SELECTION OF SUPERIOR TYPES OF KALIETHAN [(*Musa* AAB GROUP) 'NENDRAN']

By

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THESIS

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I hereby declare that this thesis entitled "Selection of superior types of Kaliethan [(*Musa* AAB group) 'Nendran'] 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 titles of any other University or Society.

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Certified that this thesis entitled **Selection of superior types of Kaliethan [(*Musa* AAB group) 'Nendran'] is a bonafide record of research work done independently by Sri. Sunilkumar. K. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to him.**

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INTRODUCTION

INTRODUCTION

Banana is an important tropical fruit crop. Banana cultivation in India is as old as Indian civilization. In our country, banana occupies first position in fruit production and is extensively cultivated in southern parts of the country. In India, the crop is cultivated in 3,25,700 hectares with a production of 60,56,400 tonnes and the percapita consumption of banana in India has reached 11.4 kg per year (Anon., 1990a). In Kerala the crop is cultivated on an area of 23,850 hectares with a production of 3,39,994 tonnes (Anon. 1996).

With respect to banana, polyclonal cultivation is the feature of our country. This is due to the differences in regional preferences and local adaptability. Therefore accepted variety in one locality will be different from that of another. India is considered as one of the centres of origin of the crop and more than 300 cultivars and clones of banana could be identified. The confusing synonyms make it difficult to identify various clones and cultivars.

The performance of a clone in a locality is a function of its genotype and environment. Therefore, performance of individual clones vary with different agro-climatic situations. Thus a systematic evaluation of individual clones for their yield potentialities is required to judge the suitability of that clone in a particular agro-climatic situation.

The occurrence of somatic mutations in banana offers greater scope for selection of the desirable type for commercial cultivation in a locality. To fully exploit the bud variations in banana cultivars appear to be very promising line of work. This can be achieved only by extensively surveying the traditional banana growing tracts (Nayar, 1962).

Nendran belonging to the French plantain group is the leading commercial banana variety in Kerala owing to its multifarious uses. Nendran banana in different parts of Kerala exhibits variation with respect to yield as well as vegetative characters. Thus a number of clones and ecotypes have been identified suited to various parts of the state of which Kaliethan is the adapted type in southern tracts of the state. Therefore, selection of desirable types among the existing population of the tract is desirable to evolve superior types with better orchard efficiency.

The present study was undertaken with the objective of surveying the Nendran growing tracts of Thiruvananthapuram district to select ecotypes of Nendran banana having superior horticultural traits such as dwarf stature, high yield potentiality and favourable reaction to biotic as well as abiotic stress for commercial cultivation in the locality. Thus variability in growth, yield and quality, yield correlations,

path analysis and discriminent function analysis were carried out to provide basic informations necessary for the improvement of this crop through selection.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Among the major tropical fruit crops banana occupies a place of prominence in India. The crop exhibits wide variation in growth and yield characters throughout the country. 'Nendran' is the important commercial cultivar in Kerala, in which occurrence of inter and intraclonal variation was evidenced by several research workers. Iyer (1987) suggested isolation of intraclonal variants as a tool for better productivity in banana.

Detailed studies on intraclonal variation in Nendran are very little. Available information on such variations and their relation to growth, yield and quality are reviewed below.

2.1 Variation in biometric characters

Gross and Simmonds (1954) assessed variations due to 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. Shephered (1957) reported that leaf ratio seemed to be a character least affected by environment and therefore, would be of great use for detection of intra-clonal variation.

Pillai and Shanmugavelu (1976) reported that the phyllachron in 'Poovan' banana varied from 8.0 to 8.6 days. They also opined that the increase in the level of functional leaves

decreased the interval of successive leaves. They also reported that the banana plant having greater functional leaf area required longer cropping period.

In an experiment conducted at Banana Research Station, Kannara (Anon, 1984b), the crop duration of Nendran clones varied from 332.3 (clone 100) to 359.3 days (Clone No.134).

Rajeevan (1985) reported significant variation in the phyllachron in different accessions of 'Palayamkodan'. He also reported significant variation in the duration of 'Palayamkodan' accessions in first ratoon. The accessions 5, 10, 13 and 15 had longer duration, while accessions 2, 7 and 22 had shorter duration.

Significant variation in the height of 'Palayamkodan' was reported by Rajeevan (1985). The variation was observed during the later stages of growth in the plant crop and throughout the growing period of first ratoon. The accessions 2, 9 and 22 were comparatively dwarf, while accessions 6, 16 and 24 were taller.

Kothavade *et al.*, (1985) revealed that the height of 'Basrai' banana increased with the increase in the number of functional leaves per plant.

Rajeevan (1985) observed significant variation in girth of pseudostem in 'Palayamkodan' accessions both in plant crop and

first ratoon. The values of girth were 63.56, 67.3 and 70.19 cm for the plant crop, first ratoon and second ratoon respectively.

In the clonal variation study in Nendran at Banana Research Station, Kannara, the crop duration varied between 332.3 and 359.3 days in 1982, 203.33 and 309.33 days in 1983 and 291.3 and 327.6 days in 1987 for the same Nendran clones (Anon., 1987).

Tang and Chu (1993) recorded slightly higher pseudostem girth for Taichiao-2, a selection of banana from the variety Cavendish Black Farm. The values of girth were 79-83 cm against 72-81 cm for the control. They also observed variation in heights. The selection Taichiao-2 had a height of 255-278 cm, some 50-60 cm shorter than the control.

Intra-clonal variations in various characters were reported in other fruit crops also.

Chen *et al*. (1990) observed variation in fruit ripening time in the satsuma mandarin strain 'Zaojin' obtained from the Japanese variety 'Xingjin'. The fruits of the former began to ripe 10 days earlier than its parent.

Early, normal or late ripening types were noted in the plum cultivar 'Buhler Fruhwetsche' (Hartmann, 1990). He could identify 3 early, 10 normal and 2 late ripening types in the above variety.

Five selections obtained from mandarin cv. 'Nanfeng Miju' showed early fruit maturity (Li *et al.*, 1991). The fruits of these selections matured 2 to 4 weeks earlier than those of the standard variety.

Among the clones of the Taiwanese mandarin variety Ponggan, Peng *et al.* (1994) obtained an early bearing selection, 'Ponggan 85-1'.

Christensen (1995) while selecting the clones of the sour cherry cv. Stevnsbaer, found that the date of flowering and harvest varied by about one month among the clones.

2.2 Variation in yield characters

In Dwarf Cavendish banana, Venkatarayappa and Narasimham (1975) reported variation in the finger length and girth as 15-94 and 10-54 cm respectively.

Evaluation of four mutants of Cavendish banana revealed that the number of fingers per bunch varied between 110 and 128 (George *et al.*, 1978). The pulp/peel ratio varied from 2.44 to 2.77, though not significant.

Studies at Kerala Agricultural University (Anon., 1982) revealed that the Nendran clone from Pampady-Meenadom area of Kottayam district recorded the highest mean bunch weight of 12.5 kg.

Experiments conducted at Kannara and Vellanikkara (Anon., 1984a) with Nendran clones revealed that the mean bunch weights were 10.67 and 10.4 kg respectively. At Kannara, 15 out of 47 clones showed an average bunch weight of above 10 kg of which 3 had a bunch weight of above 12 kg. Out of the 78 clones at Vellanikkara, 23 recorded an average bunch weight above 12 kg. A clone collected from Poovanchira of Trichur district recorded the maximum yield (16.5 kg) at Vellanikkara. Next year in the same experiment 15 clones had a mean bunch weight of 10 kg and the clone 49 (Kothala-Quilon) recorded the maximum weight of 15.42 kg followed by Clone 35 (Muttathukonam-Quilon), Clone 100 (Pandallore-Malappuram) and Clone 123 (Puthur-Trichur) with a mean bunch weight of 13.83 kg, 13.40 kg and 13.25 kg respectively.

Clonal variation studies at Banana Research Station, Kannara, indicated that the number of fingers varied between 49.7 and 66.4 per bunch for Nendran (Anon., 1984a) and 173 to 226 g (Anon, 1984b). The study also revealed that the clone 123 (Puthur-Trichur) showed significantly higher pulp/peel ratio by weight of green fingers (1.82) and was significantly superior to the clone 134 (Chengallore-Trichur) and clone 35 (Muttathukonam-Quilon).

Rajeevan (1985) reported variation in bunch weight with different accessions of Palaymkodan. The accession 21 (Kalavoor)

had the heaviest bunches (14.87 kg) followed by the accession 18 (Anchal) with a bunch weight of 14.38 kg. Very poor bunch yields were recorded in accession 10 (West Payipra), accession 12 (Moolamattom) and accession 17 (Konni). Finger length varied from 9.87 cm to 11.85 cm among different accessions.

Pooled analysis of bunch weight in Nendran clones conducted at Banana Research Station, Kannara (Anon., 1987) revealed a variation in bunch weight from 8.55 kg in clone 0 to 11.65 kg in clone 132.

Clonal variation studies in Nendran at Banana Research Station, Kannara, revealed a variation in finger weight from 162.16 to 202.72 g (Anon., 1989). However, the number of hands per bunch did not vary significantly.

According to Prasanna and Aravindakshan (1990) in banana, whatever the variation in bunch weight within a clone may be contributed by environmental and other factors.

Ten banana clones when evaluated at 8 sites, showed differential response in different environments (Rodriguez, 1991). With respect to yield characters, significant genotype x year or genotype x site or both interactions were obtained.

Among 24 accessions of Palayamkodan, Rajeevan and Mohanakumaran (1993) reported significant differences with respect to bunch weight, number of hands and number of fingers in

the plant crop and in the first ratoon. The bunch weight varied from 9.73 kg in accession 12 to 16.33 kg in accession 21. It was 9.88 kg in accession 3 and 14.81 kg in accession 21 in the first ratoon. The number of hands ranged between 10.00 each in accessions 10 and 20 and 12.00 in accession 7 in the plant crop.

Number of fingers was the highest in accession 15 (195.33) and the lowest in accession 10 (142.67) in the plant crop. In the first ratoon the number of hands ranged between 10.25 in accession 17 and 13.5 in accession 14. The number of fingers in the first ratoon varied from 157.5 in accession 14 and 198.75 in accession 19.

Variations in yield characters of other fruit crops are given below.

In mango distinct clonal variations were observed when grown in different areas, as reported by Singh (1971). He attributed root stock, soil, climatic factors as well as indiscriminate multiplication as the reasons for variation.

Ponggan 85-1, a selection from the clones of the Taiwanese mandarin variety Ponggan, was reported by Peng *et al*. (1994). The selection was having large sized fruits weighing 234.2 g on an average.

Valentini *et al*. (1994) attempted variability studies in Verdicchio, the grape popular in Italy. Accordingly, the

genetic variability could be considered as the widest, than for the locations.

Clonal evaluation of grape revealed that in the clones of the Furmint type yield varied from 5.5 to 18 t/ha where as in Lipovina from 6 to 14 t/ha (Sekera and Ruman, 1994).

There were marked difference in the fruit size among clones of the plum 'Domaci Svestky' (Paprstein, 1995). Clones SE 4013, SE 4011 and HL 7/11 had the largest fruit with a mean fruit weight of over 20 gram.

2.3 Variation in quality of fruits

The clonal variation studies in 'Nendran' at Banana Research Station, Kannara revealed that there was no significant variation in quality characters of fruits such as TSS acidity and pulp:peel ratio (Anon., 1984a). The TSS per cent varied from 28.7 to 34.3 and the acidity from 0.27 to 0.34 per cent.

Rajeevan (1985) observed significant differences in the quality parameters such as TSS, total sugars and reducing sugars in 'Palayamkodan' accessions. The observed variations are as follows. The TSS ranged between 22 and 26.17 per cent, acidity varied between 0.30 - 0.48 per cent, total sugars from 16.41 to 17.4 per cent, reducing sugars from 15.5 to 17.18 per cent and non-reducing sugars from 0.14 to 0.27 per cent. However, in respect of acidity, sugar/acid ratio and Vitamin-C content, the

differences were not significant. In the study of intra-clonal variation in Musa (AAB) 'Mysore', Rajeevan and Mohanakumaran (1993) reported no significant variation in quality characters like acidity and non reducing sugars. However, they observed variation in TSS, reducing sugar and total sugar.

Similar lines of work in other fruit crops also showed significant variations in fruit quality.

In the clonal variation studies in apricot 'Velkopavlovicka', Vachun (1981) observed that the variability was low for fruit quality.

Three Valencia orange clones were evaluated by Muinos and Romillo (1987) for quality aspects. The clone Frost recorded the highest acidity. No difference could be detected between clones with respect to rind thickness, number of seeds per fruit, juice content and per cent of soluble solids.

2.4 Variation in the incidence of diseases and pests

2.4.1 Incidence of diseases

According to Brun (1962) the level of resistance to sigatoka displayed by a given cultivar may vary within relatively wide limits according to local conditions and the amount of infective inoculum.

Simmonds (1966) reported that the resistance to sigatoka increases as the proportion of B genome increases.

In an effort to screen tolerance / resistance to leaf spot disease, Gopimony (1977) reported that under AAB group only seven varieties out of a total of twenty three scored were either tolerant or highly tolerant. Most of the native varieties of Kerala including Chenkadali, Vadakkan Kadali, Ambalakadali, Palayamkodan, Kodappanilla Kunnan, Poomkalli, Neymannan, Monthan, Veneethu mannan, Peykunnan, Neypoovan, Njali poovan, Valiyakunnan and Veneethukunnan were found to be tolerant to leaf spot diseases when compared to the exotic Grosmichel and Robusta.

The Sigatoka infection index of palayamkodan varied from 2.48 to 6.93 for various accessions (Rajeevan, 1985). He also reported a mortality per cent ranging from 0 to 33 due to bunchy top disease among different accessions.

Mohan and Lakshmanan (1987) in their effort to evaluate banana germplasm against bunchy top virus, reported that all clones representing AAA and AA genomes were severely affected. The disease incidence varied from 20 to 80 per cent in the above categories. Where as all hybrids of Klue Teparod with *Musa accuminata*, *Musa balbisiana* Wather and Nendran were free from the disease.

Among 18 AAA clones, 'Manoranjitham' showed high field resistance to sigatoka leaf spot (Anon., 1990b). Under AAB clones, a moderate level of multiple resistance was observed in 'Thiruvananthapuram', 'Mysore ethan' and 'Padalimoongil' against rhizome weevil, nematode and sigatoka leaf spot.

Babylatha *et al*. (1990) reported that cultivars vary widely in their reaction to leaf spot diseases. (*Cercospora musae*, *Cordana musa*, *Septoria* or *Macrophoma musae*). Fairly high tolerance was noticed in Pisang Lilin, Sannachenkadali and Tongat.

2.4.2 Incidence of pests

Not much variation was reported within the banana clones with respect to their reaction to infestation of pests.

Viswanath (1981) evaluated the resistance of some banana varieties to attack by *Cosmopolites sodidius* (rhizome weevil). The study revealed that Lacatan was the least susceptible variety while Maduranga was the most susceptible. Nendran ranked third with respect to tolerance among the varieties evaluated.

Babylatha *et al*. (1990) reported that there was wide variability in the reaction to rhizome weevil by various cultivars of banana. Pisang Lilin, Sanna Chenkadali and Tongat showed fairly high tolerance to rhizome weevil along with tolerance to leaf spot diseases.

2.5 Genetic analysis in banana

Sreerangaswamy *et al*. (1980) observed little difference between genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for the seven characters studied in 12 dessert and 6 culinary varieties. High GCV values were found for number of fruits and hands per bunch in both the groups and for bunch weight in culinary types. High heritability (H^2) and genetic advance (GA) were found for number of fruits per bunch, bunch weight and number of days to flowering in dessert varieties and number of fruits per bunch and number of days to flowering in culinary varieties.

While studying the influence of biometric characters on yield in some culinary varieties, Vijayaraghavakumar and associates (1984 a) found that the heritability values were high for characters like height, weight of fingers, thickness of fingers, number of fingers per hand and yield per plant. In dessert varieties (1984 b) all the characters except number of hands and the number of leaves showed high heritability.

Rajeevan and Geetha (1984) reported highly significant differences among fourty genotypes, for all the plant and bunch characters studied. Maximum values for genotypic variance were exhibited by height of pseudostem at flowering, number of fingers per bunch and weight of finger. Minimum values were shown by area of third leaf at flowering, girth of finger and number of

leaves at flowering. The GCV was maximum for weight of bunch (50.96) and was minimum for girth of pseudostem at flowering (13.86). The heritability estimates showed the highest values for length of fingers (97.66), weight of bunch (95.17), number of fingers per bunch (94.0), height of pseudostem at flowering (92.56) and number of hands per bunch (91.95). The lowest value was noted in the case of number of leaves at flowering (56.44). High genetic advance was also noticed for height of pseudostem at flowering (130.82) and number of fingers per bunch (65.92).

Sixty two cultivars of banana were grouped into 8 clusters based on a genetic divergence study (Valsalakumari *et al.*, 1985). The D^2 analysis indicated that pulp : peel ratio on volume basis contributed maximum towards divergence (34.06 per cent) followed by fruit weight (20.57 per cent) and total sugars (19.46 per cent). These three characters along with petiole length and fruit volume contributed 74.09 per cent of total divergence.

Wei *et al.* (1985) carried out variability studies in two seasons for 9 characters in banana. In the first season with five varieties, it was observed that weight per bunch had the highest GCV, followed by girth of the plant, while in second season height had the highest value. Girth had the highest heritability value (91.78 per cent) in first season while in the second season, height had the highest value (89.66 per cent).

Valsalakumari and Nair (1986) reported that highest value of GCV was in petiole length (83.15) followed by pulp / peel ratio on weight basis (51.97), number of fingers (49.19) and finger volume (44.54) and the minimum by TSS per cent (4.77). The value of PCV was higher than GCV suggesting the influence of environment on the expression of these characters. The highest heritability was recorded for leaf area per plant (0.9998) followed by petiole length (0.9995) and pulp-peel ratio on volume basis (0.9983). The lowest heritability was recorded for plant girth (0.8237) followed by non-reducing sugar content (0.8522) indicating that the influence environment is more in the expression of these characters. Characters like number of fingers, petiole length, finger weight and volume showed higher genetic advance combined with higher heritability and GCV compared to others.

In an experiment with 30 culinary varieties of banana, Mercy and George (1987) reported significant difference with regard to different morphological characters. The characters bunch weight and hand weight centributed maximum towards divergence, while girth and height contributed minimum towards divergence.

Chundawat *et al*. (1988) in an evaluation of 33 banana varieties made the following findings. The genotypic variance was higher for all characters except leaves per plant and TSS,

where environmental variance was higher. High GCV and heritability were observed for bunch weight, plant height, fingers per bunch, hands per bunch and days to ripening.

D^2 analaysis in 56 varieties for 12 characters indicated that the characters finger length and peduncle length contributed maximum towards divergence. But leaves per plant and girth contributed minimum towards divergence (Mercy and George, 1988).

Rosamma and Namboodiri (1990) reported that width of petiole canal, weight of individual finger, total number of fingers per bunch and bunch weight had very high estimates of GCV and PCV (> 40 per cent). Components like number of fingers per bunch, bunch length and bunch weight have registered high heritability (> 86 per cent) coupled with high or moderately high genetic advance (> 50 per cent).

High estimates of GCV, heritability and genetic advance were obtained for number of hands per bunch, number of fingers per bunch, finger weight and bunch weight (Rekha and Prasad 1993), in a trial with 170 genotypes for 14 yield components.

2.6 Correlation and path analysis studies in banana

Correlation provides information on the nature and extent of relationship between characters that contribute to yield. The absolute contribution of each component towards yield

was studied by path coefficient analysis, where the phenotypic correlation coefficient of different morphological characters with bunch yield were partitioned into direct and indirect affects.

Various workers attempted correlation and path coefficient analysis studies to understand the relative contribution of each character and their inter-relationships in banana.

Rao (1961) reported that the correlations was highest with weight of hands. Negative correlation was observed between position of hand in the bunch and pulp/peel ratio of fruits.

Of the four quantitative characters employed for simple, partial and multiple correlation studies Teaotia *et al*. (1970) observed that bunch yield in banana was strongly correlated with pseudostem circumference and its contribution to yield was large.

Gopimony and Marykutty (1980) in a correlation study with three genomic groups (AAA, AAB and ABB) of banana indicated that only the number of fingers per bunch was significantly correlated with bunch weight, in all the three groups. But in AA and AAB groups, the correlation of bunch weight with stem girth was also significant, as was the correlation with number of hands in AAB and ABB groups.

In an experiment with 12 dessert and 6 culinary varieties, Sreerangaswamy *et al.* (1980) observed negative genotypic association of bunch weight with height in dessert varieties and positive association of bunch weight with stem girth, bunch length and number of fruits and number of hands in the culinary types. Path analysis indicated a direct effect on bunch weight by bunch length, number of fruits and stem girth in dessert varieties, while number of hands per bunch had the highest direct effect on bunch weight in culinary types.

The correlations calculated between yield and five components in four clones showed that finger number was the most important variable, where the 'r' value was 0.86 (Hernandez, 1983).

Krishnan and Shanmugavelu (1983) studied yield correlations in banana cv. Robusta and revealed that the number of fingers per bunch (0.9377), weight of fingers (0.8843) and number of hands per bunch (0.8766) exerted a profound influence on the bunch weight.

The height and girth of pseudostem at shooting and total leaf area showed a significant positive association with bunch weight (Krishnan and Shanmugavelu, 1983). The time taken for shooting and harvest indicated a significant negative association with bunch weight. Among the yield characters significant positive association was seen for number of hands and

fingers per bunch and finger weight in addition to total dry matter production. As such the number of fingers/bunch (0.9377), drymatter production at harvest (0.8845), weight of finger (0.8843) and number of hands per bunch (0.8766) exerted profound influence on the bunch weight.

In a correlation study with yield and related characters of dessert varieties, Vijayaraghavakumar and associates (1984a&b) observed that phenotypic and genotypic correlations of all the traits with yield were positive. It was also observed that hand weight had the highest direct contribution to yield whereas finger weight and number contributed indirectly. In culinary varieties also all the characters had positive phenotypic and genotypic correlations except the number of hands. The number of fingers recorded maximum direct effect towards yield (2.2744).

Path analysis in 'Palayamkodan' accessions (Rajeevan, 1985) indicated that the maximum positive direct effect was contributed by the weight of hands (1.6043) followed by the average weight of a green finger (0.6649) and weight of ripe finger (0.5855).

Kurian *et al*. (1985) observed that fruit yield in Nendran exhibited strong positive correlation with number of hands, number of fingers, number of functional leaves/plant, girth of stem and total duration of the crop. Highest positive

direct effect on yield was observed in the number of fingers (0.6776), followed by total crop duration (0.1275) and number of suckers (0.1174). Lower direct effects by number of leaves and girth of stem. It showed negative direct effect.

Positive genotypic and phenotypic correlations were observed between weight per bunch and height and between hands per bunch for two seasons in five varieties (Wei *et al*., 1985).

Rosamma and Namboodiri (1990) observed highest positive correlation of bunch weight with bunch length followed by number of hands per bunch. High positive correlations was also seen in case of girth of individual fingers, total number of fingers per bunch, leaf area, girth at base of pseudostem at shooting time, weight of individual finger and total number of leaves per plant. The path coefficient analysis revealed that weight of individual finger had the maximum direct effect (0.7268) towards bunch weight followed by total number of fingers (0.4051), number of hands per bunch (0.2332), bunch length (0.2305) and girth at base of pseudostem (0.0987). They concluded that improvement in the weight of individual finger, total number of fingers, number of hands, bunch length and girth of pseudostem will result in increased bunch weight in banana.

Rekha and Prasad (1993) observed significant positive phenotypic correlations between finger weight and bunch weight and between most other yield components studied. But number of

hands per bunch and fingers per bunch had either non-significant positive correlations or highly negative correlations with most of the yield components.

According to Sumam George (1994) the number of hands per bunch, number of fingers per bunch, weight of hand, length of fruit, girth of fruit and weight of fruit showed significant positive relationship with yield in banana var. Nendran. The number of fingers per bunch had the maximum direct effect (0.5809) on yield followed by girth of fruit (0.4514) and weight of hand (0.3486).

Baiyeri and Mbah (1994) reported that in False horn plantain cv. Agbagba, bunch weight was strongly correlated with finger weight, length and circumference. Plant girth recorded the highest correlation with bunch yield.

2.7 Discriminent function analysis

The present work aims at the formulation of a dependable criteria (Selection index) for isolating elite types in banana, in terms of the observational components that bear a significant association with yield. Earlier works of selecting banana using selection index are reviewed here.

Nayar *et al*. (1979) from the study of 13 characters using 59 varieties reported that the fruit number per bunch, fruit weight, pedicel length, plant height and root number per

plant in banana were determined by additive gene action and that selection based on these characters would be effective for yield improvement.

From the biometrical analysis in banana, Vijayaraghava kumar *et al*. (1984 a&b) indicated that in dessert varieties genetic advance was greater for straight selection for yield than for selection by means of index of traits. In culinary varieties restricted selection with pseudostem circumference and finger number showed maximum genetic advance and 'Peykunnan' and 'Walha' had the highest selection index values.

Wei *et al*. (1985) observed, from the various selection indices tried, that plant height and girth were the two characters of most importance in selection.

In an experiment with 48 banana varieties for 18 characters Rosamma and Namboodiri (1990) reported that selection through discriminent function by considering characters viz. number of hands per bunch, bunch length, total number of fingers per bunch and weight of individual finger together with bunch weight was the most effective one.

Rekha and Prasad (1993) evaluated 170 genotypes for 14 yield components and revealed the importance of bunch and finger weight as selection criteria for yield improvement in banana.

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigations on "Selection of superior types of Kaliethan [(*Musa* AAB group) 'Nendran']" was conducted at the Department of Horticulture, College of Agriculture, Vellayani, Thiruvananthapuram, during 1995-96. A detailed survey was conducted in the major Nendran growing tracts of Thiruvananthapuram district and elite mother plants were identified from 10 locations based on growth and yield. Suckers from these mother plants were collected and each location was considered as single treatment. The suckers were maintained under uniform conditions and raised as per the package of practices recommendations of Kerala Agricultural University for irrigated Nendran banana (Anon., 1989).

The details of locations of collection of suckers are given below.

Treatment No.	Location of collection
T_1	Koliyoor
T_2	Vellayani
T_3	Keezhoor
T_4	Venjaramoodu
T_5	Anad
T_6	Balaramapuram
T_7	Venniyoor
T_8	Palode
T_9	Karakkonam
T_{10}	Neyyattinkara

The location of the experiment is situated at 8°5' North latitude and 77°1' East longitude at an altitude of 29 m above mean sea level. Predominant soil type of the experimental site is red loam belonging to Vellayani series, texturally classified as sandy clay loam.

The experiment was laid out in Randomised Block Design with three replications, taking each location as individual treatment. Every treatment in each replication was composed of four observational plants.

The following observations were recorded to evaluate the performance of the treatment plants.

3.1 Biometric characters

3.1.1 Height of the plant

Height of the plant was measured from soil level to the base of the unopened leaf and expressed in centimetres. The plant height was recorded at monthly interval till flowering.

3.1.2 Girth of the plant

Girth was recorded at monthly interval till flowering, at 10 cm above ground level and expressed in centimetres.

3.1.3 Number of leaves per plant

Leaf number recorded at monthly interval till flowering.

3.1.4 Number of suckers

Number of suckers recorded at monthly interval from their appearance till harvest of the mother plant.

3.1.5 Time taken for flowering

Number of days from planting till visual bunch emergence was taken as the time for flowering.

3.1.6 Time taken for harvest

Recorded as the number of days from shooting to harvest.

3.1.7 Total crop duration

Crop duration was calculated as the number of days from planting to harvest.

The height, girth and number of leaves were analysed for specific growth stages viz.

a) Pre-floral vegetative phase - 3 months after planting
b) Flower initiation phase - 5 months after planting
c) Post-floral phase - 7 months after planting

3.2 Physiological characters

3.2.1 Leaf area

Leaf area was calculated using the model suggested by Robinson and Nel (1988) as given below

$$LA = 0.83 \times L \times B$$

Where, LA = leaf area per leaf

L = leaf length

B = leaf breadth

3.2.2 Leaf Area Index (LAI)

Leaf Area Index was calculated using the following equation suggested by Watson (1952)

$$LAI = \frac{\text{Leaf area per plant}}{\text{Land area occupied per plant}}$$

3.2.3 Leaf Area Duration (LAD)

Leaf Area Duration was arrived at by multiplying the area of last three leaves with the number of days from shooting to harvest (Stover and Simmonds, 1987).

3.2.4 Phyllachron

Phyllachron was recorded by observing the time interval between the opening of two successive leaves.

Leaf area, leaf area index and phyllachron were analysed for three specific growth stages viz. pre-floral vegetative phase, flower initiation phase and just before flowering (3 months, 5 months and 7 months after planting).

3.3 Yield characters

3.3.1 Bunch weight

The bunch weight was recorded immediately after harvest and expressed in kilograms.

3.3.2 Bunch length

Bunch length in centimetres was measured as the distance from the point of attachment of first hand to that of last hand.

3.3.3 Number of hands per bunch

3.3.4 Number of fingers per bunch

3.3.5 Length of finger

The middle finger in the top row of the second hand was sampled (Gottreich *et al.*, 1964) to record finger measurements. Length of the finger was measured through the convex side.

3.3.6 Girth of finger

Girth of index finger was measured at the thickest portion of finger and expressed in centimetres.

3.3.7 Weight of finger

Fresh weight of the index finger was measured and recorded in grams.

3.3.8 Volume of finger

Volume of index finger was measured using water displacement technique and expressed in cubic centimeter.

3.3.9 Pulp : peel ratio

Pulp-peel ratio was arrived at by dividing the pulp weight of fully ripe index finger with its peel weight.

3.4 Quality

Fully ripe fruits from each treatment were used for quality analysis. The middle fruit at the top row of the second hand was taken as index finger. From each fruit, samples were taken from top, middle and bottom portions and pooled. Each sample consisted of 25 grams which was macerated in a waring blender and made upto 250 ml with distilled water for quality analysis.

3.4.1 Acidity

Titrable acidity was estimated following the method proposed by Ranganna (1977). Results were expressed as per cent anhydrous citric acid.

3.4.2 Total soluble solids

Content of total soluble solids was measured using Erma refractometer (pocket type) and expressed as percentage on fresh weight basis.

3.4.3 Total sugars

The total sugars on fresh weight basis was estimated as per the method described by Ranganna (1977) and expressed in percentage.

3.4.4 Reducing sugars

The estimation of reducing sugars was also done as per the method described by Ranganna (1977) and expressed as percentage on fresh weight basis.

3.4.5 Non-reducing sugars

The non-reducing sugar content was arrived at by deducting the value for reducing sugars from the value of total sugars (Ranganna, 1977).

3.4.6 Total carbohydrates

Total carbohydrates was estimated using the Anthrone method (Sadasivam and Manikam, 1992) and expressed as percentage on dry weight basis.

3.4.7 Sugar/acid ratio

Sugar/acid ratio was computed by dividing the value of total sugars with the value of titrable acidity.

3.4.8 Fullness index of finger

Fullness index was obtained by dividing the fruit weight with length on the convex side of the fruit. (Stover and Simmonds, 1987).

3.4.9 Fruit curvature

Fruit curvature was arrived at by dividing the length of fruit through the convex side with the length of fruit through the concave side in centimetres. (Stover and Simmonds, 1987).

3.4.10 Pedicel Strength Index

Pedicel strength Index was computed as the ratio of length of pedicel to the diameter in centimetres. (Stover and Simmonds, 1987).

3.4.11 Openness of bunch

The openness of bunch was expressed as the average distance between the hands measured in centimetres.

3.4.12 Bunch shape

Bunch shape was calculated using the equation

$$\frac{D_1 - D_2}{L}$$, proposed by Champion, 1967

Where, D1 is the diameter of bunch at the basal hand level (cm).

D_2 is diameter of the bunch at apical hand level (cm).

L is the length of bunch

3.4.13 Shelf life of fruits

Number of days required from the date of harvest to the development of black colour on the peel was taken as the storage life of fruits at room temperature.

3.5 Incidence of pests and diseases

3.5.1 Leaf spot disease

Intensity of incidence of Sigatoka leaf spot was scored as per the method suggested by Suharban (1977).

3.5.2 Bunchy top disease

Incidence of Bunchy top disease was observed and recorded as and when noticed.

3.5.3 Rhizome weevil

In each treatment observational plants were uprooted at the itme of harvest and observed for the incidence of banana rhizome weevil. Number of adults and young ones together was recorded and expressed as the average.

3.5.4 Pseudostem weevil

Incidence of banana pseudostem weevil was observed and recorded as the average number of adults and youngones together, per treatment.

3.6 Statistical analysis

The observations recorded from field experiment and laboratory analysis were subjected to the following statistical analysis.

3.6.1 Variance analysis

ANOVA was conducted to test whether there was any significant difference among the different accessions with respect to the various characters under study (Panse and Sukhatme, 1978).

The components of variance were estimated as follows,

Environmental variance, σ^2_e = MSE

Genotypic variance, $\sigma^2_g = \frac{\text{MST-MSE}}{\text{-------}}$

Phenotypic variance, $\sigma^2_p = \sigma^2_g + \sigma^2_e$

where MST and MSE are the mean squares for treatment and error respectively, from ANOVA.

$$\text{Genotypic coefficient of variation, GCV} = \frac{\sigma g \times 100}{\bar{X}}$$

$$\text{Phenotypic coefficient of variation, PCV} = \frac{\sigma p \times 100}{\bar{X}}$$

3.6.2 Heritability

Heritability in broad sense was estimated as the fraction of genotypic variance to the phenotypic variance, expressed as percentage

$$H^2 = \frac{\sigma^2_g \times 100}{\sigma^2_P}$$

3.6.3 Path analysis

Path analysis was done as per the method suggested by Wright (1921) and elaborated by Dewey and Lu (1959). Path analysis was applied to study the direct and indirect effects of causative factors on the response 'yield'. This was done separately for bunch characters and vegetative characters.

4.6.4 Selection index

Selection indices were worked out through the application of discriminent function proposed by Smith (1936). With 'n' characters, the selection index was defined as

$I = b_1 x_1 + b_2 X_2 + \ldots\ldots\ldots bnXn$ where

b1, b2 .. bn are determined such that the correlation between the genotypic worth and phenotypic performance was maximum. The above function discriminates the superior types from the inferior ones.

EXPERIMENTAL RESULTS

EXPERIMENTAL RESULTS

The present investigations were carried out to select elite types of Nendran banana having superior horticultural traits such as dwarf stature, high yield potentiality and favourable reaction to abiotic and biotic stresses, for commercial cultivation in Thiruvananthapuram district. The experiment was conducted at the Department of Horticulture, College of Agriculture, Vellayani, during 1995-96. The results of the study are presented below.

4.1 Biometric characters

4.1.1 Height of the plant

Data on the variation in height of the plant in various accessions of Kaliethan are given in Table 1 and Fig. 1.

Statistical analysis of the data revealed that there was significant difference among various accessions with respect to the height of the plants during all the three stages of crop growth, viz. adult prefloral vegetative stage (3 MAP), floral initiation stage (5 MAP) and post floral stage (just after shooting).

Height of the plant in the adult-prefloral vegetative stage was the highest in T_7 (157.08 cm) followed by T_1 (135.25 cm) and T_8 (133.66 cm). Statistically T_7 was significantly

Table 1 Variation on plant height of various accessions of Kaliethan

Treatments	Height of plant (cm)		
	Stages after planting		
	Adult pre-floral vegetative stage (3 MAP)	Floral initiation stage (5 MAP)	Post floral stage (just after shooting)
T_1	135.25	245.00	308.00
T_2	107.83	218.75	298.75
T_3	126.43	236.96	293.85
T_4	129.75	247.16	300.41
T_5	61.58	157.66	226.25
T_6	132.18	255.25	313.68
T_7	157.08	281.00	303.75
T_8	133.66	242.50	285.66
T_9	86.15	164.35	253.35
T_{10}	108.93	176.30	274.35

$F_{(Accessions)} = 17.34^{**}$

$F_{(Stages)} = 1663.63^{**}$

$F_{(Accession \& stage)} = 3.86^{**}$

$CD_{(Accession \& stage)} = 18.791$

** - Significant at 1% level
* - Significant at 5% level

different from all other accessions. The treatment T_1 was on par with T_8 (133.66 cm), T_6 (132.18 cm) T_4 (129.75 cm) and T_3 (126.43 cm). The treatment T_3 in turn was on par with T_{10} (108.93 cm) and T_2 (107.83 cm). The treatment T_5 (61.58 cm) recorded the lowest plant height which was significantly less than the height for other treatments along with T_9.

During floral initiation stage T_7 (281.00 cm) maintained the highest plant height which was significantly superior to all other treatments. This was followed by T_6 (255.25 cm), T_4 (247.16 cm), T_1 (245.00 cm), T_8 (242.5 cm) and T_3 (236.96 cm) and these treatments were statistically on par. The treatment T_3 was in turn on par with T_2 (218.75 cm). Plant height was lower in treatments T_5 (157.66 cm), T_9 (164.35 cm) and T_{10} (176.30 cm) which were on par and significantly different from the above treatments.

In the post floral stage (just after shooting) T_6 (313.68 cm) recorded the highest plant height and it was statistically on par with T_1 (308.00 cm), T_7 (303.75 cm), T_4 (300.41 cm) and T_2 (298.75 cm). The treatment T_3 was on par with the last four treatments and also with T_8 (285.66 cm). Again T_8 was on par with T_{10} (274.35 cm). The treatment T_5 (226.25 cm) which recorded the lowest plant height and the treatment T_9 were significantly different from the rest of the treatments.

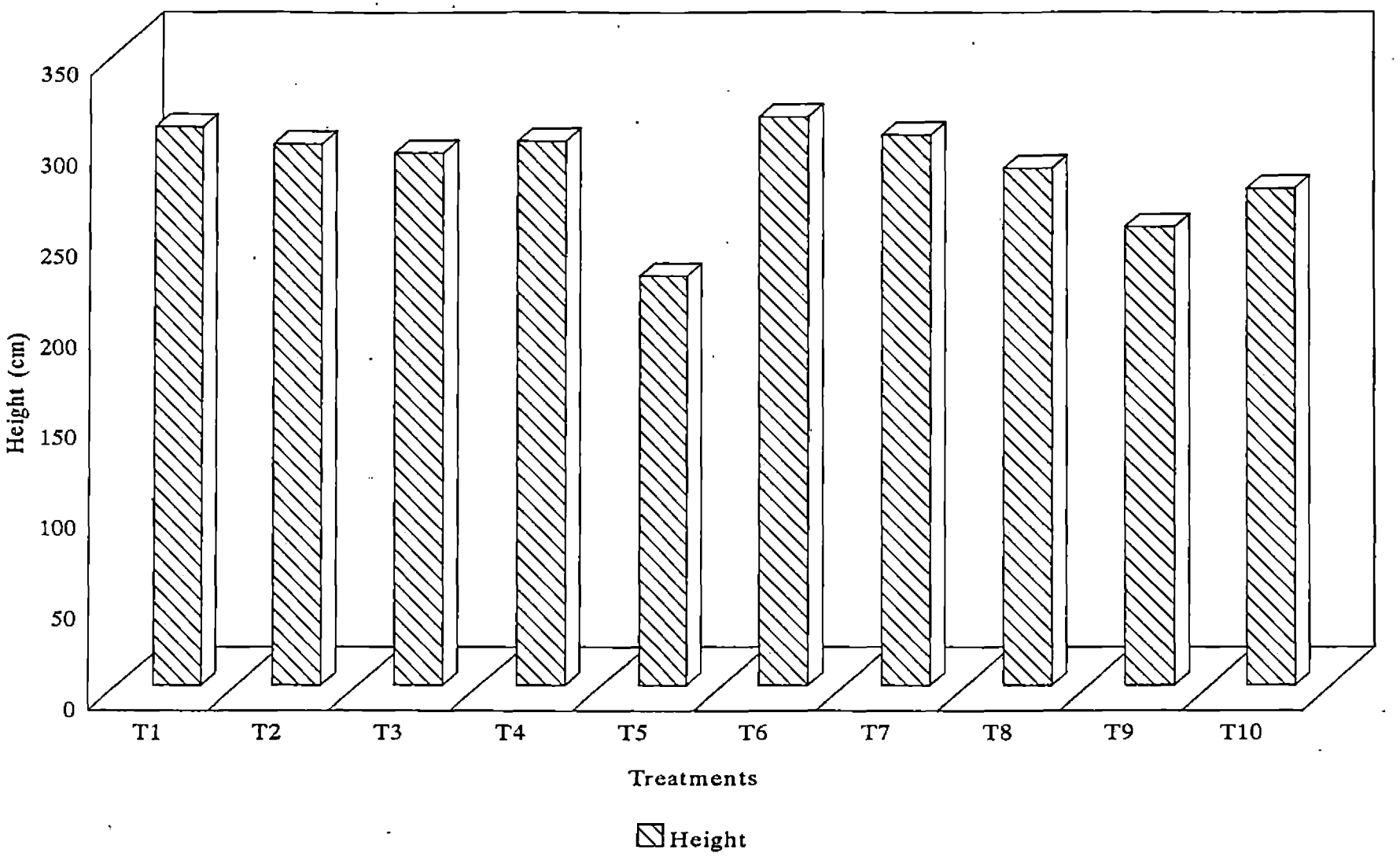

Fig. 1. Variation on plant height of various accessions of Kaliethan

The results thus revealed that the height of the plants of various accessions differed significantly at various stages of growth. The treatment T_5 (Palode) recorded the lowest plant height in all the three stages of growth. Plant height was lower in T_9 (Karakkonam) and T_{10} (Neyyattinkara) also during the three stages of growth. The treatments T_7 (Venniyoor), T_6 (Balaramapuram) and T_1 (Koliyoor) recorded higher plant heights in different growth stages.

4.1.2 Girth of plant

The data on the variation of plant girth of various accessions of Kaliethan are presented in the Table 2 and Fig. 2.

Girth of the plant varied with different treatments during adult-prefloral vegetative stage. Mean girth was higher in T_7 (39.08 cm) followed by T_8 (37.91 cm) and T_4 (37.41 cm) which were statistically on par. The treatment T_6 (34.85 cm) was on par with T_8, T_4, T_1 (34.79 cm), T_3 (34.33 cm) and T_2 (30.91 cm). But T_2 was also on par with T_{10} (27.85 cm) and the latter was on par with T_9 (24.57 cm). The treatment T_5 which recorded the lowest girth of plants was significantly different from all other treatments.

During flower initiation stage girth was higher in T_7 (61.00 cm) and T_6 (59.26 cm) which were statistically on par. The treatment T_6 inturn was on par with T_8 (56.08 cm) and

Table 2 Variation on girth of pseudostem of various accessions of Kaliethan

Treatments	Girth of pseudostem (cm)		
	Stages after planting		
	Adult pre-floral vegetative stage (3 MAP)	Floral initiation stage (5 MAP)	Post floral stage (just after shooting)
T_1	34.79	55.20	60.29
T_2	30.91	52.00	57.58
T_3	34.33	54.53	59.26
T_4	37.41	55.41	59.83
T_5	18.66	39.41	45.75
T_6	34.85	59.26	59.26
T_7	39.08	61.00	57.37
T_8	37.91	56.08	52.91
T_9	24.57	47.33	54.18
T_{10}	24.85	46.18	54.68

$F_{(Accessions)}$	=	14.31^{**}
$F_{(Stages)}$	=	841.54^{**}
$F_{(Accession \& stage)}$	=	3.46^{**}
$CD_{(Accession \& stage)}$	=	4.055

** - Significant at 1% level
* - Significant at 5% level

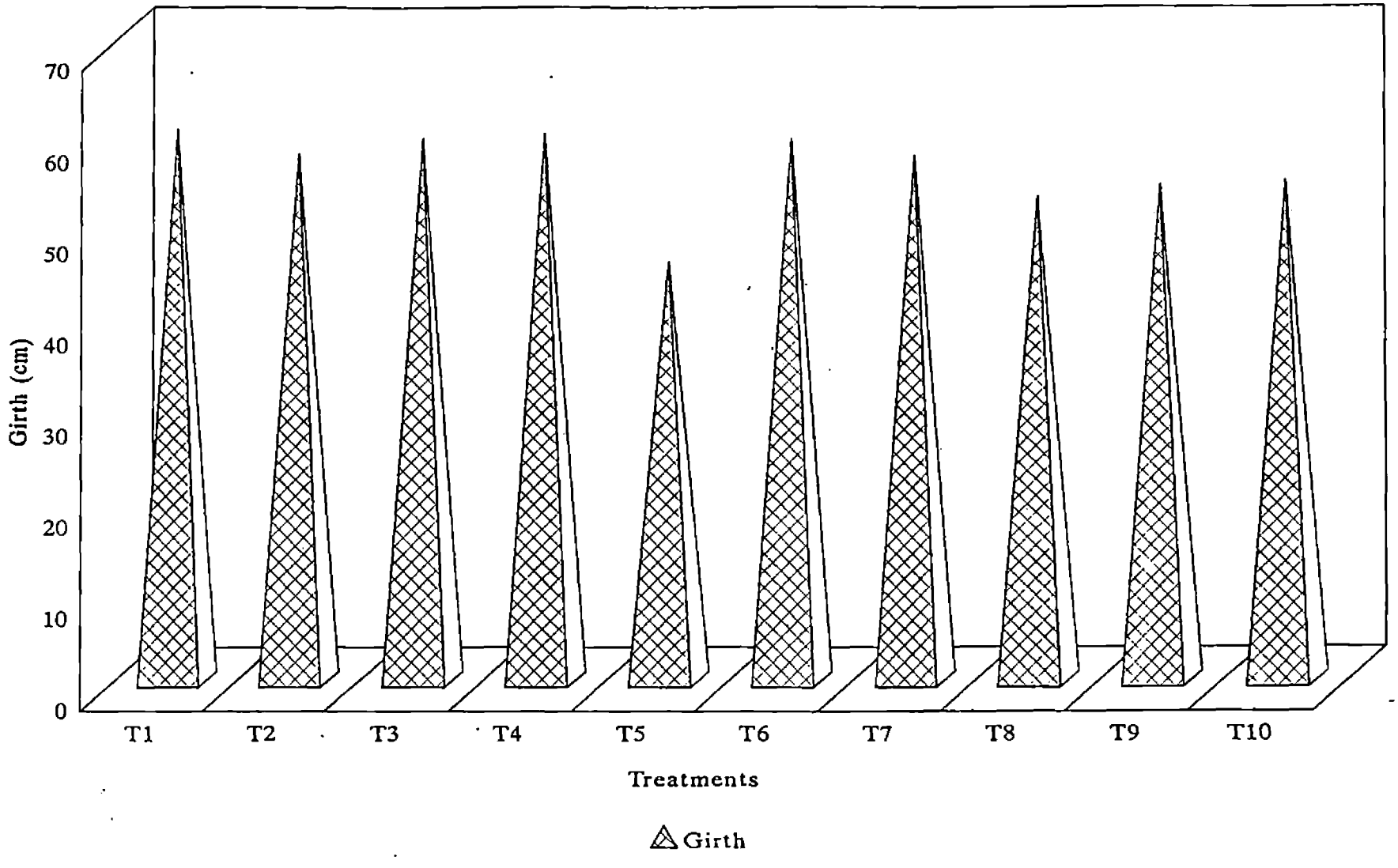

Fig. 2. Variation on girth of pseudostem of various accessions of Kaliethan

T_4 (55.41 cm). The treatments T_4, T_1 (55.20 cm), T_3 (54.53 cm) and T_2 (52.00 cm) were on par. The treatments T_9 (47.33 cm) and T_{10} (46.18 cm) were on par and differed significantly from all other treatments. The treatment T_5 (39.41 cm) which recorded the lowest girth differed significantly from all other treatments.

In post-floral stage girth was the highest in T_1 (60.29 cm) followed by T_4 (59.83 cm), T_3 (59.26 cm), T_6 (59.26 cm), T_2 (57.58 cm) which were statistically on par with T_7 (57.37 cm). Post-floral plant girth was lower in T_{10} (54.68 cm) which was on par with T_9 (54.18 cm) and T_8 (52.91 cm). The treatment T_5 (45.75 cm) recorded the lowest girth which was significantly lower than the girth recorded in all other treatments.

The data thus revealed that girth of plant differed significantly among the treatments during various growth stages observed. The plant girth was the highest in T_1, T_4, T_3 and T_6 when bunch has emerged. Treatments T_7, T_6, T_4 and T_8 in general had higher plant girth and T_5, T_9 and T_{10} recorded lower plant girth.

4.1.3 Number of leaves produced

Data on variation on the monthly leaf production of various accessions of Kaliethan are presented in Table 3 and Fig. 3.

Table 3 Variation on monthly leaf production of various accessions of Kaliethan

Treatments	Number of leaves produced		
	Stages after planting		
	Adult pre-floral vegetative stage (3 MAP)	Floral initiation stage (5 MAP)	Post floral stage (at flowering)
T_1	8.66	9.58	5.66
T_2	8.00	8.36	7.00
T_3	8.00	9.76	5.69
T_4	10.41	11.33	6.16
T_5	8.08	7.50	7.66
T_6	9.60	9.18	6.35
T_7	9.16	9.41	4.08
T_8	8.75	8.16	5.50
T_9	6.10	9.11	9.70
T_{10}	6.11	9.00	9.83

$F_{(Accessions)} = 3.03^{*}$

$F_{(Stages)} = 99.15^{**}$

$F_{(Accession \& stage)} = 18.82^{**}$

$CD_{(Accession \& stage)} = 1.093$

** - Significant at 1% level
* - Significant at 5% level

During adult-prefloral vegetative phase number of leaves produced varied significantly in different treatments. The highest number of leaves was observed in T_4 (10.41) and that was on par with T_6 (9.60). The treatment T_8 was also on par with T_7 (9.16), T_8 (8.75) and T_1 (8.66). The latter two treatments in turn were on par with T_5 (8.08) and treatment T_2 and T_3 (8.0 each). The treatment T_9 (6.1) which recorded the lowest number of leaves was on par with T_{10} (6.11).

During the flower initiation stage T_4 (11.33) had the highest number of leaves and was significantly different from all other treatments. This was followed by T_3 (9.76), T_1 (9.58), T_7 (9.41), T_6 (9.18), T_9 (9.11) and T_{10} (9.00) which were statistically on par. The treatment T_6 in turn was on par with T_9 (9.11), T_{10} (9.00) T_2 (8.36) and T_8 (8.16). The number of leaves recorded was the lowest in T_5 (7.50) which was statistically on par with T_8 (8.16) and T_2 (8.36).

In the post floral phase the highest leaf number was seen in T_{10} (9.83), followed by T_9 (9.70) which were statistically on par. These two treatments were significantly different from all other treatments. The treatment T_6 (7.66) and T_2 (7.00) which followed the former group were statistically on par and T_2 in trun was on par with T_6 (6.33) and T_4 (6.14). Treatment T_7 (4.08) recorded significantly lower number of leaves followed by T_8 (5.50), T_1 (5.66), T_3 (5.69), T_4 (6.16) and T_6 (6.35); the latter five treatments being statistically on par.

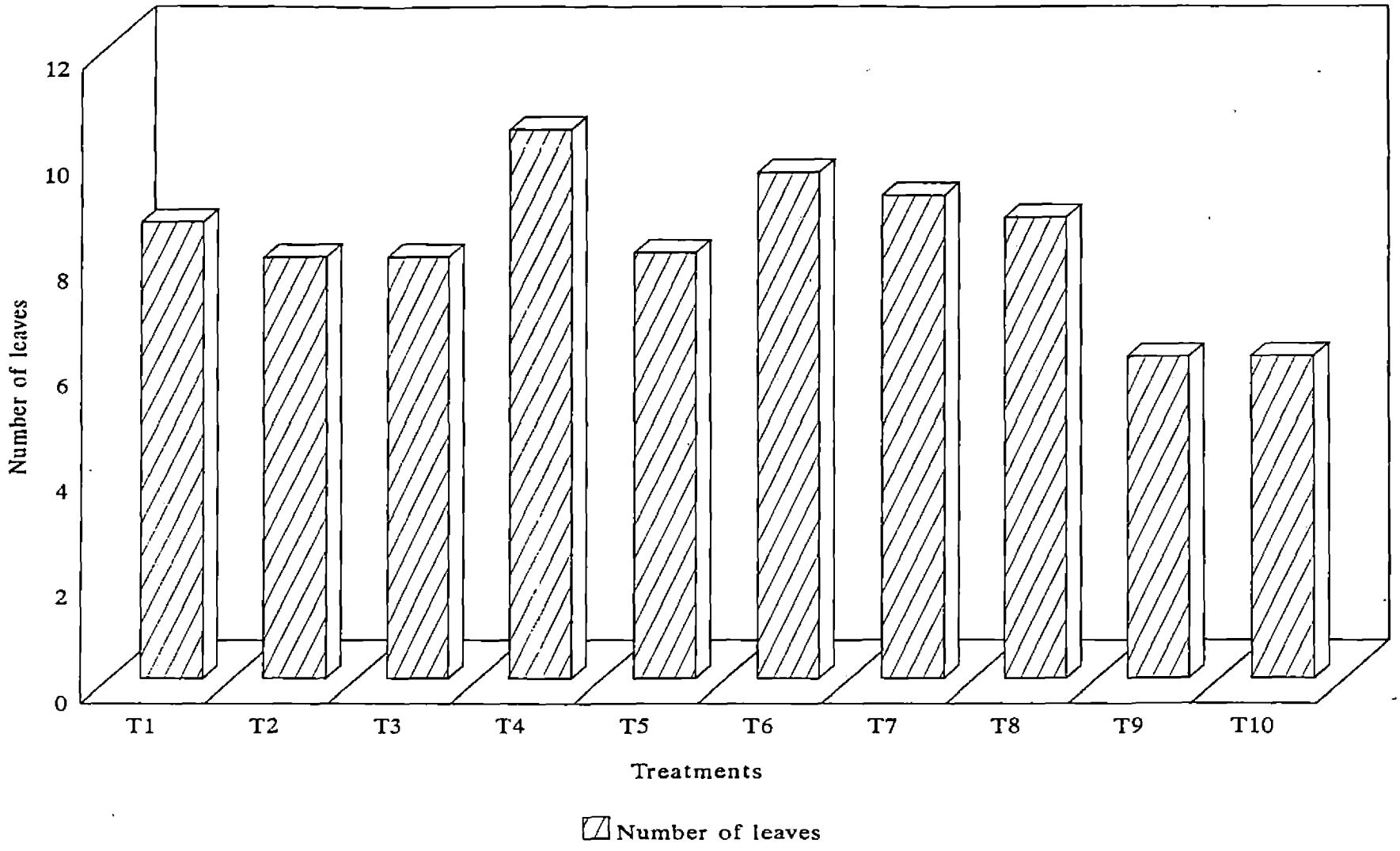

Fig. 3. Variation on number of leaves of various accessions of Kaliethan

Data on the leaf production showed significant variation among the treatments at all the three stages observed. In the adult prefloral vegetative phase the highest leaf number was seen in T_4 followed by T_6 and T_7. During the floral initiation stage also T_4 had the highest leaf number and was followed by T_3 and T_1. However during post floral stage T_{10} had the highest leaf number which was followed by T_9 and T_5

4.1.4 Number of suckers produced

Results of the statistical analysis of number of suckers produced at the time of harvest are presented in Table 4.

There was no significant difference in the sucker production of various accessions of Kaliethan. The mean number of suckers produced varied from 4.00 in T_5 to 7.66 in T_4.

The highest number of suckers were produced by T_4 (Venjaramoodu) followed by T_{10} (Neyyattinkara) and T_1 (Koliyoor) at the time of harvest. The treatments T_5 (Palode), T_2 (Vellayani) and T_8 (Anad) produced comparatively lower number of suckers.

4.1.5 Time taken for flowering, time taken for harvest and total crop duration

The data on the time taken for flowering, time taken for harvest and total crop duration are presented in Table 5 and Fig. 4 which showed significant difference among various treatments.

Table 4 Variation on sucker production of various accessions of Kaliethan

Treatments	No. of suckers/plant
T_1	6.43
T_2	5.50
T_3	5.70
T_4	7.66
T_5	4.00
T_6	6.22
T_7	6.00
T_8	5.50
T_9	5.75
T_{10}	7.14
F_9	NS
SE (M)	0.797

NS - Not significant

Table 5 Variation on time taken for flowering, time taken for harvest and total duration of various accession of of Kaliethan

Treatments	Time for flowering (days)	Time for harvest (days)	Total crop duration (days)
T_1	207.58	82.75	290.33
T_2	222.50	73.50	296.00
T_3	205.29	75.86	281.14
T_4	198.83	78.83	277.67
T_5	239.42	66.58	306.00
T_6	214.46	71.39	285.86
T_7	190.25	81.92	272.17
T_8	209.00	78.00	287.00
T_9	238.58	79.25	319.17
T_{10}	234.39	78.50	312.89
F_9	**	*	**
CD (0.05)	15.564	8.566	12.355

** - Significant at 1% level
* - Significant at 5% level

The shortest flowering time was observed in T_7 (190.25 days) and it was on par with T_4 (198.83 days) and T_3 (205.28 days). The treatment T_3 was on par with T_1 (207.58 days), T_8 (209.00 days) and T_6 (214.46 days) and T_6 in turn was on par with T_2 (222.5 days). Flowering time was longer in T_5 (239.41 days), T_9 (238.58 days) and T_{10} (234.39 days) which were statistically on par while T_{10} in turn was on par with T_2.

Results thus indicated that T_7 (Venniyoor) recorded the shortest time for flowering and was followed by T_4 (Venjaramoodu) and T_3 (Keezhoor). The treatments T_{10}, T_9 and T_5 required longer duration for flowering.

Harvest time was the shortest in T_5 (66.58 days) followed by T_6 (71.39 days) and T_2 (73.50 days) which were statistically on par. The treatment T_2 was in turn on par with six treatments viz. T_3 (75.85 days), T_8 (78.00 days), T_{10} (78.50 days), T_4 (78.83 days), T_9 (79.5 days) and T_7 (81.91 days). Among the different treatments T_1 (82.75 days) taken the maximum time for harvest which was found to be on par with T_3, T_8, T_{10}, T_4, T_9 and T_7.

From the results it was evident that the shortest duration for harvest was in T_5 (Palode) followed by T_6 (Balaramapuram) and T_2 (Vellayani) compared to other treatments.

Among the various treatments T_7 (272.16 days) recorded the shortest crop duration which was on par with T_4 (277.66 days)

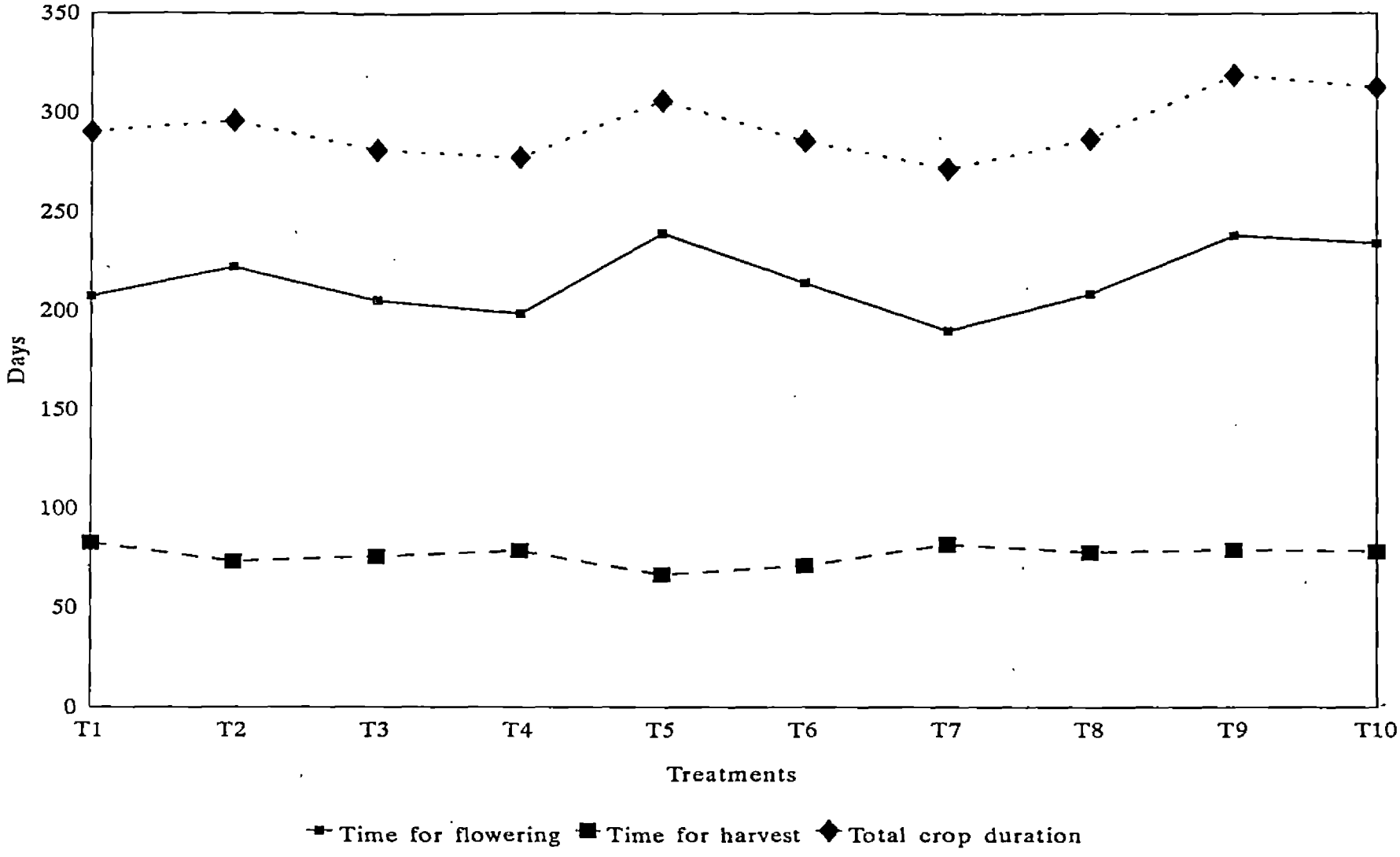

Fig. 4. Variation in crop duration of various accessions of Kaliethan

and T_3 (281.14 days). Treatment T_3 was in turn on par with T_6 (285.86 days), T_8 (287.00 days) and T_1 (290.33 days) while T_1 was on par with T_2 (296.00 days). T_5 (306.00 days) and T_2 did not differ significantly and the former was also on par with T_{10} (312.89 days). Treatment T_9 (319.16 days) which recorded maximum crop duration was found to be on par with T_{10}

The accession T_7 (Venniyoor) was having the shortest crop duration followed by T_4 (Venjaramoodu) and T_3 (Keezhoor). Whereas T_9 (Karakkonam) had the longest crop duration which was followed by T_{10} (Neyyattinkara) and T_5 (Palode).

The results thus indicated that crop cycle was completed earlier in those treatments in which flowering was early. The fruit maturity time did not influence the total crop duration.

4.2 Physiological characters

4.2.1 Leaf Area

The variation in leaf area of different accessions of Kaliethan presented in Table 6 and Fig. 5 showed significant differences among the treatments at all the three stages of growth, viz. adult prefloral vegetative stage, floral initiation stage and post floral stage.

Table 6 Variation on leaf area of various accessions of Kaliethan

Treatments	Leaf area m^2		
	Stages after planting		
	Adult pre-floral vegetative stage (3 MAP)	Floral initiation stage (5 MAP)	Post floral stage
T_1	2.776	6.750	8.933
T_2	2.909	5.082	6.848
T_3	3.176	6.902	7.218
T_4	5.081	9.016	7.324
T_5	3.324	3.593	5.520
T_6	5.824	8.702	6.215
T_7	5.328	8.628	6.381
T_8	4.456	7.076	4.477
T_9	1.521	4.949	8.093
T_{10}	1.856	5.804	8.302

$F_{(Accessions)}$	=	2.99^{*}
$F_{(Stages)}$	=	56.67^{**}
$F_{(Accession \& stage)}$	=	3.63^{**}
$CD_{(Accession \& stage)}$	=	2.202

* - Significant at 5% level
** - Significant at 1% level

During the adult prefloral vegetative stage leaf area was maximum in T_6 (5.82 sq.m) followed by T_7 (5.32 sq.m), T_4 (5.08 sq.m) and T_8 (4.45 sq. m); all the treatments being statistically on par. The treatment T_8 in turn was on par with T_5 (3.32 sq.m), T_3 (3.17 sq.m), T_2 (2.90 sq.m) and T_1 (2.77 sq.m). The latter three treatments were in turn on par with T_{10} (1.82 sq.m) and T_9 (1.52 sq.m) which were having lower leaf areas.

During the floral initiation stage leaf area was maximum in T_4 (9.01 sq.m) followed by T_6 (8.70 sq.m) and T_7 (8.62 sq.m) which were statistically on par with each other and with T_8 (7.07 sq.m) and T_3 (6.90 sq.m). The treatments T_6, T_7, T_8, T_3 and T_1 (6.73 sq.m) were on par with each other. The last three treatments were in turn on par with T_{10} (5.80 sq.m), T_2 (5.08 sq.m) and T_9 (4.94 sq.m). Lower leaf areas were recorded in the on par treatments T_5 (3.55 sq.m), T_9 (4.94 sq.m) and T_2.

The data revealed that leaf area at post-floral stage was the highest in T_1 (8.93 sq.m) followed by T_{10} (8.30 sq.m) and T_9 (8.09 sq.m) which were on par with each other and with T_4 (7.32 sq.m), T_3 (7.21 sq.m) and T_2 (6.84 sq.m). The latter five treatments were in turn on par with T_7 (6.38 sq.m) and T_8 (6.21 sq.m). The lowest leaf area was recorded in T_8 (4.47 sq.m) which was followed by the on par treatments T_5 (5.52 sq.m) T_6 and T_7.

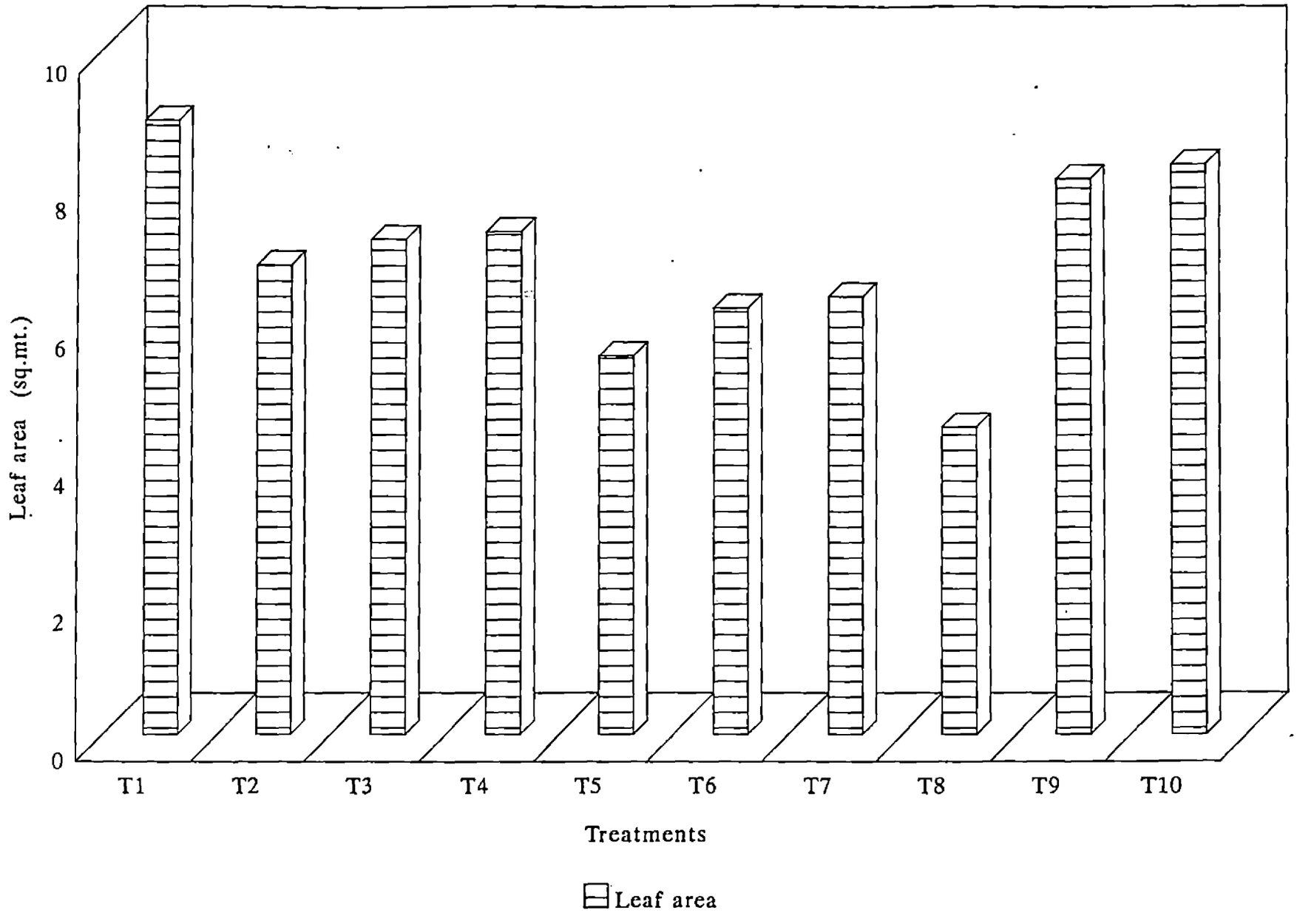

Fig. 5. Variation on leaf area of various accession of Kaliethan

The results thus indicated that during the adult prefloral vegetative stage, leaf area was the highest in T_6 (Balaramapuram). This was followed by T_7 (Venniyoor) and T_4 (Venjaramoodu). However, during floral initiation stage T_4 had maximum leaf area followed by T_6 and T_7. In general T_6, T_7 and T_4 recorded maximum leaf area in these two stages of growth. During post floral stage highest leaf area was observed in T_1 (Koliyoor) which was followed by T_{10} (Neyyattinkara) and T_9 (Karakkonam).

4.2.2 Leaf Area Index

Data on leaf area index (LAI) of various accessions of Kaliethan presented in Table 7 showed significant differences among the treatments at all three stages viz. adult prefloral vegetative stage, floral initiation stage and post floral stage.

During the adult prefloral vegetative stage LAI was the highest in T_6 (1.456) which was on par with T_7 (1.333), T_4 (1.270) and T_8 (1.114). The treatment T_8 was in turn on par with T_5 (0.831), T_3 (0.794), T_2 (0.695) and T_1 (0.694). The lowest LAI was observed in T_9 (0.380) followed by T_{10} (0.457) and T_1. These three treatments were on par with each other and with T_2, T_3 and T_5.

At floral initiation stage T_4 (2.254) recorded the maximum LAI followed by T_6 (2.175) and T_7 (2.117) which were

Table 7 Variation on leaf area index of various accessions of Kaliethan

Treatments	Leaf area index (Stages after planting)		
	Adult pre-floral vegetative stage (3 MAP)	Floral initiation stage (5 MAP)	Post floral stage (just after shooting)
T_1	0.694	1.682	2.233
T_2	0.695	1.272	1.712
T_3	0.794	1.718	1.788
T_4	1.270	2.254	1.831
T_5	0.831	0.898	1.380
T_6	1.456	2.175	1.554
T_7	1.332	2.177	1.595
T_8	1.114	1.768	1.119
T_9	6.380	1.237	2.023
T_{10}	0.457	1.419	2.077

$F_{(Accessions)} = 3.08^{*}$

$F_{(Stages)} = 57.73^{**}$

$F_{(Accession \cdot \& \ stage)} = 3.70^{**}$

$CD_{(Accession \ \& \ stage)} = 0.546$

* - Significant at 5% level
** - Significant at 1% level

statistically on par with each other along with T_8 (1.768) and t_3 (1.718). The treatment T_6 in turn was on par with T_3 (1.718) and T_1 (1.682). The lowest LAI during this stage was observed in T_5 (0.898) followed by T_9 (1.237) and T_2 (1.272). The treatments T_5, T_9 and T_2 were on par with each other along with T_{10} (1.419). The last four treatments were in turn on par with T_3 and T_1.

During post-floral stage T_1 (2.233) recorded the highest LAI followed by T_{10} (2.077) and T_9 (2.023) and these were found to be on par with each other and with T_4 (1.831), T_3 (1.788) and T_2 (1.712). The latter three treatments viz. T_4, T_3 and T_2 were also on par with T_7 (1.595), T_6 (1.554) and T_5 (1.380). The treatment T_8 (1.119) registered the lowest LAI followed by T_5 (1.380), T_6 (1.554) and T_7 (1.595) all being statistically on par with each other.

The results thus indicated that various accessions of Kaliethan had significant differences in their LAI values at all the three stages studied. LAI was the highest in T_8 (Balaramapuram) followed by T_7 (Venniyoor) and T_4 (Venjaramoodu) during the adult pre-floral vegetative stage. The same treatments registered higher LAI ($T_4 > T_6 > T_7$) at floral initiation stage also. But during the post floral stage T_1 (Koliyoor) had maximum LAI followed by T_{10} (Neyyattinkara) and T_9 (Karakkonam).

4.2.3 Phyllachron (interval of leaf production)

Data on the phyllachron of various accessions of Kaliethan are presented in Table 8 and Fig. 6 which showed no significant difference between treatments at any of the stages studied. However, there was significant difference in the interval of leaf production at different growth stages.

The results showed no significant differences among the various treatments with respect to the interval of leaf production. However, the mean interval of leaf production was the longest T_2 (8.15 days) which in turn was followed by T_{10} (7.91 days) and T_8 (7.85 days). The treatment T_4 (7.07 days) recorded the shortest interval of leaf production followed by T_6 (7.24 days) and T_9 (7.36 days).

4.2.4 Leaf area duration

The leaf area duration (LAD) of various accessions of Kaliethan presented in Table 9 showed no treatment difference.

The results indicated that the mean LAD values varied between 74.26 and 167.62 in T_5 and T_1 respectively. The treatment T_1 (Koliyoor) had the highest LAD and was followed by T_7 (Venniyoor) and T_3 (Keezhoor) while it was the lowest in T_5 (Palode).

Table 8 Variation on phyllachron of various accessions of Kaliethan

Treatments	Phyllachron (days) — Stages after planting: Adult pre-floral vegetative stage (3 MAP)	Floral initiation stage (5 MAP)	Just before shooting	Mean Phyllachron
T_1	8.02	7.06	7.93	7.67
T_2	9.71	6.54	8.21	8.16
T_3	8.33	6.22	8.33	7.63
T_4	6.50	5.20	9.52	7.08
T_5	6.50	7.83	7.83	7.39
T_6	7.02	4.87	9.83	7.24
T_7	8.05	6.05	8.33	7.48
T_8	6.89	5.00	11.66	7.85
T_9	7.32	6.43	8.32	7.36
T_{10}	8.69	7.22	7.83	7.92

$F_{(Accessions)}$	=	NS
$F_{(Stages)}$	=	24.96^{**}
$F_{(Accession \& stage)}$	=	2.49^{**}
CD (Accession & stage)	=	0.481

** - Significant at 1% level
NS Not significant

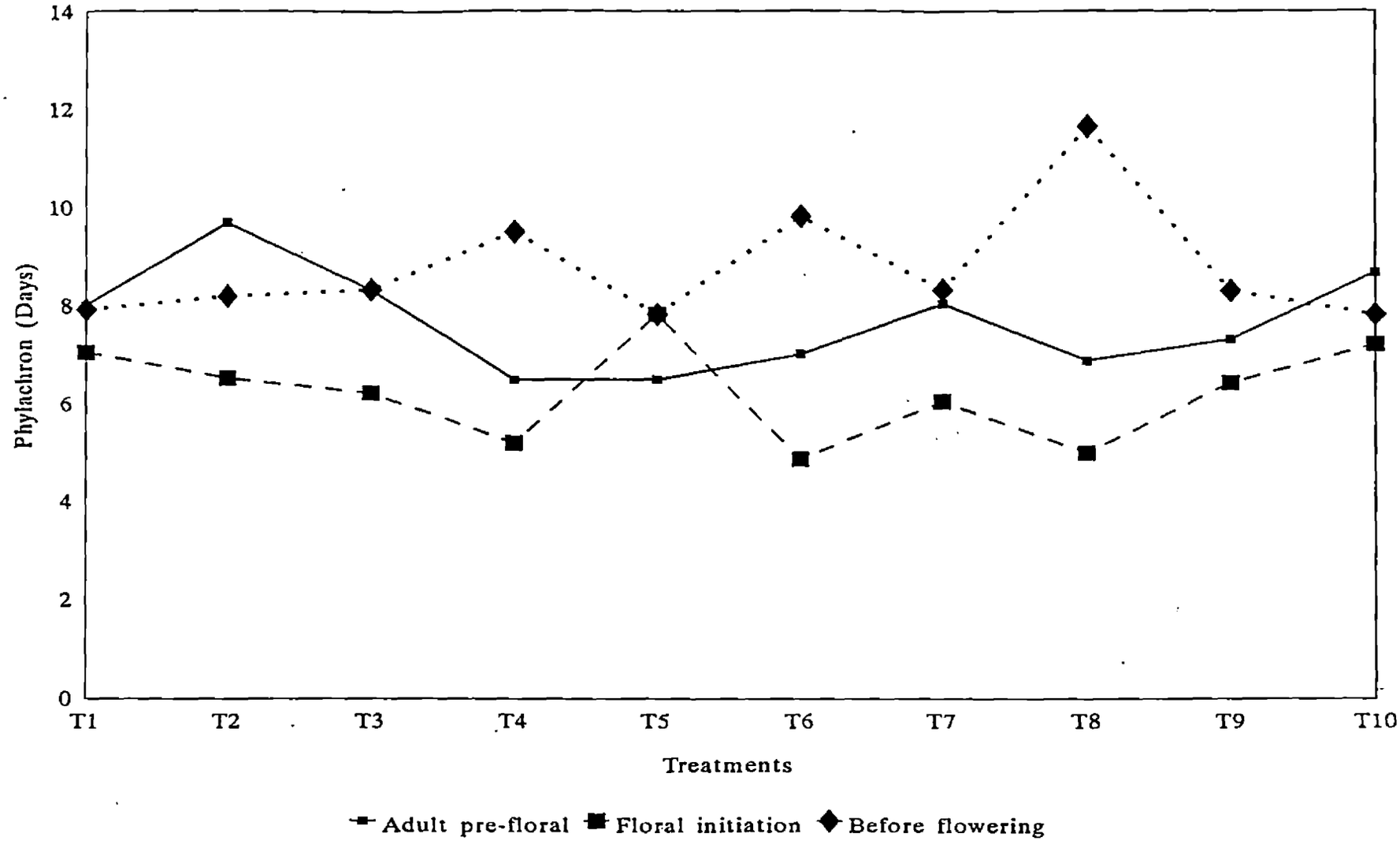

Fig. 6. Variation on phyllachron of various accessions of Kaliethan

Table 9 Variation on Leaf Area Duration of various accessions of Kaliethan

Treatments	Leaf Area Duration (days)
T_1	167.62
T_2	136.08
T_3	152.59
T_4	121.53
T_5	74.26
T_6	144.06
T_7	160.90
T_8	145.86
T_9	148.71
T_{10}	119.23
F_9	NS
CD (0.05)	-

4.3 Yield characters

The data on the variation on yield characters of accessions of Kaliethan are presented in Table 10, Figures 7, 8 9 and 10 and Plates 1 and 2.

4.3.1 Bunch weight

Results of the studies indicated variation of bunch weight among the various accessions of Kaliethan. The bunch weight ranged from 7.45 kg in T_5 to 10.85 kg in T_6. The highest bunch weight recorded in T_6 (10.85 kg) was statistically on par with T_2 (10.02 kg), T_1 (9.92 kg), T_4 and T_7 (9.70 kg each) and T_3 (9.57 kg). The lowest bunch weight recorded in T_5 (7.45 kg) was statistically on par with T_9 (8.18 kg) and T_{10} (8.73 kg). The treatment T_{10} in turn was on par with T_8 (9.00 kg), T_3, T_7, T_4, T_1 and T_2.

The results thus indicated that T_6 (Balaramapuram) recorded the highest bunch weight followed by T_2 (Vellayani) and T_1 (Koliyoor). While T_5 (Palode) recorded the lowest bunch weight which was followed by T_9 (Karakkonam) and T_{10} (Neyyattinkara).

4.3.2 Length of bunch

The data on bunch length of accessions of Kaliethan showed significant difference. The mean bunch length ranged from 40.89 cm in T_9 to 48.25 cm in T_6. The treatment T_6 (48.25 cm)

Table 10 Variation on yield characters of various accessions of Kaliethan

Treatments	Bunch weight (kg)	Bunch length (cm)	Number of hands	Number of fingers	Finger length (cm)	Finger girth (cm)	Finger weight (g)	Finger volume (cc)	Pulp: peel ratio
T_1	9.92	43.87	4.91	43.91	23.36	8.84	191.78	198.76	4.58
T_2	10.02	45.01	4.75	41.52	23.67	14.10	196.55	198.35	4.49
T_3	9.57	43.54	4.41	39.91	24.94	14.37	196.20	199.82	4.17
T_4	9.70	46.70	4.75	44.58	24.80	14.58	198.95	203.33	4.48
T_5	7.45	41.79	4.50	38.33	21.40	13.02	157.95	164.70	4.45
T_6	10.85	48.25	5.25	48.66	24.84	14.47	203.50	208.75	4.52
T_7	9.70	43.91	4.75	43.25	23.50	14.00	187.18	191.04	4.49
T_8	9.00	43.91	4.91	44.58	22.42	13.58	166.75	171.76	4.44
T_9	8.18	40.89	4.47	40.86	21.89	12.97	166.26	176.33	4.59
T_{10}	8.73	43.54	4.75	44.33	23.59	13.97	170.12	173.41	4.43
F_9	**	*	**	**	NS	NS	*	*	NS
CD(0.05)	1.374	3.962	0.283	4.392	-	-	27.889	27.53	-

NS - Not significant

* - Significant at 5% level

** - Significant at 1% level

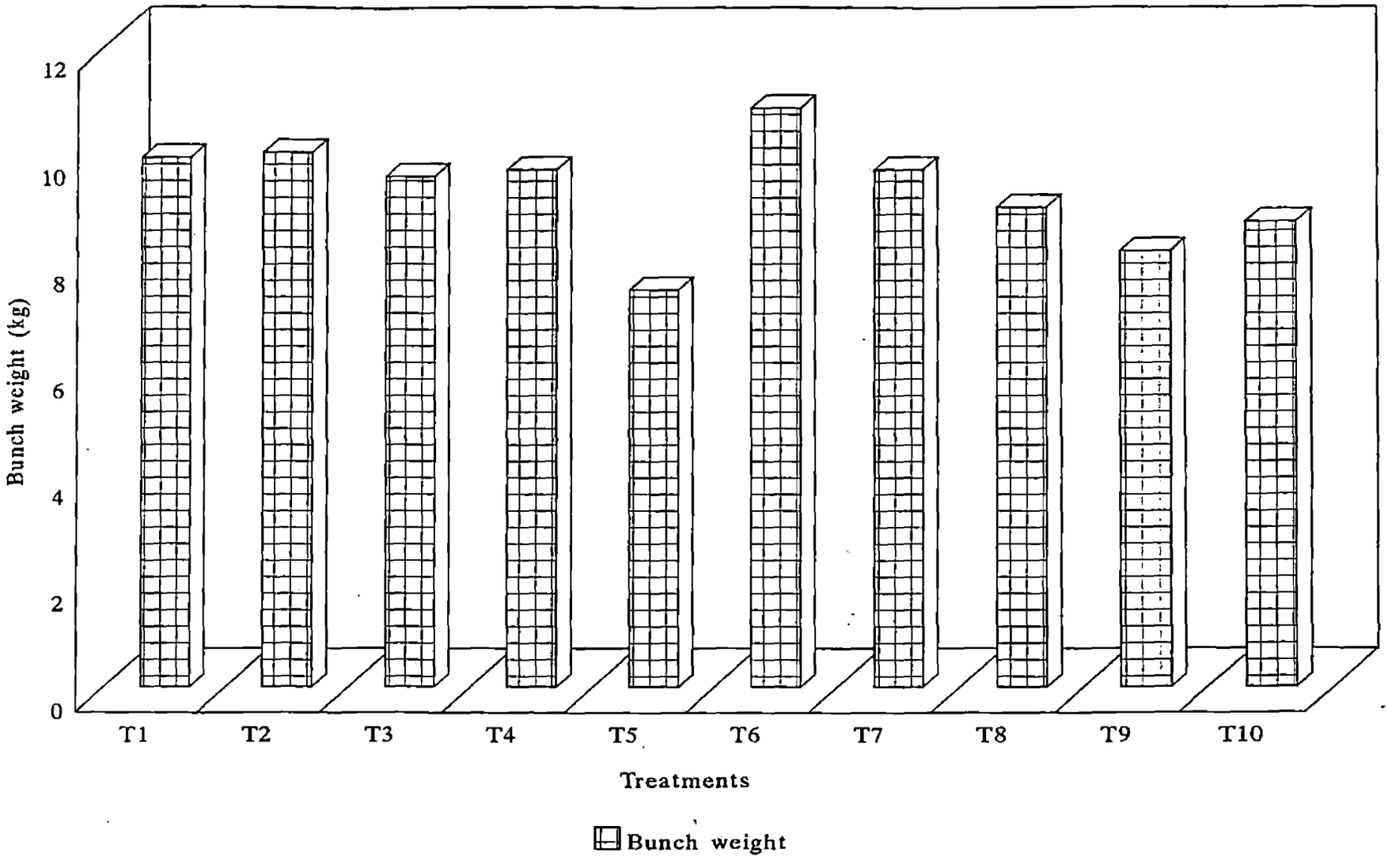

Fig. 7. Variation on bunch weight of various accessions of Kaliethan

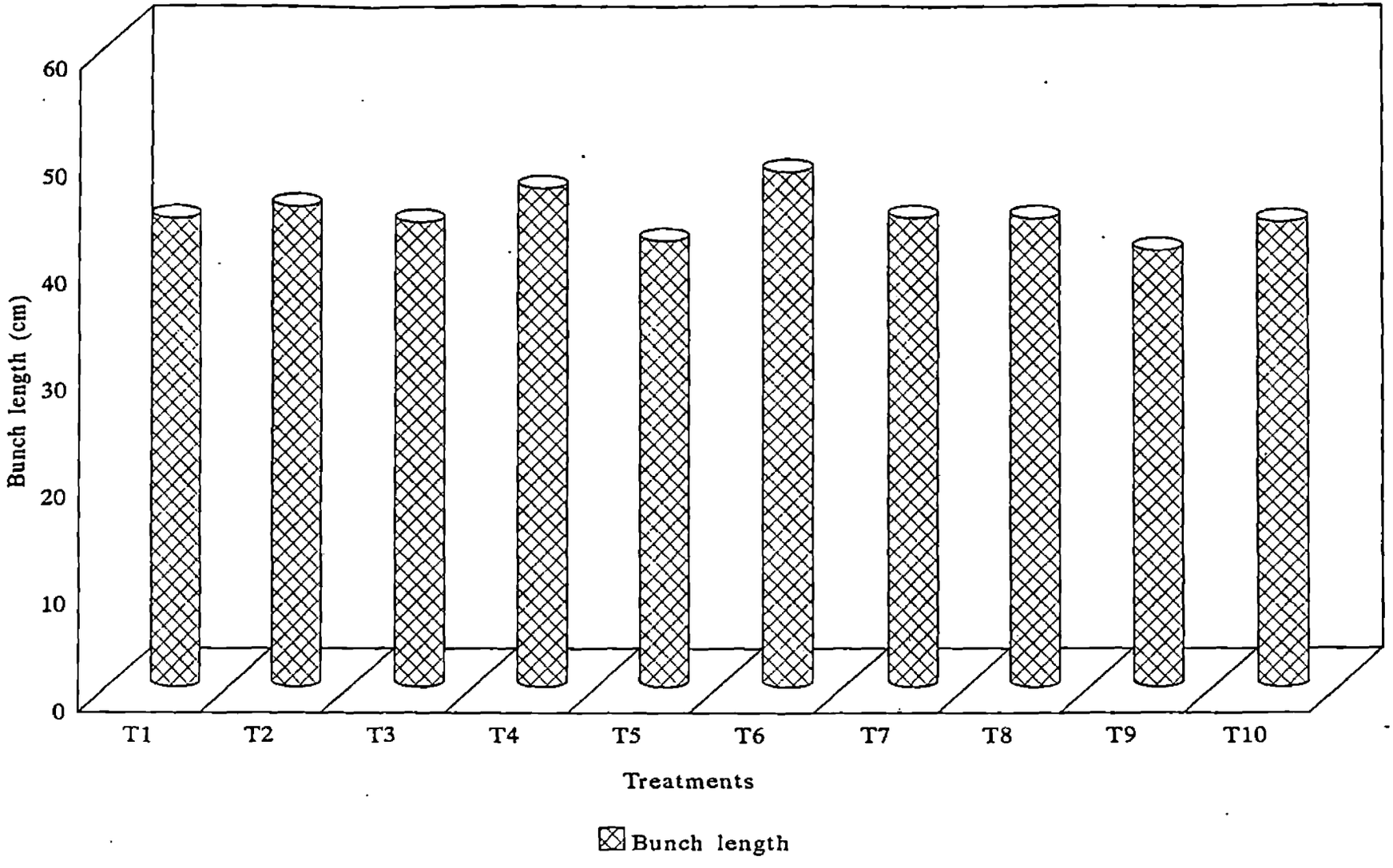

Fig. 8. Variation on bunch length of various accessions of Kaliethan

which recorded the highest bunch length was statistically on par with T_4 (46.70 cm) and T_2 (45.01 cm). The treatments T_4 and T_2 in turn were on par with T_7 (43.91 cm), T_1 (43.87 cm) and T_3 and T_{10} (43.54 cm each). At the same time T_7, T_1, T_3 and T_{10} were on par with T_5 (41.79 cm), T_8 (41.58 cm) and T_9 (40.09 cm).

Among the accessions of Kaliethan bunch length was the highest in T_6 (Balaramapuram) followed by T_4 (Venjaramoodu) and T_2 (Vellayani) and the lowest in T_9 (Karakkonam) followed by T_8 (Anad) and T_5 (Palode).

4.3.3 Number of hands per bunch

Analysis of data on the number of hands showed significant differences among the accessions. The mean number of hands ranged from 4.41 in T_3 to 5.25 in T_6. The treatment T_8 had significantly higher number of hands compared to other treatments. Treatments T_1 and T_8 (4.91 each) and T_4 (4.75) which followed T_6 were statistically on par. Again T_8 and T_4 were found to be on par with T_2, T_7 and T_{10} in turn were statistically on par with T_3 (4.41).

The results thus showed that number of hands was the highest in T_6 (Balaramapuram) followed by T_1 (Koliyoor) and T_8 (Anad). Lowest hand number was seen in T_3 (Keezhoor) followed by T_9 (Karakkonam) and T_5 (Palode).

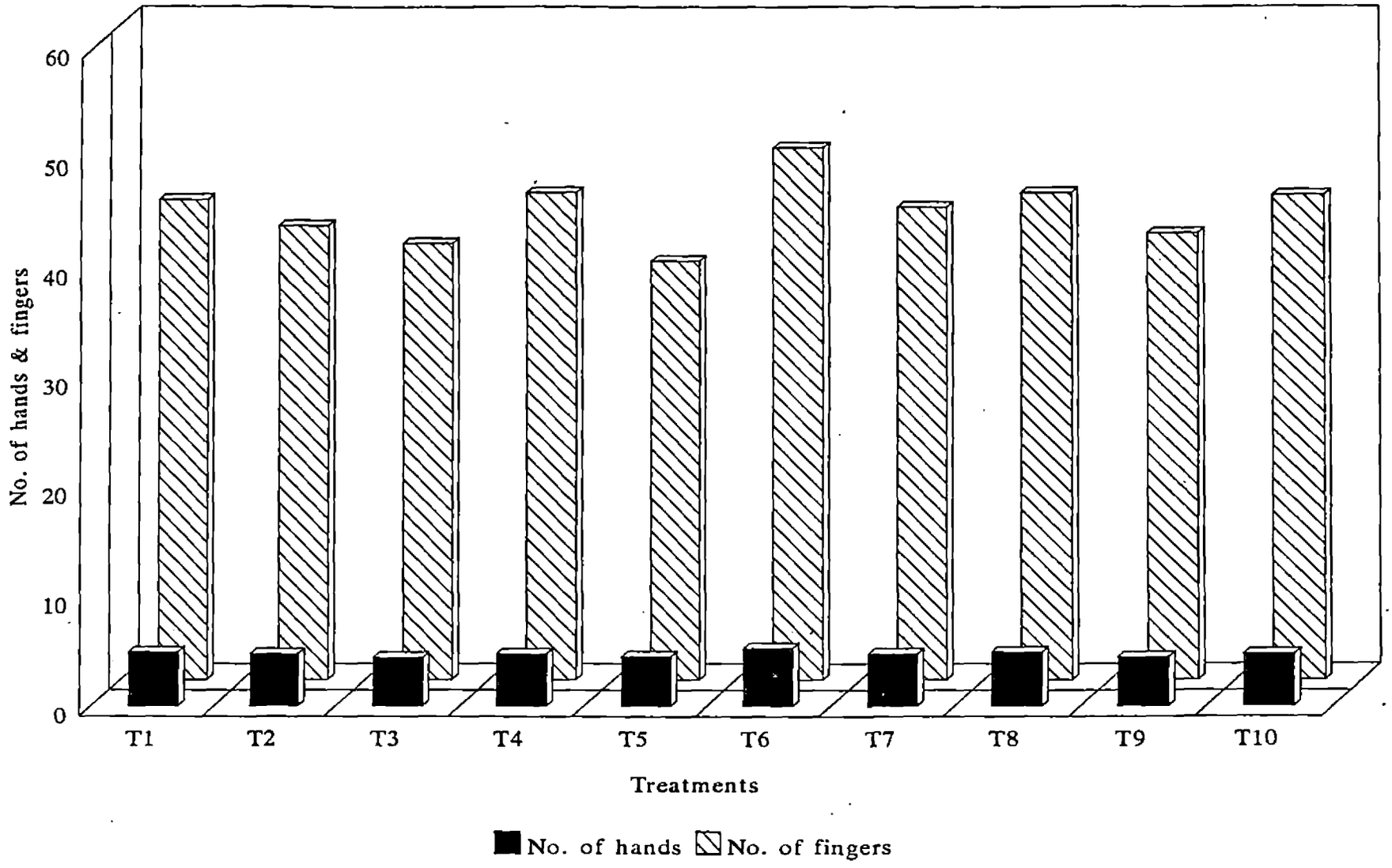

Fig. 9. Variation on number of hands and number of fingers of various accessions of Kaliethan

Plate 1 Bunch characters of selected accessions of Kaliethan

6 - Balaramapuram

2 - Vellayani

1 - Koliyoor

4 - Venjaramoodu


6


2


1


4

Plate 2. Finger characters of ten accessions of Kaliethan


1
2
3
4
5
6
7
8
9
10

4.3.4 Number of fingers per bunch

The number of fingers per bunch showed significant difference among the various treatments. The finger number varied from 38.33 in T_5 to 48.66 in T_6. The treatment T_6 which recorded the highest number of fingers was statistically on par with T_4 and T_8 (44.58 each) and T_{10} (44.33). The latter three in turn were on par with T_1 (43.91), T_7 (43.75), T_2 (41.52) and T_9 (40.86). The lowest number of fingers was recorded in T_5 (38.33) which was statistically on par with T_3 (39.91), T_9 (40.86) and T_2 41.52).

The results thus revealed that maximum number of fingers was in T_6 (Balaramapuram). This was followed by T_4 (Venjaramoodu) and T_8 (Anad). Minimum number of fingers was seen in T_5 (Palode) followed by T_3 (Keezhoor) and T_9 (Karakkonam).

4.3.5 Length of fingers

Data on the length of fingers in various treatments did not show any statistically significant differences. The mean finger length varied from 21.4 cm in T_5 to 24.94 cm in T_3.

The highest finger length was recorded in T_3 (24.94 cm) followed by T_6 (24.84 cm) and T_4 (24.80 cm). Length of finger was the lowest in T_5 (21.40 cm) which was followed by T_9 (21.39 cm) and T_8 (22.42 cm).

4.3.6 Girth of fingers

Statistical analysis of the data on girth of fingers of various treatments did not reveal any significant differences. Mean girth of fingers ranged from 8.84 cm in T_1 to 14.58 cm in T_4

Gith of fingers was the highest in T_4 (14.58 cm) followed by T_6 (14.47 cm) and T_3 (14.37 cm). The girth of fingers was the lowest in T_1 (8.84 cm) followed by T_9 (12.97 cm) and T_5 (13.02 cm).

4.3.7 Weight of fingers

Data on the weight of fingers showed significant difference among the various treatments. The mean weight of finger varied from 157.95 g in T_5 to 203.5 g in T_6. The treatment T_6 which recorded the highest weight of fingers was on par with T_4 (198.95 g), T_2 (196.55 g), T_3 (196.20 g), T_1 (191.78 g) and T_7 (187.18 g). The treatments T_2, T_3, T_1 and T_4 were found to be on par with T_{10} (170.12 g) while T_{10} was on par with T_8 (166.75 g), T_9 (166.26 g) and T_5 (157.95 g).

The treatment T_6 (Balaramapuram) recorded the highest weight of fingers which was followed by T_4 (Venjaramoodu) and T_2 (Vellayani). The lowest weight of finger was in T_5 (Palode) followed by T_9 (Karakkonam) and T_8 (Anad).

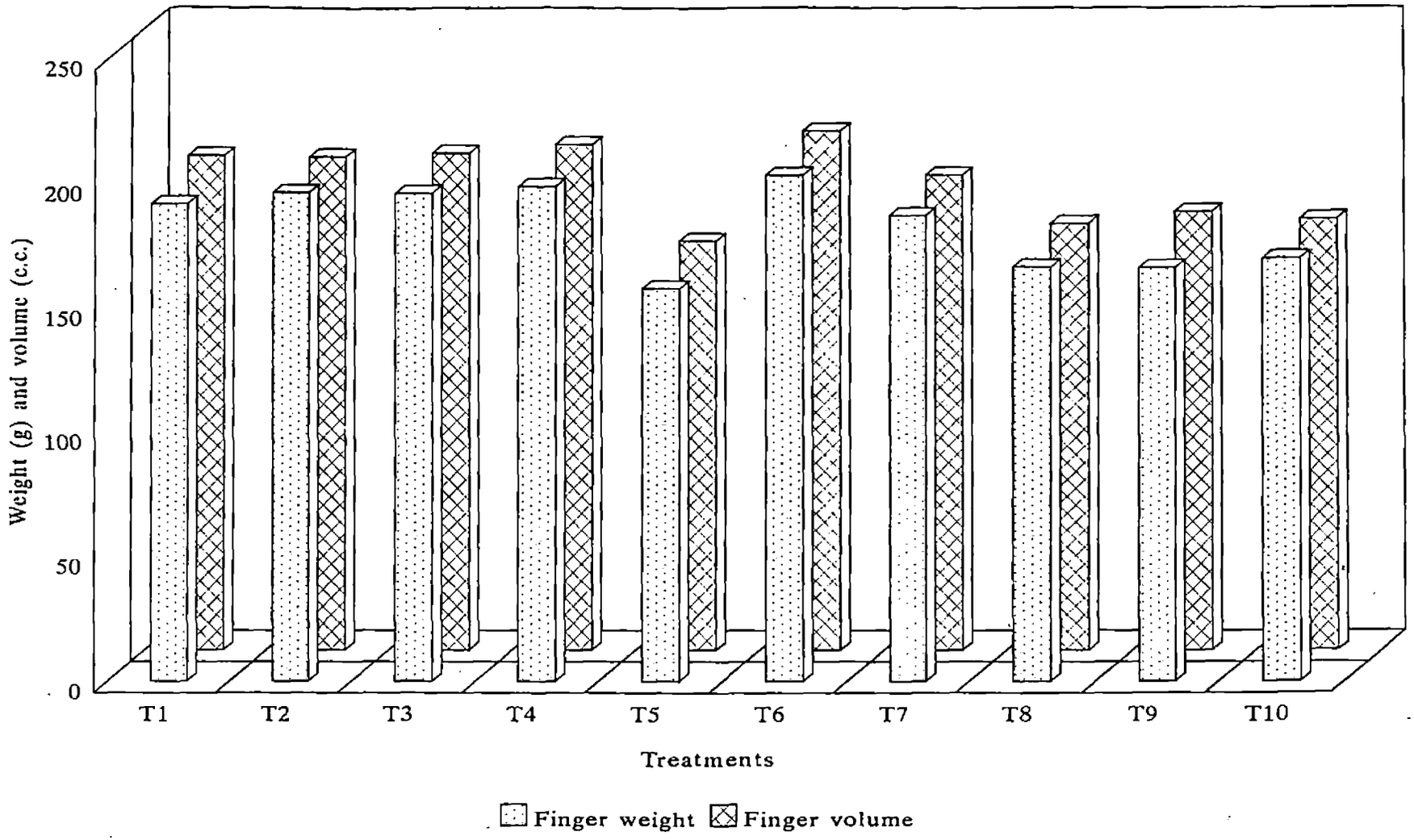

Fig. 10. Variation on finger characters of various accessions of Kaliethan

4.3.8 Volume of fingers

Statistical analysis of the data on volume of fingers showed significant difference among various treatments. Mean volume of fingers varied from 164.70 cc in T_5 to 208.75 cc in T_6. The highest volume of fingers was recorded in T_6 (208.75 cc) which was statistically on par with T_4 (203.33 cc), T_3 (199.82 cc), T_1 (198.76 cc), T_2 (198.35 cc) and T_7 (191.04 cc). The treatment T_7 was in turn found to be on par with T_9 (176.33 cc), T_{10} (173.41 cc), T_8 (171.76 cc) and T_5 (164.7 cc).

Volume of finger was maximum in T_6 (Balaramapuram) followed by T_4 (Venjaramoodu) and T_3 (Keezhoor). The treatment T_5 (Palode) recorded the lowest mean value for volume of fingers. This in turn was followed by T_8 (Anad) and T_{10} (Neyyattinkara).

4.3.9 Pulp-peel ratio

There was no significant difference among various treatments with regard to the pulp-peel ratio. The mean value varied from 4.17 in T_3 to 4.59 in T_9.

The treatment T_9 (4.59) was having the highest pulp-peel ratio followed by T_1 (4.58) and (4.52). The lowest pulp-peel ratio was observed in T_3 (4.17) followed by T_{10} (4.43) and T_8 (4.44).

4.4 Quality characters

Results of the studies on variation in quality characters of various accessions of Kaliethan are presented in Tables 11 and 12.

Statistical analysis of the data revealed that there was no significant variation among the different accessions with regard to total soluble solids (T.S.S.) content. Maximum T.S.S. recorded was 28.84 per cent in T_7 while minimum T.S.S. was 26.63 per cent in T_2. Thus the results indicated that T_7 (28.84 per cent) had the highest T.S.S. followed by T_8 (28.83 per cent) and T_{10} (28.53 per cent). The lowest value for T.S.S. recorded was in T_2 (26.63 per cent) followed by T_3 (26.80 per cent) and T_1 (27.25 per cent).

The treatments did not show significant difference for the titrable acidity of fruits. Acidity was the highest in T_4 (0.552 per cent) and lowest in T_3 (0.36 per cent). The treatment T_4 with highest acidity was followed by T_2 (0.533 per cent) and T_8 (0.487 per cent) while the lowest value for acidity was observed in T_3 (0.360 per cent) followed by T_{10} (0.373 per cent) and T_9 (0.405 per cent).

Significant variation could not be observed for reducing sugar content of fruit samples from various treatments. The mean reducing sugar content ranged between 11.34 per cent in

Table 11 Variation in quality characters of various accessions of Kaliethan

Treatments	TSS (%)	Acidity (%)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	Sugar-aid ratio	Total carbohydrate (%)
T_1	27.25	0.413	12.25	5.95	18.15	44.99	81.38
T_2	26.63	0.533	15.17	3.12	18.29	36.16	84.85
T_3	26.80	0.36	12.83	8.84	21.57	38.28	89.89
T_4	27.28	0.552	14.84	4.89	19.17	35.48	57.43
T_5	28.00	0.435	12.35	5.60	17.96	41.49	84.23
T_6	27.51	0.447	13.20	4.91	18.22	41.09	85.51
T_7	28.84	0.43	14.78	5.18	19.96	39.21	86.99
T_8	28.83	0.487	14.03	3.87	18.23	38.66	83.73
T_9	28.16	0.405	16.64	4.21	20.86	44.85	83.26
T_{10}	28.53	0.373	11.34	5.95	17.30	46.97	83.46
F_9	NS	NS	NS	NS	NS	NS	NS
CD (0.05)	-	-	-	-	-	-	-

NS - Not significant

T_{10} to 16.65 per cent in T_9. Reducing sugar per cent was the highest in T_9 (16.64 per cent) followed by T_2 (15.17 per cent) and T_4 (14.84 per cent) while it was the lowest in T_{10} (11.34 per cent) followed by T_1 (12.75 per cent) and T_5 (12.35 per cent).

The non reducing sugar content of fruits did not show significant variation among the different treatments. The mean value ranged from 3.12 per cent in T_2 to 8.85 per cent in T_3. The results thus indicated that the highest non-reducing sugar per cent was in T_3 (8.85 per cent) followed by T_1 (5.95 per cent) and T_{10} (5.95 per cent). The lowest non-reducing sugar content was observed in T_2 (3.12 per cent) followed by T_8 (3.87 per cent) and T_9 (4.21 per cent).

The total sugars in the fruit samples from different treatments did not show significant variation. However the mean value of total sugars varied from 17.30 per cent in T_{10} to 21.58 per cent in T_3. The highest mean values of total sugars was recorded in T_3 (21.58 per cent) followed by T_8 (20.86 per cent) and T_7 (19.96 per cent) while T_{10} (17.30 per cent) recorded the lowest total sugar content followed by T_5 (17.96 per cent) and T_1 (18.15 per cent).

There was no significant variation in the sugar-acid ratio in fruit samples of different treatments. The mean sugar acid-ratio varied between 35.49 in T_4 and 46.97 in T_{10}. The treatment T_{10} which recorded the highest sugar-acid ratio value

Table 12 Variation in quality characters of various accessions of Kaliethan continued

Treatments	Fullness Index	Fruit curvature	Pedicel strength index	Openness of bunch (cm)	Bunch shape	Shelf life of fruits
T_1	8.302	1.175	0.923	6.88	0.298	8.083
T_2	8.092	1.166	0.573	6.699	0.350	9.517
T_3	8.001	1.244	0.905	6.782	0.252	10.333
T_4	8.067	1.192	0.955	6.881	0.319	9.417
T_5	7.363	1.142	0.977	6.443	0.331	9.667
T_6	8.224	1.223	0.862	6.985	0.225	13.25
T_7	7.962	1.193	0.947	6.762	0.293	10.00
T_8	7.429	1.172	0.873	6.65	0.248	9.417
T_9	7.67	1.258	0.937	6.697	0.292	10.25
T_{10}	7.235	1.140	0.909	7.003	0.360	11.417
F_9	NS	NS	NS	NS	NS	NS
CD (0.05)	-	-	-	-	-	-

NS - Not significant

was followed by T_1 (44.99) and T_9 (44.85). In the treatments T_4 (35.48), T_2 (36.16) and T_3 (38.28) lower sugar-acid ratios were observed.

Total carbohydrate content of various treatments differed significantly. Mean value of carbohydrate varied between 81.38 per cent in T_1 and 89.89 per cent in T_3. The treatment T_3 which recorded the highest carbohydrate content was statistically on par with T_4 (87.49 per cent) and T_7 (86.99 per cent). The latter two treatments were on par with T_6 (85.51 per cent) and T_2 (84.85 per cent). The treatment T_1 (81.38 per cent) which recorded the lowest carbohydrate content was found to be on par with T_2 and four other treatments viz. T_9 (83.26 per cent), T_{10} (83.46 per cent), T_8 (83.73 per cent) and T_5 (84.23 per cent).

The results thus indicated that the total carbohydrate content was the highest in T_3 (Keezhoor) which was succeeded by T_4 (Venjaramoodu) and T_7 (Venniyoor). The lowest carbohydrate content was in T_1 (Koliyoor) followed by T_9 (Karakkonam) and T_{10} (Neyyattinkara).

Fullness index of fruits did not show significant difference among various treatments. Higher values for this character were recorded in T_1 (8.30), T_6 (8.22) and T_2 (8.09) while lower values were recorded in T_{10} (7.23), T_5 (7.36) and T_8 (7.42). From the results it was evident that T_1 was having the

highest fullness index value followed by T_6 and T_2. While T_{10} recorded the lowest value for fullness index followed by T_5 and T_8.

Fruit curvature of different treatments did not vary significantly. The mean value of fruit curvature varied between 1.25 in T_9 and 1.14 in T_{10} and T_5. The results thus indicated that the highest fruit curvature was in T_9 followed by T_3 (1.24) and T_6 (1.22) while it was lowest in T_{10} and T_5 (1.14 each) followed by T_2 (1.16) and T_3 and T_1 (1.17 each).

Pedicel strength index of fruits showed no significant variation among treatments. Mean value of pedicel strength index ranged from 0.862 in T_6 to 0.977 in T_5. Comparatively higher pedicel strength index values were recorded for T_5 (0.977), T_4 (0.954) and T_7 (0.947) while treatments T_6 (0.862), T_8 (0.872) and T_3 (0.905) recorded lower values. From the data it was evident that T_5 had the highest and T_6 had the lowest values for pedicel strength index.

There was no significant difference among the treatments for the bunch openness. The mean values for this character ranged from 6.44 in T_5 to 7.00 in T_{10}. The treatment T_5 had more compact bunch followed by T_8 (6.65), T_9 (6.69) and T_2 (6.69) while T_{10} (7.00) had more open bunch.

Bunch shape of various treatments did not differ significantly. The mean value for bunch shape ranged between

0.36 in T_{10} and 0.225 in T_8. The results thus indicated that the treatment T_{10} recorded the highest mean value followed by T_2 (0.35) and T_5 (0.331) while it was the lowest in T_6 followed by T_8 (0.248) and T_3 (0.252).

Shelflife of the fruit samples from different treatments had no significant difference among them. Mean shelf life of fruits varied from 8.83 days in T_1 to 13.25 days in T_6. Thus the results revealed that T_6 had the maximum shelf life of fruits followed by T_{10} (11.41 days) and T_3 (10.33 days) while the minimum shelf life was observed in T_1 (8.08 days) followed by T_4 and T_8 (9.41 days each).

4.5 Incidence of major pests and diseases

The incidence of major pests and diseases in various accessions of Kaliethan are given in Table 13.

Incidence of Sigatoka leafspot showed statistically significant difference among various treatments. The disease index score ranged from 0.692 in T_7 to 3.53 in T_{10}. Eight treatments viz. T_7 (0.692), T_4 (0.913), T_6 (1.142), T_5 (1.275), T_2 (1.465), T_3 (1.516), T_1 (1.93) and T_8 (1.941) were found to be on par. Treatments T_9 (2.45) and T_{10} (3.53) were on par which recorded significantly higher disease index.

From the results it was observed that incidence of leaf spot was the highest in T_{10} (Neyyattinkara) followed by T_9

Table 13 Incidence of major pests and diseases

Treatments	Sigatoka leaf spot (Disease Index)	Bunchy top	Pseudostem weevil (Nos.)	Rhizome weevil (Nos.)
T_1	1.937	-	0.651	0.227
T_2	1.465	-	1.199	1.076
T_3	1.516	-	1.568	0.733
T_4	0.913	-	0.471	0
T_5	1.275	-	0	0
T_6	1.143	-	0	0.487
T_7	0.692	-	0	0
T_8	1.941	-	0	0
T_9	2.45	-	1.144	0.94
T_{10}	3.537	-	0.08	0.702
F_9	**	-	NS	NS
CD (0.05)	1.1265	-	-	-

** - Significant at 1% level
NS - Not significant

Note: Sigatoka leaf spot scoring

Disease Index	Leaf area infected
Negligible	0 - 5
1	6 - 10
2	11 - 25
3	26 - 30
4	31 - 40
5	41 - 50
6	51 - 75
7	75 and above

(Karakkonam) and T_8 (Anad). Least incidence was noticed in T_7 (Venniyoor) followed by T_4 (Venjaramoodu) and T_6 (Balaramapuram).

Studies on the incidence of the Bunchy top disease revealed that none of the plants in various treatments was affected.

Data on pseudostem weevil infestation in various treatments did not show any significant difference. The maximum of 1.568 weevils were noticed in T_3 followed by 1.199 in T_2 and 1.144 in T_9. In four treatments viz. T_5, T_8, T_7 and T_8 there was no infestation at all.

The results thus revealed that the highest intensity of pseudostem weevil infestation was seen in T_3 (Keezhoor) while T_5 (Palode), T_6 (Balaramapuram), T_7 (Venniyoor) and T_8 (Anad) were free from infestation.

The incidence of rhizome weevils did not show significant difference. The mean number of weevils ranged from 0 in T_4, T_5, T_7 and T_8 to 1.076 in T_2

The observations thus revealed that T_2 (Vellayani) had the highest intensity of rhizome weevil attack followed by T_9 (Karakkonum) and T_3 (Keezhoor). The least affected treatments were T_4 (Venjaramoodu), T_5 (Palode), T_7 (Venniyoor) and T_8 (Anad).

4.6 Genetic parameters

The variability components viz. genetic, phenotypic and environmental variability were assessed and banana being vegetatively propagated the phenotypic variability is completely usable. The results of the variability analysis are presented in Table 14.

Results of the variability analysis revealed that the phenotypic coefficient of variation (PCV) was the highest for the character leaf area index (30.93), followed by leaf area (30.91), number of leaves (28.34), number of suckers (25.13) and LAD (24.49). Moderate PCV values were recorded for bunch weight (12.70), weight of finger (11.56), volume of finger (10.79), shelf life of fingers (19.05), sugar acid ratio (16.50) and plant height (10.90). However, characters like pulp-peel ratio (4.55), length of fingers (7.28), total crop duration (5.66), bunch length (6.75), number of hands (5.96) and girth of finger (5.73) showed low PCV values.

The highest genotypic coefficient of variation (GCV) was observed for leaf area (20.53) followed by leaf area index (20.48), number of leaves (18.57) and leaf area duration (18.49). Moderate GCV values were observed for bunch weight (9.35), weight of fingers (7.42), volume of fingers (6.64), plant height (8.86), plant girth (7.44), shelf life of fruits (9.93) and number of

Table 14 Genetic parameters of various Kaliethan accessions

Character	σ^2_g	σ^2_e	σ^2_p	H^2 (%)	GCV (%)	PCV (%)
1. Bunch weight (kg)	0.760	0.642	1.402	54.18	9.35	12.70
2. Bunch length (cm)	3.463	5.336	8.799	39.36	4.24	6.75
3. Number of hands	0.053	0.027	0.080	65.74	4.83	5.96
4. Number of fingers	6.460	6.557	13.017	49.63	5.91	8.39
5. Length of finger (cm)	0.840	2.068	2.909	28.89	3.91	7.28
6. Girth of finger (cm)	0.170	0.460	0.630	27.00	2.97	5.73
7. Weight of finger (g)	185.441	264.309	449.750	41.23	7.42	11.56
8. Pulp-peel ratio	ne	0.069	0.041	ne	ne	4.55
9. Shelf life (days)	1.012	2.716	3.729	27.15	9.93	19.05
10. Volume of finger(cc)	157.285	257.688	414.970	37.90	6.64	10.79
11. Sugar acid ratio	0.035	45.130	45.165	0.07	0.45	16.50
12. LAD	669.780	528.442	1228.223	56.98	18.49	24.49
13. Height (cm)	641.657	329.833	971.49	66.04	8.86	10.90
14. Girth of plant (cm)	17.444	7.111	24.555	71.04	7.44	8.83
15. Leaf area (m^2)	0.917	1.162	2.078	44.11	20.53	30.91
16. LAI	0.057	0.073	0.131	43.82	20.48	30.93
17. Number of leaves at flowering	0.717	0.952	1.670	42.97	18.57	28.34
18. Number of suckers	0.362	1.905	2.266	15.95	10.04	25.13
19. Time for flowering	265.171	82.319	347.49	76.31	7.54	8.63
20. Time for harvest	16.373	24.936	41.209	39.49	5.26	8.37
21. Total crop duration	222.910	51.875	274.785	81.12	5.09	5.66

σ^2_g = Genotypic variance σ^2_e = Environmental variance ne = Not estimable

σ^2_p = Phenotypic variance H^2 = Heritability

PCV&GCV = Phenotypic and genotypic coefficients of variation

suckers (10.04). Characters like pulp-peel ratio (negligible), sugar-acid ratio (0.450), girth of finger (2.97), length of finger (3.91), bunch length (4.24), number of hands (4.83) and total crop duration (5.09) showed very low GCV values.

4.7 Heritability

Heritability values were expressed as low (5-10%) medium (10-13%) and high (30-60%) as suggested by Robinson (1966). Majority of the characters indicated high heritability values such as bunch weight (54.18 per cent), bunch length (39.36 per cent), number of hands (65.75 per cent), number of fingers (46.63 per cent), number of hands (65.75 per cent), number of fingers (46.63 per cent), finger weight (41.23 per cent), finger volume (37.90 per cent), LAD (56.98 per cent), plant height (66.04 per cent), plant girth (71.04 per cent), LAI (43.82 per cent), number of leaves (42.97 per cent), time for flowering (76.31 per cent), time for harvest (39.49 per cent) and total crop duration (81.12 per cent). Characters with medium heritability values included finger length (28.89 per cent), finger girth (27.00 per cent), shelf life (27.15 per cent) and number of suckers (15.95 per cent). Heritability values were lower for pulp-peel ratio (negligible) and sugar acid ratio (0.07 per cent).

4.8 Correlation studies

The estimates of phenotypic and environmental correlations between bunch yield and twelve other characters are presented in Table 15 and Figures 11 and 12.

Phenotypic correlation of bunch length with bunch weight was positive and significant (0.718). The environmental correlation was also positive and high (0.537).

Number of hands had significant positive phenotypic correlation with bunch length (0.455) and bunch yield (0.659). The environmental correlation was positive and significant with bunch yield (0.597) but negligible with bunch length (0.077).

Phenotypic association of the number of fingers was high and positive with number of hands (0.786), bunch length (0.671) and bunch weight (0.698). The environmental correlation with bunch length (0.675), number of hands (0.647) and bunch yield (0.721) was positive and significant.

Finger length recorded positive significant phenotypic correlation with number of fingers (0.584), number of hands (0.361), bunch length (0.758) and bunch weight (0.800). The environmental correlation was positive and significant with number of fingers (0.716), number of hands (0.428), bunch length (0.692) and bunch weight (0.804).

Table 15 Phenotypic and error correlations in Kaliethan accessions

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
Bunch weight X_1	-	0.537**	0.597**	0.721**	0.804**	0.756**	0.831**	0.144	0.251	-0.433*	-0.192	0.398*	-0.376*
Bunch length X_2	0.718**	-	0.077	0.675**	0.682**	0.581**	0.623**	-0.097	0.176	-0.306	0.278	0.092	-0.371*
No. of hands X_3	0.659**	0.455**	-	0.467**	0.428*	0.491**	0.398*	0.136	-0.046	-0.186	-0.317	-0.003	-0.118
No. of fingers X_4	0.698**	0.671**	0.786**	-	0.716**	0.787**	0.733**	-0.073	0.124	-0.277	-0.011	0.052	-0.256
Finger length X_5	0.800**	0.758**	0.361*	0.584**	-	0.782**	0.726**	-0.093	-0.036	-0.500**	-0.073	0.192	-0.528**
Finger girth X_6	0.768**	0.723**	0.406*	0.620**	0.874**	-	0.806**	-0.205	0.028	-0.426*	-0.143	0.276	-0.539**
Finger weight X_7	0.887**	0.759**	0.406*	0.555**	0.819**	0.828**	-	0.223	0.404	-0.370*	-0.040	0.614**	-0.347
Height X_8	0.742**	0.452**	0.519**	0.467**	0.478**	0.421*	0.661**	-	0.729**	0.525**	0.281	0.551**	0.110
Girth X_9	0.713**	0.504**	0.292	0.414*	0.534**	0.480**	0.734**	0.870**	-	0.392*	0.296	0.437*	0.149
No of leaves X_{10}	-0.0.15	0.05	0.149	-0.026	-0.300	-0.196	-0.176	0.176	0.176	-	0.544**	-0.166	0.107
Leaf Area X_{11}	0.241	0.376*	0.231	0.172	0.056	0.026	0.237	0.342	0.221	0.342	-	-0.089	0.081
LAD X_{12}	0.573**	0.278	0.195	0.329	0.526*	0.413*	0.632**	0.713**	0.762**	-0.043*	0.008	-	-0.185
Crop duration X_{13}	-0.589**	-0.459**	0.294	-0.312	-0.549**	-0.599**	-0.563**	-0.575**	-0.442**	0.176	-0.345	-0.495**	-

Upper diagonal figures are the error correlations
Lower diagonal figures are the phenotypic correlations

Phenotypic association of finger girth was positive and significant with finger length (0.874), number of fingers (0.620), number of hands (0.406), Bunch length (0.723) and bunch weight (0.768). The environmental correlations with finger length (0.782), number of fingers (0.787), number of hands (0.491), bunch length (0.581) and bunch weight (0.756) were positive and significant.

Finger weight showed positive significant phenotypic correlations with finger girth (0.828), finger length (0.819), number of fingers (0.555), number of hands (0.406), bunch length (0.759) and bunch weight (0.887). Environmental correlations recorded were also positive and significant with finger girth (0.806), finger length (0.726), number of fingers (0.733), number of hands (0.398), bunch length (0.623) and bunch weight (0.831).

The phenotypic correlation shown by plant height was positive and significant with finger weight (0.661), finger girth (0.421), finger length (0.478), number of fingers (0.467), number of hands (0.579), bunch length (0.452) and finally bunch weight (0.742). The environmental correlations were negative or insignificant with all the characters.

Plant girth recorded positive significant phenotypic correlation with plant height (0.870), finger weight (0.734), finger girth (0.480), bunch length (0.504) and bunch yield (0.713). However the environmental correlations were either

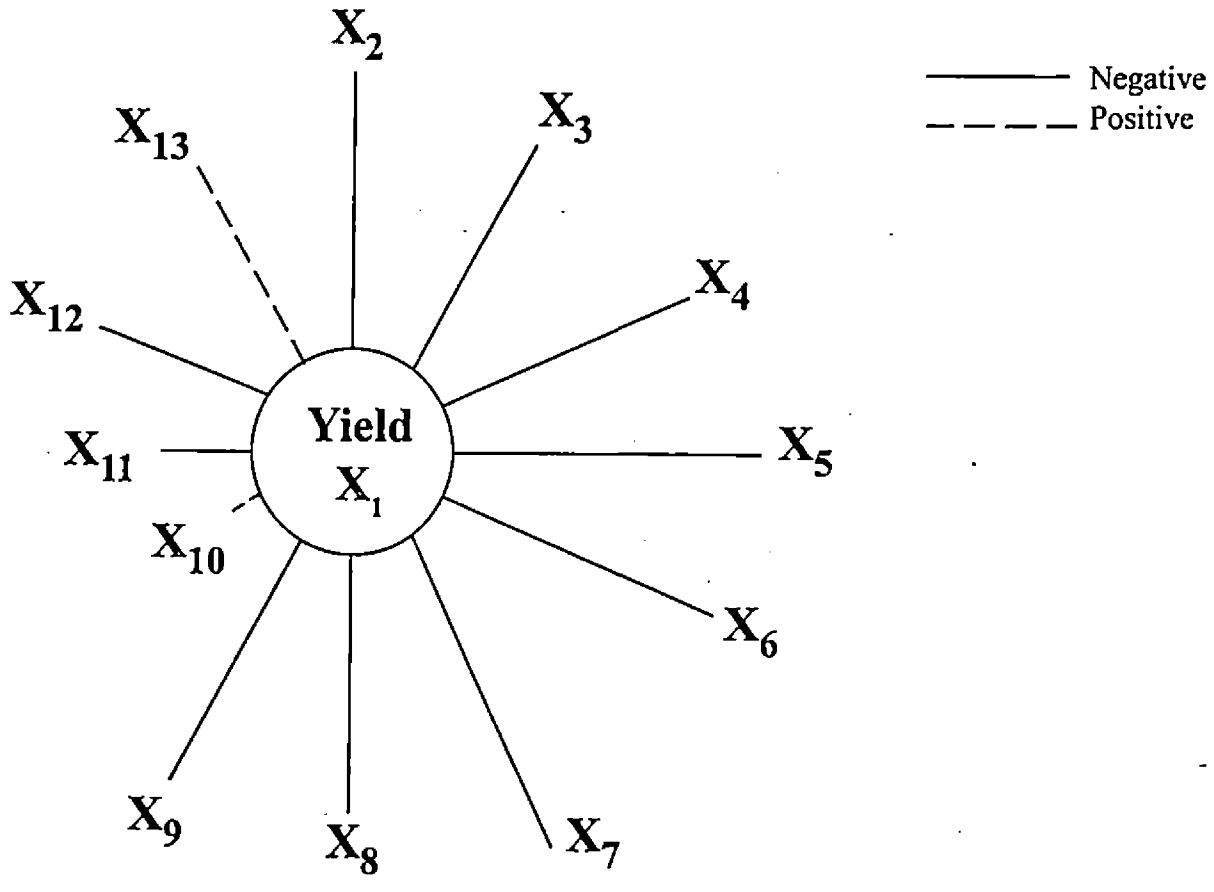

Fig. 11. Phenotypic correlation between yield and other characters

negative or insignificant with all the characters except for plant height (0.729).

Number of leaves showed negative and insignificant phenotypic associations with most of the characters. However the environmental correlation was positive and significant for plant girth (0.392) and plant height (0.525). But with finger weight (-0.370), finger girth (-0.426), finger length (-0.500) and then bunch weight (-0.433) the environmental correlation was significant but negative.

Phenotypic association of leaf area was positive and significant only with bunch length (0.376) while it was negative or insignificant for rest of the characters. The only positive and significant environmental correlation was seen with number of leaves (0.544).

Leaf Area Duration had positive significant phenotypic association with plant girth (0.762), plant height (0.713), finger weight (0.632), finger girth (0.413), finger length (0.426) and bunch weight (0.573). The phenotypic association with number of leaves was negative, though significant (-0.430). The environmental correlations were positive and significant with girth (0.437), height (0.551), finger weight (0.614) and bunch weight (0.398).

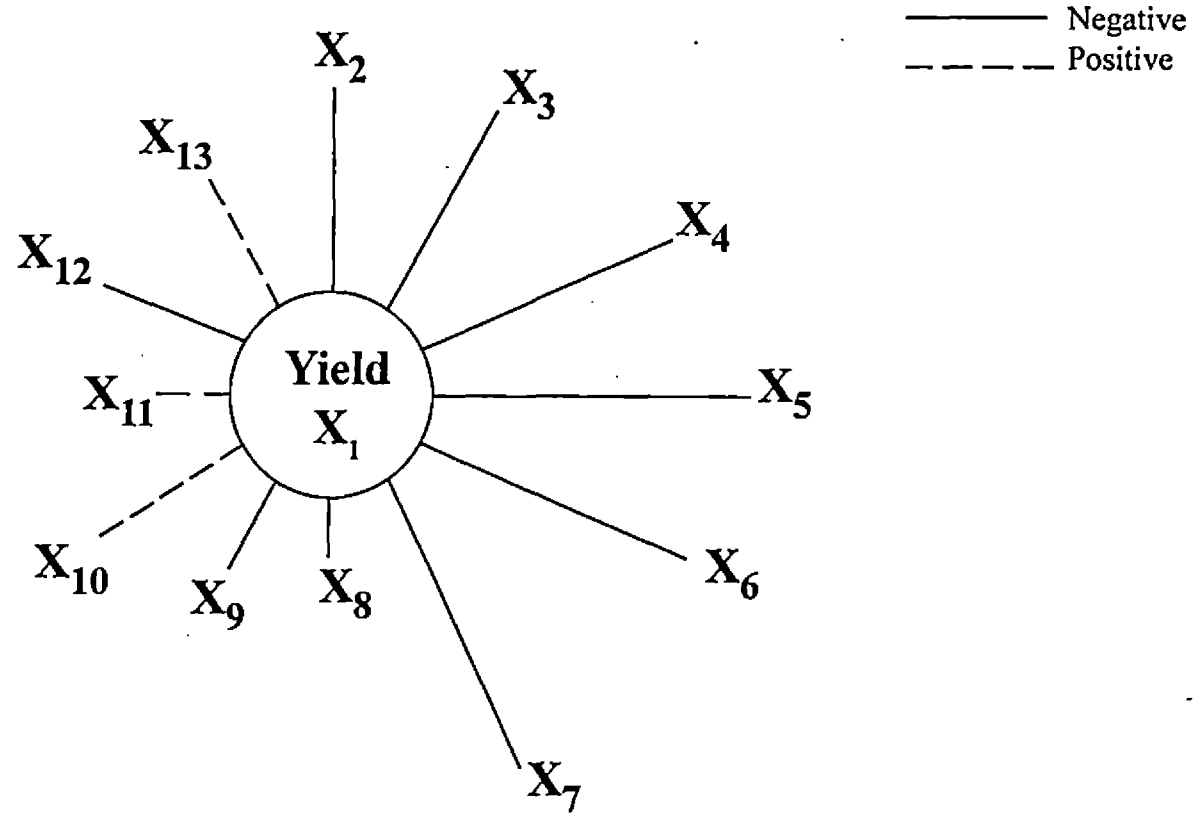

Fig. 12. Error correlation between yield and other characters

Crop duration recorded significant but negative phenotypic association with LAD (-0.495), plant girth (-0.442), plant height (-0.575), finger weight (-0.563), finger girth (-0.599). finger length (-0.575), bunch length (-0.459) and bunch weight (-0.589). The significant environmental correlations being with finger girth (-0.539), finger length (-0.528), bunch length (-0.371) and bunch weight (-0.376).

4.9 Path analysis

Path analysis of yield of different accessions of Kaliethan was carried out at phenotypic level for bunch characters and vegetative characters separately. The phenotypic correlation coefficient of the component characters with bunch yield were partitioned into direct and indirect effects as per the method suggested by Dewey and Lu (1959).

4.9.1 Bunch characters

Results of the path analysis using bunch characters as causal factors and bunch yield as effect are presented in Table 16 and Fig. 13.

Direct effect of bunch length on bunch yield was low and negative (0.0950). The highest indirect effect was through finger weight (0.5069) followed by finger length (0.2396), number of hands (0.1699) and number of fingers (0.0025). The indirect effect through finger girth was low but negative (-0.1059). The

Table 16 Direct (diagonal) and indirect (off diagonal) effects of bunch characters on bunch weight

Characters	X_1 Bunch weight	X_2 Number of hands	X_3 Number of fingers	X_4 Finger length	X_5 Finger girth	X_6 Finger weight	Total correlation
X_1 bunch length	-0.0950	0.1699	0.0025	0.2396	-0.1059	0.5069	0.7180
X_2 No.of hands	-0.0432	0.3735	0.0030	0.1141	-0.0595	0.2711	0.6590
X_3 No.of fingers	-0.0638	0.2936	0.0038	0.1846	-0.0908	0.3706	0.3980
X_4 Finger length	-0.0720	0.1348	0.0022	0.3161	-0.1280	0.5469	0.8000
X_5 Finger girth	-0.0687	0.1516	0.0024	0.2762	-0.1465	0.5529	0.7680
X_6 Finger weight	-0.0721	0.1516	0.0021	0.2589	-0.1213	0.6678	0.8870

Residue = 0.2945

high phenotypic association of bunch length with bunch yield was explained by the high indirect effect via. finger weight and finger length.

The number of hands had high positive direct effect on bunch yield (0.3735). The indirect effect was highest through finger weight (0.2711) followed by finger length (0.1141) and number of fingers (0.003). The number of hands registered negative and low indirect effects through finger girth (-0.0908) and bunch length (-0.0430). The high positive phenotypic association was explained by the direct effect of the number of hands along with the indirect effect via. finger weight.

The direct effect of number of fingers on bunch yield was positive but negligible (0.0038). However the indirect effect through the finger weight (0.3706) was the highest followed by number of hands (0.2936) and finger length (0.1846). The indirect effect through bunch length (-0.0638) and finger girth (-0.0908) were found to be low and negative. Thus the high phenotypic association of number of fingers with bunch yield was mainly due to the indirect effect through finger weight.

Length of finger had shown high and positive direct effect with bunch yield (0.3161), while it was lower than the indirect effect exerted through finger weight (0.5469). Indirect effects of length of finger via. bunch length (-0.0720) and girth of finger (-0.1280) were found to be negative but low. Other

indirect effects recorded through number of hands (0.1348) and number of fingers (0.0022) were also low, though positive. Thus it was evident that the high phenotypic association was due to the direct effect and high indirect effect registered through finger weight.

Direct effect of the girth of finger on yield was negative and low (-0.1465) but its correlation with yield was positive. Girth of finger had highest positive indirect effect through finger weight (0.5529), followed by finger length (0.2762), number of hands (0.1516) and number of fingers (0.0024). The indirect effect through bunch length was negative but negligible (-0.0687). So the high phenotypic association of finger girth, on bunch yield was due to the highly positive indirect effect via. weight of fingers and finger length.

The weight of finger had high and positive (0.6678) direct effect on bunch yield. The highest indirect effect was through length of fingers (0.2589) followed by number of hands (0.1516) and number of fingers (0.0021). The indirect effects through bunch length (-0.0721) and finger girth (-0.1213) were low and negative. Thus the high phenotypic association with bunch yield was explained by the direct effect and its indirect effect via. finger length.

Path analysis of the bunch characters thus revealed that maximum direct effect on bunch weight was contributed by

weight of finger, followed by number of hands and length of finger. With regard to the number of fingers, bunch length and girth of finger, the influence was mainly through their indirect effects on finger weight.

The residual effect accounted for 0.294 which in turn showed that upto 71 per cent of the variation on bunch yield was contributed by the above six characters.

4.9.2 Vegetative characters

Results of the path analysis using vegetative characters as causal factors and bunch yield as the effect are presented in Table 17.

Height of the plant had highest direct effect on yield (0.884). Of the various indirect effects studied those via. plant girth was the highest (0.2362) followed by LAD (0.0127) and leaf area (0.0047). Thus the higher phenotypic association between plant height and yield was explained due to the high direct effect and indirect effect via. girth.

The direct effect of the girth of pseudostem on bunch yield was lower (0.2715). However the indirect effect through plant height was high and positive (0.4249). The indirect effects via LAD (0.0136) and leaf area (0.0031) were positive but negligible. So the higher phenotypic association was due to the high indirect effect exerted through plant height along with the direct effect.

Table 17 Direct (diagonal) and indirect (off diagonal) effects of vegetative characters on bunch weight

Characters	X_1 Height	X_2 Girth	X_3 Leaf Area	X_4 LAD	Total correlation
X_1 Height	0.4884	0.2362	0.0047	0.0127	0.7420
X_2 Girth	0.4229	0.2715	0.0031	0.0136	0.7131
X_3 Leaf Area	0.1670	0.0600	0.0138	0.0001	0.2409
X_4 LAD	0.3482	0.2069	0.0001	0.0178	0.5730

Residue = 0.6561

Leaf area had very low direct effect (0.0138) on bunch yield. However the indirect effect through plant height was high (0.1670) followed by girth of plant (0.0600) and LAD (0.001). The phenotypic association of leaf area on bunch weight was mainly due to the indirect effect via. plant height.

LAD had positive but low direct effect (0.0176) on bunch yield. The highest indirect effect was through plant height (0.3482) followed by plant girth (0.2069) and leaf area (0.0001). Thus the high phenotypic association of LAD on bunch yield was explained due to the high indirect effect through plant height and girth.

Path analysis of vegetative characters thus indicated that, plant height had the maximum direct effect on bunch yield (0.4884). The girth of the plant, leaf area and LAD contributed indirectly via. their effect on plant height. The residual effect accounted for 0.66 which meant that only 34 per cent of the variation on bunch yield was contributed by the above characters.

4.10 Discriminent function analysis

Estimation of selection indices (discrimination indices) and ranking of the accessions based on indices are presented in Table 18. The highest scoring 4 accessions were selected by exercising 40 per cent selection, namely T_6 (Balaramapuram), T_2 (Vellayani), T_1 (Koliyoor) and T_4 (Venjaramoodu).

Table 18 Accessions and their selection indices in descending order (based on yield and bunch characters)

Sl.No.	Accessions	Selection indices
1.	Balaramapuram (T_6)	520.04
2.	Vellayani (T_2)	503.94
3.	Koliyoor (T_1)	475.87
4.	Venjaramoodu (T_4)	465.77
5.	Venniyoor (T_7)	465.60
6.	Keezhoor (T_3)	455.59
7.	Anad (T_8)	423.12
8.	Neyyattinkara (T_{10})	416.25
9.	Palode (T_5	407.94
10.	Karakkonam (T_9)	394.61

DISCUSSION

5. DISCUSSION

Variation is the law of nature, though its amount varies. In banana variation due to bud mutations is generally brought about by spontaneous rearrangement of chromasomes in somatic meristem and structural reassortment. Clonal propagation and selection have helped in perpetuation of these mutants and continually adding to these changes. Such variations offers a greater scope for selecting desirable types from the existing population of a locality. This will give way to evolve better plant types, well adapted to the particular locality and to enhance orchard efficiency.

The present studies were undertaken to identify superior types among various accessions of Kaliethan based on a systematic evaluation. The extend of variability and heritability of important traits, correlation among characters at phenotypic level, path coefficient analysis and discriminent function analysis were carried out with a view to select the desirable types and to suggest measures to bring about improvement for yield and its components. During the course of the experiment, plant growth, yield and quality of the produce of various accessions were critically observed and the results obtained are discussed here under. Research works in similar lines in banana are very few. Hence results obtained in other crops are also utilized to establish the validity of results obtained from the present studies.

5.1 Biometric characters

5.1.1 Height of plant

The present studies revealed that height of the various accessions differed significantly at various stages of growth. The treatment T_5 (Palode) recorded the lowest plant height in all the three stages of growth namely adult pre-floral vegetative stage, floral initiation stage and post-floral stage. Lower plant height was also recorded in T_9 (Karakkonam) and T_{10} (Neyyattinkara) in all the three stages. However treatments T_7 (Venniyoor), T_6 (Balaramapuram) and T_1 (Koliyoor) recorded higher plant height in different growth stages.

Experiments in similar lines (Rajeevan, 1985) with accessions of 'Palayamkodan' also revealed variation in plant height. He reported variation of plant height during the later stages of growth in the plant crop and throughout the growing period in first ratoon. Kothavade *et al*. (1985) observed an increase in plant height in Basrai banana with the increase in the number of functional leaves. Tang and Chu (1993) revealed decreased plant height in Taichiao-2, a selection from 'Cavendish Black Farm' with respect to standard.

Thus the results of the present studies are in agreement with the results of similar works done earlier.

5.1.2 Girth of plant

Results of the present studies revealed that girth of plant differed significantly among treatments, during various stages of growth. At bunch emergence, plant girth was the highest in T_1 (Koliyoor), T_4 (Venjaramoodu), T_3 (Keezhoor) and T_6 (Balaramapuram). However treatments T_7 (Venniyoor), T_6, T_4 and T_8 (Anad) in general had higher plant girth while considering all the three stages and T_5 (Palode), T_9 (Karakkonam) and T_{10} (Neyyattinkara) recorded lower plant girth.

Results of similar works with different accessions of 'Palayamkodan' (Rajeevan, 1985) revealed variation in plant girth, both in plant crop and first ratoon. Tang and Chu (1993) revealed slightly higher plant girth for Taichiao-2, a selection of Cavendish Black Farm banana, than the standard. The above reports are in agreement with the trends observed in the present studies.

5.1.3 Number of leaves produced

Data on the monthly leaf production showed significant variation among various accessions at all the stages of growth. During the adult pre-floral vegetative phase, the highest leaf number was seen in T_4 (Venjaramoodu) followed by T_6 (Balaramapuram) and T_7 (Venniyoor). During the floral initiation stage also T_4 had the highest leaf number and was followed by T_3

(Keezhoor) and T_1 (Koliyoor). However during post floral stage T_{10} recorded the highest leaf number which was followed by T_9 and T_5.

Results obtained from the present studies are in agreement with the reports of Pillai and Shanmugavelu (1976) who observed that in Poovan banana the increase in the level of functional leaves decreased the interval of successive leaves. Shepherd (1957) reported that leaf ratio seemed to be a character least affected by environment and therefore would be of great use in detection of intraclonal variation. Gross and Simmonds (1954) assessed variations due to mutations in Dwarf Cavendish group with the help of differences in leaf ratios. Thus the variation in leaf production among the accessions of 'Kaliethan' observed in the present studies are in agreement with earlier reports in banana.

5.1.4 Number of suckers produced

No significant variation could be observed in the number of suckers produced by different accessions. This may be due to the fact that the extent of variability may not be strong enough to create notable changes in sucker production among the different accessions. No report on such an influence could be traced among early works.

5.1.5 Crop duration

Results from the present studies revealed that there was significant difference among various accessions with respect to the time taken for flowering, time taken for bunch maturity and total crop duration. The treatment T_7 (Venniyoor) took the shortest time for flowering followed by T_4 (Venjaramoodu) and T_3 (Keezhoor). The treatment T_{10}, T_9 and T_5 took longest time for flowering. The shortest bunch maturity period was recorded in T_5 (Palode) followed by T_6 (Balaramapuram) and T_2 (Vellayani).

The treatment T_7 was having the shortest crop cycle followed by T_4 and T_3. The treatment T_9 (Karakkonam) had the longest crop cycle followed by T_{10} and T_5. The results thus indicated that the crop cycle was completed earlier in those treatments in which flowering was early. The fruit maturity time did not influence the total crop duration.

Rajeevan (1985) reported significant variation in the duration of 'Palayamkodan' accessions. Similar studies with Nendran clones at Kannara (Anon., 1984b) revealed variation of crop duration. from 332.3 days to 359.3 days for clone 100 and clone 134 respectively. Similar results were also reported from Kannara (Anon., 1987) on Nendran clones. Thus the variations in time for flowering and harvesting observed among the accessions of Kaliethan are in agreement with the results of earlier reports in similar line.

Li *et al*. (1991) could isolate five selections of mandarin cv. Nanfeng Miju with earliness in maturity. Christensen (1995) observed variation in the flowering time and harvest among the clones of sour cherry cv. Stevnsbaer. Peng *et al*. (1994) obtained an early bearing selection from the clones of the Taiwanese mandarin variety Ponggan. These studies also indicate possibility of variation in flowering and harvesting time as observed in the present studies.

5.2 Physiological characters

In the present studies, the leaf area of various accessions showed significant differences at all the three phases of growth. During the adult pre-floral vegetative phase leaf area was the highest in T_6 (Balaramapuram) followed by T_7 (Venniyoor) and T_4 (Venjaramoodu). However during floral initiation stage T_4 had maximum leaf area which was followed by T_6 and T_7. Thus, in general T_6, T_7 and T_4 recorded maximum leaf area in both these stages of growth. However, during the post-floral stage the highest leaf area was observed in T_1 which was followed by T_{10} and T_9.

Analysis of the leaf area index (LAI) indicated significant differences among various treatments at all stages of crop growth. LAI was higher in T_6 (Balaramapuram), T_7 (Venniyoor) and T_4 (Venjaramoodu) during the adult pre-floral vegetative phase and floral initiation phase. However, during

the post-floral stage, T_1 (Koliyoor) had maximum LAI followed by T_{10} (Neyyattinkara) and T_9 (Karakkonam).

From the results it was evident that the phyllachron (interval of leaf production) varied significantly among different treatments in every stage of growth. During the adult pre-floral vegetative stage, phyllachron was shorter in T_5, T_4 and T_8 and it was longer in T_2, T_{10} and T_3. At floral initiation stage, phyllachron was shorter in T_8 (Balaramapuram), T_8 (Anad) and T_4 (Venjaramoodu) and was longer in T_5, T_{10} and T_1. However, immediately before flowering, T_{10}, T_5 and T_1 registered shorter interval of leaf production and it was the longest in T_8. In general, shorter phyllachron was observed in T_5 (Palode), T_4 (Venjaramoodu) and T_8 (Anad).

There was no significant variation in the leaf area duration (LAD) of various treatments at different stages of crop growth. The treatment T_1 (Koliyoor) had the highest LAD and this was followed by T_7 (Venniyoor) and T_3 (Keezhoor), while it was the lowest in T_5 (Palode).

Research works on similar lines (Pillai and Shanmugavelu, 1976) revealed variation of phyllachron from 8.0 to 8.6 days in 'Poovan' banana. The same study also revealed that the banana plants having greater functional leaf area required longer cropping period. Variation in phyllachron was also reported by Rajeevan (1985) in different accesssions of

'Palayankodan'. Thus the variations observed in the leaf characters are supported by the above research results in different cultivars of banana.

5.3 Yield characters

5.3.1 Bunch weight

Results of the present studies indicated that there was variation in the bunch weight of different accessions. The treatment T_6 (Balaramapuram) recorded the highest bunch weight followed by T_2 (Vellayani) and T_1 (Koliyoor). Among the accessions tested T_5 (Palode) recorded the lowest bunch weight followed by T_9 (Karakkonam) and T_{10} (Neyyattinkara).

Similar experiments with different Nendran clones (Anon., 1984a) revealed variation in bunch weight. The average bunch weight varied from 10 kg to 15.42 kg at Vellanikkara. It was also reported (Anon., 1982) that the Nendran clone from Pampady-Meenadom area of Kottayam district with the highest mean bunch weight of 12.5 kg. Pooled analysis of bunch weight in Nendran clones (Anon., 1987) revealed variation in bunch weight ranging from 8.55 to 11.65 kg. Rajeevan (1985) reported variation in bunch weight in different accessions of 'Palayankodan'. Rajeevan and Mohanakumaran (1993) reported variation in the yield of plant crop and first ratoon in 'Palayankodan' accessions. The above reports support the results obtained in the present studies with respect to bunch weight.

5.3.2 Bunch length

Results of the present investigations revealed that there was variation in the bunch length of different treatments. The treatment T_6 (Balaramapuram) recorded the highest bunch length followed by T_4 (Venjaramoodu) and T_2 (Vellayani) and the lowest in T_9 (Karakkonam) followed by T_8 (Anad) and T_5 (Palode).

The correlation studies conducted as a part of the present investigations revealed positive correlation of bunch length with bunch weight. Thus the treatments with higher bunch weight had higher bunch length also.

5.3.3. Number of hands per bunch

There was significant variation in the number of hands per bunch of different accessions of Kaliethan. Number of hands was the highest in T_6 (Balaramapuram) followed by T_1 (Koliyoor) and T_8 (Anad). Lowest number of hands was seen in T_3 followed by T_9 and T_5.

Experiments in similar lines with 'Palayankodan' accessions (Rajeevan and Mohanakumaran, 1993) revealed variation in the number of hands in plant crop (10 to 12) and in the first ratoon (10.25 - 13.50).

5.3.4 Number of fingers per bunch

The data on the number of fingers per bunch showed significant variation among different accessions. The maximum

number of fingers was in T_8 (Balaramapuram) followed by T_4 (Venjaramoodu) and T_8 (Anad). However, T_5 recorded the lowest number of fingers followed by T_3 and T_9.

Similar experiments with four mutants of Cavendish banana revealed variation in finger number (George *et al.*, 1978). Among Nendran clones also variation in finger number was observed (Anon., 1984 a). Rajeevan and Mohanakumaran (1993) observed variation in the number of fingers among different accessions of 'Palayankodan' both in plant crop and first ratoon.

5.3.5 Finger size

With respect to the length of fingers, no significant variation was observed among various accessions. However, the highest finger length was observed in T_3 (Keezhoor) followed by T_6 (Balaramapuram) and T_4 (Venjaramoodu). Length of finger was the shortest in T_5 followed by T_9 and T_8.

Girth of finger also did not show significant variation. The treatment T_4 (Venjaramoodu) had the highest girth for finger followed by T_6 (Balaramapuram) and T_3 (Keezhoor). However treatments T_1, T_9 and T_5 recorded lower values of finger girth.

There was significant difference among treatments for weight of fingers. The treatment T_6 (Balaramapuram) had the highest mean weight of finger followed by T_4 (Venjaramoodu) and

T_2 (Vellayani). The lowest weight of finger was in T_5 followed by T_9 and T_{10}.

Mean volume of fingers also showed signifiant difference among treatments. Volume of finger was the maximum in T_6 (Balaramapuram) followed by T_4 (Venjaramoodu) and T_3 (Keezhoor). However T_5 recorded the lowest volume of finger followed by T_8 and T_{10}.

Data on the pulp/peel ratio of different treatments showed no significant difference. The treatment T_9 (Karakkonam) was having the highest pulp/peel ratio followed by T_1 (Keezhoor) and T_6 (Balaramapuram).

Earlier research works by Venkatarayappa (1975) reported variation in finger length and finger girth in Dwarf Cavendish banana. Variation of finger length in different accessions of 'Palayankodan' was also reported by Rajeevan (1985). Experiments in similar lines (Anon., 1984 a and b) showed significant variation in the weight of fingers among Nendran clones. Similar variation of finger weight was reported later also in Nendran clones (Anon., 1989). Variation in the pulp/peel ratio in Cavendish banana was reported by George *et al*. (1978) and in Nendran clones (Anon., 1984a and b).

Evidences of such variations in yield characters in other fruit crops are also reported by various workers.

Variations of yield character were reported in mango (Singh, 1971), in Taiwanese mandarin 'Ponggan' (Peng *et al*., 1994), in grape variety Verdicchio (Valentini *et al*., 1994) in Furmint type (Sekera and Ruman, 1994) and in plum variety Domaci Svestky (Paprstein, 1995).

5.4 Quality characters

Results of the present studies revealed that there was no significant difference among various accessions for most of the quality characters except for total carbohydrate content.

The results revealed that the highest total soluble solids content was in T_7 followed by T_8 and T_{10}. The lowest value of TSS was recorded in T_2 followed by T_3 and T_1.

The titrable acidity of fruits was the highest in T_4 followed by T_2 and T_8, while it was the lowest in T_3 followed by T_{10} and T_9.

The mean reducing sugar content of fruits was the highest in T_4 followed by T_{10} and T_9 followed by T_2 and T_4, while it was the lowest in T_{10} followed by T_1 and T_5.

The highest non-reducing sugar content of fruits was noticed in T_3 followed by T_1 and T_{10} and it was the lowest in T_2 followed by T_8 and T_9.

The mean total sugar content of fruits was maximum in T_3 followed by T_9 and T_7. However, it was the lowest in T_{10} followed by T_5 and T_1.

The results revealed that the sugar/acid ratio was the highest in T_{10} followed by T_1 and T_9, while it was the lowest in T_4, T_2 and T_3.

The total carbohydrate content of fruits in various treatments showed significant difference. The highest value of total carbohydrate was noticed in T_3 followed by T_4 and T_7. However, treatments T_1, T_9 and T_{10} recorded lower carbohydrate values.

Fullness index of fruits did not vary among treatments. However, higher values of the index was noted in T_1, T_6 and T_2 while lower values were in T_{10}, T_5 and T_8.

The results indicated that the fruit curvature value was the highest in T_9 followed by T_3 and T_6 while it was the lowest in both T_{10} and T_5 which were followed by T_2 and both T_8 and T_1. There was no significant difference among treatments.

The pedicel strength index of fruits showed no significant difference among various treatments. Higher pedicel strength index values were recorded in T_5, T_4 and T_7 while treatments T_6, T_8 and T_3 recorded lower values.

There was no significant variation among different accessions for bunch openness. The treatment T_5 had more compact bunch followed by T_8 and both T_9 and T_2. However, T_{10} had bunch with maximum openness.

Bunch shape of different accessions showed no variation. The results indicated that the treatment T_{10} recorded the highest mean value for bunch shape followed by T_2 and T_5 while it was the lowest in T_6 followed by T_8 and T_3.

Shelflife of fruit samples also showed no variation among different treatments. Maximum shelf life was noticed in T_6 followed by T_{10} and T_3 while it was minimum in T_1, T_4 and T_8.

Experiments in similar lines with 'Nendran' clones (Anon, 1984 a) showed that there was no significant variation in quality of fruits such as TSS and acidity. This is in conformity with the present results. It was also observed that the total sugars and sugar-acid ratio showed significant variation, in contradiction to the present study. Rajeevan (1985) indicated that in 'Palayankodan' accessions the differences were insignificant for acidity and sugar-acid ratio and significant for reducing sugar and total sugar. Similar experiments by Rajeevan and Mohankumaran (1993) showed that there was no variation for acidity and non-reducing sugar. However TSS, reducing sugar and total sugar showed significant variation. Vachun (1981) observed that the variability was low for fruit

quality in apricot 'Velkopavlovicka' which is in agreement with the present results. Muinos and Romillo (1987) reported that there was no variability in the quality parameters of Valencia orange clones.

5.5 Incidence of major diseases and pests

Results of the present studies revealed significant variation in the incidence of Sigatoka leaf spot among various accessions. Least incidence of the disease was observed in T_7 (Venniyoor) followed by T_4 (Venjaramoodu) and T_6 (Balaramapuram) while T_{10}, T_9 and T_8 were the most affected. Studies on the incidence of Bunchy top disease revealed that none of the plants in various treatments were affected.

Brun (1962) revealed that the level of resistance to Sigatoka by a given cultivar may vary according to local conditions and the amount of infective inoculum. Rajeevan (1985) reported significant variation in the Sigatoka infection index of 'Palayankodan' accessions. He also revealed a mortality per cent of 0 to 30 due to Bunchy top disease in various accessions. Babylatha *et al*. (1990) indicated that cultivars of banana vary in their reaction to leaf spot diseases. Mohan and Lakshmanan (1987) found that hybrids of Klue teparod with Nendran was free from the disease. Under AAB clones, a moderate level of resistance was observed in 'Thiruvananthapuram', 'Mysore ethan' and 'Padali moongil' against Sigatoka leaf spot (Anon., 1990). In

the present studies also variations in the incidence of leaf spot among the accessions were observed as reported in the above studies. Incidence of Bunchy top disease was not observed probably due to the care taken while collecting suckers and the prophylatic measures taken during crop growth.

Data on the infestation of pseudostem weevil and rhizome weevil did not show significant variation among different accessions.

Babylatha *et al*. (1990) from a related study reported that there was wide variability in the reaction to rhizome weevil by various cultivars of banana. The very low incidence of the weevils in the experimental plots may be due to the care taken while selecting the planting materials.

5.6 Genetic analysis

Variability is the law of nature. Phenotypic variability is the measurable variability which results from genetic and environmental effects. The results of present studies revealed that the phenotypic and genotypic coefficients of variation were low for bunch length, number of hands, girth of finger, length of finger and total crop duration. However, the phenotypic and genotypic coefficients of variations were moderate for bunch weight, weight of finger, volume of finger, plant height and shelflife of fruits. Most of the vegetative

characters such as leaf area, leaf area index, number of leaves and leaf area duration indicated high GCV and PCV.

Rajeevan and Geetha (1984) observed high PCV and GCV values for bunch weight, number of fingers, number of hands, length of finger and weight of finger in a study with forty banana cultivars. Similar reports of high PCV and GCV were made by Sreerangaswamy *et al*. (1980), Wei *et al*. (1988) and Rekha and Prasad (1993) in banana. Thus the low and moderate PCV and GCV obtained for most of the yield components observed in the present studies are in contradiction to the earlier reports. These lower values obtained may be due to the genetic similarity of various accessions subjected to evaluation.

5.7 Heritability

Results of the present studies revealed that the heritability values (in broad sense) were high for the characters such as bunch weight, bunch length, number of hands, number of fingers, weight of finger, volume of finger, leaf area duration, height of plant, girth of plant, leaf area index, number of leaves at flowering, time for flowering, time for harvest and total crop duration.

The high heritability for number of fruits per bunch, bunch weight and number of days to flowering obtained in the present studies are in agreement with the finding of

Sreerangaswamy *et al*. (1980) in banana. The high heritability for plant height, weight of finger, girth of finger and bunch yield are in consonance with the findings of Vijayaraghavakumar *et al*. (1984b). The high heritability for number of leaves at flowering and number of hands (Rajeevan and Geetha, 1984), leaf area per plant and finger volume (Valsala kumari and Nair, 1986) and bunch length (Rosamma and Namboodiri, 1990) was also in agreement with the present findings. High heritability for plant girth in banana was also reported by Wei *et al*. (1985). The high heritability for time taken for harvest obtained in the present study is in accordance with the findings of Chundawat *et al*. (1988) using different banana cultivars.

5.8 Correlation studies

Correlation provides information on the nature and extend of association between characters in a population. The component characters always show interrelationships. When selection pressure is applied on a trait, the population under selection is not only improved for that trait but also for other characters associated with it. This facilitates simultaneous improvement of two or more characters. Therefore, analysis of yield in terms of phenotypic and environmental correlation coefficients of component characters leads to the understanding of characters that can form the basis of selection.

The results of the present studies revealed that the bunch yield had highly significant positive correlation with characters like bunch length, number of hands, number of fingers, finger length, finger girth, finger weight, plant height, plant girth and leaf area duration. The crop duration had significant negative phenotypic correlation with yield. Leaf area had positive correlation, though not significant, while number of leaves had low and negative correlation with yield.

Positive significant environmental correlation with yield was seen for bunch length, number of hands, number of fingers, finger length, finger girth, finger weight and leaf area duration, indicating that these characters are strongly influenced by environment. Number of leaves and crop duration recorded significant negative environmental correlations with yield. Plant height, plant girth and leaf area did not show significant environmental correlations with yield which indicated that the influence of environment in these characters was negligible.

The highly positive phenotypic correlation of bunch weight with finger weight obtained in the present study is in agreement with the findings of Shanmugavelu (1983), Rosamma and Namboodiri (1990) in a trial with 48 banana varieties, Rekha and Prasad (1993) using 170 genotypes of banana, Baiyeri and Mbah (1994) in plantain cv. Agbagba and Sumam George (1994) in cv. Nendran.

Highly positive and significant association of bunch yield in banana with number of fingers is in conformity with reports of Krishnan and Shangmugavelu (1983). Kurian *et al*. (1985), Wei *et al*. (1985), Rosamma and Namboodiri (1990) and Sumam George (1994).

Significant association of bunch yield in banana with number of hands at phenotypic level was reported by Shanmugavelu (1983), Krishnan and Shanmugavelu (1983), Kurien *et al*. (1985), Wei *et al*. (1985) and Rosamma and Namboodiri (1990).

High positive phenotypic association of bunch yield and finger girth obtained in the present study is in conformity with the findings of Rosamma and Namboodiri (1990), Sumam George (1994), Baiyeri and Mbah (1994), in different banana varieties.

The present results indicating positive and high phenotypic association of finger length and bunch yield was supported by the findings of Sumam George (1994) and Baiyeri and Mbah (1994) in banana cv. Nendran and plantain cv. Agbagba respectively.

Positive and significant phenotypic correlation of plant height with bunch yield as seen in the present studies was earlier reported by Krishnan and Shanmugavelu (1983).

Significant positive association of plant girth and bunch yield at phenotypic level is in agreement with the earlier

reports in this line by Krishnan and Shanmugavelu (1983), Wei *et al*. (1985) and Rosamma and Namboodiri (1990).

Significant positive association of bunch length at phenotypic level with bunch yield was reported by the findings of Rosamma and Namboodiri (1990).

Negative or very low phenotypic association obtained for leaf area and number of leaves with yield were in condradiction to the earlier reports (Krishnan and Shanmugavelu (1983) and Kurian *et al*., (1985).

The significant negative phenotypic correlation obtained for crop duration with yield was in agreement with the findings of Krishnan and Shanmugavelu (1983).

In a closer look at the correlation of other characters with yield, it can be concluded that the yield can be improved by exercising selection for the characters bunch length, number of hands, number of fingers, finger length, finger girth, finger weight, height and girth of the plant, LAD and total crop duration.

5.9 Path analysis

The phenotypic correlation coefficient of component characters with bunch yield were partitioned into direct and indirect effects as per the method suggested by Deway and Lu

(1959). This is to get a clear picture of the relative contribution of the component characters to yield.

5.9.1 Vegetative characters

Path analysis using vegetative characters as causal factors and bunch weight as the effect indicated that plant height had the maximum direct effect. The girth of plant, leaf area and LAD contributed indirectly to yield through plant height.

Experiments in similar lines revealed high direct effect of plant girth on yield (Sreerangaswamy *et al.*, 1980 and Rosamma and Namboodiri, 1990) while low or negligible direct effect by plant height (Kurian *et al.*, 1985). Thus the present results are not in agreement with the previous reports in this line.

5.9.2 Bunch characters

Path analysis using bunch characters on causal factors and bunch weight as the effect revealed that the maximum direct effect on yield was contributed by weight of finger and number of hands. Characters like number of fingers, length of fingers, bunch length and girth of finger contributed indirectly to bunch weight.

The higher direct effects of finger weight and number of hands on bunch weight observed in the present study are in

conformity with the findings of Rajeevan (1985) and Rosamma and Namboodiri (1990). High indirect effects of number of fingers on bunch yield in dessert varieties was reported by Vijayaraghavakumar *et al*. (1984). The high indirect effect of length of fruit on yield is in conformity with the reports of Sumam George (1994), in banana cv. Nendran. The higher indirect effects of bunch length and girth of finger on bunch weight are not in accordance with the findings of Rosamma and Namboodiri (1990) and Sumam George (1994) where these characters had high direct effects on yield.

5.10 Discriminent function analysis

Discriminent function analysis as a method of selection of desirable types from a population was first developed by Fisher (1936) and then applied by Smith (1936). In the present study a selection index through discriminent function analysis was formulated to increase the efficiency of selection taking into account the yield and other important characters contributing to it. Since the bunch characters alone explained 71 per cent of variation on yield as against 34 per cent by vegetative characters, the former group only was considered in constructing the selection index.

Bunch characters like bunch length, number of hands, number of fingers, finger length, finger girth, finger weight and bunch weight were considered for constructing the selection

index. As a result, the highest scoring four accessions namely T_6 (Balaramapuram), T_2 (Vellayani), T_1 (Koliyoor) and T_4 (Venjaramoodu) can be considered worth of selection among the Kaliethan accessions observed in the present studies.

Construction of selection index in banana using number of hands, bunch length, number of fingers, weight of individual finger together with bunch weight and utilizing this index as a criteria for selecting superior types was reported by Vijayaraghavakumar *et al*. (1984), Rosamma and Namboodiri (1990), Rekha and Prasad (1993) and Nair *et al*. (1979).

From the present studies the following conclusions could be derived:

* Variability exists among various Kaliethan accessions for most of the vegeative and yield characters but not for quality aspects.

* High heritability estimates obtained for most of the vegetative and yield characters indicate the possibility of crop improvement through selection.

* High phenotypic and environmental correlations observed for bunch length, number of hands and fingers per bunch, length, girth and weight of fingers, height and girth of plant and LAD indicated that these characters are equally influenced by genotype and environment.

* High direct effect of weight of finger, number of hands and finger length on bunch yield revealed the possibility of yield improvement in banana by improving these characters.

* Based on the selection index formulated, the top ranking four acessions namely Balaramapuram, Vellayani, Koliyoor and Venjaramoodu can be considered as superior types among the Kaliethan accessions.

SUMMARY

SUMMARY

The present investigations entitled "Selection of superior types of Kaliethan [(*Musa* AAB group) 'Nendran']" were carried out to select elite types of Nendran banana having superior horticultural traits for commercial cultivation in Thiruvananthapuram district of Kerala. The experiment using ten accessions of Kaliethan collected from important 'Nendran' growing tracts, was laid out in the Department of Horticulture, College of Agriculture, Vellayani, Thiruvananthapuram, during 1995-96. The major findings of the study are summarised here under.

Variability studies revealed that the accessions differed in their vegetative characters in all the three stages of growth namely adult-prefloral vegetative stage, floral initiation stage and post-floral stage. The accession T_5 (Palode) followed by T_9 (Karakkonam) and T_{10} (Neyyattinkara) recorded the lowest plant height in all the three stages of crop growth. At flowering the plant height in these treatments were 226.25, 253.35 and 274.35 cm respectively. The girth of the plant at flowering stage was the highest in T_1 (Koliyoor) followed by T_4 (Venjaramoodu), T_3 (Keezhoor) and T_6 (Balaramapuram). The plant girth was 60.29, 59.83 and 59.26 cm

respectively in these treatments. The highest number of leaves at flowering time were 9.83, 9.70 and 7.66 in T_{10} (Neyyattinkara), T_9 (Karakkonam) and T_5 (Palode) respectively. There was not much variation in the sucker production among various accessions. Different accessions varied in the time for flowering, time for bunch maturity and total crop duration. The accession T_7 (Venniyoor) was having the shortest crop cycle of 272.17 days followed by T_4 (Venjaramoodu) recording 277.67 days and T_3 (Keezhoor) with 281.14 days. Leaf area and leaf area index were the highest in T_1 (Koliyoor) followed by T_{10} (Neyyattinkara) and T_9 (Karakkonam) during the post-floral phase. Characters like phyllachron and LAD showed no significant variation.

For yield characters significant variation was observed among different accessions. The accession T_6 (Balaramapuram) had the highest bunch weight of 10.85 kg followed by 10.02 kg in T_2 (Vellayani) and 9.92 kg in T_1 (Koliyoor). Bunch length was also the highest in T_6 (Balaramapuram) followed by T_4 (Venjaramoodu) and T_2 (Vellayani). The highest number of hands and fingers was observed in T_6 followed by T_1, T_4 and T_8 (Anad). Among the finger characters the length and girth of fingers did not vary. However, accessions varied in finger weight where T_6 (Balaramapuram) recorded the highest value followed by T_4 (Venjaramoodu) and T_3 (Keezhoor). The pulp/peel ratio also did not vary with accessions.

There was no significant variation among different accessions for most of the quality parameters viz. total soluble solids, acidity, reducing sugar, non-reducing sugar, total sugar, sugar/acid ratio, fullness index, fruit curvature, pedicel strength index, bunch shape, bunch openness and shelf life of fruits. However, total carbohydrate content varied between accessions where the highest value was recorded in T_3 (Keezhoor) followed by T_4 (Venjaramoodu) and T_7 (Venniyoor).

Various accessions did not show difference in their reaction to pest and disease incidence except for Sigatoka leaf spot. The accession T_7 (Venniyoor) was the least affected one by Sigatoka which was followed by T_4 (Venjaramoodu) and T_6 (Balaramapuram).

Genetic analysis in Kaliethan accessions indicated high phenotypic and genotypic coefficients of variation (PCV and GCV) for number of leaves, leaf area, LAI and LAD. The PCV and GCV were moderate for yield characters viz. bunch weight, weight of finger, volume of finger, shelf life of fruits and for plant height. Characters like bunch length, number of hands per bunch, girth of finger and total crop duration had low PCV and GCV.

Heritability estimates were high for most of the yield and vegetative characters viz. bunch weight, bunch length, number of hands and fingers per bunch, weight and volume of fingers,

height and girth of the plant, number of leaves at flowering, LAI, LAD, time taken for flowering, time taken for bunch maturity and total crop duration.

Bunch weight exhibited highly significant and positive phenotypic correlation with bunch length, number of hands, number of fingers, length, girth and weight of fingers, plant height, plant girth and LAD. The crop duration showed negative and significant phenotypic correlation with yield. However, leaf area and number of leaves at flowering did not have notable correlation with yield at phenotypic level. The environmental correlation was positive and significant for bunch length, number of hands and fingers per bunch, length, girth and weight of fingers and LAD which showed the strong influence of environment on these characters. Number of leaves and crop duration had significant but negative environmental correlations.

Path coefficient analysis revealed that weight of finger contributed maximum direct effect on bunch weight followed by number of hands per bunch and length of finger. Characters like number of fingers, bunch length and girth of fingers influenced bunch weight mainly through their indirect effects on finger weight. However, effect of vegetative characters viz. plant height, plant girth, leaf area and LAD were low on bunch yield.

A selection index was formulated using bunch length, number of hands and fingers per bunch, length, girth and weight of fingers and bunch weight. Based on this index, the highest scoring four accessions namely T_6 (Balaramapuram), T_2 (Vellayani), T_1 (Koliyoor) and T_4 (Venjaramoodu) were selected as superior types from among the Kaliethan accessions for cultivation in Thiruvananthapuram district.

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APPENDIX

APPENDIX

Weather data prevailed during the cropping period

Year and month		Temperature (°C)		Relative humidity (%)	Total rainfall (cm)
		Mean Maximum	Mean Minimum		
1995	June	31.1	23.8	83.2	22.80
	July	30.1	23.6	80.6	14.40
	August	30.5	24.1	79.4	5.90
	September	30.7	24.4	80.3	8.40
	October	31.0	23.8	80.8	11.40
	November	30.8	23.8	81.4	24.60
	December	33.1	20.6	78.8	0.00
1996	January	31.4	18.8	69.9	0.80
	February	31.3	20.7	66.8	2.05
	March	32.7	21.4	70.2	0.00
	April	32.7	22.7	79.7	5.07
	May	32.5	24.7	74.9	5.09
	June	29.8	22.0	81.2	25.82

ABSTRACT

SELECTION OF SUPERIOR TYPES OF KALIETHAN [(MUSA AAB GROUP) 'NENDRAN']

By

SUNILKUMAR. K.

ABSTRACT OF THE THESIS

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ABSTRACT

The present investigation was carried out to select elite types of Nendran banana having superior horticultural traits such as dwarf stature, high yield potentiality and favourable reaction to biotic and abiotic stress, for commercial cultivation in Thiruvananthapuram district of Kerala. The experiment using ten accessions of Kaliethan collected from important Nendran growing tracts of Thiruvananthapuram and nearby areas was conducted in the department of Horticulture, College of Agriculture, Vellayani, Thiruvananthapuram, during 1995-96. The salient results of the experiment are given below.

Variability analysis revealed significant variations among different accessions for most of the vegetative characters viz. height of plant, girth of plant, number of leaves produced, leaf area, leaf area index, leaf area duration, phyllachron and crop duration. With respect to yield characters significant variation was recorded for bunch weight, bunch length, number of hands per bunch, number of fingers per bunch and finger size including girth, weight and volume of fingers. For quality characters there was not much variation except for total carbohydrate content among different accessions. Kaliethan accessions varied significantly in their reaction to Sigatoka leaf spot disease.

Genetic analysis in various accessions indicated high phenotypic and genotypic coefficients of variation (PCV and GCV) for leaf area, number of leaves, leaf area index (LAI) and leaf area duration (LAD). The PCV and GCV values were moderate for bunch weight, weight of finger, volume of finger, shelf life of fruits and plant height.

High heritability estimates were obtained for most of the characters viz. bunch weight, bunch length, number of hands per bunch, number of fingers per bunch, weight of finger, volume of finger, plant height, plant girth, number of leaves at flowering, LAI, LAD, time taken for flowering, time taken for bunch maturity and total crop duration.

Bunch yield at phenotypic level was positively correlated with bunch length, number of hands per bunch, number of fingers per bunch, length, girth and weight of finger, plant height, plant girth and LAD. The crop duration showed significant negative correlation with yield at phenotypic level. Bunch yield had significant and positive environmental correlation with bunch length, number of hands per bunch, number of fingers per bunch, length, girth and weight of finger and LAD. Number of leaves and crop duration showed significant but negative environmental correlation with yield.

Path analysis indicated that maximum direct effect on bunch weight was contributed by weight of finger, followed by number of hands per bunch and length of finger. With regard to the number of fingers, bunch length and girth of finger, the influence on bunch yield was mainly through their indirect effects on finger weight. However,the effect of vegetative characters viz. plant height, plant girth, leaf area and LAD were low on bunch yield.

Based on the selection index formulated through discriminent function analysis, the top ranking four accessions namely Balaramapuram, Vellayani, Koliyoor and Venjaramoodu, were selected as superior types from the various accessions studied.