 (72.17)	0.059 (1.71)	0.221 (6.41)	3.45
T_{12}	¼ 0 ¼ 0	1.13 (24.54)	3.19 (69.29)	0.098 (2.13)	0.186 (4.04)	4.60
T_{13}	¼ ¼ 0 0	0.92 (24.05)	2.49 (65.08)	0.066 (1.73)	0.350 (9.14)	3.83
T_{14}	¼ 0 ¼ 0	1.53 (34.89)	2.55 (58.15)	0.076 (1.74)	0.229 (5.22)	4.39
T_{15}	¼ 0 0 ¼	1.39 (31.19)	2.67 (59.92)	0.086 (1.93)	0.310 (6.96)	4.46
CD (5%)		NS	NS	NS	NS	NS
SEm ±		0.44	0.51	0.02	0.07	0.72

Note: Figures in parentheses indicate the percentage to the total

organs as well as the total Fe uptake in the plant, as influenced by the different treatments. The Fe uptake in the different plant organs and the total Fe uptake in the plant showed no statistically significant differences with regard to the treatments.

ix) Manganese

Data furnished in Table 74 indicate the effect of the different treatments on the uptake and the percentage contribution of Mn by the various plant parts as well as the total Mn uptake in the plant. Significant differences were obtained with regard to the Mn uptake in the fruits. T_{14} (¼, 0, ¼, 0) recorded the maximum uptake (0.776 g). This was on par with T_2 (½, 0, ½, 0) and T_{15} (¼, 0, 0, ¼) with 0.694 g and 0.634 g, respectively. The control, T_1 (½, ½, 0, 0), had the minimum uptake (0.334 g).

x) Zinc

Data pertaining to the uptake and the percentage contribution of Zn, as influenced by the treatments, in the different plant parts, as well as the total Zn uptake in the plant, are given in Table 75. Significant differences due to treatments could be observed only in the case of the fruits. T_{13} (¼, ¼, 0, 0) had the highest value (166.7 mg). This was significantly superior to that of the control,

Table 74. Effect of split application of NPK on the Mn uptake of the different plant parts at harvest

Treatment		Uptake of Mn (g)				
Code	Splitting	Pseudo-stem	Leaves	Peduncle	Fruits	Total
T_1	½ ½ 0 0	1.15 (6.91)	15.13 (90.89)	0.033 (0.20)	0.334 (2.00)	16.65
T_2	½ 0 ½ 0	1.70 (10.58)	13.61 (84.68)	0.068 (0.42)	0.694 (4.32)	16.07
T_3	½ ¼ ¼ 0	2.31 (14.30)	13.35 (82.64)	0.046 (0.28)	0.449 (2.78)	16.16
T_4	½ 0 ¼ ¼	1.66 (15.75)	8.32 (78.94)	0.050 (0.47)	0.510 (4.84)	10.54
T_5	½ ¼ 0 ¼	1.53 (10.43)	12.73 (86.78)	0.046 (0.31)	0.364 (2.48)	14.67
T_6	¼ ¼ ¼ ¼	0.99 (5.68)	15.92 (91.33)	0.053 (0.30)	0.468 (2.69)	17.43
T_7	¼ ½ 0 ¼	0.96 (7.00)	12.35 (89.99)	0.045 (0.33)	0.368 (2.68)	13.72
T_8	¼ ½ ¼ 0	1.81 (13.75)	10.88 (82.67)	0.056 (0.43)	0.414 (3.15)	13.16
T_9	¼ 0 ½ ¼	1.69 (11.10)	13.08 (85.91)	0.057 (0.37)	0.399 (2.62)	15.23
T_{10}	¼ ¼ ½ 0	1.28 (5.70)	20.62 (91.92)	0.051 (0.23)	0.482 (2.15)	22.43
T_{11}	¼ ¾ 0 0	1.84 (11.29)	13.99 (85.83)	0.044 (0.27)	0.425 (2.61)	16.30
T_{12}	¼ 0 ¾ 0	1.13 (6.52)	15.59 (89.97)	0.063 (0.36)	0.545 (3.15)	17.33
T_{13}	¼ ¼ 0 0	1.25 (6.00)	19.07 (91.59)	0.053 (0.26)	0.448 (2.15)	20.82
T_{14}	¼ 0 ¼ 0	1.96 (8.74)	19.62 (87.48)	0.071 (0.32)	0.776 (3.46)	22.43
T_{15}	¼ 0 0 ¼	2.03 (8.44)	21.32 (88.68)	0.057 (0.24)	0.634 (2.64)	24.04
CD (5%)		NS	NS	NS	0.213	NS
SEm ±		0.29	3.17	0.01	0.07	3.34

Note: Figures in parentheses indicate the percentage to the total

Table 75. Effect of split application of NPK on the Zn uptake of the different plant parts at harvest

Treatment		Uptake of Zn (Mg)				
Code	Splitting	Pseudo-stem	Leaves	Peduncle	Fruits	Total
T_1	½ ½ 0 0	27.1 (17.21)	64.5 (40.95)	4.5 (2.86)	61.4 (38.98)	157.5
T_2	½ 0 ½ 0	78.1 (30.45)	95.4 (37.19)	4.9 (1.91)	78.1 (30.45)	256.5
T_3	½ ¼ ¼ 0	51.1 (22.05)	104.5 (45.10)	2.8 (1.21)	73.3 (31.64)	231.7
T_4	½ 0 ¼ ¼	67.5 (27.89)	91.3 (37.73)	3.9 (1.61)	79.3 (32.77)	242.0
T_5	½ ¼ 0 ¼	42.6 (15.11)	144.7 (51.33)	6.2 (2.20)	88.4 (31.36)	281.9
T_6	¼ ¼ ¼ ¼	30.1 (14.39)	92.1 (44.02)	8.2 (3.92)	78.8 (37.67)	209.2
T_7	¼ ½ 0 ¼	62.0 (30.15)	67.8 (32.98)	6.1 (2.97)	69.7 (33.90)	205.6
T_8	¼ ½ ¼ 0	72.2 (20.38)	166.9 (47.11)	6.8 (1.92)	108.4 (30.59)	354.3
T_9	¼ 0 ½ ¼	17.0 (8.01)	94.4 (44.46)	8.4 (3.96)	92.5 (43.57)	212.3
T_{10}	¼ ¼ ½ 0	40.5 (13.06)	217.3 (70.10)	5.6 (1.81)	46.6 (15.03)	310.0
T_{11}	¼ ¾ 0 0	46.2 (26.46)	95.0 (54.41)	3.4 (1.95)	30.0 (17.18)	174.6
T_{12}	¼ 0 ¾ 0	42.5 (13.79)	206.1 (66.87)	7.5 (2.43)	52.1 (16.91)	308.2
T_{13}	¾ ¼ 0 0	47.7 (16.81)	66.1 (23.29)	3.3 (1.16)	166.7 (58.74)	283.8
T_{14}	¾ 0 ¼ 0	58.2 (20.44)	160.5 (56.37)	8.7 (3.06)	57.3 (20.13)	284.7
T_{15}	¾ 0 0 ¼	53.9 (22.16)	135.9 (55.88)	4.9 (2.02)	48.5 (19.94)	243.2
CD (5%)		NS	NS	NS	48.6	NS
SEm ±		12.38	42.96	1.95	16.76	29.18

Note: Figures in parentheses indicate the percentage to the total

T_1 (½, ½, 0, 0), which had an uptake of 61.4 mg. Lowest uptake (30.0 mg) was recorded by T_{11} (¼, ¼, 0, 0).

d. Range of nutrient uptake

Data pertaining to the mean, standard deviation and range values of nutrient uptake in the different plant parts, as influenced by the treatments, are presented in Table 76. An abstract of the data on the uptake of different nutrients in the plant parts as a percentage of the total uptake in the plant are given in Table 77. The values were arrived at by pooling the values for all the treatments.

Of the 10 elements studied, the maximum uptake was that of K (155.80 g) with a range of 111.07 to 206.63 g. This was followed by N (111.83 g) with a range of 89.58 to 143.20 g. P uptake was too low (7.14 g with a range of 5.84 to 8.46 g) and was lesser than those of Ca, Mg and Mn (mean values 45.17 g, 22.79 g and 17.13 g, respectively).

As regards the relative contribution of the different plant parts in the total uptake of the nutrients by the plant, all the nutrients except P was maximum in the leaves. The leaves contributed 49.26% N, 40.05% K, 57.44% Ca, 44.37% Mg, 58.28% S, 46.65% Cu, 60.24% Fe, 87.29% Mn and 47.19% Zn. Maximum P (42.01%) was contributed by the fruits. Peduncle had the minimum uptake of all the elements.

Table 76. Effect of split application of NPK on the mean, standard deviation and range of the uptake of elements in the different plant parts at harvest

Nutrient	Pseudostem	Leaves	Peduncle	Fruits	Total
N(g)	25.48* ± 4.72** (17.69 – 35.95)***	54.99 ± 7.14 (45.94 – 71.81)	2.65 ± 0.59 (2.04 – 3.99)	28.71 ± 7.29 (18.81 – 42.70)	111.83 ± 12.99 (89.58 – 143.20)
P(g)	1.62 ± 0.26 (1.10 – 2.00)	2.25 ± 0.26 (1.92 – 2.96)	0.261 ± 0.045 (0.196 – 0.359)	3.01 ± 0.87 (2.26 – 4.18)	7.14 ± 0.85 (5.84 – 8.46)
K(g)	32.30 ± 6.97 (23.80 – 48.43)	62.49 ± 13.91 (40.97 – 94.57)	6.71 ± 1.68 (3.59 – 10.58)	54.30 ± 12.28 (42.71 – 79.90)	155.80 ± 26.04 (111.07 – 206.63)
Ca(g)	13.56 ± 3.72 (7.35 – 19.82)	25.71 ± 3.82 (19.82 – 33.36)	0.473 ± 0.089) (0.293 – 0.665)	5.43 ± 2.45 (1.96 – 10.42)	45.17 ± 6.91 (29.62 – 56.84)
Mg(g)	5.47 ± 1.61 (3.44 – 7.93)	9.96 ± 1.34 (7.72 – 12.38)	0.325 ± 0.077 (0.147 – 0.434)	7.03 ± 2.60 (3.57 – 13.87)	22.79 ± 3.35 (15.96 – 27.82)
S(g)	0.962 ± 0.232 (0.714 – 1.474)	2.72 ± 0.39 (2.03 – 3.35)	0.211 ± 0.045 (0.144 – 0.294)	0.777 ± 0.138 (0.600 – 1.127)	4.67 ± 0.56 (3.92 – 5.89)
Cu(mg)	65.3 ± 12.3 (47.3 – 83.6)	97.5 ± 16.4 (72.2 – 123.6)	3.5 ± 1.0 (2.6 – 6.8)	42.5 ± 8.9 (32.0 – 65.6)	208.8 ± 23.7 (161.2 – 247.0)
Fe(g)	1.35 ± 0.51 (0.68 – 2.42)	2.57 ± 0.51 (1.68 – 3.46)	0.079 ± 0.030 (0.045 – 0.161)	0.276 ± 0.064 (0.186 – 0.408)	4.28 ± 0.68 (2.92 – 5.66)
Mn(g)	1.55 ± 0.41 (0.96 – 2.31)	15.04 ± 3.72 (8.32 – 21.32)	0.053 ± 0.010 (0.033 – 0.071)	0.487 ± 0.126 (0.334 – 0.776)	17.13 ± 3.79 (10.54 – 24.04)
Zn(mg)	49.1 ± 17.0 (17.0 – 78.1)	120.2 ± 49.3 (64.5 – 217.3)	5.7 ± 1.9 (2.8 – 8.7)	75.4 ± 32.3 (30.0 – 166.7)	250.4 ± 54.5 (157.5 – 354.5)

* Mean ** Standard deviation *** Range

Table 77. Effect of split application of NPK on the mean, standard deviation and range of the uptake of elements in the different plant parts as a percentage to total uptake

Nutrient	Pseudostem	Leaves	Peduncle	Fruits
N	22.89* ± 4.08** (17.14 – 28.02)***	49.26 ± 3.93 (43.90 – 56.62)	2.37 ± 0.42 (1.68 – 3.13)	25.48 ± 4.74 (18.74 – 32.62)
P	22.57 ± 2.08 (18.30 – 25.37)	31.74 ± 3.78 (24.23 – 40.49)	3.68 ± 0.64 (2.80 – 5.33)	42.01 ± 4.45 (30.92 – 49.64)
K	20.83 ± 3.44 (15.69 – 29.04)	40.05 ± 5.25 (33.12 – 49.34)	4.28 ± 0.62 (3.23 – 5.96)	34.84 ± 4.52 (26.23 – 42.63)
Ca	29.72 ± 5.45 (20.96 – 38.75)	57.44 ± 7.35 (47.02 – 69.50)	1.08 ± 0.32 (0.59 – 1.66)	11.76 ± 4.42 (5. 58 – 21.63)
Mg	23.79 ± 4.87 (15.73 – 30.64)	44.37 ± 7.32 (31.41 – 56.31)	1.48 ± 0.51 (0.58 – 2.70)	30.36 ± 8.34 (16.80 – 51.56)
S	20.58 ± 4.04 (16.91 – 21.32)	58.28 ± 3;91 (50.45 – 65.31)	4.54 ± 0.84 (3.05 – 6.06)	16.60 ± 2.87 (12.40 – 21.23)
Cu	31.22 ± 4.39 (23.13 – 40.20)	46.65 ± 5.72 (37.98 – 58.23)	1.77 ± 0.63 (1.09 – 3.54)	20.36 ± 3.46 (14.29 – 26.73)
Fe	31.17 ± 8.97 (19.71 – 51.93)	60.24 ± 8.56 (38.84 – 72.17)	1.87 ± 0.71 (0.98 – 3.46)	6.72 ± 2.36 (3.41 – 12.09)
Mn	9.48 ± 3.30 (5.68 – 15.75)	87.29 ± 3.87 (78.94 – 91.92)	0.32 ± 0.10 (0.20 – 0.47)	2.91 ± 0.79 (2.00 – 4.84)
Zn	19.89 ± 6.70 (8.01 – 30.45)	47.19 ± 12.43 (23.29 – 70.10)	2.33 ± 0.87 (1.16 – 3.96)	30.59 ± 11.74 (15.03 – 58.74)

* Mean

** Standard deviation

*** Range

e. Removal of nutrients

The removal of nutrients per hectare and per tonne of fruits produced were worked out. The data presented in Table 78 were arrived at from the pooled values for nutrient uptake.

The per hectare removal of K was @ 343.38 kg whereas the rates for N and P were 246.47 kg and 15.74 kg, respectively. The range of removal of K among the different treatments were 244.80 to 455.41 kg and those for N and P were 197.43 to 315.61 kg and 12.87 to 18.65 kg, respectively. Cu and Zn were removed in very small quantities (mean values 0.46 kg and 0.55 kg, respectively). As regards the removal of the major nutrients per tonne of fruits produced, the values were 9.03 kg, 0.58 kg and 12.58 kg for N, P and K, respectively.

f. Inter relationships among nutrient uptake and yield

Data pertaining to the inter-correlations among the yield, dry matter production and the uptake of the ten nutrient elements, viz., N, P, K, Ca, Mg, S, Cu, Fe, Mn and Zn, are presented in Table 79.

Nitrogen had significant positive correlation with all the nutrient elements and the highest was recorded with P ($r = 0.825$). P had significant positive correlations with all the elements except Zn ($r = 0.289$). Apart from N, it had

Table 78. **Effect of split application of NPK on the removal of nutrients from one hectare**

Number of plants : 2204

Yield (mean) : 27.3 t.

Nutrient	Removal (Kg) per hectare		Removal (Kg) per tonne of fruits produced
	Range	Mean	
N	197.43 - 315.61	246.47	9.028
P	12.87 - 18.65	15.74	0.577
K	244.80 - 455.41	343.38	12.578
Ca	65.28 - 125.28	99.56	3.647
Mg	35.18 - 61.32	50.23	1.840
S	8.64 - 12.98	10.29	0.377
Cu	0.36 - 0.54	0.46	0.017
Fe	6.44 - 12.48	9.43	0.345
Mn	23.23 - 52.98	37.76	1.383
Zn	0.35 - 0.78	0.55	0.020

Table 79. Correlation coefficient among the bunch weight, dry matter production and the uptake of the nutrient elements

Character	Bunch weight	Dry matter	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Sulphur	Copper	Iron	Manganese	Zinc
Bunch weight	1.000	0.600**	0.497**	0.572**	0.509**	0.294	0.215	0.383*	0.360*	0.155	0.396**	0.121
Dry matter		1.000	0.871**	0.907**	0.694**	0.632**	0.608**	0.794**	0.746**	0.530**	0.401**	0.364*
Nitrogen			1.000	0.825**	0.571**	0.572**	0.497**	0.752**	0.640**	0.537**	0.524**	0.340*
Phosphorus				1.000	0.727**	0.591**	0.538**	0.754**	0.636**	0.528**	0.413**	0.289
Potassium					1.000	0.369*	0.312*	0.471**	0.351*	0.286	0.218	0.351*
Calcium						1.000	0.805**	0.529**	0.528**	0.488**	0.362*	0.176
Magnesium							1.000	0.552**	0.699**	0.386**	0.170	0.199
Sulphur								1.000	0.754**	0.618**	0.500**	0.423**
Copper									1.000	0.536**	0.351*	0.427**
Iron										1.000	0.405**	0.315*
Manganese											1.000	0.110
Zinc												1.000

* Significant at 5% level

** Significant at 1% level

high correlations with S ($r = 0.754$) and K ($r = 0.727$) too. The correlation of K with Fe and Mn were not significant.

Calcium and Mg showed strong positive correlations ($r = 0.805$). But Zn had no significant correlation with Ca. Similarly Mn and Zn did not have significant correlation with Mg. The correlations of S with all the elements were significant and highest correlation was obtained with Cu ($r = 0.754$). Cu also had significant positive correlation with all the other elements, except with K. With regard to Mn, significant correlations were obtained with K and Mg. Zn did not have significant positive correlations with P, Ca, Mg and Mn.

3. Influence of mattocking on the translocation of phosphorus-32

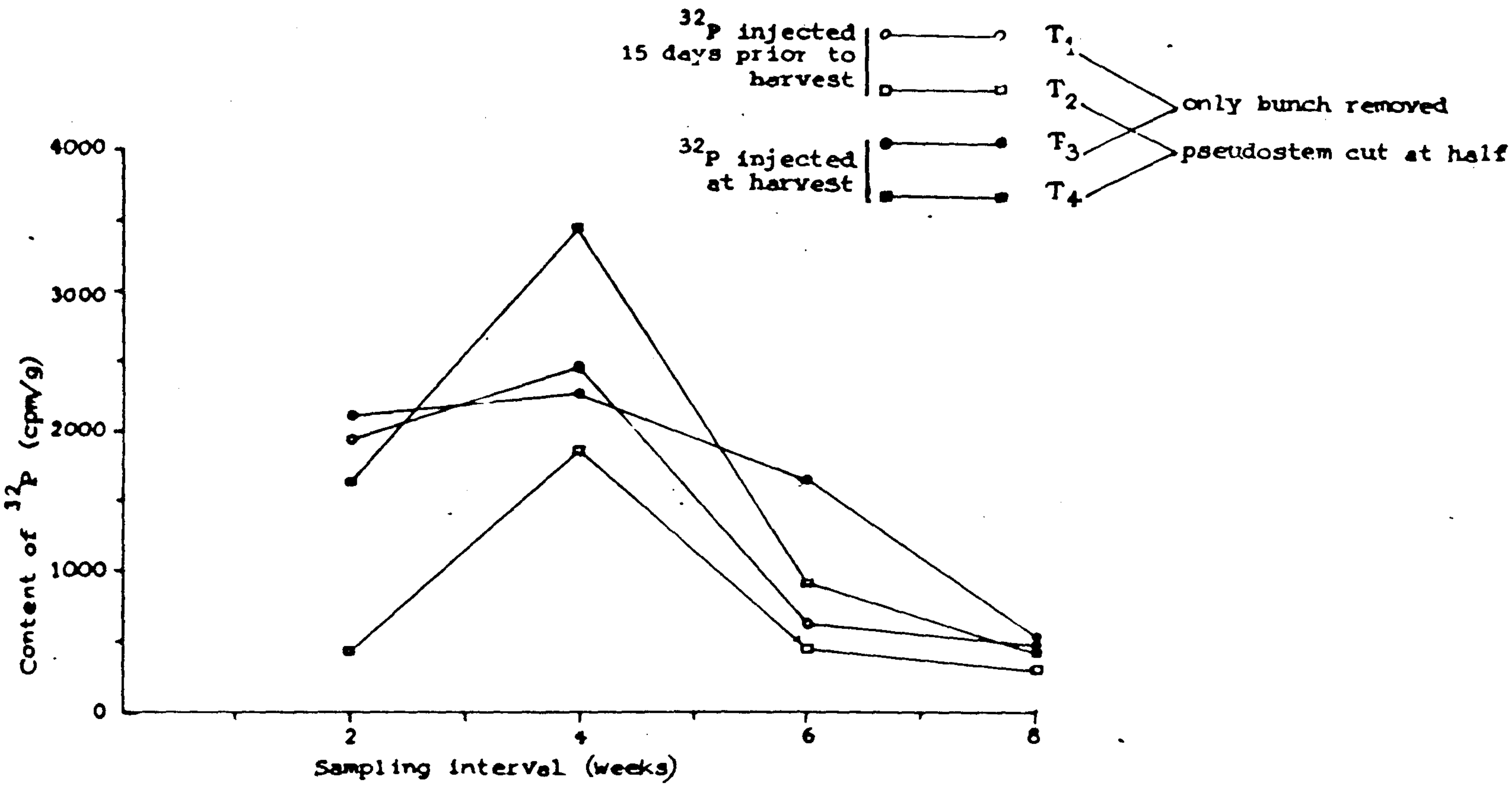
Data relating to the translocation of radioactive P from the mother plant to its suckers, as influenced by the treatments, are given in Table 80 and Fig.8.

Radioactivity could be detected in the suckers of all the treatment plants. In general, the radioactivity in the leaf tissue of the suckers increased slightly in the early stages after inoculation. Thereafter, a decrease was observed. The activity of ^{32}P was found to be slightly more when the bunch alone was removed than when the pseudostem was cut off at half the height.

Table 80. Content of ^{32}P in the leaves of mother plant and suckers at different sampling intervals

Treatment	Parts	Content of ^{32}P (cpm/g)			
		2nd week	4th week	6th week	8th week
T_1	Mother plant	1047.00	1771.00	345.34	1321.34
	Suckers	1928.33	2441.33	612.66	492.00
T_2	Mother plant	-	-	-	-
	Suckers	424.50	1855.00	440.00	290.66
T_3	Mother plant	1303.33	279.00	87.00	219.00
	Suckers	2112.00	2256.67	1658.66	511.34
T_4	Mother plant	-	-	-	-
	Suckers	1626.00	3431.67	919.34	490.66

FIG. 8. CONTENT OF ^{32}P IN THE LEAVES OF SUCKERS AT DIFFERENT SAMPLING INTERVALS



Discussion

DISCUSSION

The results generated from the present investigations on the banana cv. 'Palayankodan' are discussed under two major heads, intraclonal variation studies and nutritional studies.

A. Intraclonal variation

Twenty four accessions of Musa (AAB group) 'Palayankodan' were evaluated at the Banana Research Station, Kannara during a three-year period (1981-84) to assess intraclonal variation, if any, in the clone.

'Palayankodan' is one of the two commercial cultivars of the State, the other being 'Nendran'. It is popular in the neighbouring states also and is known as 'Poovan' (Tamil Nadu), 'Mysore Poovan' (Karnataka), etc. In Kerala, it is mainly grown as a rainfed crop in garden lands. The widespread nature of the clone has given rise to appreciable amount of variability in the plant and fruit characteristics. A preliminary survey conducted by the author, while he was working at the College of Horticulture, revealed that intraclonal variation might be existing in the clone. This prompted him to attempt the studies reported herein.

As a first step, a total of 24 accessions (Table 2) of the clone was collected through a systematic survey, catalogued and brought to Kannara for further studies. The results obtained from the studies are discussed in the following pages.

1. Growth parameters

Inorder to unravel the possible variations with respect to plant growth among the 24 accessions, five parameters, namely, height of the plants, girth of the pseudostem, number of functional leaves, area of index leaf and duration of the crop were considered. Among these parameters, height and girth will directly indicate vigour. The number of functional leaves and the total leaf area (as reflected by the area of the index leaf) will contribute to the production *per se*. The duration of the crop is economically important because of its contribution to per day production.

The height of the plants was subjected to analysis in the different growth stages of the plant crop and ratoon 1. The accessions 22 (Ernakulam) and 21 (Kalavoor) in the plant crop and 24 (Nattukal) and 18 (Anchal) in ratoon 1 had the tallest plants. The plants belonging to the accessions 23 (Edavanna) and 15 (Karukachal) in the plant crop and 7 (Morayur) and 12 (Moolamattom) in ratoon 1 were among the shortest. The difference in height, which was significantly clear in the growth stages, reduced considerably at the time of shooting in both the plant crop and ratoon 1. As such, the plants belonging to the accessions did not show statistically significant difference with respect to plant height at shooting.

It may be recalled that the monthly observations on the height of the plants which commenced at fourth month of planting ceased when one of the accessions came to shooting. Thereafter only the final height of the plant (height at shooting) was recorded and analysed. The data revealed that the plants belonging to the accessions did not differ significantly with respect to plant height at the time of shooting (when the duration taken for shooting was disregarded). This probably indicates that plant height cannot be taken as a criterion for assessing intra-clonal variation in banana. In ratoon 2, therefore, the plant height at shooting alone was subjected to analysis. In this case also statistically significant differences were not obtained.

'Palayankodan' is considered to be a clone belonging to the tall group. The average height of the plants (taking all the accessions together) in the plant crop was 281.75 cm. A progressive increase in height of the plants was observed in ratoon 1 (296.52 cm) and ratoon 2 (306.83 cm). Such progressive increase in plant vigour towards the advancement of ratooning has been reported by Robinson and Nel (1985).

The second criterion taken as indicative of plant vigour was the girth of the plants. The differences in girth of the pseudostem among the accessions were statistically significant in the different growth stages and at shooting in the plant crop and in ratoon 1. However, in ratoon 2, where girth at shooting alone was analysed, statistical significance was not obtained. The accessions 21 (Kalavoor), 6 (Tamarasseri), 14 (Kalaketty) and 19 (Vellayani) in the plant crop and the accessions 24 (Nattukal), 16 (Tiruvalla) and 18 (Anchal) in ratoon 1 produced significantly thicker pseudostem at the different stages of growth and at shooting. However, the superiority of the clones was not consistent. Further, in ratoon 2, statistical significance was not observed. Thus, the possibility of utilising the girth of the pseudostem as a criterion for assessing the intraclonal variation in 'Palayankodan' does not exist.

The inconsistency that is observed between the plant crop and the ratoon 1 could be the result of differential response of the accessions to ratooning. In this case also progressive increase in vigour as indicated by the girth of the pseudostem has been observed from the plant crop (63.56 cm) to ratoon 1 (67.36 cm) and ratoon 2 (70.19 cm).

Bananas are noted for the enormous size of their leaves. The functional leaf area and the number of functional leaves together contribute towards the photosynthetic efficiency of the plants. In the present investigations, the accessions, although exhibited significant differences with respect to number of leaves at different growth stages, did not yield statistically significant results at shooting. Further, consistency in performance was not observed between the three crops. Taking all the accessions together, it can be observed that the number of leaves did not differ significantly between the plant crop and ratoon 1 (13.98 and 13.91 respectively). However, a significant reduction to 11.62 was observed in ratoon 2.

In banana, leaf production is continuous till shooting. However, the retention of leaves at functional level is mainly a varietal (clonal) character (Rosamma, 1982 and Rajeevan and Geetha, 1984), which depends upon the interval of leaf production and functional life of a leaf. Seasonal difference was found to affect the leaf emergence rates (Robinson and Nel, 1985).

It is clearly established that the functional leaf area of the plant will have a direct influence on the production *per se*. The area of the index leaf (third fully opened youngest leaf) which was analysed at the time of shooting showed statistically significant results. Although the accessions which topped the list varied from the plant crop to ratoon 1 and ratoon 2, the accessions 7 (Morayur), 13 (Kuravilangad), 15 (Karukachal), 18(Anchal), 19 (Vellayani) and 21 (Kalavoor) consistently remained in the top bracket.

Considering all the accessions together, the average leaf area (area of the index leaf) showed negligible difference between the plant crop (1.25 m^2), ratoon 1 (1.22 m^2) and ratoon 2 (1.33 m^2).

The consistant performance of some of the accessions over the three crops and the fact that the area of the third leaf showed negligible difference between the three crops seem to indicate the possibility of utilising this criterion for identifying intraclonal variation in the clone 'Palayankodan'. Infact, leaf ratio, which is also arrived at from the same components used for leaf area estimation, viz., length and width of the leaf, was reported to be a character that could help to identify mutations in a clone (Gross and Simmonds, 1954 and Shepherd, 1957).

Duration of the crop is of utmost importance in as much as it directly accounts for per day production and net income to the cultivators. In a crop like banana which occupy the land for about 11 to 13 months, this criterion gets added importance. With respect to this character, the banana clones have been classified into long duration, medium duration and short duration. 'Red banana' and 'Horn plantain' are examples of long duration (14 to 16 months) clones and 'Pisang lilin' and 'Chingan' of short duration (6 to 9 months). Majority of the popular commercial clones of banana including 'Palayankodan' have been categorised as medium duration (10 to 13 months).

In the present investigations, the 24 accessions studied exhibited significant differences only in the ratoon 1. For critical evaluation, the duration of the crop was split into two phases, planting to shooting and shooting to harvest. The accessions 22 (Ernakulam) and 8 (Maraikal) were comparatively of short duration in ratoon 1. In this case the Phase I contributed the significant differences. Although sufficient care was bestowed in the selection of uniform suckers for the original planting, the age differences cannot be completely ruled out. This would have contributed to the statistically non-significant difference in the plant crop. In the ratoon 1, two month old (pre-tagged) suckers were left as the follower plants and the uniformity in age thus achieved has helped realise statistically significant results. However, the pre-tagging and retention of suckers of uniform age for the second ratoon did not yield significant differences. This could be attributed to the considerable staggering obtained in the ratoon 2.

A comparison of the three crops revealed that the plant crop took longer time (355.67 days) as compared to ratoon 1 (256.11 days) and ratoon 2 (269.84 days) to come to shooting. Nevertheless, the duration between shooting to harvest was more or less uniform (81.06 days, 81.85 days and 87.33 days respectively). It is widely understood that the practice of ratooning can shorten the duration of the crop. The major saving comes from the fact that the ratoons waste no time in the establishment of the plants.

It may be recalled that in the plant crop as well as in ratoon 1, significant differences in plant height were recorded at the time of monthly observations till shooting, and that, the differences were nullified at the final observation (when each clone came to shooting). Coupled with these observations it is worth examining the duration taken by the plants from planting to shooting. It can be seen that the plants which were taller at the final monthly observation, came to shooting earlier than those that were shorter. There seems to be a positive correlation between the increment in height and early shooting. Results of analysis of the girth of pseudostem also revealed positive association between increment in girth and early shooting. Hence it can be concluded that vigorous plants in the clone came to early shooting. Records of vigorous plants coming to early shooting are available in banana (Jambulingam *et al*., 1975 and Singh *et al*., 1977).

2. Leaf characters

Among the leaf characters studied, the interval of leaf production and the total leaves produced by the plant showed significant variation. The interval (phylacron) ranged from 11.90 days in the accession 3 (Pullur) to 17.20 days in the accession 12 (Moolamattom). The total number of leaves produced was maximum (31.83 each) in the accessions 3 (Pullur) and 6 (Tamarasseri) and minimum (27.50) in the accession 22 (Ernakulam).

Although the life of leaves ranged from 69.67 days in the accession 3 (Pullur) to 81.50 days in the accession 19 (Vellayani), the differences were not statistically significant. In Queensland, Summerville (1944) observed that the life span of leaves ranged from 71 to 281 days in 'Dwarf Cavendish'.

As regards the leaf ratio (length/width) the minimum value of 2.71 was observed in the accession 19 (Vellayani) whereas the accession 21 (Kalavoor) had the maximum ratio

(3.06). According to Shepherd (1957), leaf ratio was least affected by environment and therefore he considered it to be most important in the diagnosis of mutants of plant height. Gross and Simmonds (1954) also opined that leaf ratio would help to identify the mutants beyond doubt. In the present study, the differences among the accessions were not significant with respect to the leaf ratio. It is therefore probable that mutants of 'Palayankodan' were not included among the accessions.

The density of stomata differed significantly on the upper surface of the lamina. The range was from 95.37 per mm^2 in the accession 14 (Kalaketty) to 181.21 per mm^2 in the accession 4 (Adukkam). The density of stomata on the lower surface was two to three times more than that on the upper surface, the range being from 247.56 to 347.08 per mm^2. Considerable variation in the number of stomata per unit area among the clones of potato (Dwelle et al., 1983) has been reported. Information on the intraclonal variation with respect to stomatal density is however, lacking.

3. Petiole characters

The different accessions failed to establish significant differences in the various petiolar characters studied. The ranges in the length of the petiole, girth of the petiole, width of the petiolar canal and the depth of the petiolar canal in the accessions were from 44.00 cm (Kalaketty) to 58.33 cm (Kalavoor), from 9.00 cm (Takazhi) to 12.50 cm (Vellayani), from 0.90 cm (Takazhi) to 2.00 cm (Vellayani) and from 1.53 cm (Taliparamba, Udumbannur and Takazhi) to 2.43 cm (Morayur and Vellayani) respectively. Gross and Simmonds (1954) had recorded variation in petiolar length in the two mutants of 'Dwarf Cavendish'. Occurrence of variation in petiolar length as a result of differential fertilization has been reported by Mathew (1980). She observed that the higher fertilizer level induced significant increase in the length of the petiole at certain stages of growth. Mathew (1980)'s observation indicates that the petiolar characters are amenable to agronomic manipulations.

4. Nutrient content of index leaf

The content of the ten nutrient elements studied in the index (third fully opened youngest) leaf at the time of shooting did not present significant differences among the accessions. The contents ranged from 2.41 to 3.14 per cent for N, from 0.158 to 0.213 per cent for P, from 3.17 to 3.98 per cent for K, from 0.20 to 0.45 per cent for Ca, from 0.24 to 0.46 per cent for Mg, from 0.067 to 0.091 per cent for S, from 36.0 to 77.4 ppm for Cu, from 147.1 to 317.8 ppm for Fe, from 791.0 to 1559.7 ppm for Mn and from 19.6 to 55.3 ppm for Zn. It seems that the accessions did not differ significantly in their efficiency to utilise the nutrients and that this character does not contribute towards divergence within a clone.

Of the major elements, the values obtained for N and K were comparable with the optimum level suggested by Hewitt (1955), Boland (1960), Murray (1960) and Bhangoo _et al_. (1962). As regards P, the values were low but was comparable with those of Mathew (1980) in 'Palayankodan'. The content of Ca obtained in the present study was very low as compared to those reported by Murray (1960) and Arunachalam _et al_. (1976). The value was, however, comparable with that obtained by Bhangoo _et al_. (1962) in 'Giant Cavendish'. In Mg, the range observed in the present studies was as reported by Arunachalam _et al_. (1976) and Veerannah _et al_. (1976 b); but higher than that reported by Bhangoo _et al_. (1962).

5. Reaction to pests and diseases

Inorder to assess the reaction of the accessions to rhizome weevil, bunchytop and Sigatoka, scoring was done in the field during the third year of the crop. Scoring for Sigatoka leaf spot was done with the onset of monsoon. For the other two, the scoring was done at the harvest of the crop (ratoon 2).

As regards the Sigatoka leaf spot disease, the infection index (Mc Kinney, 1923) ranged from 2.48 to 6.93. In the case of rhizome weevil, the ratio of infected rhizome to the total ranged from zero to 4.36. The range of mortality due to bunchytop disease was from zero to 33%. In general, the accessions 10 (West Payipra), 11 (Udumbannur), 13 (Kuravilangad), 17 (Konni), 18 (Anchal) and 21 (Kalavoor) showed field tolerance to the three maladies. Reports on differential reaction of the accessions of a clone are not available in banana. However, in the sub-clones of the potato variety 'Majestic', Cockerham and Macarthur (1956) had observed that there was variability in their reaction to certain diseases and pests. In the present studies, plant protection measures were adopted asrecommended (KAU, 1978) and as such, the data indicate the field tolerance. Further work is needed to ascertain the level of resistance of the different accessions to the above maladies. The results emnating from the studies could be made use of in future breeding programmes.

6. Bunch characters

The bunch weight, number of hands and the number of fingers were the salient bunch characters studied. It was found that these characters differed significantly both in the plant crop and in ratoon 1. In both the crops, the accession 21 (Kalavoor) excelled the others with respect to bunch weight and was closely followed by the accession 18 (Anchal). In the ratoon 2, the differences in the bunch characters were not significant. However, in the analysis of the pooled mean, significant differences were obtained. The accession 21 (Kalavoor) had the heaviest bunches (14.872 kg), followed by the accession 18 (Anchal) which recorded a bunch weight of 14.378 kg.

As regards the number of hands and the number of fingers, the variation among the accessions was not consistent during the three crops. Though these characters were significant in the plant crop and in ratoon 1, significant differences could not be obtained in ratoon 2. In the pooled analysis, significant differences were obtained in the number of fingers; but not in the number of hands.

Variation in yield within the same clone, collected from different localities, was clearly established by the present study. A comparison of the yield in the three crops revealed that the plant crop had recorded the highest mean bunch weight (12.68 kg), followed by the ratoon 1 (12.00 kg). Ratoon 2 gave the lowest bunch weight (10.83 kg). Segars (1963), in his studies with 'Dwarf Cavendish', also observed that the yields declined after the plant crop. This he ascribed as due to the depletion in the soil organic matter content. In vegetatively propagated crops like potato, which are not ratooned, similar decline in performance in subsequent crops has been recorded. Rieman et al. (1950), in the clonal variation studies with 'Chippewa' variety of potato, observed decline in the performance after three succeeding crops. In such cases, degeneration of the planting material due to cumulative effect of unfavourable factors (viruses, nematodes, toxins, etc.) have been ascribed as the main cause of the decline. Whether or not occurrence of such a phenomenon is possible in banana (which is ratooned) is to be investigated.

The findings of Turner and Barkus (1982) that higher yields in 'Williams' banana were obtained in ratoon 2, than in previous crops, are contrary to those of the present studies. In the present studies, though the bunch weight declined after the first crop, the rank of the accessions did not differ considerably. Number of hands per bunch and number of fingers per hand are the two factors (besides the average weight of a finger) that contribute to the weight of bunch. With respect to the number of hands and the number of fingers per bunch, the accessions showed significant difference in the plant crop and in ratoon 1. In ratoon 2, the variation among the accessions was not statistically significant. In the pooled analysis the number of fingers showed significant results.

7. **Fruit characters**

Of the different bunch characters, the physical and chemical characteristics of the fruits are directly related to the acceptability. Large plump 'Palayankodan' fruits with sub-acid taste are preferred in the market. In the present study, the various characters relating to the appearance and the edible quality of the fruits were subjected to detailed analysis. Of the physical attributes studied, the accessions differed significantly in respect of weight of the fruit, weight of the pulp, length of the stalk and girth of the fruit. The differences in the fruit weight was contributed more by the girth than the length of the fruit. This suggests that it is the plumpness that decides both the appearance and the weight, rather than the length of the fruit.

The length of the stalk varied from 1.97 cm in the accession 22 (Ernakulam) to 3.37 cm in the accession 21 (Kalavoor). The possibility that the length of the stalk is a differentiating feature within the clone as is the case seen between the clones of banana is indicated. The maximum (11.83 cm) and the minimum (9.87 cm) girth were those of the accessions 21 (Kalavoor) and 22 (Ernakulam), respectively. The weight of the fruit varied from 48.33 g in the accession 22 (Ernakulam) to 99.00 g in the accession 21 (Kalavoor).

As regards the weight of the pulp, the range was from 39.67 g to 82.67 g, recorded by the same accessions as above. Though the weight of the fruit as well as the weight of the pulp differed significantly among the accessions, the ratio of the two did not show such a difference. It is probable that there exists a relation between the weight of the fruit and weight of the pulp within the clone, which remains unaffected. The difference between the lowest and the highest values, as a percentage over the lowest values, were worked out for the four parameters. The values for the length of the stalk and the finger weight were comparable (71.07% and 104.84% respectively) than that of the total length of the fruit (39.27%). In the case of girth the difference was 19.86%.

The quality analysis with respect to the total soluble solids, total sugars and reducing sugars also revealed significant differences among the accessions. No significant difference was observed with respect to acidity, sugar/acid ratio and vitamin C. The accessions differed only in the sweetness of the pulp. In the clonal selection studies in the apricot 'Velkopavlovicka', Vachun (1981) observed that the variability was low for fruit quality. The present studies on the fruit characters also indicated that the differences among the accessions were more due to the physical attributes than due to the chemical attributes.

The grading of the fruits based on visual standards also showed marked differences among the accessions. Of the different characters studied, the disposition and the curvature of the fingers exhibited more differences than the colour, angularity and the presence of blotches/speckles. Overall superiority in the grade was shown by the accession 21 (Kalavoor) which also had produced the heaviest fruits and bunches. This accession was closely followed by the accession 2 (Taliparamba) in the overall grade. The accession 18 (Anchal), which had recorded second place in bunch weight, had a medium grade.

8. Variability and correlations

Information about the variability is an essential pre-requisite for any breeding programme. Heritability and estimates of genetic advance help in formulating further improvement techniques. Degree of association of one character with the other, as obtained from correlation studies, also helps in the selection of the desired or the elimination of the undesired characters. In the present study 24 characters were taken into account based on which the variability and the correlation were worked out. The accessions were significantly different for 16 of the above characters.

The range of variation for all the characters studied was large, particularly with respect to the stomatal density, leaf production interval, number of leaves at shooting, length of the petiole, weight of the bunch, number of fingers, weight of the finger, length of the pedicel etc. Such variability in yield was reported in potato by Rieman et al. (1950) in the variety 'Chippewa', Davidson and Lawley (1953) in the variety 'King Edward' and Cockerham and Macarthur (1956) in the variety 'Majestic'. Singh (1971) in the mango varieties 'Alphonso' and 'Dashehari', Vachun (1981) in the apricot 'Velkopavlovicka' and Milutinovic et al. (1981) in the sour cherry 'Oblacinska' also reported such variability in yield and its attributes.

The variability observed was partitioned into genotypic and environmental components to ascertain the contribution of each towards the variability. It was found that the variances in the 21 out of the 24 characters studied were mainly due to environment. With regard to the bunch weight, the contribution from the genotypic and the environmental components were almost equal. Weight of the ripe finger and weight of the pulp had more contribution from the genotypic component. This finding indicates that most of the variations are highly influenced by the fluctuations in the environment. With respect to the coefficient of variation, weight of the bunch, weight of the hands, weight of the ripe finger, weight of the pulp, length of the pedicel and stomatal density of the upper surface of the leaf showed relatively high estimates. These characters offer more scope for selection than the others.

The magnitude of genotypic coefficient of variation alone will not help to determine the amount of variation that is heritable (Gandhi *et al*., 1964). However, in conjunction with heritability estimates, it would be possible to obtain an amount of progress to be expected by selection (Burton, 1952). Relatively higher values of heritability were obtained in the weight of the pulp, weight of the ripe finger, weight of the bunch, weight of the hands and the stomatal density of the upper surface of the leaf. These characters also showed high genotypic coefficient of variation. Hence these characters offer greater scope for improvement by selection.

Genetic advance and genetic gain were suggested to be considered jointly with heritability estimates to get a better appraisal of the genetic progress that would result from selecting the best individuals (Johnson *et al*., 1955a). In the present study the expected genetic advance under five per cent intensity of selection varied from 0.030 (in the case of the leaf ratio) to 18.758 (in the case of the stomatal density of the upper surface of the leaf). The weight of the ripe finger could be improved by 16.434 g, the number of fingers by 10.025 and the bunch weight by 2.272 kg. The study of genetic gain has indicated that the characters could be improved from 0.040% (in the case of number of hands) to 24.602% (in the case of the weight of the ripe finger). The bunch weight had a genetic gain of 17.876%. High heritability coupled with high genetic gain will indicate additive gene effects (Panse, 1957). In the present study, the weight of the ripe finger, weight of the pulp, weight of the bunch and weight of the hands, which showed high heritability and genetic gain, could be improved through straight selection. With regard to certain desired characters like height, duration etc., there was little scope for further improvement. A comparison of the accessions with reference to the expression of the 24 characters suggested that variation within the clone exist.

It was revealed from the results of the correlation studies that, of the 24 characters studied, eight characters (interval of leaf production, leaf ratio, total number of leaves produced, stomatal density of the upper surface of the leaf, duration from planting to shooting, duration from planting to harvest, life of a leaf and length of the petiole) failed to establish significant phenotypic correlation with the bunch weight. The relationship of the leaf ratio and the leaf production interval with the bunch weight was negative. Only two characters (total number of leaves and the duration from planting to harvest) failed to establish significant genotypic correlation with the bunch weight. Of these, the correlation with the interval of leaf production was negative and significant, suggesting that a longer interval is unfavourable for the increase in the bunch weight. In general, the genotypic correlation was higher than the phenotypic correlation thereby indicating the preponderence of inherent relationship.

Of the different vegetative characters studied, the area of the third leaf had highest correlation with the bunch weight followed by the number of leaves and the girth of the pseudostem at shooting. A positive correlation of the leaf area as well as the circumference of the pseudostem at shooting with the weight of the bunch was reported by Venkatesam et al. (1965). Fernandez and Garcia (1972) also had reported a positive correlation between the circumference of the pseudostem and the bunch weight. These results indicate that an improvement in the vegetative characters like the girth of the pseudostem and the leaf area would benefit the yield.

Genotypic and phenotypic correlation coefficients among the 16 selected characters that had recorded significant differences, showed that in most cases significant association existed. There was significant correlation between the number of hands and the girth of the pseudostem. A similar trend has been reported by Fernandez and Garcia (1972). The number of hands was highly correlated with the number of fingers, weight of the hands and the length of the bunch. Hernadez (1983) also obtained a high correlation between the number of fingers and the number of hands. This indicates that the number of fingers borne in a hand does not show much variation. The number of hands and the number of fingers had high correlation with the girth of the pseudostem and the area of the third leaf. The interval of leaf production, however, showed a negative relation in that, a shorter interval is necessary for the improvement of the number of hands and the number of fingers. With regard to the correlation of the different finger characteristics on the weight of the ripe finger, weight of pulp showed the highest correlation followed by the girth of the finger. Length of the pedical also showed significant positive correlation with the weight of the ripe finger. Besides its role in improving the appearance of the finger, the girth has greater role than the length in increasing the finger weight. The length of the bunch has important role in that it decides the compactness of the bunch. As such, a bunch of shorter length with higher weight would be preferable for marketing. But in the present study it was found that the bunch weight was significantly correlated with the bunch length. Besides having more number of hands and fingers, a longer bunch had larger fingers too, which is evident from the correlation of the bunch length with the girth of the finger. These factors might have eventually contributed towards the higher weight of the longer bunches.

9. Path analysis and selection index

Correlation studies provide the relationship among the different components. But, inorder to have an understanding of the direct as well as indirect effects of each character on the final bunch weight, path coefficient analysis (Wright, 1921) was carried out. From the present studies it was observed that the maximum positive direct effect was recorded by the weight of the hands (1.6045). This was followed by the average weight of a finger (0.6649) and the weight of the ripe finger (0.5885). Negative direct effects were produced by the mean weight of a hand (-0.8968), weight of the pulp (-0.7671) and the number of hands (-0.2451). Considerable indirect effects could be observed mainly through the area of the third leaf, number and weight of the hands, mean weight of a hand, number of fingers, mean weight of a finger, weight and girth of the ripe finger, length of the pedicel as well as the length of the bunch. The number of hands, mean weight of a hand and the weight of the pulp, though had negative direct effect, recorded high indirect effect through other characters. Hence these characters could also be considered important in contributing towards the bunch weight. Rosamma (1982) had also stressed the importance of the weight of the individual finger, number of the fingers, number of the hands and the length of the bunch in the yield of bananas. The residual effect worked out in the path analysis was 0.026. This means that over 97 per cent of the bunch weight in banana is contributed by the 16 components included in the study. It could be concluded from the study that the weight of the finger has a major role in increasing the yield, which, together with the number of fingers has resulted in the highest direct effect obtained for the weight of the hands.

One of the main objectives of the present study was to isolate superior accessions based on their merits. To satisfy this, four selection indices were formulated using different combinations of the eight characters selected through path coefficient analysis. A comparison of these indices revealed that selection through discriminant function considering eight characters was the most efficient, which was 49.17 per cent superior to direct selection. In the selection index using four characters, however, a relative effectiveness of 34.19 per cent was obtained. This, besides being close to the best selection index in its effectiveness, has the added advantage that only half the number of characters were taken into consideration compared to the most effective one. Hence, considering the practical convenience and the efficiency together, the latter index was used to perform selection in the present study. Based on this, two accessions, viz., Anchal and Kalavoor were selected from the group of accessions as the superior ones.

10. Genetic divergence

One of the main objectives of the present investigations was to ascertain whether intraclonal variation existed in banana. The analysis of variance and variability studies gave indications of variation within the clone 'Palayankodan'. To confirm the divergence and to group the similar types, D^2 analysis was carried out. The accessions on the whole, when considered on the basis of 16 selected characters simultaneously, were significantly different. Using D^2 values, five clusters were formed. The intra cluster distance did not exceed the inter cluster distance, thus confirming the homogenous nature of the clusters.

The first cluster contained 13 accessions, viz., Pullur, Tamarassery, Tiruchirapally, Udumbannur, Moolamattom, Karukachal, Tiruvalla, Vellayani, Takazhi, Kalavoor, Ernakulam, Edavanna and Nattukal. In the expression of the different characters, this cluster was intermediary. The second cluster was formed with the accessions Manantoddy and Ulleari. This was also intermediary with respect to the expression of the characters studied, but was inferior to the first cluster. The third cluster included seven accessions. These were Taliparamba, Maraikal, West Payipra, Kuravilangad, Kalaketty, Konni and Anchal. This cluster had the best finger characters but with respect to majority of the characters, this was inferior to the other clusters. The fourth cluster contained the accession Morayur only. This was superior to all other clusters with respect to growth and yield parameters. The fifth cluster also contained one accession, Adukkam, which emerged first in certain leaf characters but was second in vigour and yield parameters.

As regards the contribution of characters towards divergence, bunch weight was found to contribute the maximum percentage which was followed by the girth of the fruit. Of the vegetative characters, low contributions were obtained from the interval of leaf production and the total number of leaves. The role of bunch weight and finger girth in increasing the variability is clearly understood. With the alternate method tried also these two characters were found to contribute more. Besides, high contribution was also recorded by the density of stomata in the upper surface of the leaf.

11. The superior accessions

From the various aspects of the study it has been established beyond doubt that intraclonal variation existed in the clone 'Palayankodan'. Two accessions, namely, Anchal (18) and Kalavoor (21) have been found to be the superior ones among the 24 accessions. A comparison of the salient features of these two accessions with that of the local accession, Maraikal, based on the observations made in the plant crop, are furnished in Table 81. It is evident that Kalavoor is the best accession in terms of yield and quality. By proper selection of the sub-clone alone, besides improving the quality, the yield could be increased to 34.59% more, over the local clone.

B. Nutritional studies

The present recommendations with respect to the fertilization of banana in the package of practices (KAU, 1978) are to apply the prescribed dose in two equal splits, the first at two months after planting and the second at four months after planting. Reports are available indicating some beneficial effects of applying fertilizers after four months of planting banana (Gopimony et al., 1979; Nambiar et al., 1979 and Irizarry et al., 1981), eventhough the benefit may not work out to be economical after six months (Shanmugam and Velayutham, 1972). There has been a persistent demand

Table 81. A comparison of the salient features of the two selected accessions with that of the local accession

Character *	Mean values/grade		
	Local (Kannara)	Anchal	Kalavoor
1. Growth parameters			
a. Height of the plant at shooting (cm)	268.95	295.33	233.89
b. Girth of the pseudostem at shooting (cm)	63.33	65.22	67.56
c. Duration from planting to shooting (days)	368.00	368.22	358.45
d. Duration from shooting to harvest (days)	84.28	79.05	75.00
2. Leaf and petiole characters			
a. Interval of leaf production (days)	14.33	15.40	13.13
b. Life of a leaf (days)	76.37	78.23	75.50
c. Total number of leaves produced	29.50	29.50	30.00
d. Area of the third leaf at shooting (m^2)	1.15	1.35	1.30
e. Number of functional leaves at shooting	14.17	15.89	14.33
f. Length of the petiole (cm)	51.83	50.83	58.33
3. Bunch characters			
a. Weight of the bunch (kg)	12.60	16.02	16.33
b. Number of hands	11.00	11.00	11.67
c. Number of fingers	169.50	173.83	179.17
d. Mean weight of a finger (g)	61.83	73.77	76.60
e. Length of the bunch (cm)	44.08	47.50	50.33
4. Fruit morphology			
a. Length (total) of the fruit (cm)	13.77	16.04	16.24
b. Length of the pedicel (cm)	2.50	3.27	3.37
c. Girth of the fruit (cm)	10.70	11.40	11.83
d. Weight of the fruit (g)	63.33	86.33	99.00
5. Fruit quality			
a. T.S.S. (%)	25.00	23.17	22.33
b. Total sugars (%)	17.24	16.81	17.30
c. Reducing sugars (%)	17.06	16.64	17.03
d. Non-reducing sugars (%)	0.18	0.17	0.27
6. Fruit grade			
a. Rind colour	Uniform deep yellow	Uniform yellow	Uniform bright yellow
b. Disposition	Moderately compact	Spreading	Moderately compact
c. Curvature	Straight	Slightly curved	Straight
d. Angularity	Slight	Slight	Absent
7. Incidence of pests/diseases			
a. Rhizome weevil	Moderate	Less	Moderate
b. Sigatoka leaf spot	Moderate	Less	Moderate
c. Bunchytop	Nil	Nil	Nil

* Based on the plant crop, except the item no.7, the data of which was collected from the ratoon 2.

from the progressive banana growers for ascertaining the application of fertilizers vis a vis the returns. The second part of the present investigations were, therefore, aimed at ascertaining the influence of split application of the recommended dose (taken as control) from two to eight months of planting and also examining the uptake pattern of the important nutrient elements. The studies also aimed at determining the translocation of nutrients from the mother plant to its suckers consequent on mattocking. The salient results generated from the studies are discussed hereunder.

1. Growth parameters

The effect of split application of the recommended dose on the growth of the plant was estimated in terms of height of the plant, girth of the pseudostem, number of functional leaves, leaf area (at the time of shooting), and the time taken for shooting and harvest. The observations were made both in the plant crop and in ratoon 1. In the plant crop as well as in ratoon 1 the growth parameters such as plant height, girth of the pseudostem and the number of functional leaves were significantly influenced by the treatments during the later stages of vegetative growth only, as compared to during the initial stages. This might be because the differences in the quantity of fertilizers obtained in the different splits (treatments) could manifest the effect at this stage. A similar pattern of increase in the vegetative characters due to an increment in the supply of fertilizers was reported by various workers (Jambulingam _et al_., 1975; Arunachalam _et al_., 1976 and Singh _et al_., 1977).

In the plant crop, with respect to the vegetative characters, the splits ½, ¼, 0, ¼ and ¼, 0, 0, ¼ recorded significantly lower values (dwarf, thin and less leaves) than the control (present recommendation) during the later stages of growth. The split ¼, 0, ½, ¼ exhibited significantly less height over the control. The above three treatments had received only ¼ quantity of the prescribed fertilizer dose before the time the observations were taken (at 7 and 8 months after planting). In ratoon 1, three treatments, viz., the splits ¼, 0, ½,¼; ½, 0, ¼, ¼ and ¼, ¼, ¼, ¼ were among the five that produced plants which were significantly dwarf as compared to the control at the 6th month. Since the ratoon plants came to shooting before the 7th month, data on plant height, girth of the pseudostem and number of functional leaves, as indicative of the growth of the plants, could not be collected beyond 6th month.

Observations on height of the plants, girth of the pseudostem and number of functional leaves, taken at the time of shooting, did not yield any significant differences between the control and the different treatments, both in the plant crop and in ratoon 1. In the plant crop, consequent on the receipt of the entire quantity of fertilizers, the growth differences may have considerably narrowed. In ratoon 1, the summer showers could have also played a role. The soil moisture status, which improved with the receipt of summer showers, was pointed out to be a factor in increasing uptake of nutrients in rainfed banana (Mathew, 1980 and Sheela, 1982). A comparison of the height of the plants at the time of shooting revealed that the plants in ratoon crop were taller (mean height 326.68 cm) than in the plant crop (mean height 298.75 cm). Robinson and Nel (1985) also observed that the pseudostem height increased progressively with the advancement of ratooning. With regard to the girth of the pseudostem, the differences were negligible (mean girth of 66.61 cm in the plant crop and 67.23 cm in ratoon 1).

Another criterion taken as a component of the growth of the plants was the duration of the crop. In the plant crop, two treatments, viz., the splits ½, 0, ½, 0 and ¼, 0, ¾, 0 took significantly longer time than the control to come to harvest. The total duration when split into duration from planting to shooting and from shooting to harvest revealed that the differences were significant only in the duration from planting to shooting. Thus it is clear that the split application of the recommended dose exhibited influence only in the duration between planting and shooting. Venkatesam _et al_. (1965), after conducting a trial employing different levels of nitrogen, also opined that though the duration from planting to shooting was markedly influenced, the maturity period of the bunch was not influenced by the treatments. More vigorous plants took comparatively lesser time to shooting. The works of Martin-Prevel (1969), Singh _et al_. (1977), Mathew (1980) and Sheela (1982) were also on similar lines.

The data on ratoon 1 did not yield any significant differences in the duration of the crop. The absence of replanting the already established suckers (although exhibiting very slight growth differences) coupled with the receipt of summer showers might have boosted up the growth, thus reducing the difference. In the plant crop, however, the time required for establishment (after planting) would have made the difference. The slight differences in the age of the suckers (eventhough care was bestowed to select uniform suckers) would have also contributed to this. As a result there was more uniformity in shooting in ratoon 1, as compared to the plant crop. It may also be observed that the total duration ranged from 355.17 to 430.00 days (mean 381.46 days) in the plant crop and from 305.50 to 337.16 days (mean 321.44 days) in ratoon 1. Thus the lessening of the mean duration could be the main reason for the elimination of the inferiority of the splits ½, 0, ½, 0 and ¼, 0, ¼, 0, as compared to the control, in ratoon 1.

By analysing the data on plant height during the vegetative phase and at shooting, as well as the duration in the plant crop, it can be observed that the splits ½, 0, ½, 0 and ¼, 0, ¼, 0, which exhibited significantly lesser height than the recommended dose (½, ½, 0, 0), were at par with the control at 8th month. At the time of shooting no significant differences in plant height were observed among the treatments. It seems that the extended duration under the above two treatments might have nullified the height difference in the plants.

2. Bunch characters

The data on the weight of the bunches presented in Tables 49, 50 and 51 indicated the variation due to the treatments to be significant only in ratoon 1 and ratoon 2. The split in the ratio of ¼, 0, ¼, 0 was the best in both these ratoons. However, this treatment significantly differed from the control only during ratoon 1. In ratoon 1 the splits ¼, ¼, 0, 0; ¼, ¼, ¼, ¼ and ¼, ¼, 0, 0 and in ratoon 2 the splits ¼, ¼, 0, 0; ¼, ¼, 0, 0; ¼, ¼, ¼, ¼; ¼, 0, ¼, 0; ½, 0, ½, 0; ¼, ½, 0, ¼; ½, 0, ½, 0 and ½, ¼, ¼, 0 were at par with the split ¼, 0, ¼, 0. But, the pooled analysis of the mean bunch weight in the plant crop and in two ratoons indicate the splits ¼, 0, ¼, 0 and ¼, ¼, 0, 0 to be significantly superior to the control

As regards the number of hands in ratoon 2 the splits ½, 0, ¼, ¼; ½, ¼, 0, ¼; ¼, 0, ½, ¼ and ¾, 0, 0, ¼ were significantly inferior to the control. It is interesting that, out of the six treatments wherein ¼ quantity of the recommended dose was applied at 8 months after planting, the above four treatments proved to be inferior to the control. The other two treatments, the splits ¼, ¼, ¼, ¼; ¼, ½, 0, ¼, however, were on par with the control. It can also be seen that the treatments had no significant effect on the number of hands during the plant crop and the ratoon 1. The analysis of the pooled mean also did not bring out significant results.

With respect to the number of fingers, the treatments did not differ significantly from the control in the plant crop and in two ratoons. The pooled analysis also did not give significant results. It is also probable that the number of fingers is influenced more by the quantity than by the time of application of the fertilizers.

A comparison of bunch characters (weight of bunch, number of hands and number of fingers) in the three years (plant crop, ratoon 1 and ratoon 2) revealed that none of the characters was influenced by the treatments in the plant crop.

In the subsequent crops, however, significant differences were obtained with regard to bunch weight. Moreover, in the ratoon 2, the number of hands also showed significant differences. The bunch weight was maximum in the ratoon 1 as compared to the plant crop and the ratoon 2. Robinson (1981) also obtained a higher yield in the ratoon 1 than the control in the 'Williams' banana. This, however, is contradictory, to the fingings of Segars (1963) and Turner and Barkus (1982) in 'Williams' banana. They received highest yield in the plant crop and the ratoon 2 respectively. This difference might be due to the varieties tried. Though the yield was lower in ratoon 2 as compared to ratoon 1 in the present study, it was superior to that of the plant crop. It can be seen from the data that the higher bunch weight in ratoon 1 was due to the higher mean number of fingers (188.71) and hands (11.45) as compared to the ratoon 2, in which case the mean number of fingers and hands were low (154.50 and 9.73 respectively).

The higher yields obtained in the ratoon 1 may be largely due to the inherent organic matter content of the soil coupled with the nutrients available in the residues of the plant crop. In ratoon 2, depletion of organic matter, combined with the uneven spacing and incidence of pests and diseases as evidenced from Part A, towards the advancement of the ratoons, might have caused the slight reduction in yield. Segars (1963) also reported that the yield was declined after the second crop in the 'Dwarf Cavendish' banana. Decline in fertility was attributed to the loss of organic matter rather than the loss of minerals (Wardlaw, 1929). Simmonds (1959) is of the opinion that accumulation of minor soil pathogens, too much irregular spacing and the tendency of the plants to grow out of the soil are the causes of declining yields in the ratoon crops.

It is worth pointing out at this juncture that in the Padugai lands of Thanjavur district, banana, especially the varieties 'Poovan' and 'Monthan', are cultivated under perennial rainfed conditions. This is due to the richness of the soil due to the deposition of silt (Hayes, 1970 and Sunderaraj et al., 1970). Another form of perennial cultivation is on the slopes of Coorg and Palni hills where 'Malavazhai' is the main variety. Here the high fertility of the soil coupled with heavy rainfall covering major part of the year makes the cultivation possible. In these areas, plantations of over 50 or 100 years of age are often met with (Hayes, 1970).

A critical examination of the data on bunch characters for the three crops separately and the analysis of their pooled mean revealed the possibility of giving the second dose till the 8th month of planting without causing significant reduction in yeild. However, Murray (1961) and Shanmugam and Velayutham (1972) are of opinion that fertilizers do not help in increasing the yield if applied after six months. A higher yield obtained in the present study in respect of the split ¼, ¼, ¼, ¼ might be due to the uniform receipt of fertilizers from two months after planting in four equal splits. Among the treatments the splits ¼, ¼, 0, 0 and ¼, 0, ¼, 0 where significantly superior to the split ½, ½, 0, 0 (recommended split).

3. Fruit characters

Among the fruit characters, viz., the length, girth, weight, volume and the pulp/peel ratio (by weight), taken in the ratoon 1, no significant differences were observed except in the pulp/peel ratio (by weight). In banana, the yield (bunch weight) is a function of the number of hands, number of fingers and weight of individual finger (Simmonds, 1959; Venkatesam *et al*., 1965 and Arunachalam *et al*., 1976). In the present study the significant differences in the weight of bunch were mainly contributed by the number of hands and the number of fingers, rather than the weight of individual finger. Of the various qualitative characters studied, significant differences were obtained with respect to total sugars and reducing sugars only. Defenite relationship between the treatments and quality, however, could not be obtained. Here too, rather the quantity of fertilizers than the splits might influence the quality.

4. Dry matter production

There were no significant differences due to the treatments in the dry matter production of the individual plant parts such as pseudostem, leaves, peduncle and fruits. However, the total dry matter production was significantly influenced by the treatments. The split ¼, 0, ¼, 0 had the maximum (8.207 kg) dry matter content. This was followed by the split ¼, 0, 0, ¼ and ¼, ¼, 0, 0 which had the dry matter content of 8.161 kg and 7.875 kg respectively.

In the present study, the range of dry matter content was from 5.500 to 8.207 kg per plant. These values are lower compared to the dry matter content of 18 kg/plant recorded by Baillon *et al*. (1933) in 'Dwarf Cavendish'. The observations of Boland (1960) in 'Lacatan' and Martin-Prevel (1962) in 'Dwarf Cavendish', are, however, comparable with the present study. In those studies the dry matter contents were 4.5 to 10.0 kg and 6.5 kg per plant respectively. It may further be noted that comparatively lower values were recorded in the variety 'Palayankodan' by Mathew (1980) and Sheela (1982). In those studies, the dry matter content ranged from 4.59 to 5.88 kg and from 4.58 to 5.32 kg/plant, respectively. The differences could be mainly due to the differences in the dry weight of the leaves. Leaves present at the time of harvest alone were collected by Mathew (1980) and Sheela (1982), whereas in the present study, all the leaves produced by the plants were collected. This again is the reason for obtaining maximum dry matter from fruits in their study as against from leaves in the present study. Though the corm was also included in their study, contribution from it was low (mean weight of 307.12 g and 301.84 g respectively). The moisture stress might also decide the accumulation of dry matter which might be another reason for obtaining low dry weight in the studies of Mathew (1980) and Sheela (1982). These works were conducted at Vellanikkara, a relatively dry area as compared to Kannara where the present studies were undertaken.

Varietal difference could be one factor deciding the dry matter content of the plants. Certain varieties might show more efficiency in dry matter accumulation than others. However, the major factor responsible for the variability in dry matter production seems to be soil type, for, Twyford and Walmsley (1973) obtained a variation of 5.520 to 15.205 kg/plant in the cultivar 'Robusta' when grown under different soil types. In their studies, Martin-Prevel (1962) and Baillon et al. (1933) obtained the dry matter content of 6.5 kg and 18 kg respectively in the clone 'Dwarf Cavendish', which also shows a vide variation in dry matter production within the same variety.

Of the total dry matter content in the aerial parts, the contribution from the leaves was the highest (32.37 to 46.54%) followed by that from the fruits (28.87 to 42.05%). This is contradictory to the findings of Matew (1980) and Sheela (1982) who obtained maximum dry matter content in the fruits and the probable reasons are already discussed. The dry matter production per day was found to be the maximum (25.78 g/day) in the split ¼, 0, ¼, 0 closely followed by the split ¼, ¼, 0, 0 which had recorded the dry matter production of 25.62 g/day. Over the control (recommended practice) ½, ½, 0, 0,these treatments accounted for 24.12% and 23.25% more production of dry matter per day. This was reflected on the yield of these treatments too.

5. Nutrient content and uptake

In order to understand the nutrient content of the plants, the aerial parts were subjected to chemical analysis. The corm was not taken into account for the study because it was intended to take further crops. The nutrient content of the growing suckers were also not taken into consideration. The data obtained in the studies indicated that the differences due to the treatments with respect to the content of N and Fe were significant in the peduncle alone,K in the peduncle and pseudostem, Ca in the leaves and pseudostem, Mn in the pseudostem alone and Zn in the fruits alone. With regard to the uptake of the elements, N, P, S, Mn and Zn were significant in the fruits and K and Cu in the leaves. Ca, Mg and Fe were not significant in any of the parts.

Nitrogen content was highest in the peduncle followed by in the leaves, pseudostem and fruits. Significant differences were seen only in the case of peduncle which also recorded the highest content (2.11%). This was contrary to the findings of Samuels et al. (1978) who observed that N percentage was higher in the leaves. As regards the uptake of N, significant differences were obtained in the fruits alone. Highest content (54.99 g) was recorded in the leaves which accounted for 49.26% of the total content. The high content of N in the leaves has been reported by various workers (Hewitt, 1955; Twyford and Walmsley, 1973 and Shawky et al., 1974).

With regard to the content of P, significant differences were not obtained in any of the parts. Highest content was recorded in the peduncle (0.206%). This was not in line with the fingings of Shawky et al. (1974) and Samuels et al. (1978), who observed that the leaves contained the highest concentration. Significant differences with regard to uptake were found only in the fruits. Maximum uptake of P (3.01 g) was also found in the fruits which accounted for 42.01% of the total uptake.

The differences due to the treatments with regard to K content were significant both in the pseudostem and the peduncle. Highest concentration was recorded in the peduncle (5.23%). In their studies with rainfed 'Palayankodan', Mathew (1980) and Sheela (1982) also obtained highest K content in the peduncle as compared to the pseudostem, leaves and fruits. In contrast, Veerannah et al. (1976 b) and Samuels et al. (1978) recorded the highest percentage of K in the pseudostem. As regards the uptake of K, the differences of that in the pseudostem as well as the total content were significant. The uptake of K was found to be the maximum (62.49 g) in the leaves which accounted for 40.05% of the total uptake of K. In some of the earlier studies K was reported to be the maximum in the pseudostem (Jauhari et al., 1974; Mathew, 1980 and Sheela, 1982). Fruits were found to contain the highest quantity of K in the study conducted by Twyford and Walmsley (1974 b). In the present study the reason for leaves having the maximum uptake of K might be because all the leaves produced by the plants were collected for the estimation of nutrients.

Compared to that of N and P, the concentration of K was more in all the plant parts. In the case of P there was very little uptake compared to N and K. Little or no response to P in banana was pointed out by several workers (Fawcett, 1921; Baillon et al., 1933; Norris and Ayyar, 1942;

Osborne and Hewitt 1963; Hagin *et al*., 1964; Turner, 1969 and Pillai *et al*., 1977). Responses to added P were found to be inconsistent (Melin, 1970) and fertilizer recommendations were made by certain workers in which the quantity of P suggested was low or very low (Twyford, 1967; Champion, 1970; Joseph, 1971, Kohli *et al*., 1976; Ramaswamy and Muthukrishnan, 1973 b and Veerannah *et al*., 1976 a). The relatively low uptake of P may also be aggravated by the low P content of the soil as reported by Chattopadhyay and Mallik (1977). However, Volk (1930), after studying different soil types, remarked that P fertilization will never become a major fertility problem since satisfactory growth occurred in areas having only 0.2 to 0.4 kg available P_2O_5 per hectare. Croucher and Mitchell (1940) estimated that soils lower than 20 ppm in available phosphorus should respond to the application of P fertilizers. The results obtained by Chattopadhyay and Mallik (1977), that P uptake increased with frequent high irrigation and high level of P application, suggest the reason for low uptake of P in rainfed banana.

As regards the content of Ca, maximum was found in the leaves (0.94%) followed by the pseudostem (0.80%). Significant differences due to splits were obtained in these two parts. No significant differences were obtained in the Ca uptake in any of the plant parts. However, maximum uptake was observed in the leaves (25.71 g) and this accounted for 57.44% of the total uptake (45.17 g) in the aerial parts. Twyford and Walmsley (1974 b) had studied different soils with regard to the mineral composition of 'Robusta' and the values given for Ca at the time of harvest are comparable (33.70 to 79.00 g/plant).

Differences with regard to Mg concentration were not significant in any of the parts. As in the case of Ca, here too maximum percentage was recorded in the leaves (0.36%) followed by the pseudostem (0.32%). With regard to uptake also significant differences were not obtained in any of the parts. However, leaves recorded the maximum content (25.71 g) which comprised 44.37% of the total Mg content (22.79 g). The range obtained by Twyford and Walmsley (1974 b) for the element was 16.2 to 52.1 g/plant for four different soil types. The content of Ca was about two times the content of Mg in the plant (45.17 and 22.79 g respectively). A similar trend of uptake between Ca and Mg was reported by Irizarry et al., (1981).

Sulphur content did not differ significantly in any of the parts studied. However the highest percentage (0.167) was recorded in the peduncle. With regard to the uptake, significant differences could be observed only in the fruits. Leaves contained 2.72 g of S which accounted for 58.28% of the total uptake in the aerial parts.

Among the micronutrients studied (Cu, Fe, Mn and Zn), Cu content alone failed to establish significant differences due to the treatments in any of the plant parts. However, maximum concentration (38.5 ppm) of Cu was observed in the pseudostem. With respect to uptake, it showed significant differences in the leaves which contained 97.5 mg Cu. This accounted for 46.65% of the element in the plant. Iron recorded maximum concentration in the leaves (951.5 ppm) but significant differences could be obtained in the peduncle. However with regard to the uptake of Fe significant differences could not be obtained in any of the parts. Leaves contained the maximum quantity of Fe (2.57 g) which accounted for 60.24% of the total uptake. With regard to Mn, pseudostem alone showed significant differences in the content and the highest value (5511.1 ppm) was recorded in the leaves. The uptake of Mn showed significant differences in the fruits alone. Leaves recorded the maximum uptake of 15.04 g and shared 87.29% of the total uptake in the plant. The concentration of Zn differed significantly in the fruits alone whereas maximum concentration (45.2 ppm) was recorded in the peduncle. As in the case of Mn, the uptake of Zn showed significant differences only in the case of fruits. Leaves shared the highest portion (120.2 mg) of Zn which accounted for 47.19% of the total uptake in the aerial parts.

Taking together the uptake of all the nutrient elements, leaves were found to contain the maximum share (40.05 to 87.29%

to total for the different elements) except in the case of P. Fruits ranked first with a share of 42.01% in the case of P. With respect to the uptake of various nutrients in the leaves, maximum share (87.29% to total) was recorded in the case of Mn. It may be noted that although the content of only four of the nutrient elements (Ca, Mg, Fe and Mn) were found to be maximum in leaves, all the elements except one (P) exhibited their highest uptake in the leaves. This is largely because of the highest dry weight (39.03% to total) combined with the higher percentage of nutrients in the leaves. In all the cases peduncle contributed the least (4.54% and less) uptake. This, however, was largely due to the lowest dry weight (1.80% to total) of the peduncle.

The plant parts, viz., pseudostem, leaves, peduncle and fruits, differed in their ability in the accumulation of nutrient elements as well as dry matter. In the pseudostem the elements K, Ca, S and Mn recorded significant differences due to the treatments. The highest content in the pseudostem was that of K (1.93%) and the lowest that of Zn (28.2 ppm). As regards the uptake, 32.30 g and 49.1 mg in the pseudostem were recorded for K and Zn respectively though the differences were not significant. In the leaves, Ca alone showed significant differences due to treatments. The maximum content in the leaves was that of K which recorded 2.28%. The uptake of K and Cu showed significant differences in the leaves, the maximum uptake being that of K (62.49g). In the peduncle, N, K and Fe showed significant differences with regard to the content and the maximum was that of K (5.23%). However, there was no significant differences among the treatments in respect of the uptake of nutrients in the peduncle,although the highest uptake (6.71 g) was that of K. The Zn content in the fruits recorded significant differences, although the highest value was that of K (2.18%). As regards the uptake of the nutrients, N, P, S, Mn and Zn recorded significant differences and the maximum uptake (155.80 g) was recorded in the element K. Thus, in all the plant parts, the quantity of K was the highest compared to other nutrients. Among the plant parts, leaves contained the highest quantity, mainly because of the highest dry weight of the leaves.

The present study also gives a guideline for fixing plant parts in banana for the estimation of different nutrients. As such, pseudostem seems to be the best plant part for the estimation of K, leaves for Ca, peduncle for N, K and Fe as well as fruits for N, P, S, Mn and Zn. Veerannah et al. (1976 a), based on their studies in the varieties 'Poovan' and 'Robusta', had suggested that K could be best diagnosed in the sheath (ie. the pseudostem) and Ca in the leaves. The suggestions based on the present investigations also are on the same lines. However Lahav et al. (1981) observed no differences between the organs for the analysis of K.

6. Nutrient removal

It can be observed from the results generated in the study that K was the nutrient which was taken up in the largest quantity (155.80 g/plant) followed by N (111.83 g/plant). The other major nutrient, namely P, came only sixth in the uptake of nutrients (7.14 g/plant). These data correspond to the removal of 246.47, 15.74 and 343.48 kg/hectare for N, P and K respectively. The observations made by Martin-Prevel (1962) do not correspond with the present values. This could be largely because of the agro-climatic differences. However, the value given by Veerannah et al. (1976 a) for P (15.4 kg/hectare) for the variety 'Poovan' is agreeable. With regard to Ca and Mg the removal was at the rates of 45.17 and 22.79 g/plant respectively. These values corresponded to the removal of 99.56 kg Ca and 50.23 kg Mg (138.6 kg CaO and 83.88 kg MgO) per hectare. Thus Ca has become the third chief element in the plant. Norris and Ayyar (1942) also obtained high values for K and Ca. The observations recorded by Martin-Prevel (1962) for CaO was 125 kg/ha which agreed with the present value. The value obtained by Joseph (1971) for Mg (49.0 kg/ha) is also corresponding. The quantity removed that of the nutrient S was 208.8 mg/plant, which accounted for the removal of 10.29 kg/ha. Zn and Cu were proved to be essential for growth and development according to Srivastava (1964). In the present study, however, the values obtained for Cu and Zn were too low (0.46 and 0.55 kg per hectare respectively).

With regard to the quantity of nutrients removed by the plants for the production of one tonne of fruits, the values of 9.028 kg N, 0.577 kg P and 12.578 kg K were obtained. Of these, the fruits alone contained 2.318 kg N, 0.242 kg P (0.556 kg P_2O_5) and 4.384 kg K (5.261 kg K_2O). These values are in line with the findings of Martin-Prevel (1962) who obtained 2 kg N, 0.5 kg P_2O_5 and 6 kg K_2O from one tonne of fruits. Jaramillo and Garita (1982) also obtained same values for P_2O_5 and K_2O (0.5 kg and 6 kg respectively) though the value for N was low (1.25 to 2.00 kg). Jacob and Uexkull (1960) had also recorded corresponding values for N and P_2O_5 (1.67 to 2.50 kg and 0.50 to 0.67 kg respectively) but the value for K_2O was higher (5.83 to 7.33 kg). The differences obtained may be due to the inherent fertility of the soil and the efficiency of the varieites tried.

A close perusal of the importance of the major elements N, P and K based on the study would reveal that N and K are of greater importance in banana nutrition. Of the two, K was found in larger quantity. Norris and Ayyar (1942) also observed that while banana required large quantities of K and moderate amounts of N, relatively little P were needed for optimum production. Based on the composition and uptake studies of the variety 'Dwarf Cavendish' in the Canaries, Baillon *et al*. (1933) had also suggested that the fertilizers should be high in N and K_2O.

The present study indicated little response to P. Reports from elsewhere also indicate that there is little response to P in banana. In the present study the entire quantity of the recommended dose of fertilizers were split to form the various treatments. In the future studies the entire dose of P may be applied along with the first application and the other two major nutrients (N and K) alone may be split. An excess dose of N and K also could be tried.

It may further be pointed out that in the present study the uptake of nutrients by the corm was not subjected to analysis for the fear that it would affect ratooning. As such, further studies utilising the technique of destructive sampling have to be carried out to obtain more accurate informations regarding the uptake of nutrients.

7. Correlations and regressions

Though the yield had no strong correlation with any of the nutrient elements, the relatively greater correlation with N, P and K might be because (i) only these elements were applied to the plants in the present studies and (ii) only these elements directly contributed towards yield. Since the uptake of nutrients were estimated from the percentage of nutrients as well as the dry matter production, a positive relationship between uptake of nutrients and dry matter production is expected. But such strong relationships were obtained only with N, P, S and Ca, indicating that the concentration of these elements in the plant were consistent. This also explains the low correlations obtained with Fe, Mn and Zn wherein the concentration of these elements did not increase with an increase in the growth of the plant. The correlations among the various nutrient elements explain the extent of synergism between the different elements. The study revealed strong synergism between N and P, P and K, N and S, P and S, Ca and Mg as well as between S and Cu. Synergistic relationship between P and K was reported by Lahav (1973) and Sheela (1982), and between S and N was reported by Melin (1970).

The coefficient of determination obtained in all the cases was very low and these regressions cannot be used effectively.

8. Economics of cultivation

Economics of cultivation of 'Palayankodan' with the same quantity of the recommended dose in different types of splitting showed that the percentage of profit, as compared to the control, varied from -14.48 to + 17.76 (Table 82 and Fig.9). When three splits were employed, the profit was less than that of the control. Application in four splits resulted in increased profits. All the split applications involving ¼ dose as one of the splits (treatments 11 to 15) gave more profit than the control. The profits obtained from the splits ¼, ¼, 0, 0 and ¼, 0, ¼, 0 were 17.76 and 17.39% respectively and these were significantly superior to the control. The highest profit corresponded to Rs.2.70 more per plant than the control which could be obtained just by adjusting the splits.

9. Nutrient translocation on mattocking

Although the studies indicated differences in the radioactivity among the treatments, this cannot be attributed to the effects of the treatments. This is because the dilution resulting from unequal biomass of the plants (both the mother plant and the suckers) as well as the uneven number of the suckers produced are all confounded

Table 82. Effect of split application on the economics of cultivation (per hectare)

Treatment Code	Splitting				Mean yield (Bunch weight, Kg)	Cost of bunches (@ Re. 1.25/Kg) Rs.	Extra cost on additional splits* Rs.	Income (deducting extra cost) Rs.	Increase over the control, T_1 Rs.	% increase over the control, T_1
T_1	½	½	0	0	26754.36	33442.95	-	33442.95	-	-
T_2	½	0	½	0	26754.36	33442.95	-	33442.95	-	-
T_3	½	¼	¼	0	25469.42	31836.78	939.50	30897.28	-2545.67	-7.61
T_4	½	0	¼	¼	25039.64	31299.55	939.50	30360.05	-3082.90	-9.22
T_5	½	¼	0	¼	23631.29	29539.11	939.50	28599.61	-4843.34	-14.48
T_6	¼	¼	¼	¼	29815.71	37269.64	1879.00	35390.64	+1947.69	+5.82
T_7	¼	½	0	¼	27367.07	34208.84	939.50	33269.34	-173.61	-0.52
T_8	¼	½	¼	0	25469.42	31836.78	939.50	30897.28	-2545.67	-7.61
T_9	¼	0	½	¼	23937.64	29922.05	939.50	28982.55	-4460.40	-13.34
T_{10}	¼	¼	½	0	26937.29	33671.61	939.50	32732.11	-710.84	-2.13
T_{11}	¼	¾	0	0	30549.64	38187.05	-	38187.05	+4744.10	+14.19
T_{12}	¼	0	¾	0	27243.64	34054.55	-	34054.55	+611.60	+1.83
T_{13}	¾	¼	0	0	31407.00	39258.75	-	39258.75	+5815.80	+17.39
T_{14}	¾	0	¼	0	31506.18	39382.73	-	39382.73	+5939.78	+17.76
T_{15}	¾	0	0	¼	27146.67	33933.34	-	33933.34	+490.39	+1.47

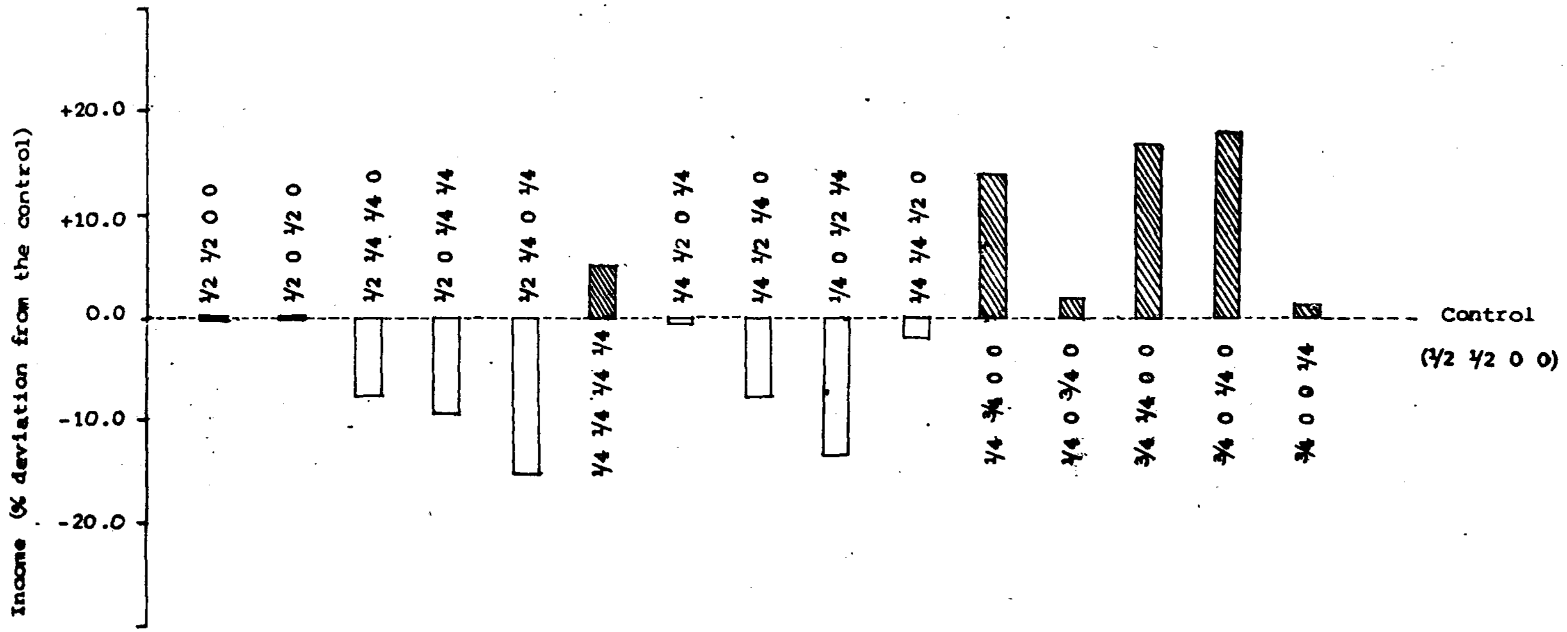
* This is on account of the additional cost of cultivation. For one additional split, the charges will be as given below: (man @ Rs.26/- and woman @ Rs.24/50 per day)

a) Taking basins for application of fertilizers (100 basins/man) Rs. 572.00+
b) Mixing and application charges (150 basins/woman) Rs. 367.50

Total Rs. 939.50

(Based on July, 1985 at the Banana Research Station, Kannara)

FIG. 9 . EFFECT OF SPLIT APPLICATION OF NPK ON THE ECONOMICS OF CULTIVATION



in the observed cpm values. Hence it is impossible to distinguish the cpm values. This may in part also explain the irregular trend in the cpm values at different intervals. However, translocation of nutrients from the mother plant to its suckers after harvest whether half of the pseudostem or the whole plant is retained, could be clearly established. Based on his studies in 'Robusta', Balakrishnan (1980) also established that there was translocation of nutrients from the pseudostem cut to half, to the developing suckers. The studies point out that it is beneficial to retain the mother plant for one month after harvest. Pattern of mattocking vis a vis number of cuttings should form a part of future investigations. Relative translocation of different nutrient elements also should be studied.

Summary

SUMMARY

Investigations on the intraclonal variations in the *Musa* (AAB group) 'Palayankodan' were carried out at the Banana Research Station, Kannara, Trichur during 1981-84. The effect of split application of the recommended dose of fertilizers on the growth, yield and quality of one of the accessions was another major aspect studied in detail. The salient findings from these studies are summarised below under two major heads, viz., intraclonal variations in banana and nutritional aspects.

Intraclonal variations in banana

The plants showed significant differences in height during the later stages of growth in the plant crop and throughout the growing period of ratoon 1. But, at the time of shooting, in all the three crops (plant crop, ratoon 1 and ratoon 2), significant differences in height were not observed. In general, the accessions 2 (Taliparamba) 9 (Tiruchirapalli) and 22 (Ernakulam) were dwarf, while, the accessions 6 (Tamarasseri), 16 (Tiruvalla) and 24 (Nattukal) were comparatively taller. The height of plants at the time of shooting was less in the plant crop (281.75 cm) which increased, however, in ratoon 1 (296.52 cm) and in ratoon 2 (306.83 cm).

Girth of plants showed significant differences during the later stages of growth both in the plant crop and in ratoon 1. The differences were significant at the time of shooting also, but in ratoon 2 the differences were not significant. The accessions 21 (Kalavoor), 24 (Nattukal) and 19 (Vellayani) had more girth than others. The accessions 23 (Edavanna), 15 (Karukachal) and 12 (Moolamattom) were comparatively thin. The girth of plants at the time of shooting increased progressively in ratoon 1 and ratoon 2; the values were 63.56, 67.36 and 70.19 cm for the plant crop, ratoon 1 and ratoon 2 respectively.

Number of functional leaves, borne by the plant did not vary with the stage of growth. Not much differences were also observed among plant crop and ratoons in this respect. On an average, the number of functional leaves present on the plant crop was 13.98 while it was 13.91 and 11.62 in ratoon 1 and ratoon 2 respectively.

Area of the third leaf recorded at the time of shooting differed significantly in all the three crops. The accessions 18 (Anchal), 19 (Vellayani), 21 (Kalavoor) and 7 (Morayur) had broader leaves than the accessions 4 (Adukkam), 17 (Konni), 22 (Ernakulam) and 12 (Moolamattom). The differences in the area of the third leaf among the plant crop, ratoon 1 and ratoon 2 were marginal, the values being 1.25, 1.22 and 1.33 m^2 respectively. The interval of leaf production, total number of leaves produced and the density of stomata on the upper surface of the leaf lamina differed significantly among the accessions. The accession 3 (Pullur) had the shortest interval and produced maximum number of leaves. As regards stomatal density, the accession 4 (Adukkam) recorded the highest value. The life of leaf, leaf ratio and stomatal density were more or less similar for all the accessions. The length and girth of the petiole as well as width and depth of the petiolar canal were also similar in all the accessions.

The duration of the crop varied significantly in ratoon 1; that too for the time taken from planting to shooting only. The accessions 5 (Ulleari), 10 (West Payipra), 13 (Kuravilangad) and 15 (Karukachal) had longer duration whereas the accessions 2 (Taliparamba), 7 (Morayur) and 22 (Ernakulam) had shorter duration in general. The plant crop on an average took 356 days to shooting but in ratoon 1 and ratoon 2 the time taken to shooting was much less (256 and 270 days respectively).

The nutrient composition of the third fully opened leaf at the time of shooting did not differ significantly among the accessions. The ranges in nutrient concentrations were from 2.41 to 3.14% for N, from 0.158 to 0.213% for P, from 3.17 to 3.98% for K, from 0.20 to 0.45% for Ca, from 0.24 to 0.46% for Mg, from 0.067 to 0.091% for S, from 36.0 to 77.4 ppm for Cu, from 147.1 to 317.8 ppm for Fe, from 791.0 to 1559.7 ppm for Mn and from 19.6 to 55.3 ppm for Zn.

Reaction of the accessions to important pest (rhizome weevil) and diseases (bunchytop and Sigatoka) showed wide variation. In the case of rhizome weevil, the ratio of the infected to the total rhizome ranged from 0.0 to 4.36 whereas the mortality due to bunchytop disease was from zero to 33 per cent. The range of infection index for Sigatoka was from 2.48 to 6.93. In general, the accessions 10 (West Payipra), 11 (Udumbannur), 13 (Kuravilangad), 17 (Konni), 18 (Anchal) and 21 (Kalavoor) showed greater field tolerance to the maladies. Weight of bunch, number of hands and the number of fingers differed significantly in the plant crop and in ratoon 1 but not in ratoon 2. The pooled analysis showed significant differences in bunch weight and also in the number of fingers but not in the number of hands. The accession 21 (Kalavoor) had the heaviest bunches (14.87 kg) followed by the accession 18 (Anchal) which had a bunch weight of 14.38 kg. The accessions 10 (West Payipra), 12 (Moolamattom) and 17 (Konni) produced very poor bunches. On the whole, the plant crop had the highest bunch weight (12.68 kg) followed by the ratoon 1 (12.00 kg) whereas ratoon 2 gave the lowest bunch weight (10.83 kg). The number of hands was the least in the plant crop but the number of fingers did not show much variation among the three crops. The difference in bunch weight was in general due to the weight of fingers rather than the number of hands or the number of fingers.

Among the various physical attributes of the fruits, weight of the fruit, weight of the pulp, length of the stalk and girth of the fruit were significantly influenced by the accessions. The girth (plumpness) of fingers was found to decide both the appearance and the weight of the bunch. The maximum (11.83 cm) and the minimum (9.87 cm) girth were those of the accessions 21 (Kalavoor) and 22 (Ernakulam) respectively.

Grading of the fruits based on visual standards showed marked differences among the accessions. The disposition and the curvature of the fingers presented greater differences than the colour, angularity and the presence of blotches/ speckles. The overall superiority in the grade was recorded by the accession 21 (Kalavoor); which was closely followed by the accession 2 (Taliparamba), whereas the accession 10 (West Payipra) had the poorest grade. It seems that the grade of the bunches could be determined from the quantitative parameters of the bunch.

The quality analysis showed significant differences with respect to total soluble solids, total sugars and reducing sugars. The differences in the accessions were more due to sugar content than due to acidity or ascorbic acid content.

The variations for all the characters studied was large. The variances in 21 out of the 24 characters studied were mainly due to environment. Weight of the ripe finger and weight of the pulp were influenced more by the genetic make-up. With respect to the bunch weight, the contributions from the genetic and the environment components were almost equal. Weight of the bunch, weight of the hands, weight of the ripe finger, weight of the pulp, length of the pedicel and the stomatal density of the upper surface offered more scope for selection than other characters. Relatively higher values of heritability were obtained for weight of the bunch, weight of the hands, weight of the ripe finger, weight of the pulp and the stomatal density of the upper surface of the leaf. The expected genetic advance under five per cent intensity of selection indicated that the characters studied could be improved from 0.03% (in the case of the leaf ratio) to 18.76% (in the case of the stomatal density of the upper surface of the leaf). The genetic gain was found to be maximum for the weight of the ripe finger (24.602%) whereas the number of hands recorded the minimum value (0.040%). As regards certain desirable characters like dwarfness, earliness etc., there was little scope for further improvement. Of the different vegetative characters studied, the area of the third leaf had maximum correlation with the bunch weight, followed by the number of leaves and the girth of the pseudostem at shooting. The relationship of the leaf ratio and the leaf production interval with the bunch weight was negative. In general, the genotypic correlation was higher than the phenotypic correlation, indicating thereby the preponderence of inherent relationship. The genotypic and phenotypic correlation coefficients among sixteen selected characters were worked out. The number of hands had strong positive correlation with the number of fingers, weight of the hands, length of the bunch, girth of the pseudostem and area of the third leaf, but its correlation with phylarom was negative. Weight of the finger was highly correlated with the weight of the pulp, girth of the finger and length of the pedicel.

The path analysis conducted indicated that the maximum positive direct effect was recorded by the weight of hands (1.6045), followed by the average weight of a green finger (0.6649) and the weight of the ripe finger (0.5885). The yield could be considerably improved through the weight of the individual finger together with the number of fingers.

Considering the practical convenience and the efficiency together, a selection index using four characters (weight of the bunch, number of hands, number of fingers and mean weight of a green finger) was used to perform selection. Accordingly, two accessions, viz., Anchal and Kalavoor were selected as the superior ones. To confirm the divergence and to group the similar types, D^2 analysis was carried out. Using the D^2 values, five clusters were formed. The intra-cluster distance did not exceed the inter-cluster distance. This confirmed the homogenous nature of the clusters.

As regards the contribution of characters towards divergence, bunch weight was found to contribute the maximum percentage. This was followed by the girth of the fruit.

From the various aspects of the study existence of intra-clonal variation in the clone 'Palayankodan' was established. By proper selection of the sub-clone alone, besides improving the quality, the yield could be increased to 34.59% more, over the local accession.

Nutritional aspects

Height of the plants were significantly different during the later stages of growth only, both in the plant crop and in ratoon 1. In both cases, however, significant differences in height were not observed at shooting. In general, plants which received the splits ½, ¼, 0, ¼ and ¼, 0, ½, ¼ were dwarf and those of the splits ¼, ¼, 0, 0 and ¼, 0, 0, ¼ were taller than those receiving other treatments. A comparison of the height of the plants at shooting in the plant crop and in ratoon 1 revealed that plants in ratoon 1 were taller (326.68 cm) than the plant crop (298.75 cm). Girth of the pseudostem showed significant differences only in the plant crop, at the 8th month of growth. The splits ¼, ¼, 0, 0 and ¼, ½, 0, ¼ induced more girth. Least girth was recorded in the plants of the splits ¼, 0, 0, ¼ and ½, ¼, 0, ¼. The differences in girth were not significant at shooting in both the crops. Between the two crops, the girth differences were narrow (66.61 cm in the plant crop and 67.23 cm in ratoon 1).

The number of functional leaves were significantly different only at the 8th month in the plant crop. Here maximum number of leaves was recorded by the plants of the splits ½, ¼, ¼, 0 and ¼, ½, ¼, 0 and the minimum of the splits ¼, 0, 0, ¼ and ½, ¼, 0, ¼. At shooting the differences were not significant in the plant crop and in ratoon 1.

The time taken from planting to shooting and also from planting to harvest differed significantly in the plant crop. In this case, plants which received the splits ¼, ½, 0, ¼ and ¼, ¼, 0, 0 took the shortest time to come to shooting and harvest. Plants receiving the splits ½, 0, ½, 0 and ¼, 0, ¼, 0 had the longest duration. In ratoon 1 the differences were not statistically significant. A comparison of the two crops revealed that ratoon 1 had more uniformity in shooting and lesser duration than the plant crop. The total duration ranged from 355.17 to 430.00 (mean 381.46) days in the plant crop and from 305.50 to 337.16 (mean 321.44) days in ratoon 1.

Bunch weight recorded significant differences in ratoon 1 and in ratoon 2 but not in the plant crop. The split ¼, 0, ¼, 0 was the best in both the crops. The number of hands was significantly different only in ratoon 2. There were no significant differences with regard to the number of fingers in any of the three crops. In the pooled analysis the bunch weight alone was found to differ significantly. The splits ¼, 0, ¼, 0 and ¼, ¼, 0, 0 were significantly superior to the control in increasing the bunch weight. A comparison of the three crops revealed that the bunch weight was maximum in ratoon 1, followed by ratoon 2 and the plant crop.

Among the fruit characters, only the pulp/peel ratio by weight differed significantly as influenced by the splits. As regards the quality, significant differences were obtained in the content of total sugars and reducing sugars.

There were no significant differences due to the treatments in the dry matter production of the individual plant parts such as pseudostem, leaves, peduncle and fruits. However, the total dry matter production was significantly influenced by the treatments. The split ¼, 0, ¼, 0 recorded the maximum dry matter production and rate of dry matter production. Of the total dry matter production by the different aerial parts, the contribution from the leaves was the highest (32.27 to 46.54%) followed by that from the fruits (28.87 to 42.05%).

The concentration of N and Fe were significantly different in the peduncle alone, K in the peduncle and pseudostem, Ca in the leaves and pseudostem, Mn in the pseudostem alone and Zn in the fruits alone. Peduncle had the highest concentration of N, P, K and S. The elements Ca, Mg, Fe, Mn and Zn were maximum in the leaves. Pseudostem had the maximum concentration of Cu.

Uptake studies of the nutrient elements revealed that N, P, S, Mn and Zn were significant in the fruits and K and Cu in the leaves. Leaves contained the maximum share of all the elements, except that of P, which was the highest in the fruits.

Potassium was taken up in the largest quantity by the plant (155.80 g) followed by N (111.83 g). The uptake of P was too low (7.148 g). These data corresponded to the removal of 246.47 kg N, 15.74 kg P and 343.48 kg K per hectare. The quantity of the nutrients removed by the plants for the production of one tonne of fruits were 9.03 kg N, 0.58 kg P and 12.58 kg K. The study indicated greater response to K and little response to P in banana.

Yield (bunch weight) had strong correlation with the uptake of N, P and K. The study also revealed synergism between N and P, P and K, N and S, P and S, Ca and Mg as well as between S and Cu.

The percentage of profit over the control in the different splits varied from -14.48 to +17.76. All the split applications involving ¼ dose as one of the splits gave more profit than the control. Highest profit corresponded to Rs. 2.70 more per plant over the control.

Existence of translocation of nutrients from the mother plant to its suckers after harvest, whether half the pseudostem or the whole plant (after removal of bunch) was retained, was established. The study indicated that it would be advantageous to keep the pseudostem of the mother plant for at least one month after harvest in order to benefit its suckers.

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* Original not seen

Appendices

APPENDIX-I

Weather data for the period from March 1981 to August 1984

Year/Month	Temperature (°C) Maximum	Minimum	Relative humidity (%)	Total rainfall (mm)	Number of rainy days
1	2	3	4	5	6
1981					
March	37.5	23.9	60.0		
April	36.4	25.3	67.1	57.1	2
May	34.7	24.5	75.3	118.8	8
June	28.9	22.4	92.8	1113.0	28
July	29.7	22.1	89.4	536.5	18
August	29.2	21.9	89.6	580.9	25
September	29.7	24.6	86.9	540.1	19
October	31.3	25.2	86.4	136.6	10
November	32.3	24.3	72.6	99.8	3
December	32.4	25.2	60.9		
1982		Not avilable			
January	33.2		60.4		
February	35.4		53.0		
March	37.4		57.3		
April	37.5		60.0	78.1	2
May	34.9		77.0	173.0	8
June	31.1		86.7	756.2	25
July	30.2		87.8	602.0	21
August	29.7		90.1	658.7	28
September	31.9		84.7	78.4	6
October	33.4		81.4	270.5	13
November	31.5		80.5	83.5	6
December	30.3		49.7	4.8	1

(contd.)

Appendix-I (concl.)

1	2	3	4	5	6
1983		Not available			
January	34.2		47.8		
February	35.4		53.2		
March	37.1		59.6		
April	38.0		Not available		
May	37.0			43.3	3
June	32.7			409.3	18
July	30.1			732.2	21
August	29.2			793.0	26
September	29.0			489.4	24
October	32.1			128.1	9
November	31.1			86.4	3
December	31.3			36.8	4
1984		Not available			
January	32.6		60.5		
February	34.5		65.1	5.0	1
March	36.0		66.0	31.2	4
April	35.2		66.1	115.5	7
May	36.4		70.1	29.8	4
June	29.5		87.4	780.2	29
July	29.1		89.4	752.0	22
August	30.1		86.2	300.9	20

Source: Central Plantation Crops Research Institute (Sub Station) Kannara, Trichur.

APPENDIX II

Analysis of variance for different characters

Character	Mean squares	
	Treatment	Error
1	2	3
A. Intraclonal variation studies		
(Degrees of freedom	23	46)
1. Growth parameters		
a. Plant height (plant crop)		
i) 4th month	507.36	401.10
ii) 5th month	647.85	371.27
iii) 6th month	978.57	379.15**
iv) 7th month	1018.30	364.70**
v) 8th month	1113.34	334.74**
vi) 9th month	972.89	312.81**
vii) 10th month	643.54	243.02**
b. Plant height (ratoon 1)		
i) 4th month	640.12	413.37**
ii) 5th month	613.53	345.02*
iii) 6th month	726.33	378.99*
iv) 7th month	580.03	311.61*
c. Plant girth (plant crop)		
i) 4th month	34.67	22.35
ii) 5th month	53.37	25.41*
iii) 6th month	56.98	27.19*
iv) 7th month	57.07	23.56**
v) 8th month	55.37	23.38**
vi) 9th month	54.12	21.79**
vii) 10th month	45.19	16.25**

(contd.)

Appendix II (contd.)

1	2	3
d. Plant girth (ratoon 1)		
i) 4th month	54.14	36.81
ii) 5th month	54.35	33.06
iii) 6th month	55.19	25.26*
iv) 7th month	47.24	22.84*
e. Number of functional leaves (plant crop)		
i) 4th month	1.23	4.68**
ii) 5th month	0.99	0.84
iii) 6th month	0.73	0.44
iv) 7th month	0.75	0.44
v) 8th month	1.02	0.31**
vi) 9th month	1.17	0.54*
vii) 10th month	1.54	1.08
f. Number of functional leaves (ratoon 1)		
i) 4th month	0.42	0.32
ii) 5th month	0.83	0.40*
iii) 6th month	0.57	0.40
iv) 7th month	0.72	0.55
g. Plant characters at shooting (plant crop)		
i) Height	342.60	397.96
ii) Girth	16.26	7.92*
iii) Number of functional leaves	3.32	4.41
iv) Area of 3rd leaf	00.029	0.012**

(contd.)

Appendix II (contd.)

1		2	3
h.	Plant characters at shooting (ratoon 1)		
i)	Height	447.40	381.07
ii)	Girth	41.28	12.40**
iii)	Number of functional leaves	1.61	1.03
iv)	Area of 3rd leaf	0.034	0.018*
i.	Plant characters at shooting (ratoon 2)		
i)	Height	554.12	4401.29
ii)	Girth	10.55	14.47
iii)	Number of functional leaves	1.96	1.34
iv)	Area of 3rd leaf	0.0821	0.0271**
j.	Duration of the crop (plant crop)		
i)	Planting to shooting	559.67	572.97
ii)	Shooting to harvest	47.15	29.45
iii)	Planting to harvest	542.71	632.09
k.	Duration of the crop (ratoon 1)		
i)	Planting to shooting	681.94	333.59*
ii)	Shooting to harvest	9.140	17.117
iii)	Planting to harvest	622.59	414.50
l.	Duration of the crop (ratoon 2)		
i)	Planting to shooting	867.87	675.63
ii)	Shooting to harvest	14.45	20;65
iii)	Planting to harvest	984.35	674.30

(contd.)

Appendix II (contd.)

1	2	3
2. Leaf characters		
a. Phylacron	6.03	3.25*
b. Life of a leaf	22.55	25.42
c. Number of functional leaves	3.39	1.51*
d. Leaf ratio	0.0230	0.1718
e. Stomatal density		
i) Upper leaf surface	1091.98	408.97**
ii) Lower leaf surface	1741.57	1867.69
3. Petiole characters		
a. Legnth	36.06	33.37
b. Girth	1.81	1.31
c. Width	0.23	0.19
d. Depth	0.17	0.13
4. Nutrient composition of index leaf		
a. Nitrogen	0.16	0.16
b. Phosphorus	0.0004	0.0004
c. Potassium	0.09	0.13
d. Calcium	0.0096	0.0097
e. Magnesium	0.0135	0.0082
f. Sulphur	0.0001	0.0001
g. Copper	407.4	281.8
h. Iron	7346.8	5387.7
i. Manganese	97087.0	110655.3
j. Zinc	225.4	226.3

(contd.)

Appendix II (contd.)

1	2	3
5. Bunch characters		
a. Plant crop		
i) Bunch weight	10.10	2.66**
ii) Number of hands	1.11	0.55*
iii) Weight of hands	7.04	2.60**
iv) Mean weight of a hand	0.03	0.01**
v) Number of fingers	527.58	257.94*
vi) Mean weight of a finger	112.02	55.35*
vii) Length of bunch	30.65	14.81*
b. Ratoon 1		
i) Bunch weight	4.5244	1.3446**
ii) Number of hands	1.1549	0.4882**
iii) Number of fingers	251.25	141.17*
c. Ratoon 2		
i) Bunch weight	5.120	4.227
ii) Number of hands	1.434	1.447
iii) Number of fingers	413.08	392.05
d. Pooled mean		
i) Bunch weight	7.4731	3.356*
ii) Number of hands	0.6794	0.4247
iii) Number of fingers	258.91	107.43**

(contd.)

Appendix II (contd.)

1	2	3
6. Fruit characters		
a. Physical		
i) Weight of fruit	396.40	75.96**
ii) Weight of pulp	252.36	38.25**
iii) Pulp/peel ratio	1.92	0.90
iv) Length of stalk	0.44	0.19**
v) Length of edible portion	1.17	0.87
vi) Length of apex	0.03	0.03
vii) Total length	2.59	1.57
viii) Girth	0.86	0.34**
b. Chemical		
i) T.S.S.	3.56	1.34**
ii) Reducing sugars	0.2950	0.0193**
iii) Non-reducing sugars	0.0028	0.0031
iv) Total sugars	0.2974	0.0195**
v) Acidity	0.0058	0.0056
vi) Sugar/acid ratio	91.48	79.25
vii) Ascorbic acid	0.337	1.134
B. Nutritional studies		
(Degrees of freedom	14	28)
1. Growth parameters		
a. Plant height (plant crop)		
i) 4th month	297.81	257.28
ii) 5th month	305.28	313.43

(contd.)

Appendix II (contd.)

1	2	3
iii) 6th months	622.22	349.64
iv) 7th month	754.03	252.90**
v) 8th month	729.96	349.82*
b. Plant height (ratoon 1)		
i) 4th month	721.74	606.47
ii) 5th month	301.71	250.74
iii) 6th month	365.73	136.57*
c. Plant girth (plant crop)		
i) 4th month	17.66	13.35
ii) 5th month	17.66	14.93
iii) 6th month	21.23	17.13
iv) 7th month	22.32	12.46
v) 8th month	20.84	8.69*
d. Plant girth (ratoon 1)		
i) 4th month	25.58	23.51
ii) 5th month	24.64	16.89
iii) 6th month	27.64	15.51
e. Number of functional leaves (plant crop)		
i) 4th month	0.48	0.31
ii) 5th month	0.23	0.23
iii) 6th month	0.84	0.44
iv) 7th month	0.24	0.22
v) 8th month	0.64	0.12**

(contd.)

Appendix II (contd.)

1	2	3
f. Number of functional leaves (ratoon 1)		
i) 4th month	1.35	1.24
ii) 5th month	1.13	1.58
iii) 6th month	1.85	1.07
g. Plant characters at shooting (plant crop)		
i) Height	297.20	216.22
ii) Girth	16.33	10.88
iii) Number of functional leaves	2.04	1.12
h. Plant characters at shooting (ratoon 1)		
i) Height	327.52	402.65
ii) Girth	18.71	16.89
iii) Number of functional leaves	1.37	0.81
i. Duration of the crop (plant crop)		
i) Planting to shooting	1239.62	441.92**
ii) Shooting to harvest	65.69	42.12
iii) Planting to harvest	1589.72	437.95**
j. Duration of the crop (ratoon 1)		
i) Planting to shooting	209.72	372.42
ii) Shooting to harvest	13.58	16.60
iii) Planting to harvest	252.55	364.83
k. Dry matter content		
i) Pseudostem	0.21	0.12
ii) Leaves	0.28	0.16
iii) Peduncle	0.001	0.001

(contd.)

Appendix II (contd.)

1	2	3
iv) Fruits	0.53	0.28
v) Total	1.56	0.68*
2. Bunch characters		
a. Plant crop		
i) Bunch weight	1.28	1.61
ii) Number of hands	0.75	0.40
iii) Number of fingers	458.12	328.13
b. Ratoon 1		
i) Bunch weight	8.73	2.95**
ii) Number of hands	1.67	0.86
iii) Number of fingers	21.02	489.07
c. Ratoon 2		
i) Bunch weight	7.99	2.75**
ii) Number of hands	1.46	0.54*
iii) Number of fingers	725.50	381.19
d. Pooled mean		
i) Bunch weight	3.9156	1.3523**
ii) Number of hands	0.5888	0.2940
iii) Number of fingers	320.41	162.51
3. Fruit characters		
a. Physical		
i) Length of stalk	0.09	0.08
ii) Length of edible portion	1.03	1.05
iii) Length of apex	0.01	0.01
iv) Total leggth	1.20	1.14
v) Girth	0.57	0.36

(contd.)

Appendix II (contd.)

1		2	3
vi)	Weight of fruit	137.12	99.46
vii)	Weight of pulp	106.82	60.58
viii)	Volume of fruit	174.21	111.62
ix)	Volume of pulp	110.70	66.05
x)	Pulp/peel ratio (by weight)	1.65	0.72*
b.	Chemical characters		
i)	T.S.S.	2.31	2.01
ii)	Reducing sugars	0.54	0.04**
iii)	Non-reducing sugars	0.03	0.04
iv)	Total sugars	0.43	0.03**
v)	Acidity	0.0015	0.0019
vi)	Sugar/acid ratio	4.69	8.52
4.	Nutrient content		
a.	Nitrogen		
i)	Pseudostem	0.0667	0.0669
ii)	Leaves	0.1013	0.1387
iii)	Peduncle	0.55	0.19**
iv)	Fruits	0.11	0.65
b.	Phosphorus		
i)	Pseudostem	0.0006	0.0003
ii)	Leaves	0.00021	0.00027
iii)	Peduncle	0.0019	0.0024
iv)	Fruits	0.0001	0.0001
c.	Potassium		
i)	Pseudostem	0.31	0.08**

Appendix II (contd.)

1	2	3
ii) Leaves	0.61	0.52
iii) Peduncle	2.55	0.93*
iv) Fruits	0.07	0.18
d. Calcium		
i) Pseudostem	0.09	0.04*
ii) Leaves	0.063	0.029
iii) Peduncle	0.0209	0.0224
iv) Fruits	0.02	0.02
e. Magnesium		
i) Pseudostem	0.03	0.02
ii) Leaves	0.0074	0.0086
iii) Peduncle	0.0142	0.0188
iv) Fruits	0.0168	0.0210
f. Sulpher		
i) Pseudostem	0.0010	0.0003**
ii) Leaves	0.0003	0.0002
iii) Peduncle	0.0018	0.0009
iv) Fruits	0.000013	0.000029
g. Copper		
i) Pseudostem	33.36	71.69
ii) Leaves	40.97	40.73
iii) Peduncle	197.61	127.67
iv) Fruits	4.76	3.96

(contd.)

Appendix II (contd.)

1	2	3
h. Iron		
i) Pseudostem	255194.74	187800.92
ii) Leaves	78794.28	103034.01
iii) Peduncle	252555.20	114831.55
iv) Fruit	2735.18	2903.06
i. Manganese		
i) Pseudostem	87288.23	40178.86**
ii) Leaves	3597863.45	3677171.45
iii) Peduncle	11581.18	7107.03
iv) Fruit	5876.28	4093.67
j. Zinc		
i) Pseudostem	206.27	129.82
ii) Leaves	696.83	531.39
iii) Peduncle	703.86	926.46
iv) Fruit	432.71	141.07**
5. Nutrient uptake		
a. Nitrogen		
i) Pseudostem	66.89	45.23
ii) Leaves	152.80	205.52
iii) Peduncle	1.04	0.65
iv) Fruits	159.53	56.26**
v) Total	506.20	354.01
b. Phosphorus		
i) Pseudostem	0.21	0.25
ii) Leaves	0.23	0.40

(contd.)

Appendix II (contd.)

1	2	3
iii) Peduncle	0.0073	0.0105
iv) Fruits	0.99	0.44
v) Total	2.18	1.45
c. Potassium		
i) Pseudostem	145.68	64.12*
ii) Leaves	580.52	434.88
iii) Peduncle	8.45	4.69
iv) Fruits	451.98	234.47
v) Total	2033.62	928.14*
d. Calcium		
i) Pseudostem	41.44	22.34
ii) Leaves	43.76	31.97
iii) Peduncle	0.025	0.048
iv) Fruits	17.99	12.93
v) Total	138.35	76.47
e. Magnesium		
i) Pseudostem	7.79	7.56
ii) Leaves	5.40	9.38
iii) Peduncle	0.019	0.044
iv) Fruits	20.30	13.78
v) Total	33.58	37.96
f. Sulphur		
i) Pseudostem	0.161	0.113
ii) Leaves	0.46	0.40
iii) Peduncle	0.0048	0.0035
iv) Fruits	0.0623	0.0206**
v) Total	0.92	0.70

(contd.)

Appendix II (concl.)

1	2	3
g. Copper		
i) Pseudostem	464.29	451.07
ii) Leaves	1000.00	357.14*
iii) Peduncle	3.98	2.79
iv) Fruits	237.57	138.21
v) Total	1730.71	997.86
h. Iron		
i) Pseudostem	0.79	0.58
ii) Leaves	0.78	0.77
iii) Peduncle	0.0028	0.0017
iv) Fruits	0.0124	0.0137
v) Total	1.38	1.56
i. Manganese		
i) Pseudostem	0.50	0.25
ii) Leaves	41.53	30.15
iii) Peduncle	0.0003	0.0002
iv) Fruits	0.0482	0.0163**
v) Total	42.16	33.45
j. Zinc		
i) Pseudostem	850.0	460.0
ii) Leaves	7714.30	5535.71
iii) Peduncle	9.83	11.39
iv) Fruits	4057.14	843.00**
v) Total	4528.57	2553.57

* Significant at 5% level

** Significant at 1% level

INTRACLONAL VARIATIONS AND NUTRITIONAL STUDIES IN BANANA cv. 'PALAYANKODAN'

By

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ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement for the degree of Doctor of Philosophy in Horticulture

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ABSTRACT

The investigations were carried out at the Banana Research Station, Kannara, during 1981-84 in the banana cv. 'Palayankodan'.

Twenty four accessions were subjected to detailed analysis with respect to growth, yield and quality. The plants of the accessions differed significantly with regard to height and girth of pseudostem during the later stages of growth, both in the plant crop and in ratoon 1. Significant differences observed in the number of functional leaves were not consistent. Area of the third leaf at shooting varied significantly in all the three crops. The trend in variation between the crops, however, was not consistent. Interval of leaf production, total number of leaves produced and the density of stomata in the upper surface of the leaf lamina showed significant differences. The duration from planting to shooting in ratoon 1 alone varied significantly. The plant crop took more time than ratoon 1 and ratoon 2 to come to harvest. The content of nutrient elements in the index leaf did not exhibit significant variations. The reaction of the accessions to the important pest (rhizome weevil) and diseases (bunchytop and Sigatoke) varied considerably.

Weight of the bunch, number of hands and number of

fingers differed significantly in the plant crop and in ratoon 1; but not in ratoon 2. Pooled analysis showed significant differences with regard to bunch weight and the number of hands. The accession 21 (Kalavoor) produced the heaviest bunches (14.87 kg) followed by 18 (Anchal) with a bunch weight of 14.38 kg. Bunch weight was the highest in the plant crop and lowest in ratoon 2. Weight of the fruit, weight of the pulp, length of the stalk and girth of the fruit were significantly influenced by the accessions. Significant differences were also obtained with respect to total soluble solids, total sugars and reducing sugars. Among the characters used for grading, the disposition and the curvature of fingers presented greater differences.

The variations for all the characters studied was large. The characters such as weight of the bunch, weight of the hands, weight of the ripe finger and weight of the pulp offered more scope for improvement through selection. There was strong correlation between the girth of the pseudostem and the leaf area on the one hand and the yield on the other.

Using a selection index, two superior accessions, namely, Anchal and Kalavoor were selected. The accession Kalavoor was found to be the best in terms of yield and quality.

D^2 analysis carried out with 16 characters exhibiting significant differences with respect to the accessions gave rise to five homogenous clusters. Bunch weight was found to contribute the highest percentage towards divergence, followed by the girth of the fruit.

The studies revealed that intraclonal variation existed in the clone and that by proper selection, high yielding sub-clones (as Kalavoor, Anchal etc) could be identified.

In the studies on the effect of split application of NPK, the splits ¼, 0, ¼, 0 and ¼, ¼, 0, 0 were significantly superior to the control (½, ½, 0, 0) in increasing the bunch weight. Of these, the split ¼, 0, ¼, 0 recorded the highest dry mater production. Ratoon 1 recorded the highest bunch weight, followed by ratoon 2 and the plant crop. Of the physical characters of the fruits, only the pulp/peel ratio (by weight) differed significantly among the treatments. The chemical characters (quality) showed significant differences in the content of total sugars and reducing sugars.

Potassium was taken up in the largest quantity by the plant (155.80 g) followed by N (111.83 g). Uptake of P was too low (7.15 g). These data corresponded to the removal of 246.47 kg N, 15.74 kg P and 343.48 kg K/ha.

By suitable splitting (¼, 0, ¼, 0) of the recommended dose of fertilizers, the yield could be improved upto 17.76% more, than the control, which corresponded to an additional profit of Rs.2.70 per plant.

Existence of translocation of nutrients from the mother plant to its suckers after harvest, whether half the pseudostem or the whole plant was retained, was also confirmed through ^{32}P studies.