EVALUATION OF 'NENDRAN' (*MUSA* AAB GROUP) ECOTYPES

By

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1996

Dedicated

to

My

Beloved Parents

DECLARATION

I here by declare that this thesis entitled **"EVALUATION OF `NENDRAN' (*MUSA* AAB group) ECOTYPES"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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CERTIFICATE

Certified that the thesis entitled "**EVALUATION OF `NENDRAN' (*MUSA* AAB group) ECOTYPES**" is a record of research work done independently by Mrs. BINDU VIVEKA DEVI under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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INTRODUCTION

INTRODUCTION

Banana is one of the oldest fruits of the world. It is also one of the major fruit crops of India and is cultivated extensively in Kerala. In India, the crop is grown in an area of 3,25,700 hectares with an annual production of 60,56,400 tonnes. This corresponds to 9.75 percentage of total area and 21.45 percentage of total production of fruit crops in India (Anon., 1990 a). In Kerala, the crop is cultivated in an area of 23,850 hectares with a production of 3,39,994 tonnes, which corresponds to 7.32 percentage of area and 5.61 percentage of production of banana crop in India (Anon., 1996).

Of the various varieties of banana, `Nendran' is well known for its multifarious use. The cultivation of `Nendran' is mainly concentrated in the state of Kerala in South India. In India banana is grown under varying soil and climatic conditions exploiting the wide varietal variability that exists in the crop.

India has a number of clonal banana cultivars ranging in diversity from the delicate edible diploid acuminata types that can be cultivated only in sheltered and

humid environments to hardy hybrid triploids which can tolerate seasonally arid monsoon climate prevailing in most parts of the country. Several synonyms of the local names of banana clones make it difficult to identify them. It is estimated that more than 300 cultivars are available in India. It is well established that the performance of an ecotype in a locality is a function of its genotype and environment. Therefore the performance will vary under different agroclimatic situations. Though several banana cultivars are available now, a systematic evaluation of the cultivars and their yield potentialities are required to suggest particular ecotypes for a particular location.

`Nendran' banana exhibits clonal and ecotype variation with respect to growth, yield and reaction to biotic and abiotic stress. Nayar (1962) reported several ecotypes of `Nendran' in different parts of Kerala. These ecotypes showed slight difference in their growth and yield characters. (Anon., 1990b).

The clonal variation studies in Nendran which is in progress at Banana Research Station, Kannara showed that the ecotypes selected from Muttathukonam, Kothala, Pandaloor, Puthoor and Poovanchira area are superior to 139 other selected types from different parts of Kerala (Anon. 1987 and Anon., 1990c). Further studies to evaluate the performance of different

`Nendran' ecotypes have proved the superiority of six ecotypes in central region of Kerala over Kaliethan which is the conventional ecotype of southern parts of Kerala viz. Thiruvananthapuram and Kollam districts. However, a comparison of their performance in the southern tracts is necessary to eliminate the difference due to agroclimatic conditions. If significant variation could be obtained between ecotypes with regard to growth, yield and quality, it would be of great value to explore the possibilities of selecting superior ecotypes for southern tracts in addition to Kaliethan.

The multiclonal cultivation will help to reduce chances of crop hazards due to uniform reaction to adverse condition under monoclonal culture. The study will also help to find out factors contributing to the yield potentialities of different ecotypes and thus help to stream line the selection procedure and fix up selection criteria for mass germplasm screening to locate superior types.

The present study was thus undertaken to determine the ecotypes suitable for southern tracts of Kerala by careful evaluation and analysis of the effect of ecotype variation upon qualitative and quantitative characters of `Nendran' banana.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Banana is one of the oldest fruits of the world. In India the crop is grown in an area of 3,25,700 hectares with an annual production of 60,56,400 tonnes. This corresponds to 9.75 percentage of total area and 21.45 percentage of total production of fruit crops in India (Anon., 1990a). In Kerala the crop is cultivated in an area of 23,850 hectares with a production of 3,39,994 tonnes which corresponds to 7.32 percentage of area and 5.61 percentage of production of banana crop in Kerala (Anon., 1996). In India banana is grown under varying soil and climatic conditions exploiting the wide variability that exists in the crop.

`Nendran' banana exhibits clonal and ecotype variation with respect to growth, yield and reaction to biotic and abiotic stress. Nayar (1962) reported several ecotypes of Nendran in different parts of Kerala. (Anon., 1990b) observed that these ecotypes showed slight difference in their growth and yield characters. Therefore, a study to determine the ecotype suitable for southern tracts of Kerala was found to be worthwhile.

The results of research on the effect of ecotype variation upon qualitative and quantitative characters of banana as well as other crops are depicted below:

2.1 Effect of ecotype variation on vegetative characters

2.1.1 Effect of ecotype variation on the height of plants

Difference in plant stature due to clonal and ecotype variation was reported by several research workers.

Variation in plant height between the banana varieties Boodibale, Karibale, Nendran, Poovan, Highgate, Robusta and Ney Poovan was reported by Jacob (1952).

Malik *et al.* (1966) reported significant variation in the morphological characters of twenty locally selected banana varieties under Lyllapur conditions.

Nair and Nair (1969) observed the performance of nine varieties of banana, eight exotic and one indigenous at Regional Agricultural Research Station, Ambalavayal. The height of these varieties varied from 150 to 165 cm in `Giant Governor' of Cavendish group to 347 cm in `Bodles Altafort'.

Singh *et al.* (1977), in a comparison of four dessert and four culinary banana cultivars found significant variation in the height of these cultivars.

A report of the work done on certain aspects of banana growth and development by Balakrishnan (1980) on eight clones representing the six genomes showed a variation of 175 cm (`Kunnan', AB) to 301 cm (`Monthan', ABB) in the pseudostem height.

Biswas and Hussain (1982) based on the studies on the performance of five exotic cultivars of plantain obtained from IITA, Nigeria found significant variation in their pseudostem height.

Rajeevan and Geetha (1984a) observed significant variation among morphological characters pertaining to growth and yield among forty varieties of banana.

The height of the plant `Basrai' increased as the number of functional leaves per plant was increased (Kothavade *et al.*, 1985).

Rajeevan (1985) reported significant variation in height of `Palayankodan' clones during the later stages of growth in the plant crop and through out the growing period of first ratoon. The accessions 2,9 and 22 were dwarf while accessions 6,16 and 24 were taller.

The results of the studies on the performance of fourteen banana cultivars (Gutierrez and Rodriguez, 1986) showed that the plant height of these cultivars varied in Colima state, Mexico.

There was a large range (1.85 - 5.21 m) in pseudostem heights among the cultivar in north Queensland. `Dwarf Cavendish' and `Cavendish - S' had shorter pseudostem among the Cavendish bananas (Daniells and O'Farrel, 1988).

Sato (1988) in his studies with nineteen banana cultivars grown in Hawaii observed that the plant height varied significantly with cultivars.

An evaluation of different culinary varieties of banana (Kanchikela, Beula, Batheesa Malbhog, Kothia, Bankel, Kasturi and Chinia) carried out at Faizabad by Ram *et al.*

(1989) revealed that the pseudostem height varied among the cultivars. Plant height was maximum for `Kasthuri' (323.24 cm) followed by `Kanchikela' (321.88 cm) and the lowest for `Bankel' (263.66 cm).

Valsalakumari and Nair (1990) reported that the cultivars within each genomic group were highly variable with respect to vegetative characters.

George *et al.* (1991) carried out a study at the Regional Agricultural Research Station, Ambalavayal with eight cultivars of banana viz. Rasthali/Poovan (AAB), Karpooravally (ABB), Chenkadali (AAA), Njalipoovan (AB), Gros Michel (AAA), Bodles Altafort (AAAA), `Mysore' / `Palayankodan' (AAB) and Kunnan (AB). The studies revealed that in the high ranges of Kerala `Bodles Altafort' attained the maximum height of 2.88 m which was on par with `Gros Michel' and `Njalipoovan' while Karpooravally had the minimum height of 2.3 m.

Uthaiah *et al.* (1992) observed variation in plant height of 244.00 cm (`Robusta') to 397.8 cm (`Boodibale'). The cultivars Boodibale (ABB), Karibale (ABB) and Rasthali

(AAB) were found to be taller and more vigorous, whereas the cultivar Robusta (AAA) was the dwarfest.

An experiment conducted by Ram *et al.* (1994) recorded a minimum height of 169.44 cm for `Harichal' (AAA) and a maximum height of 323.33 cm for `Alpan' (AAB).

2.1.2 Effect of ecotype variation on the girth of plants

According to Jacob (1952) variation in pseudostem girth was significantly different in banana cultivars Boodibale, Karibale, Nendran, Poovan, Highgate, Robusta and Ney Poovan.

Nayar *et al.* (1979), Sreerangaswamy *et al.* (1980) and Rajeevan and Geetha (1984a) reported that banana though clonally propagated shows significant variation in vegetative characters such as plant girth within the population.

Balakrishnan (1980) from an experiment with eight clones of banana representing six genomes observed pseudostem girth variation of 45 cm (`Kunnan', AB) to 73 cm (`Klue teparod', ABBB). From the studies on similar lines Ram *et*

al. (1989) observed a pseudostem girth variation of 35.88 cm (`Bankel') to 46.6 cm (`Beula' and `Chinia').

Girth of `Palayankodan' accessions showed significant variation during the later stages of growth both in plant crop and in first ratoon. The difference were significant at the time of shooting except in second ratoon. The values were 63.56, 67.3 and 70.19 cm for the plant crop, first ratoon and second ratoon respectively (Rajeevan, 1985).

George *et al.* (1991) reported that among the eight cultivars of banana tried at the high ranges of Kerala, Grosmichel and Chenkadali recorded the maximum girth of 64.14 cm and Njalipoovan recorded the minimum girth of 51.32 cm.

Uthaiah *et al.* (1992) from an experiment to assess the performance of eight banana cultivars under Indian West coast conditions reported a plant girth variation of 59.2 cm (`Karibale') to 85.3 cm (`Boodibale').

Among the table varieties of banana, Kabuli (AAA), Poovan (AAB), Alpan (AAB), Nepalichinia (AAB), Basrai Dwarf (AAA), Harichal (AAA) and Malbhog (AAB), a minimum girth of

35.22 cm was recorded for `Kabuli' and a maximum girth of 50.22 cm was recorded for Malbhog indicating genomic differences in plant growth (Ram *et al.*, 1994).

2.1.3 Effect of ecotype variation on leaf characters

2.1.3.1 Effect of ecotype variation on the number of leaves

Gross and Simmonds (1954) tried to identify mutations in `Dwarf cavendish' group of banana with the help of differences in leaf ratios. They suggested that rather than height, leaf ratios serve better to identify the varieties. A study by Shepherd (1957) reinforced the views of Gross and Simmonds (1954). He opined that leaf ratio seemed to be a character least affected by environment and therefore would be of great use for detection of intraclonal variation.

The gross emergence of banana leaf was studied by Skutch (1930) and Barker (1969). Rate of emergence of leaf is influenced by temperature, wind velocity and relative humidity (Turner, 1971). It is reduced by low temperatures (Summerville, 1939; Smirin, 1960 and Ticho, 1960) and decrease with increasing plant age (Champion, 1961), but is

unaffected by mineral nutrients, especially nitrogen (Murray, 1960 and Jagirdir *et al.*, 1963). Increase in leaf lamina does not continue after the leaf is fully emerged. Leaf production at growing point ceases with its conversion to the floral apex.

Many workers reported that a fairly constant number of leaves remained unemerged inside the pseudostem at any stage before floral initiation (Summerville, 1944; Champion, 1961; Barker and Steward, 1962). Turner (1970), reviewing the work of others, concluded that the number of leaves emerged before the onset of flowering might be subject to variations whereas a remarkably constant number of leaves always remained within the pseudostem irrespective of stage of development of crop variety or weather before floral initiation.

The total number of leaves produced in a banana plant varies with the varieties or growing environment (Summerville, 1944; Oppenheimer, 1960 and Champion, 1961). The effects of ploidy on banana leaves have been examined by Simmonds (1948).

Nambisan (1972) reported that the leaf number is generally controlled by the specific origin of the clone. He

observed that among the predominant acuminata clones, Poovan produced the lowest number (31.8) of leaves followed by Nendran (38.4) and Neypoovan (41.2). It appears that the number of leaves produced prior to bunch initation varies with the variety and locality. He also reported that balbisiana clones produced larger number of leaves as compared to accuminata clones. The number was 47.4 and 32.0 respectively (Nambisan and Rao, 1980). The number of leaves varies with the variety; the number being 32 for `Robusta' and 30 for `Poovan' (Anon., 1972).

Flores *et al.* (1985) in his studies with cultivars Grosmichel, Dwarf Cavendish, Giant Cavendish, Robusta and Lacatan noted that the leaf number varied between clones and decreased during the dry season. There are pronounced differences in the photosynthetic efficiency of banana leaves due to cultivar (Stover and Simmonds, 1987).

According to Rajeevan (1985), the number of functional leaves borne by the plant did not vary with the stage of growth but the number of leaves produced differed significantly among the `Palayankodan' accessions.

2.1.3.2 Effect of ecotype variation on phylacron

In a healthy banana plant a new leaf is emerging from the heart by the time the previous one has fully opened, therefore one leaf per week may be taken as a rough general figure for the rate of leaf production. In Queensland, the `Dwarf cavendish' produces leaf at this rate in the warm autumn weather (March) but much less rapidly (One leaf in 20 days) in winter (Summerville, 1944; Oppenheimer, 1960; Smirin, 1960; Ticho, 1960 and Turner, 1970). Unfurling of leaves takes about six days under favourable tropical conditions (7-10 days for `Dwarf cavendish' in French Guinea according to report Anon., 1951).

Time interval between emergence of successive leaves varies considerably. It decreases with increasing plant age (Champion, 1961) and is unaffected by mineral elements, especially nitrogen (Murray, 1960 and Jagirdar *et al.*, 1963).

Anslow (1966) reported that the rate of leaf production or phylacron in plants depends upon temperature and rate of assimilation of expanded leaves.

According to Simmonds (1966) on an average it took seven days for the emergence of one banana leaf. The growing interval between successive leaves is profoundly influenced by temperature, wind speed and relative humidity (Turner, 1971). Leaf production is in a quicker succession in tropical region than in subtropical climates.

Nambisan (1972) reported that the time interval between emergence of successive leaves (phylacron) was significantly low in acuminata derivaties.

Pillai and Shanmugavelu (1976) reported that the increase in the level of functional leaves decreased the interval of successive leaves. According to them the phylacron in `Poovan' varied from 8.0 to 8.6 days.

The phylacron of `Palayankodan' accession varied significantly (Rajeevan, 1985).

2.1.3.5 Effect of ecotype variation on leaf longevity, leaf area index and leaf area duration

Summerville (1944) found that the longevity of leaves ranged from 71 to 281 days in southern Queensland. In the tropics this was reported to be between 55 to 165 days (Charpentier and Martin-prevel, 1965 and Turner, 1970).

Nambisan and Rao (1980) reported that leaf area duration progressively increased with the balbisiana genome. Among the pure acuminata clones, the seeded *Musa acuminata* and Namrai, both of them diploids, recorded lower leaf area duration and LAD was apparently influenced by ploidy.

Rao and Edmunds (1985) showed significant variation in LAI in `Dwarf' `Horn', `Ordinary' and `Dominique'. The variation was 2.70 to 3.21. LAI of `Dwarf' was 11%, 17% and 13% lower than that of `Horn', `Ordinary' and `Dominique' respectively.

Balakrishnan(1980)reported leaf area index variation between eight banana clones; highest for `Monthan' (ABB) and lowest for `Poovan' (AAB). Higher values of LAI coincide with the stages when the plant produced highest leaf area and number.

2.1.4 Effect of ecotype variation on the number of suckers produced per plant

Venkataramani (1946) reported that sucker production varies with varieties. He recorded more number of

suckers in genomes of *M. balabisiana* derivatives and less number of suckers in derivatives of *M. acuminata*. Gregory (1954), Shanmugavelu and Balakrishnan (1980) observed that sucker production was less in tetraploid banana.

In an experiment at TNAU, Coimbatore, Balakrishanan (1980) observed that as the level of ploidy increased, there is a decrease in the mean number of suckers per plant. He observed the sucker production efficiency of different cultivars as Anaikomban, AA (6.4), Robusta, AAA (5.0), Monthan, ABB (4.2), Poovan, AAB (4.6), Klue teparod, ABBB (2.3) and Hybrid Sawai, ABBB (2.4).

2.1.5 Effect of ecotype variation on time taken for flowering and time taken for harvest

Von Loesecke (1950) observed that the time required from the first planting of rhizome to flower formation would vary with growing conditions and varietal differences.

Simmonds (1959) reported that the time to shooting in banana may be extended to 18 months in subtropical latitudes or at high altitudes in tropics, from 9 to 10

months at low altitudes in the tropics. Any extension of banana culture into the mountains of subtropics will prolong the growth cycle considerably ie., one month per 100 m altitude, according to Samson (1980).

Sanchez (1971) observed that at sea level, duration from planting to flowering ranged from 319 to 388 days and in the mountains (550m) from 371 to 448 days at Puerto Rico.

Warner *et al.* (1974) reported that the plants which flowered in 160 days required 150 days more to mature fruit, while plants which flowered on 300 days required only 100 days. Both seasonal effects during maturation and the carbohydrate-nitrogen balance of the plant appear to have big effect on the maturity.

Singh (1976) studied the relationship between the month of flowering and the time required for the bunches to mature in `Alpan' and `Malbhog'. He found that with both cultivars, plants that flowered during June, July and August required the shortest time to attain bunch maturity, those flowering between September and December requiring the longest time.

Daniells and O'Farrel (1988) reported that `Sucrier' took only 2 to 4 months for bunch filling which is approximately half that for the Cavendish group which uniformly required 4 to 7 months. Pisang Rajah, Pacific plantain and Horn plantain also had shorter bunch filling period (3.3 to 4.2 months). The Lady finger cultivars took approximately one month longer to fill than the Cavendish subgroup.

According to Gonzalez *et al.* (1990) all the seven plantain clones viz. Plantano Enano, Dominician Dwarf, Harton and Maricongo of Horn type and Congo Enano, Congo 300 and Lacknan of French type, were harvested on an average of 107 days after flowering.

2.1.7 Effect of ecotype variation on crop duration

It was estimated by Fawcett (1921) that the crop duration might be between 13 to 15 months for most of the varieties.

The banana plant having greater functional leaf area required longer cropping period (Pillai and Shanmugavelu, 1978).

An experiment conducted at Banana Research Station, Kannara (Anon, 1984b) showed that in `Nendran' clones the crop duration varied from 332.3 (Clone 100) to 359.3 days (Clone No 134).

Valsalakumari (1984) showed that the total duration of crop from planting was 264 days for `Mysore Poovan', 305 days for `Bodles Altafort', 358.5 for `Rasthali' and 342 days for `Karpooravally' under Vellanikkara (Trichur, Kerala) condition. But in Ambalavayal the crop duration was 501, 504, 494 and 512 days respectively (George *et al.*, 1991).

According to Rajeevan (1985) the duration of `Palayankodan' accessions varied significantly in first ratoon. The accessions 5,10,13,15 had longer duration whereas accessions 2,7,22 had shorter duration.

The clonal variation studies in `Nendran' at Banana Research Station, Kannara showed that the crop duration varied from 332.3 to 359.3 days in 1982, 207.33 to 309.33 days in 1983 and 291.3 to 327.6 day in 1987 for the same `Nendran' clones (Anon., 1987).

According to Uthaiah *et al.*(1992) the crop duration was more in tall varieties (433 days for Boodibale) and lesser in medium tall varieties like Robusta (339.3 days) and Nendran (342.9 days).

Rajamony *et al.* (1994) observed a variation of 327.10 to 437.71 days among the 21 banana clones of AAB group, 327.10 days for `Malaikali' and 437.71 days for `Myndoli'.

2.2 Effect of ecotype variation on yield characters of banana

Rieman *et al.* (1950) recorded significant difference in the yielding capacity of the potato variety `Chippawa'. They concluded that those variations were heritable and their occasional appearance was the rule and not the exception, in asexual propagation.

The yield of banana depends on a number of factors, such as cultivar, plant density, management practices etc. Tall cultivars usually yield 15-20 tonnes ha^{-1}. A high yield was reported by Oppenheimer (1956) for the `Dwarf Cavendish' banana in Maharashtra. For the same clone in the Canary

Islands, 40 tonnes ha^{-1} per annum appeared to be an average crop (Holmes, 1933). Milutinovic *et al.* (1981), after studying the clones of sour cherry variety `Oblacinaka' suggested that there was a possibility of improving the yield characteristics of the variety by clonal selection. Based on the results of clonal selection in the apricot `Velkopavilovicka', Vachum (1981) observed that variability was high for yield.

The variation in bunch weight was reported to be significant among the `Palayankodan' accessions (Rajeevan, 1985). The accession 21 (Kalavoor) had the heaviest bunches (14.87 kg) followed by the accession 18 (Anchal) which had a bunch weight of 14.38 kg. The accession 10 (West Payipra), 12 (Moolamattom) and 17 (Konni) produced poor bunches.

2.2.1 Effect of ecotype variation on bunch weight and yield of banana and other crops

Davidson and Lawley (1953) reported that high and low yielding clones appeared in `King Edward' and probably in other varieties of potato.

In Potato, Cockerham and Macarthur (1956) showed that there was significant difference in yield among the subclones of `Majestic'.

Nayar (1958) suggested the occurrence of Somatic mutations in banana offers greater and easier scope for selection of desirable types. This suggestion was based on the observation that in the clone `Nendran' alone atleast six mutants occured, which behaved true-to-type.

Clonal variation in potato was reported by Terry *et al.* (1970). Though they could not find significant difference with regard to clone X location interaction types, the cloneXyear X location interaction was significant for plant yield.

In mango, distinct clonal variations were observed when grown in different areas (Singh, 1971). Rootstock, soil, climate factors as well as indiscriminate multiplication were attributed as the reasons.

Variation in yield observed in the subclones of vegetatively propagated plants like apple, dahila,

chrysanthemum and potato were largely due to environment (Chandrasekharan and Pathasarathy, 1975).

Results of an experiment carried out at Kerala Agricultural University (Anon., 1982) revealed that the `Nendran' clones from Pampady and Meenadom area in Kottayam District recorded the highest mean bunch weight of 12.5 kg.

Studies conducted at Kannara and Vellanikkara (Anon., 1984a) with `Nendran' clones revealed that the mean bunch weight at Kannara and Vellanikkara centres were 10.67 kg and 10.4 kg respectively. Out of 47 clones maintained at Kannara, 15 (31.92%) showed an average bunch weight of above 10 kg of which 3 (6.38%) had a bunch weight above 12 kg. Out of the 78 clones of Vellanikkara, 23 (23.06%) recorded an average bunch weight above 12 kg. At Vellanikkara, the maximum yield was recorded (16.5 kg) by a clone collected from Poovanchira of Trichur District.

The same experiment that was repeated in the next year (Anon., 1984b) revealed that 15 clones showed 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 - Malapuram) and clone 123 (Puthur - Trichur) with a mean bunch weight of 13.83 kg, 13.40 kg and 13.25 kg respectively.

The pooled analysis for bunch weight (Anon., 1987) conducted at Banana Research Station, Kannara revealed a bunch weight variation of 8.55 (Clone 0) to 11.65 kg (Clone 132).

Based on an evaluation of 144 Nendran clones on Banana Research Station, Kannara, (Anon., 1989) revealed a bunch weight variation of 9.13 (Local variety) to 10.54 kg (Clone 123).

Prasanna and Aravindakshan (1990) reported that whatever variation in bunch weight within a clone may probably be contributed to environmental and other factors.

Shanmugavelu *et al.*, 1992 reported that Attunendran, Nananendran, Myndoli, Moongil and Nendrapadathi yielded 12,8,25,8 and 10 kg bunch plant^{-1} respectively.

Rajeevan and Mohanakumaran (1993) found significant variation in the bunch yield of 24 accessions of

the clone `Palayankodan' The accession 21 (Kalavoor) produced the heaviest bunches (14.872 kg) followed by accession 18 (Anchal) (14.378 kg). Accession 12 (Moolamattom) recorded the minimum bunch weight of 9.73 kg.

2.2.2 Effect of ecotype variation on the number of hands per bunch

Simmonds (1960) reported that the number of hands was affected by environment. The variation in the number of hands per bunch was 5.8 (`Radjasira') to 10 (`Mas') according to Nair and Nair (1969), based on a trial with nine varieties at the Central Horticultural Research Station, Ambalavayal.

Clonal variation studies in `Nendran' in progress at Banana Research Station, Kannara, shows that the number of hands per bunch did not differ significantly (Anon., 1984a, Anon., 1987 and Anon., 1989).

Plantain cultivars were tested by Rao and Edmunds (1985) who observed that the number of hands per bunch varied between 6.71 to 9.29. An evaluation of different culinary cultivars of banana (Ram *et al.*, 1989) showed that the number of hands per bunch varied between 4.66 to 8.33.

Shanmugavelu *et al.* (1992) observed a variation of 1-2 to 8-10 in some of the nendran clones. In the case of `Palayankodan' clones, the variation observed was 10 to 12 (Rajeevan and Mohanakumaran, 1993).

2.2.3 Effect of ecotype variation on number of fingers

Simmonds (1960) reported that the number of fingers in banana bunch was affected by environment.

Results of the performance of four mutants of Cavendish banana (George *et al.*, 1978) revealed that the number of fingers per bunch varied between 110 to 128.

The clonal variation studies in `Nendran' conducted at Banana Research Station, Kannara showed that the number of fingers varied between 49.7 to 66.4 per bunch (Anon., 1984a and Anon., 1987.).

Rao and Edmunds (1985) observed that among the four plantain cultivars, the number of fingers per bunch recorded was maximum in `Dominique' and minimum in `Horn' (147 and 35.7 respectively).

Results of the intraclonal variations in `Palayankodan' (Rajeevan and Mohanakumaran, 1993) showed that the number of fingers per bunch varied between 142.67 (accession 10) to 195.33 (accession 15).

2.2.4 Effect of ecotype variation on length, girth and weight of fingers

The experiment done at CBRS, Aduthurai, India in different varieties of banana showed that the increase in length and in girth of the fruit was not necessarily simultaneous. The girth of the fruit increased even when the fruits were not growing in length. The increase in size of fruits and the time taken for maturity varied with the season.

In the cultivar Dwarf Cavendish, Lodh *et al.*(1971) observed the finger length, finger girth and finger weight as 13,4.01 cm and 14.2 g respectively. In the same cultivar Venkatarayappa and Narasimhan(1975)reported the finger length and girth as 15.94 and 10.54 cm respectively.

Clonal variation studies in `Nendran' at Banana Research Station, Kannara showed finger weight variation

of 178 to 238 g (Anon., 1984a); 17.3 to 226.0g (Anon, 1984b); 162.16 to 202.72 g (Anon., 1989). According to Rajeevan (1985) among the `Palayankodan' accession, the variation in girth was 9.87 cm to 11.85 cm. Among the `Nendran' clones (Shanmugavelu *et al.*, 1992) the finger length varied between 15-20 to 33 cm and finger girth varied between 12.5 to 15-16 cm.

Rao and Edmunds (1985) observed a variation of 185 to 377g in finger weight among four plantain cultivars; 310 to 330 mm in finger length of cultivars of Queensland (Daniells and O'Farrel, 1988). The weight of fingers between `Palayankodan' clones varied between 48.33 to 99.00 g (Rajeevan and Mohanakumaran, 1993).

2.25 Effect of ecotype variation on peel weight, pulp weight and pulp/peel ratio

Studies on the performance of four mutants of `Cavendish' banana (George *et al.*, 1978) revealed a pulp/peel ratio of 2.44 - 2.77 which was not significant.

Clonal variation studies in `Nendran' at Banana Research Station, Kannara showed that the clone 123

(Puthur - Trichur) showed significantly higher pulp/peel ratio by weight of green finger (1.82) and was significantly superior to clone 134 (Chengallore - Trichur) and clone 35 from Muttathukonam - Quilon (Anon., 1984a and Anon., 1984b.).

2.3 Effect of ecotype variation on the quality of fruits

Among the 26 banana varieties evaluated at Agricultural College and Research Institute, Coimbatore, the TSS content ranged from 16.0 (Anaikomban) to 28 per cent (Karpooravally). The cultivar `Poovan' recorded 19.4 per cent (Anon., 1972). The concentration of sugars is higher in the hybrids than acuminata clones (Nambisan, 1972). He also observed that among the acuminata clones, Namrai recorded higher percentage of sugars than Dwarf cavendish. The mean sugar content of predominantly balbisiana hybrids was 1.086 per cent and this was significantly higher than that of predominantly accuminata hybrids, which recorded 0.817 per cent of sugars.

Clonal variation studies in Nendran in progress at Banana Research Station, Kannara observed significant

variation in the quality aspects such as TSS (28.7 - 34.3 per cent), acidity (0.27 - 0.34 per cent), total sugars and sugar / acid ratio (Anon., 1984a).

The quality analysis by Rajeevan (1985) showed significant differences in TSS, total sugars and reducing sugars among the accessions of `Palayankodan'.

Rajeevan and Mohanakumaran (1985) observed following quality variations in the 24 accessions of the clone `Palayankodan'. TSS: 22 to 26.17 per cent, Acidity : 0.30 to 0.48 per cent, total sugars : 16.41 to 17.40 per cent, reducing sugars : 15.5 to 17.18 per cent and non-reducing sugars : 0.14 to 0.27 per cent.

Rajamony *et al.* (1994) in an experiment with 27 banana clones of AAB group noticed a TSS variation of 22.0 in (`Mottapoovan') to 30 per cent in `Kodapanilla Kunnan'.

The quality variation of the table varieties of banana were reported to be 15.1 to 16.15 per cent, 0.22 to 0.37 per cent and 14.1 to 14.3 per cent for TSS, acidity and total sugars (Ram *et al.*, 1994).

2.4 Effect of ecotypes on the leaf nutrient status (N, P and K) at flowering and harvest

The nutrient status of the banana plant at a particular stage may be indicated by the concentration of nutrient elements in the leaf or any other specific plant part. Hewitt (1955) found that in banana, the third leaf from the apex of the plant was the best indicator of the nutritional status of the plant and the best time of sampling coincided with the inflorescences emergence. The same sampling procedure was found to be satisfactory in `Dwarf Cavendish' by Murray (1961) and `Giant Cavendish' by Bhangoo *et al.*(1962.)

According to Croucher and Mitchell (1940), in the case of `Poovan', there was a continuous uptake of nutrients and the quantity absorbed were equal upto flowering, (202.04 kg ha^{-1}) and after flowering (200.57 kg ha^{-1}).

Summerville (1944) reported that the leaf nutritent status at flowering was 3.08, 0.88 and 4.2 per cent N, P and K respectively. The critical level of `Lacatan' banana was estimated as N 2.6 per cent P_2O_5 0.45 per cent and K_2O 3.3

per cent of dry weight (Hewitt, 1955). He also observed the N, P, K status of `Robusta' and `Poovan' at flowering as 3.08, 0.88 and 4.2 per cent and 2.28, 0.112 and 3.4 per cent. At harvest the content was 2.08, 0.080, 5.7 and 2.07, 0.052 and 4.1 per cent respectively.

The optimum nitrogen and potassium content in three different cultivars at harvest stage observed by Dumas (1960) was 2.3 to 2.6, 2.9 to 3.3; 2.1 to 2.8, 3.2 to 3.8; 2.1 to 3.9 per cent for Petite Naine, Poyo and Grosmichel respectively.

At flowering and harvest stage the nutrient status (N, P and K) for `Poovan' was 2.08, 0.080, 5.7 and 2.07, 0.052. 4.1 per cent respectively (Veeranna *et al.*, 1976).

Samuels *et al.* (1978) observed that leaf N value as 3.20 per cent at 10 months of age in the Horn type Maricongo Plantain which was associated with response to N fertilizers and a value of 3.66 per cent with maximum production.

The nutrient composition of the third fully opened leaf at the time of shooting did not differ significantly among the `Palayankodan' accessions (Rajeevan, 1985).

Sheela and Aravindakshan (1990) stated that in banana cv `Palayankodan' the uptake of nitrogen increased progressively with the growth of plant till shooting time irrespective of the amount of potassium applied. But, between shooting and harvest, there was a decline. They also reported that the total uptake of phosphorous and potassium continued to increase through out the crop duration. Among the nutrients, the uptake of potassium was the highest compared to the other two major elements.

Kulasekaran (1993) reported that banana requires high amount of mineral nutrients for proper growth and production. From one hectare, by a 50 t banana crop, 320 kg N, 23 kg P_2O_5 and 925 kg K_2O were removed every year. To maintain soil fertility, nutrients must be replenished every year through organic manures and mineral fertilizers.

2.5 Effect of ecotype variation on biomass and dry matter production at harvest stage

Dry matter is one of the reliable measures for judging the stages of plant growth and it shows the pattern of distribution and redistribution of weight between

different plant parts at various stages of growth. Few studies have been made on the overall growth of a single stem on a quantitative basis. The increase in dry matter follows the normal sigmoid curve. Under tropical conditions the most rapid growth occurs 2.7 months after planting. After bunch emergence the rate of increase of dry matter in the stem is much reduced (Montagut *et al.*, 1965).

Nambisan (1972) noticed varietal differences in respect of dry matter production in banana. The dry matter content of varieties Ney Poovan (AB), Nendran (AAB), and Poovan (AAB) was found to be higher than that of Namarai and Dwarf Cavendish. Veerannah *et al.* (1976) reported that dry matter production varied in the varieties Robusta and Poovan though the leaf area was almost equal in both. After shooting, phenomenal increase in dry matter was accounted for due to bunch development in cultivar, Robusta (Vadivel, 1976). The total dry matter production was in the range of 8 to 10 kg plant^{-1} in cv. Robusta.

Turner (1972) studied the dry weight production of different parts at different stages of growth in banana in New South Wales. In vegetative stage, corm dominated in dry

matter but at pre-emergence stage it was approximately equally distributed between corm, pseudostem and leaves. Leaf constitutes 25 per cent of dry matter at this stage.

Twyford and Walmsley (1973) recorded 5 to 15 kg of dry matter in `Robusta', 4.5 to 10.5 kg in `Lacatan' (Boland, 1960 and 1962), 18 kg in `Dwarf Cavendish' (Bailon *et al.*, 1933) and 6.5 kg in `Dwarf Cavendish' under French Guinea conditions. The dry matter production varied with variety and location.

The varietal variation in dry matter content at harvest was 630 to 1533 g for corm, 1786 to 3288 g for pseudostem, 466 to 1071 g for leaf, 53 to 195 g for peduncle 1025 to 3322 g for fruit and the total dry matter varied from 4922 to 8903 g (Balakrishnan, 1980). The triploid `Monthan' (ABB) produced the largest dry matter content and diploid `Kunnan' the lowest. In general the accumulation of dry matter was high in triploids followed by tetraploids. The production of dry matter was the lowest in the diploid cultivar.

According to Stover (1985) at harvest, 20 to 25 per cent of the total dry matter of `Grand Nain' (AAA), Horn

plantain (AAB), and three ABB cooking bananas in Honduras can be found in the pseudostem. Dry matter partitioning to the pseudostem, rhizome and finger differed generally among varieties and influenced bunch weight at harvest. The percentage dry matter was higher in the leaves and fingers of plantain and cooking bananas than in `Grand Nain'. There was less dry matter in the foliage of the AAB plantain than in the two Cavendish varieties. It was noted that 5 to 8 per cent of the dry matter went into the peduncle.

Sheela and Aravindakahan (1990) noticed a progressive increase in total dry matter content of banana cv. `Palayankodan' with age of the plant and it was most rapid between the late vegetative phase and shooting time. This was because the plant showed a very high rate of growth during the period.

2.6 Effect of ecotype variation on the incidence of diseases and pests

2.6.1 Effect of ecotype variation on the incidence of leaf spot disease

The sigatoka disease came from the Sigatoka district on the island of Viti Levn, Fiji, in 1912 (Philpott and Knowles, 1913) and hence the name (Knowles, 1916). With

the introduction of `Gros Michel' and Cavendish varieties the incidence of sigatoka leaf spot disease caused by *Myscosphaerella musicola* is also found to be very prevalent in Kerala. In serious cases the entire leaf is affected. The photosynthetic process is drastically reduced resulting in poor filling up of the fingers. The disease is very severe during the South West monsoon period.

Brun (1962) commented that 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.

Nair (1966) observed considerable variation between varieties of banana in their susceptibility to leaf spot diseases. Simmonds (1966) reported that the resistance to sigatoka increases as the proportion of balbisiana genome increases. The varieties belonging to the commercially important triploid group (AAA) were very susceptible whereas AAB and ABB groups included some moderately susceptible cultivars. The diploids were either very or moderately susceptible (Meredith and Lawrence, 1970).

Vakili (1968) made a detailed study of the resistance and succeptibility to sigatoka in the genus Musa. Giant Cavendish, Dwarf Cavendish, Robusta Valery, Gros Michel, Pome and certain plantains and the cooking bananas were highly susceptible. IC-2, Silk, the Hawaiian bananas, and three ABB types were moderately susceptible. Saba and an unidentified diploid (AA) were slightly susceptible. There appears to be less natural resistance to block leaf streak than to sigatoka in many cultivars (Meredith and Lawrence, 1970; Firman, 1972).

Gopimony (1977) reported that the four varieties of AA group, Paka, Pisanglilin, Tongat and Sannachenkadali were resistant. Most of the varieties belonging to ABB group were either tolerant or highly tolerant. Under AAB group only seven varieties out of a total of the twenty three scored were either tolerant or highly tolerant. Many of the Kerala varieties like Chenkadali, Vadakan Kadali, Ambalakadali, Palayankodan, Kodappanillakunnan, Poomkali, Neymannan, Monthan, Veeneethumannan, Peykunnan, Neypoovan, Njalipoovan, Valiyakunnan and Veneethukunnan were found to be tolerant to leaf spot diseases when compared to the introduced varieties like Gros Michel and Robusta. The range of infection index

for sigatoka was from 2.48 - 6.93 among the Palayankodan accessions (Rajeevan, 1985).

Babylatha *et al.* (1990) observed that Pisanglilin, Sannachenkadali and Tongat were highly tolerant; Elavazhai, Karpooravally, Njalipoovan, Dudh sagar, Mottapoovan, Dakshin sagar, Bodles Altafort and Mysore Ethan were tolerant; Matti, Nendran, Myndoli and Zanzibar were highly susceptible to leaf spot.

2.6.2 Effect of ecotype variation on the incidence of bunchy top disease

Bunchy top virus disease was first recorded in 1879 from Fiji and in India from Kerala in 1940 (Mehta, 1964).

The mortality due to bunchy top disease was from 0 to 33 per cent among the `Palayankodan' accessions (Rajeevan, 1985) observed.

Mohan and Lakshmanan (1987) reported that all the banana clones representing AAA and AA genomes were severely affected by the bunchy top virus. The disease incidence

varied from 20 to 80 per cent . All hybrids of Klue Teparod with *Musa acuminata*, *M balbisiana*, Wather, Nendran were found free from the disease. Among AAB, ABB and AB genomes, Co-1, Poovan, Rasthali, Nendran, Virupakshi, Mottapoovan, Suganthi, Ayirankai Rasthali, Krishna Vazhai, Agniswar, Kali red and Mala Kali in AAB group, Monthan, Peyan, Jurmoney, Raja Vazhai, Barsain, Baisa, Beula, Pidimonthan, Nellu Bontha and Govakkor in ABB group and Kunnan, Adukkar and Adukka Kunnan in AB group showed resistant reactions.

2.6.3 Effect of ecotype variation on the incidence of rhizome weevil

Among the pests of banana, the banana rhizome weevil, *Cosmopolitus sordidus* is quite common and causes much damage under Kerala conditions. It is also seen that cultivars vary widely in their susceptibility/tolerance to the rhizome weevil (Babylatha *et al.*, 1990). Out of the 84 banana cultivars screened, Matti, Nendran, Myndoli and Zanzibar were highly susceptible to rhizome weevils. According to Rajeevan (1985), the ratio of the infected to the total rhizome ranged from 0.0 to 4.36 among the `Palayankodan' accessions.

2.6.4 Effect of ecotype variation on the incidence of nematodes

Nematodes are now recognised as an important soil borne organism causing decline in yield in bananas. Affected plants do not respond to fertilizer, irrigation and cultural practices. The burrowing nematode *Radopholus similis*, the leison nematode *Pratylenchus coffeae*, the spiral nematode *Helicotylenchus multicinctus* and root knot nematode *Meloidogyne incognita* and *M. javanica* have been found affecting banana. Plant parasitic nematodes are proved to be a limiting factor in banana production in many countries viz, Fiji island, Israel and Honduras (Stover and Fielding, 1958).

Radopholus similis was reported for the first time in India in banana by Nair *et al.* (1966).

Charles and Venkitesan (1984) reported the occurrence of *Heterodera oryzicola* for the first time in Kerala in banana plantation.

The result of screening conducted to assess the varietal susceptibility of bananas with reference to

infestation by *Radopholus similis* (Charles *et al.*, 1983) in banana showed that in varieties Kadali (AA), Padalimoongil (AAB), Kunnan (AAB), Pey Kunnan (AAB), Ayiranka Poovan (AB), Pisang seriby (AA) and one fruit less variety, the population of *Radopholus similis* was between 12.17 to 45.17 per g root.

Subramaniyan and Selvaraj (1990) reported that the cultivar Karpooravalli recorded the minimum nematode population (1295.6) followed by Poovan (2010.2) and Rasthali (2262.0). `Robusta' followed by `Dwarf Cavendish' were found to be heavily infested by the nematode.

2.7 Correlation and Path analysis in `Nendran' ecotypes

Correlation studies are of great importance since they provide estimates of the degree of association of a character with its components and also among the various components. When the number of characters are high, the study of correlation between these characters will be difficult. Path coefficient analysis is the solution to this problem which provides estimates of direct and indirect effect of each component on yield. In improving the yield

potential of a crop, information on interrelationship between yield and yield attributing characters is of great importance. Correlation studies and path analysis done in banana are reviewed below.

Studies on certain quantitative characters (Rao, 1961) of hands in the bunches and their variability in three varieties showed that `Mauritius' is the heaviest, the total weight of all hands being 13.4 kg, followed by `Poovan' with 13.2 kg and `Rastali' with 12.2 kg. The correlation was the highest in weight of hands. Negative correlation was observed between position of hand in the bunch and pulp/peel ratio.

Teaotia *et al.* (1970) conducted simple, partial and multiple correlation studies in four quantitative characters viz, yield, leaf number, height and circumference of the pseudostem in banana. Bunch yield was strongly correlated with pseudostem circumference and its contribution to variation in yield was large.

Gopimony and Marykutty (1980) reported the nature of association between bunch weight and six other characters

in 127 banana varieties belonging to different genomic groups. It was found that only the number of fingers per bunch was positively correlated with bunch weight in all the three genomic groups. But in AAA and AAB groups the girth of the pseudostem gave a clear indication of bunch weight.

Genetic analysis of seven characters made by Sreerangaswamy *et al.* (1980) in dessert and culinary varieties of banana indicated high genotypic coefficient of variation in respect of number of fruits and number of hands in culinary type. He also reported that the bunch weight was highly and positively correlated with plant height.

High heritability values along with high genetic advance and genotypic coefficient of variation are reported for culinary bananas for number of fingers per bunch, hand weight and fruit weight, length of pedicel, girth of plants and number of leaves per plant (Nayar *et al.*, 1980).

According to Krishnan and Shanmugavelu (1983) the height and girth of pseudostem at shooting and total leaf area showed a significant positive association with bunch

weight by r values +0.6709, +0.6880 and +0.4795 respectively. The period taken for shooting and harvest indicated a significant negative association with bunch weight. They also studied correlation in banana cv. Robusta, between the bunch weight and the morphological characters. The number of fingers per bunch (+0.9377), weight of finger (0.8843) and number of hands per bunch (0.8766) exerted a profound influence on the bunch weight.

Rajeevan and Geetha (1984b) studied variability in ratoon crop of fourty banana varieties for ten morphological characters pertaining to girth and yield. High heritability and genetic advance were noticed for number of fingers per bunch, weight of fingers, height and girth of pseudostem at flowering.

From the path coefficient analysis (Vijayaraghavakumar *et al.*, 1984) in thirty culinary varieties it was seen that the yield was influenced by number of fingers and as the number of hand increases, the number of

fingers per hand decrease. In dessert varieties, the character having maximum contribution to yield was weight of hands (1.2050). The weight of fingers also influence the yield indirectly.

Kurian *et al.* (1985) observed that the fruit yield exhibited strong positive correlation with number of hands, number of fingers, number of functional leaves per plant, girth of stem and total duration of the crop. Positive direct effect of number of fingers on yield (+0.6776) was observed.

The path analysis conducted by Rajeevan (1985) in the `Palayankodan' accessions indicated that the maximum positive direct effect was recorded by the weight of hands (1.6043) followed by the average weight of a green finger (0.6649) and the weight of the ripe finger (0.5885).

The computed D^2 values ranged from 226.74 to 38402.74 indicating wide divergence. The character pulp/peel ratio on volume basis (34.06 per cent) followed by finger weight (20.67 per cent) and total sugars (19.46 per cent) contributed maximum towards divergence (Valsalakumari *et al.*, 1985).

Wei *et al.* (1985) reported a significant positive correlation between weight of bunch and plant height, plant girth and number of fingers per bunch, number of hands per bunch and plant girth and number of fingers per bunch, plant height and finger length.

Mercy and George (1987) observed that in culinary varieties of banana the character bunch weight showed the maximum variability followed by hand weight based on D^2 values. Minimum contribution of the variability was through plant girth followed by height. The same workers in 1988 observed that finger length and pedicel length showed maximum variability based on D^2 values. Minimum variability was through number of leaves per plant and plant girth.

Out of the seventeen characters studied by Rosamma and Namboodiri (1990), thirteen showed strong correlation with bunch weight of banana. Genetic gain was the highest for weight of individual finger which recorded maximum direct effect on bunch weight.

MATERIALS AND METHODS

MATERIALS AND METHODS

The "Evaluation of `Nendran' (Musa AAB group) ecotypes" was conducted at the Department of Horticulture, College of Agriculture, Vellayani, Thiruvananthapuram during the year 1994-'95.

Suckers of almost uniform size were planted in October 1994. The plants were maintained as per the package of practices recommendations of Kerala Agricultural University for irrigated `Nendran' banana (Anon., 1993). Fertilizers were applied in six split doses as per the Kerala Agricultural University recommendations.

The experimental design adopted was Randomized Block Design (RBD); each treatment with three replications. Each replication consisted of four experimental plants from which observations were recorded. The `Nendran' ecotypes evaluated were :

Treatment No.	Ecotype
T1	BRS-35 (Muttathukonam)
T2	BRS-123 (Puthur)
T3	BRS-49 (Kothala)
T4	BRS-100 (Pandaloor)
T5	BRS-132 (Poovanchira)
T6	Chengazhikodan (Trissur)
T7	Kaliethan (Thiruvananthapuram)

The following observations were recorded to evaluate the performance of seven Nendran (Musa AAB group) ecotypes :

3.1 Vegetative characters

Vegetative characters were recorded at four stages of plant growth viz;juvenile stage (one month after planting), adult pre-floral vegetative stage (three months after planting), floral initiation stage (five months after planting) and post floral stage (just after shooting).

3.1.1 Height of the plant

Height of the plant (cm) was recorded from the soil level to the base of the unopened leaf. Observations were recorded at the four stages of plant growth.

3.1.2 Girth of the plant

Girth of the plant (cm) was recorded at 10 cm above the ground level at the four stages of plant growth.

3.1.3 Number of leaves produced per plant

The number of leaves produced per plant during the four stages of plant growth were recorded.

3.1.4 Phylacron

The time interval in days between opening of two successive leaves was recorded at the four stages of vegetative growth.

3.1.5 Leaf longevity

Leaf longevity was recorded as number of days from leaf emergence to yellowing of leaves.

3.1.6 Leaf area index (LAI)

Leaf area index was determined using the formula suggested by Watson (1952).

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

Leaf area was measured using the following model developed by Robinson and Nel (1988).

LA = 0.83 L x B , where

LA = leaf area per leaf (m^2)

L = leaf length (m)

B = leaf breadth (m)

3.1.7 Leaf area duration (LAD)

Leaf area duration was calculated using the following formula suggested by Turner (1980).

$$\text{LAD} = \text{area of last three leaves} \times \text{time taken from bunch emergence to harvest}$$

3.1.8 Monthly growth rate

Monthly growth rate was recorded as the ratio of increase in height of the plant to the original height expressed in percentage.

3.1.9 Number of suckers produced per plant

Total number of suckers produced per plant in each treatment was recorded at the time of harvest.

3.1.10 Time taken for flowering

Time taken for flowering was recorded from the date of planting to visual bunch emergence and expressed in days.

3.1.11 Time taken for harvest

Time taken for harvest was recorded from the date of visual bunch emergence to the date of harvest and expressed in days.

3.1.12 Crop duration

The total duration of the crop was recorded from the date of planting to harvest and was expressed in days.

3.2 Yield characters

The different yield characters that were recorded immediately after harvest include:-

3.2.1 Bunch weight

3.2.2 Number of hands per bunch

3.2.3 Number of fingers per bunch and hand

3.2.4 Length, girth and weight of the fingers

The middle finger in the top row of the second hand (Gottriech *et al.*, 1964) was sampled to record length, girth and weight of fruits.

3.2.5 Peel weight and pulp weight of fruits

The peel weight and pulp weight of the fully ripened sampled fruits were recorded and expressed in gram.

3.2.6 Pulp/peel ratio

Observations under 3.2.5 were used for calculating pulp/peel ratio.

3.3 Fruit quality

The middle fruit in the top row of the second hand was selected as the representative sample (Gottriech *et al.*, 1964). The fully ripe fruits were used for quality analysis. Samples were taken from three portions (top, middle and bottom) from each sample fruit and these were then pooled and

macerated. Three samples drawn from this were used for analysis of the different constituents in the fruits.

3.3.1 Total soluble solids (TSS)

TSS was measured using a pocket type refractometer and was expressed as percentage.

3.3.2 Acidity

Titrable acidity was determined by the procedure proposed by Ranganna (1977). Results were expressed as percent anhydrous citric acid.

3.3.3 Total sugars

The total sugars were determined as per the method described by Ranganna (1977). The results were expressed as percentage on fresh weight basis.

3.3.4 Reducing sugars

The reducing sugars of the samples were determined as per the method described by Ranganna (1977) as percentage on fresh weight basis.

3.3.5 Non-reducing sugars

Observations under 3.3.3 and 3.3.4 were used for calculating non-reducing sugars based on the procedure suggested by Ranganna (1977)

Non-reducing sugars = Total sugar - Reducing sugars

3.3.6 Sugar/acid ratio

Observations under 3.3.2 and 3.3.3 were used for calculating sugar / acid ratio.

3.3.7 Green life of fruits

The number of days taken from harvest to ripening at room temperature, as indicated by change in colour from green to light yellow was recorded (Stover and Simmonds, 1987).

3.4 Leaf nutrient status (N, P and K) at flowering and harvest

To assess the leaf nutrient status, leaf samples were collected at the time of flowering and harvest and

sampling was done following the method of Twyford and Walmsley (1973).

The samples were analysed for N,P and K and results were expressed on percentage dry weight basis.

3.5 Biomass production per plant at harvest stage

One plant from each replication was uprooted immediately after harvest and separated into corm, pseudostem, leaf, fruits and peduncle and their weights were recorded. A sample of 500 grams of each part was dried in hot air oven to calculate the dry matter content.

3.6. Scoring for leaf spot, bunchy top, rhizome weevil and nematodes

Scoring for leaf spot was done at juvenile stage, adult pre floral vegetative stage, floral initiation stage, and post floral stage as per the method suggested by Suharban (1977).

Occurrence of bunchy top disease was observed and recorded as and when the symptoms appeared and was expressed on percentage basis.

The number of rhizome weevils in the corm and in the soil around the corm was recorded at the time of harvest

Nematode population was assessed both in soil (250g) and root (10g) as per the method of cobb's sieving and decanting technique modified by Christie and Percy(1951)

3.7 Statistical analysis

The data collected on different characters were analysed by applying the technique of analysis of variance for randomised block design following Panse and Sukhatme (1967).

EXPERIMENTAL RESULTS

EXPERIMENTAL RESULTS

The present investigation was carried out to study the effect of ecotypes on growth, yield and quality of `Nendran' banana, so as to determine the ecotype suitable for the southern tracts of Kerala. The experiment was conducted at the Department of Horticulture, College of Agriculture, Vellayani, Thiruvananthapuram during the year 1994-'95. The results of the study are presented below :

4.1 Vegetative characters

4.1.1 Effect of ecotype variation on the height of banana cv. Nendran

The results of the study on the effect of different ecotypes on the height of Nendran banana are presented in Table 1.

The data indicated that there was significant difference among treatments in the height of the plants during all the four stages of crop growth, viz, juvenile stage (one month after planting), adult pre floral vegetative stage (three months after planting), floral initiation stage (five months after planting) and post floral stage (after shooting).

Table 1. Effect of ecotype variation on the height of banana cv. Nendran

Treatment	Height of plant (cm) — Stages after planting: Juvenile stage	Adult pre-floral vegetative stage	Floral initation stage	Post floral stage
T_1	51.417	141.360	257.887	297.667
T_2	40.497	121.303	239.687	316.553
T_3	51.167	134.830	255.500	341.500
T_4	52.917	141.417	260.417	292.500
T_5	40.150	122.667	235.000	334.000
T_6	34.000	114.667	225.750	297.777
T_7	44.167	154.750	256.417	299.917
F-test	*	*	*	*
CD (0.05)	10.4589	20.0294	20.5090	27.9747

* Significant at 5% level

During the juvenile stage, the treatment T_4 showed the highest mean value for plant height (52.917 cm) followed by T_1 (51.417 cm), T_3 (51.167 cm) and T_7 (44.167 cm); all the four treatments being statistically on par. The lowest values for plant height was recorded in T_6 (34.000 cm) followed by T_5 (40.150 cm) and T_2 (40.497 cm); all the three treatments being statistically on par. However, T_7 did not differ significantly from the above three treatments.

During the adult pre floral vegetative stage, the plant height was the highest in T_7 (154.750 cm) followed by T_4 (141.417 cm), T_1 (141.360 cm) and T_3 (134.830 cm) and these treatments were statistically on par. The treatment T_5 (122.667 cm) did not differ significantly from T_3, T_1 and T_4. The lowest values for plant height was recorded in T_6 (114.667 cm) followed by T_2 (121.303 cm) which was on par with T_5 and the latter did not differ significantly from T_3.

During the floral initiation stage T_4 showed the highest plant height with a mean value of 260.417 cm which was on par with T_1 (257.887 cm), T_7 (256.417 cm) and T_3 (255.50 cm). The lowest value for plant height was recorded

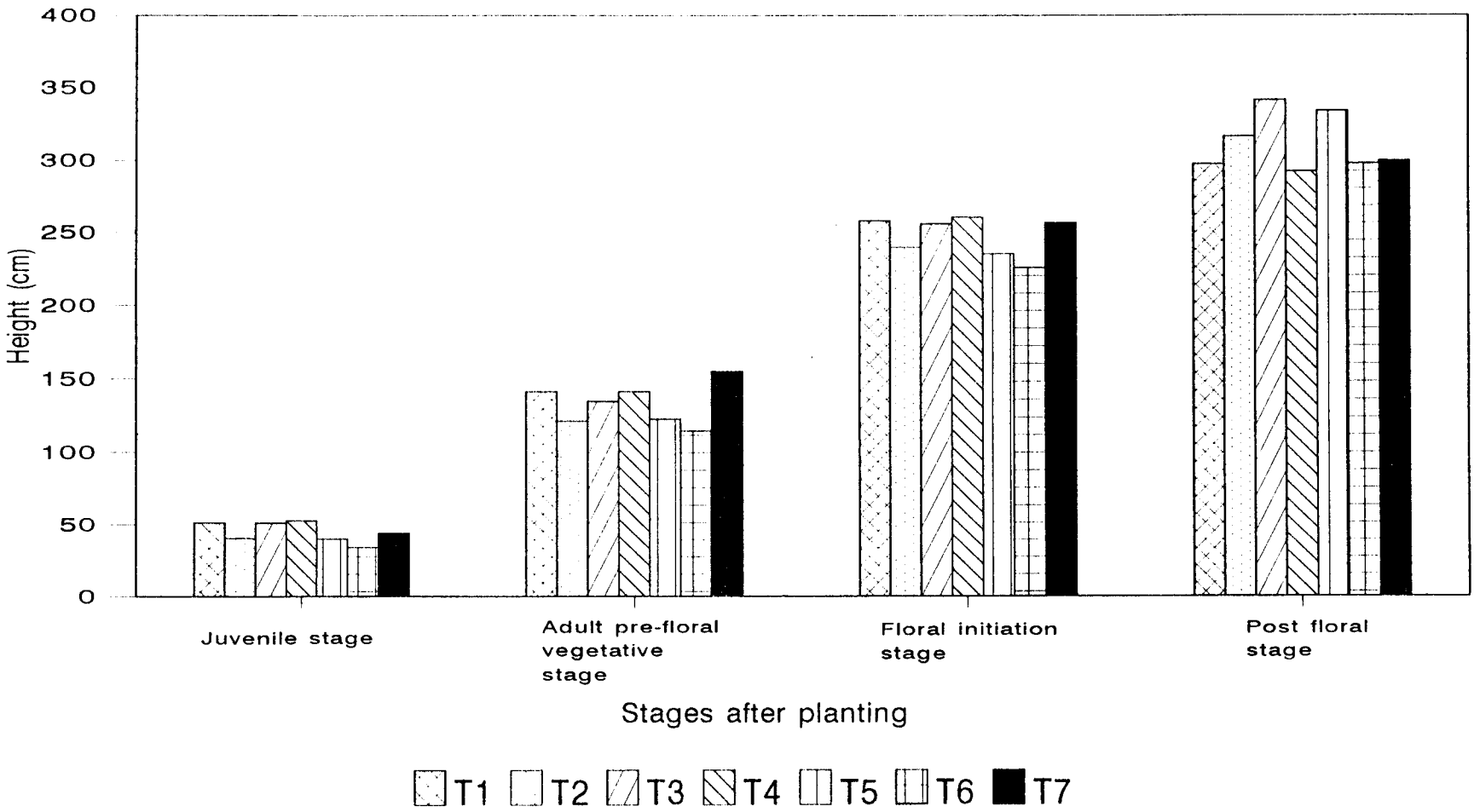


Fig. 1. Effect of ecotype variation on the height of banana cv. Nendran

in T_6 (225.750 cm) followed by T_5 (235.000 cm) and T_2 (239.687 cm); the three treatments being statistically on par However, the treatments T_5 and T_2 did not differ significantly from T_3 and the treatment T_2 did not differ significantly from T_3, T_7 and T_1.

During the post floral stage the plants were the tallest in T_3 (341.500 cm) followed by T_5 (334.000 cm) and T_2 (316.513 cm); the three treatments being statistically on par. The lowest plant height was recorded in T_4 (292.500 cm) followed by T_1 (297.667 cm), T_6 (297.777 cm) and T_7 (299.917 cm); the four treatments being statistically on par. However T_2 which followed T_7 did not differ significantly from the above four treatments.

The data thus revealed that the height of the plants varied significantly under the influence of various treatments and during the different stages of growth. Chengazhikodan, Poovanchira and Puthur types recorded the lowest plant height during the early and late vegetative phase while Pandaloor, Muttathukonam, Kothala and Kaliethan recorded the highest values. However, at flowering, plant height was the lowest in Pandaloor, Muttathukonam,

Chengazhikodan and Kaliethan and the highest in Kothala, Poovanchira and Puthur types.

4.1.2 Effect of ecotype variation on the girth of banana cv. Nendran

The results of the study are presented in Table 2. The data showed no significant difference in the girth of the plants during the early stages of growth, viz, juvenile stage and adult pre-floral vegetative stage. However, the mean values showed that girth of the plants was higher in T_4 (16.167 cm) followed by T_2 (15.913 cm) and T_7 (14.667 cm). The lowest mean plant girth was record in T_6 (12.167 cm) followed by T_5 (13.830 cm) and T_3 (14.497 cm). During the adult pre-floral stage, T_1 (39.693 cm) recorded the highest mean girth followed by T_4 (39.250 cm) and T_7 (38.583 cm). The lowest plant girth was in T_6 (32.083 cm) followed by T_5 (33.497 cm) and T_2 (34.080 cm).

During the floral initiation stage there was significant difference in the girth of plants in different treatments. The highest mean girth of 59.830 cm was recorded by T_3 followed by T_4 (59.417 cm), T_1 (56.500 cm), T_2

Table 2. Effect of ecotype variation on the girth of banana cv. Nendran

Treatment	Plant girth (cm) Stages after planting			
	Juvenile stage	Adult pre-floral vegetative stage	Floral initiation stage	Post floral stage
T_1	14.610	39.693	56.500	56.667
T_2	15.913	34.080	56.247	60.663
T_3	14.497	36.667	59.830	66.500
T_4	16.167	39.250	59.417	59.943
T_5	13.830	33.497	46.830	71.000
T_6	12.167	32.083	55.750	61.333
T_7	14.667	38.583	54.250	55.083
F-test	NS	NS	*	**
CD (0.05)	--	--	6.8390	7.6257

NS Not Significant

* Significant at 5% level

** Significant at 1% level

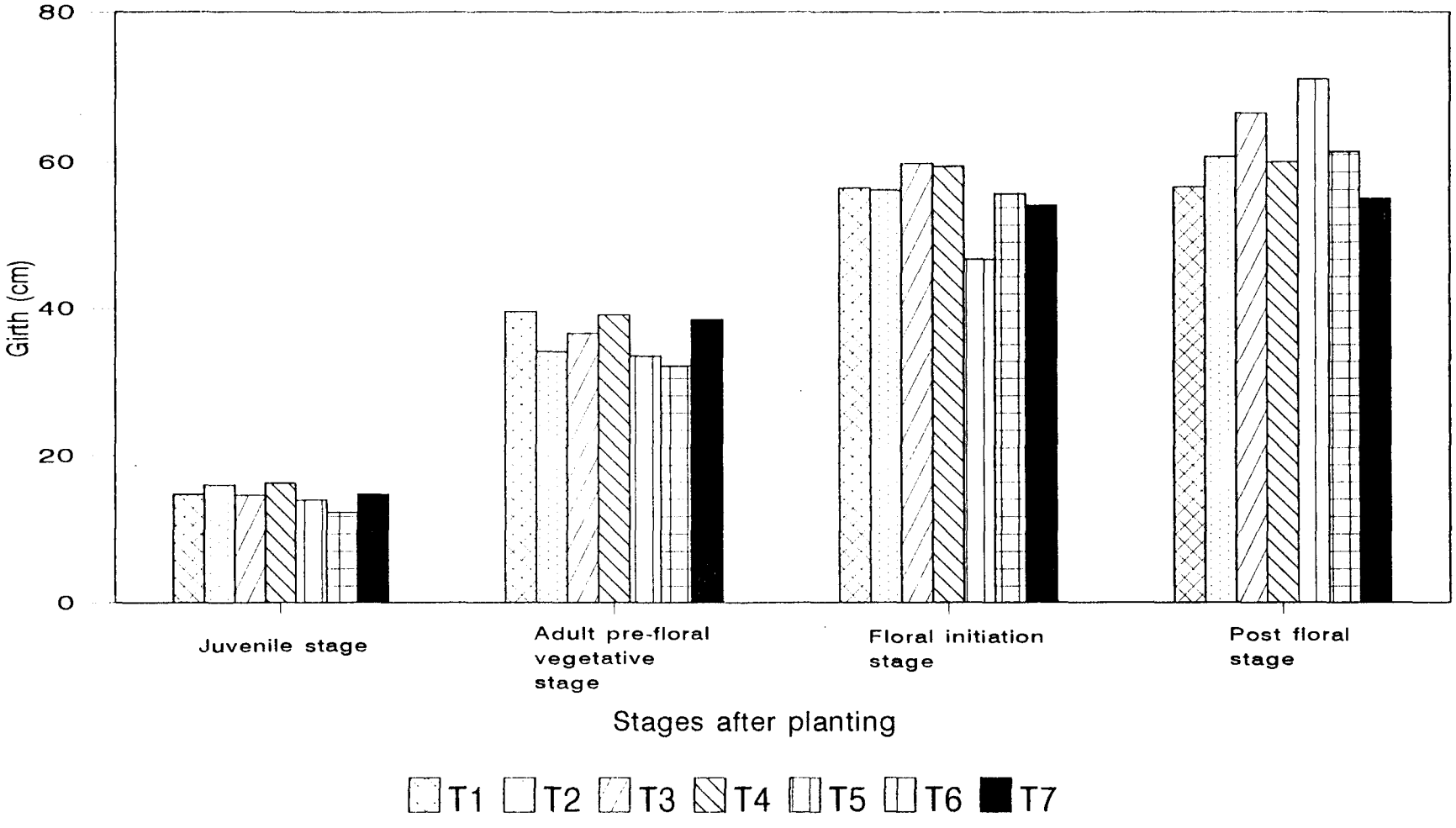


Fig. 2. Effect of ecotype variation on the girth of banana cv. Nendran

(56.247 cm), T_6 (55.750 cm) and T_7 (54.250 cm); all the six treatments being statistically on par. The lowest value (46.830cm) was recorded in T_5 which differed significantly from all other treatments.

At post floral stage, T_5 recorded the highest value (71.000 cm) followed by T_3 (66.500 cm); both the treatments being statistically on par. The lowest plant girth was showed in T_7 (55.083 cm) followed by T_1 (56.667 cm), T_4 (59.943 cm), T_2 (60.063 cm) and T_6 (61.330 cm). These five treatments being statistically on par. The treatments T_4, T_2 and T_6 were statistically on par with T_3.

From the above inference it is evident that the treatments did not show any significant influence in the girth of the plants till adult prefloral vegetative stage. The types Chenghazhikodan, Poovanchira and Kothala that showed lower plant girth during early and mid growth stages recorded the higher plant girth at shooting time.

4.1.3 Effect of ecotype variation on the number of leaves produced in banana cv. Nendran.

The data on the effect of ecotype variation on the number of leaves produced during the four stages of plant growth are presented in Table 3.

Table 3. Effect of ecotype variation on the number of leaves produced in banana cv. Nendran

Treatment	Number of leaves per plant				
	Stages after planting				
	Juvenile stage	Adult pre-floral vegetative stage	Floral initiation stage	Floral initiation stage to flowering	Total upto bunch emergence
T_1	2.583	12.360	10.637	2.500	28.080
T_2	2.330	12.327	10.997	5.000	30.653
T_3	2.497	12.820	10.497	5.490	31.303
T_4	3.330	12.830	10.750	2.167	29.077
T_5	2.330	12.160	10.657	4.160	29.307
T_6	0.500	11.583	10.667	7.083	29.833
T_7	4.053	12.967	10.553	2.803	30.377
F-test	**	**	NS	**	NS
CD (0.05)	1.0683	0.7482	--	1.6902	--

NS Not Significnat

** Significant at 1% level

During the juvenile stage the highest number of leaves were produced in T_7 (4.053) followed by T_4 (3.330) and these two treatments were statistically on par. The treatment. T_6 (0.500) produced the minimum number of leaves which was significantly lower to all other treatments. The treatments T_2 (2.330) T_5 (2.330), T_3 (2.497) and T_1 (2.583) were statistically on par with T_4.

During the adult pre-floral vegetative stage the treatments showed significant difference in the number of leaves produced. The highest number of leaves were produced, in T_7 (12.967) which was statistically on par with T_2, T_1, T_3 and T_4. The lowest number of leaves were produced by T_6 (11.583), T_5 (12.160) and T_2 (12.327); the three treatments being statistically on par. The treatments T_1, T_3 and T_4 produced 12.360, 12.820 and 12.830 leaves respectively and these were statistically on par, but did not differ significantly from T_5 and T_2.

No significant difference was observed between treatments in the number of leaves produced during the floral initiation stage. Around ten leaves were produced on an average in various treatments during this stage.

During the growth stage between floral initiation stage to flowering, the lowest number of leaves was produced in T_4 (2.167) followed by T_1 (2.500) and T_7 (2.800); the three treatments being statistically on par. However, the treatments T_1 and T_7 were statistically on par with T_5 (4.160). The treatment T_5 did not differ significantly from T_2 (5.000) and T_3 (5.490). The treatment T_3 in turn was statistically on par with T_6 which produced the highest number of leaves (7.083) among the various treatments.

Data on the total number of leaves produced in different treatments are furnished in Table 3. The data revealed no significant difference between the treatments with respect to the total number of leaves produced. The mean values indicated that among the seven treatments, T_3 produced the highest number of leaves (31.303) and lowest in T_1 (28.080).

The data thus indicated that leaf production was lesser in Chengazikodan, Puthur, Kothala and Poovanchira types compared to Kaliethan, Pandaloor, and Muttathukonam types. The number of leaves produced was more or less uniform during floral initiation stage in all the treatments and during the period between floral initation stage to

flowering, the trend in leaf production pattern was reversed and the total number of leaves produced was more or less uniform in all the treatments.

4.1.4 Effect of ecotype variation on the phylacron of banana cv. Nendran

The data on the effect of ecotype variation on the interval of leaf production (phylacron) presented in Table 4, showed that during the first two stages of plant growth, namely, juvenile stage and adult pre-floral vegetative stage there was significant difference between treatments.

During the juvenile stage, the treatment T_6 recorded the highest interval for leaf production (28.443 days). This treatment differed significantly from all other treatments. The interval of leaf production was the shortest in T_7 (6.767 days) followed by T_4 (8.740 days) and T_1 (11.587 days); the three treatments being statistically on par. However, the treatments T_4 and T_1 did not differ significantly from T_3 (12.797 days), T_2 (12.987 days) and T_5 (13.717 days).

Table 4. Effect of ecotype variation on the phylacron of banana cv. Nendran

Treatment	Phylacron (days)			
	Stages after planting			
	Juvenile stage	Adult pre-floral vegetative stage	Floral initiation stage	Floral initiation stage to flowering
T_1	11.587	5.603	6.363	5.457
T_2	12.987	5.310	5.943	5.917
T_3	12.797	5.410	5.957	5.980
T_4	8.740	5.267	6.013	5.437
T_5	13.717	5.030	6.347	5.467
T_6	28.443	7.127	6.117	6.177
T_7	6.767	5.243	6.310	5.933
F-test	**	**	NS	NS
CD (0.05)	6.0168	0.7251	--	--

NS Not Significant

** Significant at 1% level

During the adult pre-floral stage the treatment T_6 recorded the highest interval of leaf production (7.127 days); this treatment being significantly superior to all other treatments. The shortest interval for leaf production was observed in T_5 (5.030 days) which was significantly on par with T_7 (5.243 days), T_4 (5.267 days), T_2 (5.310 days), T_3 (5.410 days) and T_1 (5.603 days).

There was no significant difference between treatments during the floral initation stage and thereafter till flowering. However, the mean values indicated that during floral initiation stage, the highest interval of leaf production was on T_1 (6.363 days) followed by T_5 (6.347 days), T_7 (6.310 days) and T_6 (6.117 days) while the lowest in T_2 (5.943 days) followed by T_3 (5.957 days) and T_4 (6.013 days). Similarly, during pre-floral stage, the highest mean values of phylacron was recorded in T_6 (6.177 days) followed by T_3 (5.980 days), T_7 (5.933 days) and T_2 (5.917 days). The lowest mean value was recorded in T_4 (5.437 days) followed by T_1 (5.457 days) and T_5 (5.467 days).

The data revealed that in Chengazhikodan, Poovanchira, Puthur and Kothala types there was notable

decrease in the interval of leaf production between the first and second stages and later it stabilized. In Pandaloor and Kaliethan this decrease was not as sharp as in the former types. However, towards the last stages, there was uniformity in phylacron among all the types.

4.1.5 Effect of ecotype variation on leaf longevity and leaf area duration of banana cv. Nendran

Data on leaf longevity are presented in Table 5.

The data revealed that leaf longevity was the highest in T_6 (77.927 days) followed by T_1 (75.327 days); both the treatments being statistically on par. However, the treatment T_1 did not differ significantly from T_4 (72.723 days). The lowest leaf longevity recorded in T_3 (68.557 days) did not significantly differ from those of T_5 (68.577 days), T_7 (70.420 days) and T_2 (70.543 days).

Data on leaf area duration (LAD) presented in Table 5 revealed that the LAD was highest in T_7 (861.493) followed by T_2 (520.89); the two treatments being statistically different and superior to all other treatments. The LAD recorded in T_1 (302.437) was significantly lower than

Table 5. Effect of ecotypes variation on leaf longevity and leaf area duration of banana cv. Nendran

Treatment	Leaf longevity (days)	Leaf area duration
T_1	75.327	302.437
T_2	70.543	520.890
T_3	68.557	450.230
T_4	72.723	362.303
T_5	68.577	404.797
T_6	77.927	451.193
T_7	70.420	861.493
F-test	**	**
CD (0.05)	4.7407	48.2541

** Significant at 1% level

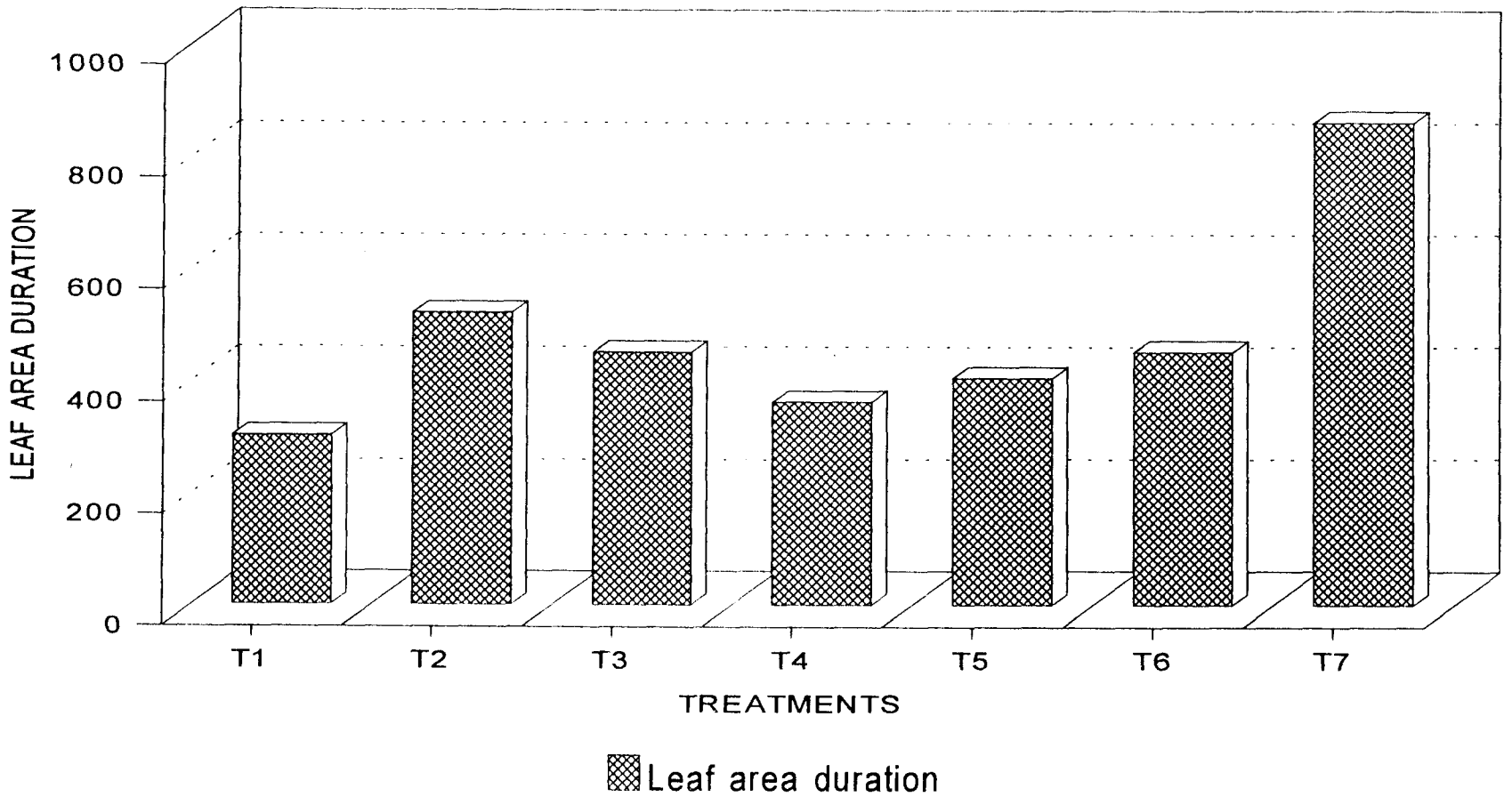


Fig. 3. Effect of ecotype variation on leaf area duration of banana cv. Nendran

that of all other treatments. The treatment T_4 (362.303 days) which followed T_1 was statistically on par with T_5 (404.797) and T_5 in turn was statistically on par with T_3 (450.230) and T_6 (451.193).

There was significant difference between treatments with respect to LAD. The results thus indicated that Kaliethan had significantly higher LAD followed by Puthur type. Muthathukonam type had the lowest LAD.

4.1.6 Effect of ecotype variation on leaf area index of banana cv. Nendran

Data on leaf area index (LAI) during the different stages of plant growth are presented in Table 6.

The data revealed that leaf area index was not significantly influenced by the treatments during the first two stages viz, juvenile stage and adult prefloral vegetative stage.

During the floral initation stage there was significant difference in the LAI among the various

Table 6. Effect of ecotype variation on leaf area index of banana cv. Nendran

Treatment	Leaf area index (LAI) — Stages after planting				
	Juvenile Stage	Adult pre-floral vegetative stage	Floral initiation stage	Floral initiation stage to flowering	At harvest
T_1	0.054	0.666	1.115	0.552	1.496
T_2	0.038	0.593	1.015	2.032	1.353
T_3	0.060	0.687	1.056	2.227	1.463
T_4	0.080	0.778	0.992	0.765	1.102
T_5	0.175	0.786	1.262	0.414	1.444
T_6	0.005	0.817	1.787	2.488	1.453
T_7	0.289	0.761	1.248	0.533	1.250
F-test	NS	NS	**	**	**
CD (0.05)	--	--	0.2169	0.6425	0.2104

NS Not Significant

** Significant at 1% level

treatments. Treatment T_6 recorded significantly higher LAI (1.787). The treatment T_5 (1.262), T_7 (1.248) and T_1 (1.115) were statistically on par and followed T_6. The lowest LAI was observed in T_4 (0.992) followed by T_2 (1.015) and T_3 (1.056); the three treatments being statistically on par. However, the treatment T_5 did not differ significantly from T_1 and T_7.

At shooting time, the highest leaf area index was observed in T_6 (2.488) followed by T_3 (2.227) and T_2 (2.032). These three treatments were statistically on par and superior to all other treatments. The treatments T_5 (0.414), T_7 (0.533), T_1 (0.552) and T_4 (0.765) were statistically on par and recorded significantly lower LAI compared to other treatments.

At harvest stage, the highest leaf area index value recorded in T_1 (1.496) was statistically on par with T_3 (1.463), T_6 (1.453), T_5 (1.444) and T_2 (1.353). The treatments T_6, T_5 and T_2 was also significantly on par with T_7 (1.250). The treatment T_4 which recorded the lowest LAI (1.102) was statistically on par with T_7.

The results thus indicated that during early stages of growth there was no significant difference in the LAI among the treatments. During the later stages of growth Chenghazhikodan and Kothala recorded the highest LAI values while Kaliethan, Pandaloor and Puthur types recorded lower LAI. The other types were intermediary with respect to LAI.

4.1.7 Effect of ecotype variation on the monthly growth rate of banana cv. Nendran

The data (Table 7) revealed that during the second, third and seventh month after planting there was significant difference in the monthly growth rate in the various treatments.

At two months after planting, the treatment T_6 recorded the maximum monthly growth rate of 118.794 per cent which was statistically on par with T_7 (97.993 per cent). The treatments T_3, T_1, T_5 and T_2 with the growth rate of 71.633, 76.837, 84.443 and 86.927 per cent respectively were statistically on par with T_7. The treatment T_4 which recorded the minimum growth rate of 63.877 per cent was statistically on par with T_3, T_1 T_5 and T_2.

Table 7. Effect of ecotype varation on the monthly growth rate of banana cv. Nendran

Treatment	Monthly growth rate (% increase in plant height)					
	Months after planting					
	2	3	4	5	6	7
T_1	76.837	57.930	49.813	22.840	15.473	0.000
T_2	86.927	65.017	68.037	21.780	26.840	4.167
T_3	71.633	53.800	56.247	21.283	20.630	10.823
T_4	63.877	63.817	53.687	20.007	12.373	0.000
T_5	84.443	66.073	57.387	21.913	17.520	19.747
T_6	118.790	54.473	58.320	24.357	23.647	7.300
T_7	97.990	77.790	40.927	17.880	24.580	0.000
F-test	*	**	NS	NS	NS	**
CD (0.05)	28.4727	14.5756	--	--	--	5.3200

NS Not Significant

* Significant at 5% level

** Significant at 1% level

At three months after planting, the treatment T_7 recorded the maximum monthly growth rate of 77.790 per cent followed by T_5 (66.073 per cent), T_2 (65.017 per cent) and T_4 (63.817 per cent); the four treatments being statistically on par. The monthly growth rate recorded was minimum in the treatment T_3 (53.800 per cent) T_6 (54.473 per cent) and T_1 (57.930 per cent); the three treatments being statistically on par. However, these three treatments did not differ significantly from T_4, T_2 and T_5.

During four, five and six months after planting, there was no significant difference between the treatments in the monthly growth rate.

During seven months after planting the highest monthly growth rate was recorded in T_5 (19.747 per cent) which was significantly superior to all other treatments. This was followed by T_3 (10.823 per cent) which was statistically on par with T_6 (7.300 per unit). However, T_6 did not differ significantly from T_2 (4.167 per cent) and T_2 did not differ significantly from T_1, T_7 and T_4 which showed no further growth, because of earlier bunch emergence.

From the above data it is evident that the treatments showed significant influence in the monthly growth rate only during the early stages of vegetative growth. The difference in growth rate was not significant in the later part of growth. However, it was evident that Kaliethan and Puthur had continued to put forth higher growth rate even during late vegetative growth stage.

4.1.8 Effect of ecotype variation on the number of suckers produced in banana cv. Nendran

The data on the number of suckers produced furnished in Table 8 revealed that there was no significant difference between treatments indicating that the ecotype variation has not generally influenced the number of suckers produced per plant. On an average 7.360 to 9.330 sucker were produced in different treatments.

4.1.9 Effect of ecotype variation on time taken for flowering, time taken for harvest and crop duration of banana cv. Nendran

The data (Table 9) indicated that the time taken for flowering was influenced by the different ecotypes evaluated. The treatment T_4 recorded the shortest duration for flowering (174.917 days) followed by T_1 (176.637 days),

Table 8. Effect of ecotype variation on the number of suckers produced in banana cv. Nendran

Treatment	Number of suckers per plant
T_1	7.360
T_2	9.330
T_3	7.667
T_4	7.500
T_5	8.330
T_6	7.777
T_7	7.627
F-test	NS
CD (0.05)	--

NS Not Significant

Table 9. Effect of ecotype variation on time taken for flowering, time taken for harvest and crop duration of banana cv. Nendran

Treatment	Time taken for flowering (days)	Time taken for harvest (days)	Crop duration (days)
T_1	176.637	79.500	256.117
T_2	193.887	80.940	274.827
T_3	195.667	84.467	280.130
T_4	174.917	81.787	256.703
T_5	184.500	86.533	271.033
T_6	205.667	83.933	289.600
T_7	180.777	87.803	268.580
F-test	**	NS	**
CD (0.05)	12.5840	--	15.4653

NS Not Significant

** Significant at 1% level

T_7 (180.777 days) and T_5 (184.500 days); the four treatments being statistically on par. The longest duration for flowering was observed in T_6 (205.667 days) followed by T_3 (195.667 days) and T_2 (193.987 days); the three treatments being statistically on par but significantly different from T_5. The treatment T_3 in turn was statistically on par with T_2, T_5 and T_7.

The results thus indicated that Pandaloor, Muttathukonam, Kaliethan and Poovanchira types took comparatively lesser duration for flowering compared to the other types.

The time taken for harvest ie. the maturity period of bunches did not vary significantly among the various ecotypes under evaluation. There was a difference of around seven days between the highest and lowest bunch maturity periods recorded.

The crop duration followed more or less similar pattern of time taken for flowering. The crop duration was the shortest in T_1 (256.117 days) followed by T_4 (256.703 days), T_7 (268.580 days) and T_5 (271.033 days); the four treatments being statistically on par. However, T_7 and T_5 did not differ significantly from T_2 (274.827 days) and T_3

(280.130 days). The longest duration recorded in T_6 (289.600 days) was statistically on par with that of T_3 and T_2.

The results thus indicated that Muttathukonam, Pandaloor, Kaliethan and Poovanchira types took comparatively lesser duration for harvest. Chengazhikodan, Kothala and Puthur required more duration for harvest.

In general, it was observed that the time taken for flowering and total crop duration were significantly influenced by the different ecotypes under evaluation. It was also observed that Pandaloor, Muttathukonam, Kaliethan and Poovanchira types took comparatively lesser time for flowering and harvest. However, there was no significant difference in the bunch maturity period between the seven ecotypes evaluated.

4.2 Yield characters

4.2.1 Effect of ecotype variation on mean bunch weight, number of hands and fingers in banana cv. Nendran

The data on the influence of ecotypes variation on bunch weight, number of hands per bunch, number of fingers per bunch and number of fingers per hand are presented in Table 10.

Table 10. Effect of ecotype variation on mean bunch weight, number of hands and fingers in banana cv. Nendran

Treatment	Mean bunch weight kg plant^{-1}	Number of hands per bunch	Number of fingers per bunch	Number of fingers per hand
T_1	9.450	4.330	38.777	8.960
T_2	11.000	4.833	41.167	8.517
T_3	11.517	5.267	45.000	8.567
T_4	9.717	5.000	40.553	8.110
T_5	10.583	5.000	46.167	9.233
T_6	10.550	6.000	50.083	8.347
T_7	13.383	4.567	35.867	7.893
F-test	**	**	**	NS
CD (0.05)	1.5457	0.4539	3.9962	--

NS Not Significant

** Significant at 1% level

The mean bunch weight per plant was influenced by different ecotypes. The highest bunch weight was recorded in T_7 (13.383 kg) which was significantly superior to all other treatments. This was followed by T_3 (11.517 kg), T_2 (11.000 kg), T_5 (10.583 kg) and T_6 (10.550 kg); the four treatments being statistically on par. However, the treatment T_4 (9.717 kg) differed significantly from T_3 but was on par with T_1 which recorded the lowest bunch weight of 9.450 kg. Thus, the data indicated that Kaliethan produced significantly higher yield compared to all other treatments. Kothala and Puthur types followed Kaliethan in the bunch yield.

The number of hands per bunch was the highest in T_6 (6.000); the treatment being significantly superior to all other treatments. This was followed by T_3 (5.267), T_4 (5.000), T_5 (5.000) and T_2 (4.833); the four treatments being statistically on par. However, the treatment T_7 (4.567) differed significantly from T_3, but was on par with T_1 which recorded the lowest number of hands per bunch (4.330).

Among the types evaluated Chengazhikodan had significantly higher number of hands per bunch followed by Kothala, Poovanchira and Pandaloor. The lowest number of hands per bunch were recorded in Muttathukonam and Kaliethan.

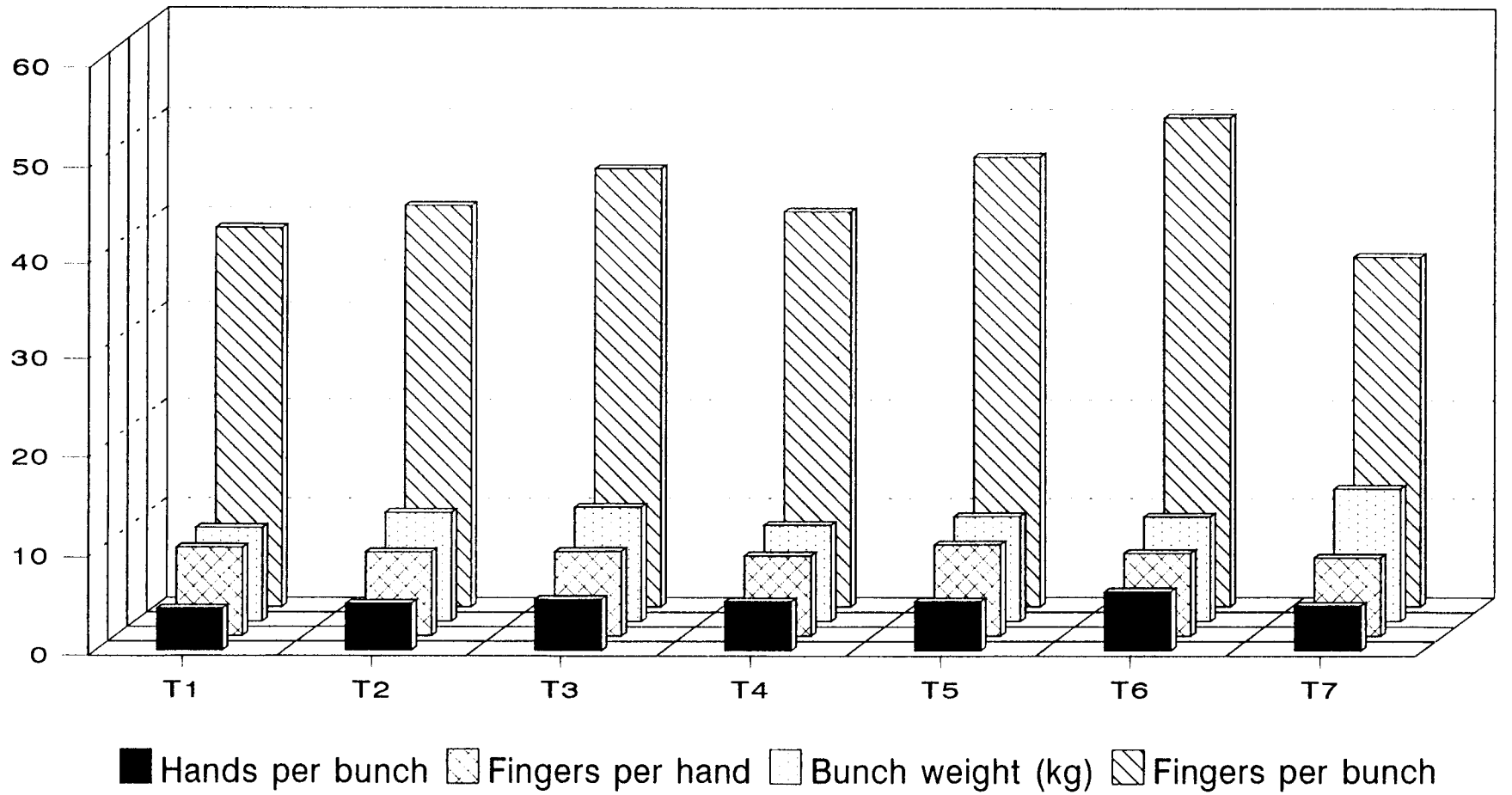


Fig. 4. Effect of ecotype variation on mean bunch weight, number of hands and fingers in banana cv. Nendran

The number of fingers per bunch was the highest in T_6 (50.083) followed by T_5 (46.167); the two treatments being statistically on par. This was followed by T_3 (45.000) and T_2 (41.167); both the treatments being statistically on par. However, the treatment T_2 did not differ significantly from T_4 (40.553) and T_1 (38.777). The lowest number of fingers per hand observed in T_7 (35.867) was statistically on par with T_1.

The data clearly showed that Chengazhikodan and Poovanchira types had significantly higher number of fingers per bunch. Kaliethan and Muthathukonam had the lowest number of fingers per bunch.

The number of fingers per hand did not show any significant difference in different treatments. However, the mean value showed that the highest number of fingers per hand was in T_5 (9.233). This was followed by T_1 (8.960), T_3 (8.567), T_2 (8.517), T_6 (8.347), T_4 (8.110) and T_7 (7.893) Thus, it was observed that Poovanchira, Muttathukonam, Kothala and Puthur types had higher number of fingers per hand and Kaliethan, Pandaloor and Chengazhikodan had lower number of fingers.

Plates 1 & 2. Effect of ecotype variation on the bunch yield of Muttathukonam and Puthur


1 m
·9 m
·8 m
·7 m
·6 m
·5 m
·4 m
·3 m
·2 m
T1
MUTTATHUKONAM


1 m
·9 m
·8 m
·7 m
·6 m
·5 m
·4 m
·3 m
·2 m
T2
PUTHUR

Plates 3 & 4. Effect of ecotype variation on the bunch yield of Kothala, Pandaloor


1·3m
1·2m
1·1m
1m
·9m
·8m
·7m
·6m
·5m
T3
KOTHALA


·9m
·8m
·7m
·6m
·5m
·4m
·3m
·2m
T4
PANDALOOR

Plates 5 & 6. Effect of ecotype variation on the bunch yield of Poovanchira and Chengazhikodan


1 m
·9 m
·8 m
·4 m
·3 m
·2 m
T5
POOVANCHIRA


1·3 m
1·2 m
1·1 m
1 m
·8 m
·7 m
·6 m
·5 m
·4 m
T6
CHENGAZHIKODAN

Plates 7. Effect of ecotype variation on the bunch yield of Kaliethan


1 m
·9 m
·8 m
·5 m
·4 m
·3 m
T7
KALIETHAN

4.2.2 Effect of ecotype variation on fruit characters of banana cv. Nendran

The data on fruit characters under the influence of different ecotypes are given in Table 11.

The data revealed that the mean length of individual finger did not show any significant difference between treatments. However, the mean value showed the highest finger length in T_5 (25.750 cm). This was followed by T_2, T_7, T_3, T_1, T_6 and T_4 with the length of 25.350, 25.200, 24.700, 23.400, 23.100 and 21.600 cm respectively.

There was significant difference in the girth of fruits in various treatments. The mean girth of individual finger was the highest in T_7 (15.400 cm) which was statistically on par with that of T_5 (14.600 cm). However, the treatment T_5 did not differ significantly from T_3 (14.033 cm) and T_4 (13.900 cm). The lowest mean finger girth was observed in T_1 (13.500 cm) followed by T_2 (13.633 cm) and T_6 (13.700 cm). The three treatments were statistically on par with T_4 and T_3. From the data it becomes evident that Kaliethan had significantly higher girth of fingers followed by Poovanchira, Kothala and Pandaloor.

Table 11. Effect of ecotype variation on fruit characters of banana cv. Nendran

Treatment	Finger length (cm)	Finger girth (cm)	Finger weight (g)	Peel weight (g)	Pulp weight (g)	Pulp/peel ratio
T_1	23.400	13.500	154.350	43.250	111.103	2.557
T_2	25.350	13.633	196.100	54.350	142.700	2.627
T_3	24.700	14.033	226.100	62.950	163.150	2.590
T_4	21.600	13.900	182.000	53.600	128.400	2.393
T_5	25.750	14.600	219.433	57.850	161.250	2.787
T_6	23.100	13.700	197.400	56.950	140.400	2.467
T_7	25.200	15.400	247.150	74.100	173.050	2.347
F-test	NS	**	**	**	**	**
CD (0.05)	--	0.8730	28.9334	8.9757	20.6017	0.1750

NS Not Significant

** Significant at 1% level

The mean weight of individual finger was the highest in T_7 (247.150 g) followed by T_3 (226.100 g) and T_5 (219.453 g). The three treatments were statistically on par. However, T_3 and T_5 did not differ significantly from T_2 (196.100 g) and T_6 (197.400 g). The treatment T_2 did not differ significantly from T_4 (184.000 g). The lowest finger weight was observed in T_1 (154.350 g) followed by T_4 and these two treatments were statistically on par. Thus Kaliethan, Kothala and Poovanchira showed higher fruit girth compared to other ecotypes.

The mean peel weight of individual fruits followed the same pattern as that of mean weight of individual fingers. The highest mean peel weight was observed in T_7 (74.10 g) which was significantly higher to all other treatments. This was followed by T_3 (62.95 g) T_5 (57.85 g), T_6 (56.95 g) and T_2 (54.35 g); the four treatments being statistically on par. However, the treatment T_4 (53.60 g) was statistically on par with the latter four treatments. The lowest peel weight was recorded in T_1 (43.25 g) differed significantly from all other treatments. The peel weight was highest in Kaliethan, while the lowest in Muttathukonam types.

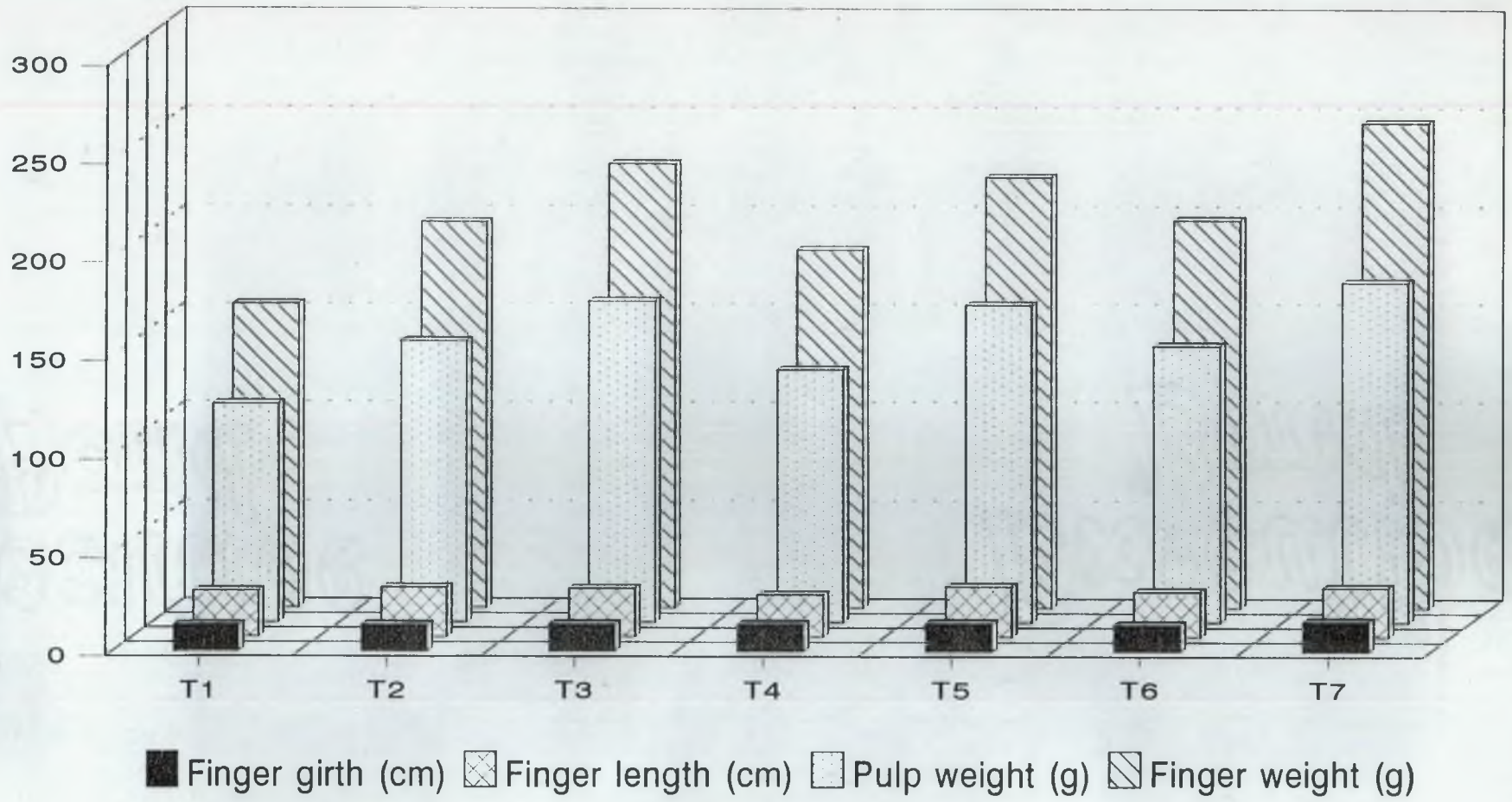


Fig. 5. Effect of ecotype variation on fruit characters of banana cv. Nendran

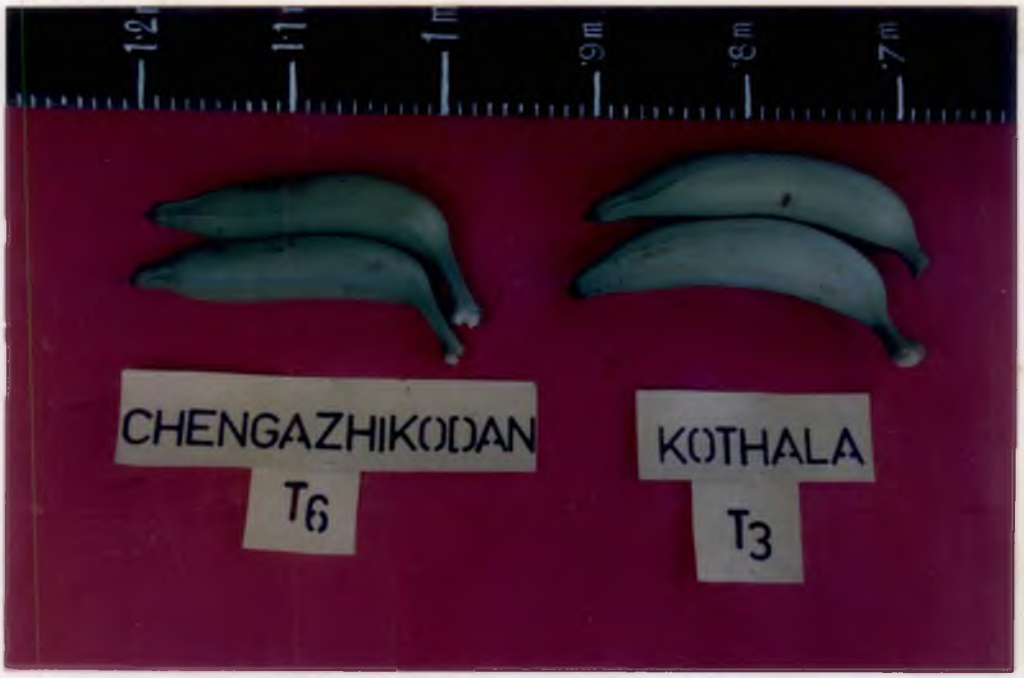
The mean pulp weight of individual fruit was the highest in T_7 (173.05 g) followed by T_3 (163.15 g) and T_5 (161.25 g); the three treatments being statistically on par. The latter two treatments did not differ significantly from T_2 (142.70 g) which was statistically on par with T_6 (140.40 g) and T_4 (128.40 g). The lowest weight of pulp was recorded in T_1 (111.103 g) which was statistically on par with T_4.

The data revealed that pulp weight was higher in Kaliethan, Kothala and Poovanchira types while it was lower in Muttathukonam and Puthur types.

The pulp/peel ratio were the highest in T_5 (2.787) and T_2 (2.627). These two treatments were statistically on par, However, the treatment T_2 did not differ significantly from T_3 (2.590), T_1 (2.557) and T_6 (2.467). The lowest pulp/peel ratio was recorded in T_7 (2.347) followed by T_4 (2.393) and these two treatments were statistically on par with T_6; the former being significantly different from T_1. The pulp/peel ratio was high in Poovanchira and Puthur types while low values were recorded in Kaliethan, Pandaloor and Chenghazhikodan types.

Plates 8 & 9. Effect of ecotype variation on the fruit character of banana cv. Nendran


MUTTATHUKONAM
PUTHUR
T4
PANDALOOR
T5
POOVANCHIRA
T7
KALIETHAN


CHENGAZHIKODAN
T6
KOTHALA
T3

The observation revealed significant variation between Nendran ecotypes in all the fruit characters studied except the length of fingers.

4.3 Quality characteristics of fruits

4.3.1 Effect of ecotype variation on fruit quality of banana cv. Nendran

The effect of different ecotypes observed on quality of fruits of Nendran banana are presented in Table 12.

The data revealed that the treatments significantly influenced the TSS content of the fruit. The highest TSS (30.200 per cent) was observed in T_6, which was significantly superior to all other treatments. This was followed by T_3 (28.000 per cent), T_1 (27.133 per cent) and T_4 (27.000 per cent); the three treatments being statistically on par. However, the treatment T_1 and T_4 did not differ significantly from T_5 (26.333 per cent) and T_2 (26.067 per cent). The lowest TSS content was observed in T_7 (18.000 per cent) which was statistically different from all other treatments.

Table 12. Effect of ecotype variation on fruit quality of banana cv Nendran

Treatment	TSS (%)	Acidity (%)	Total sugars (%)	Reducing sugars (%)	Non reducing sugars (%)	Sugar/ acid ratio	Green life of fruits (days)
T_1	27.133	0.703	21.500	11.933	9.567	31.410	5.000
T_2	26.067	0.770	28.543	13.510	15.033	37.110	6.167
T_3	28.000	0.413	35.093	13.910	21.183	85.543	4.000
T_4	27.000	0.713	22.290	9.553	12.737	31.497	4.000
T_5	26.333	0.409	24.470	11.457	13.013	60.870	5.000
T_6	30.200	0.469	32.330	13.597	18.733	69.097	5.000
T_7	18.000	0.773	23.537	10.823	13.117	30.440	5.000
F-test	**	**	**	**	**	**	**
CD (0.05)	1.0948	0.1328	3.6446	1.4902	3.6314	12.9652	0.5137

** Significant at 1% level

From the data it becomes evident that Chengazhikodan has the highest TSS and Kaliethan has the lowest TSS content among the various types under evaluation.

Acidity of fruit was significantly influenced by different treatments. The acidity was the highest in T_7 (0.773 per cent) followed by T_2 (0.770 per cent), T_4 (0.713 per cent) and T_1 (0.703 per cent). These four treatments were statistically on par. The lowest acidity values were observed in T_5 (0.409 per cent), T_3 (0.463 per cent) and T_6 (0.469 per cent); the three treatments being statistically on par. Thus, it can be noted that Kaliethan, Puthur, Pandaloor and Muttathukonam types had higher acidity compared to Poovanchira, Kothala and Chengazhikodan.

The total sugar content of fruit also showed variation in different treatments. The highest total sugar content was observed in T_3 (35.093 per cent) followed by T_6 (32.330 per cent); these treatments being statistically on par and significantly superior to other treatments. These treatments were followed by T_2 (28.543 per cent) which was significantly different from all other treatments. The lowest content of total sugars was observed in T_1 (21.500 per

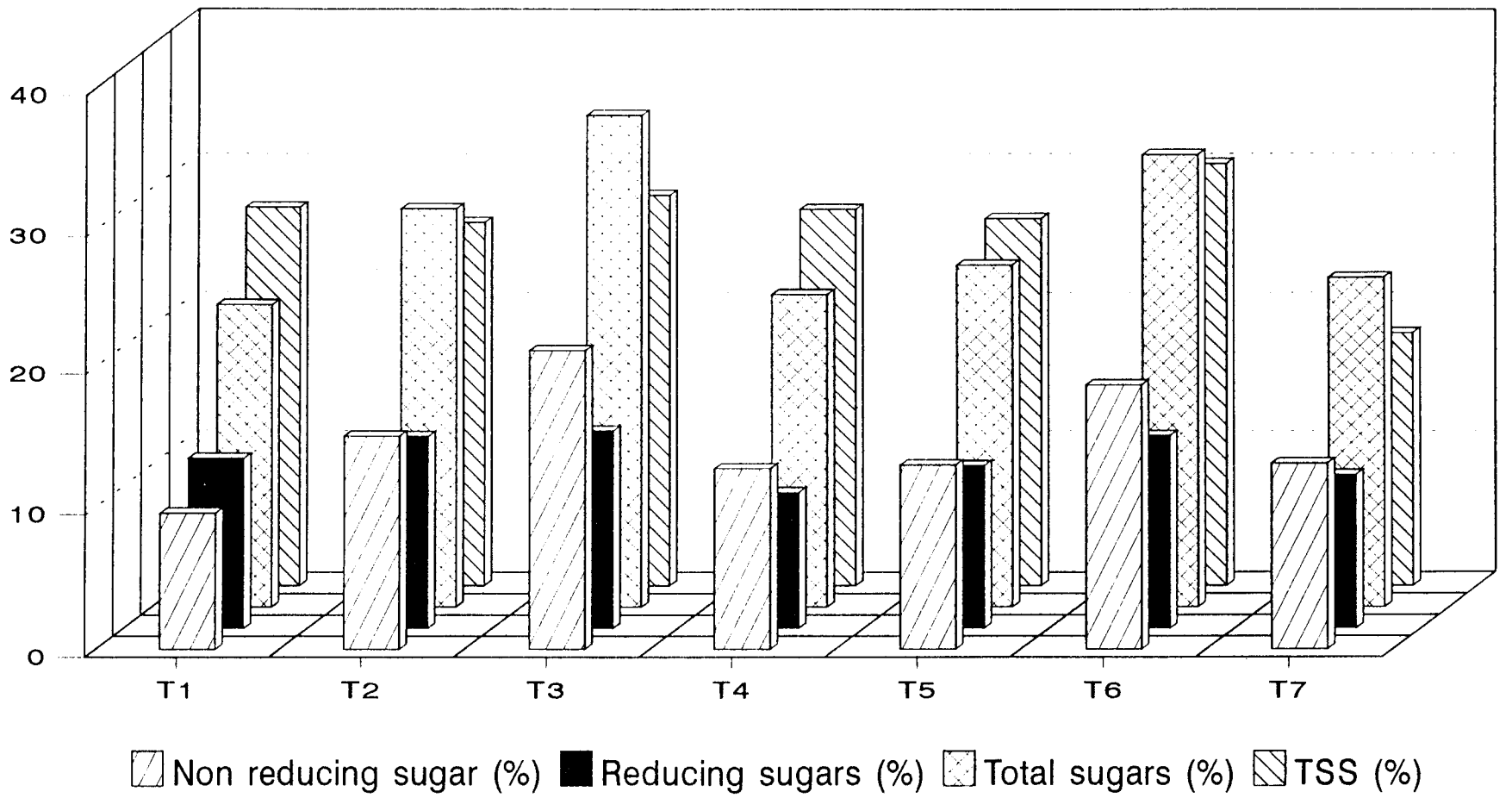


Fig. 6. Effect of ecotype variation on fruit quality of banana cv. Nendran

cent) followed by T_4 (22.290 per cent), T_7 (23.537 per cent) and T_5 (24.470 per cent) and these treatments were statistically on par. Thus, the data revealed that Kothala and Chengazhikodan types had the highest total sugar content while Muttathukonam, Pandaloor, Kaliethan and Poovanchira types had the lowest TSS content.

The reducing sugar content of fruits was the highest in T_3 (13.910 per cent), followed by T_6 (13.597 per cent) and T_2 (13.510 per cent) and these three treatments were statistically on par. The treatment T_1 (11.953 per cent) which followed the above three treatments was statistically on par with T_5 (11.457 per cent). The lowest reducing sugar content was observed in T_4 (9.553 per cent) which was statistically on par with T_7 (10.823 per cent). This leads to the conclusion that reducing sugar content was the highest in Kothala, Chengazhikodan and Puthur types and the lowest in Pandaloor and Kaliethan.

The non reducing sugar content of the fruits was the highest in T_3 (21.183 per cent) and T_6 (18.117 per cent); the two treatments being statistically on par. However, the latter did not differ significantly from T_2 (15.035 per

cent). The lowest content of non reducing sugar was observed in T_1 (9.567 per cent) followed by T_4 (12.737 per cent), T_5 (13.013 per cent) and T_7 (13.117 per cent) and these four treatments were statistically on par. However, the treatments T_4, T_5 and T_7 did not differ significantly from T_2. Thus, Kothala and Chengazhikodan had higher non reducing sugar content while Muttathukonam and Pandaloor types had lower non reducing sugar compared to other treatments.

The sugar acid ratio was the highest in T_3 (85.543) and this treatment was significantly different from all other treatments and superior to others. This treatment was followed by T_6 (69.097) and T_5 (60.870); the two treatments being statistically on par. The lowest values were recorded in T_7 (30.440) followed by T_1 (31.410), T_4 (31.497) and T_2 (37.110) and these four treatments were statistically on par. The data thus indicated that among the various types, Kothala had higher while Kaliethan, Muttathukonam and Pandaloor types had low sugar/acid ratio.

The overall assessment of quality aspects projected the superiority of Kothala and Chengazhikodan over the other types evaluated. Kaliethan was comparatively inferior with respect to quality aspects studied.

4.3.2 Effect of ecotype variation on the green life of fruits of banana cv. Nendran

The data presented on Table 12 revealed that the green life of fruits was significantly influenced by the different ecotypes tried. The fruits from T_3 and T_4 ripened in the shortest period of time (4 days) when kept at room temperature followed by T_1, T_5, T_6 and T_7 (5 days). The treatments T_3 and T_4 differed significantly from T_1, T_5, T_6 T_7 and T_2 (6.167 days) which took the longest period for ripening.

Eventhough statistically significant difference was observed in the green life of fruits in relation to the variation in ecotypes, there was a difference of only around two days between the shortest and longest periods.

4.4 Effect of ecotype variation on the leaf nutrient status (N, P and K) of banana cv. Nendran at flowering and harvest

Data presented in Table 13 shows the content of major nutrient in the sample leaves of different treatments at flowering and harvesting stage expressed as percentage dry weight.

Table 13. Effect of ecotype variation on the leaf nutrient status (N, P and K) of banana cv. Nendran at flowering and harvest

Treatment	Leaf nutrient status (percentage dry weight)					
	At flowering			At harvest		
	N	P	K	N	P	K
T_1	2.520	0.493	2.080	1.923	0.687	2.253
T_2	3.211	0.673	2.427	1.512	0.603	2.133
T_3	3.136	0.550	2.267	1.904	0.893	5.547
T_4	3.136	0.497	2.320	1.363	0.630	2.360
T_5	3.248	0.607	2.240	1.213	0.580	2.667
T_6	1.904	0.527	3.107	1.699	0.697	2.533
T_7	2.371	0.507	2.227	1.661	1.267	1.933
F-test	NS	NS	**	NS	**	**
CD (0.05)	--	--	0.4616	--	0.1707	0.6357

NS Not Significant

** Significant at 1% level

The data revealed that at flowering stage, the nitrogen and the phosphorus contents of the leaves of different treatments did not vary significantly. The highest mean value for nitrogen at flowering was in T_5 (3.248 per cent) followed by T_2 (3.211 per cent), T_3 (3.136 per cent) and T_4 (3.136 per cent) and the lowest in T_6 (1.904 per cent) followed by T_1 (2.520 per cent) and T_7 (2.371 per cent). The phosphorus content at flowering stage was the highest in T_2 (0.673 per cent) followed by T_5 (0.607 per cent) and T_3 (0.550 per cent) while the lowest was in T_1 (0.493 per cent) followed by T_4 (0.497 per cent), T_7 (0.507 per cent) and T_6 (0.527 per cent).

The potassium content of the leaf at flowering was the highest in T_6 (3.107 per cent) which was significantly superior to all other treatments. The lowest potassium content was recorded in T_1 (2.080 per cent) which was statistically on par with T_7 (2.227 per cent), T_5 (2.240 per cent), T_3 (2.267 per cent), T_4 (2.320 per cent) and T_2 (2.427 per cent).

The nitrogen content in the leaf at harvesting stage did not differ significantly with treatments. However,

the mean values showed that T_1 (1.923 per cent) followed by T_3 (1.904 per cent) and T_6 (1.699 per cent) had comparatively higher leaf nitrogen content while the lowest was in T_5 (1.213 per cent) followed by T_4 (1.363 per cent), T_2 (1.512 per cent) and T_7 (1.661 per cent).

The phosphorus and potassium contents of the leaf at harvest varied significantly with treatments.

The phosphorus content of the leaf was highest in T_7 (1.267 per cent) followed by T_3 (0.893 per cent); these two treatments were significantly different from one another and superior to all other treatments. The lowest phosphorus content was recorded in T_5 (0.580 per cent) which was statistically on par with T_2 (0.603 per cent), T_4 (0.630 per cent). T_1 (0.687 per cent) and T_6 (0.697 per cent).

The potassium content of the leaf at harvest observed in T_3 (5.547 per cent) was significantly superior to all other treatments. This was followed by T_5 (2.667 per cent), T_6 (2.533 per cent), T_4 (2.360 per cent), T_1 (2.253 per cent) and T_2 (2.135 per cent); the five treatments being statistically on par. However, the treatment T_7 (1.933 per

cent) differed significantly from T_5 but not from T_2, T_1, T_4 and T_6.

The data revealed that in general, Poovanchira, Puthur and Kothala had higher levels of nitrogen, phosphorus and potassium when compared to other types at flowering though Chengazhikodan had the highest potassium at this stage. However, during the harvest stage Kothala and Chengazhikodan had higher nitrogen, phosphorus and potassium contents compared to other types.

4.5 Biomass production per plant at harvest stage

4.5.1 Effect of ecotype variation on the biomass production of banana cv. Nendran at harvest stage

The effect of ecotype variation on the biomass production presented in Table 14 revealed that this character was influenced by the treatments.

The fresh weight of the corms was the highest in T_3 (16.060 kg) followed by T_5 (14.450 kg); both the treatments being statistically different from one another and superior to other treatments. The treatments T_4 (13.147 kg), T_1

Table 14. Effect of ecotype variation on the biomass production of banana cv Nendran at harvest stage

Treatment	Plant parts (Fresh weight Kg)					Total Fresh weight (kg plant^{-1})
	Corm	Pseudostem	Leaf	Fruit	Peduncle	
T_1	12.580	35.283	6.500	8.617	0.643	63.623
T_2	9.483	24.627	4.490	10.173	0.800	49.573
T_3	16.060	40.373	2.567	9.850	0.877	69.727
T_4	13.147	21.260	2.420	8.543	0.530	45.900
T_5	14.450	25.890	2.470	9.590	0.910	53.317
T_6	8.200	27.250	2.257	10.300	1.623	49.097
T_7	12.453	41.827	4.450	12.883	1.200	72.813
F-test	**	**	**	**	**	**
CD (0.05)	0.9703	2.9025	0.3546	1.3327	0.0992	3.0628

** Significant at 1% level

(12.580 kg) and T_7 (12.453 kg) which followed T_5 were statistically on par. The lowest fresh weight of corms was recorded in T_6 (8.200 kg) followed by T_2 (9.483 kg); the two treatments being statistically different and inferior to other treatments.

The fresh weight of the pseudostem was the highest in T_7 (41.827 kg) followed by T_3 (40.373 kg); both the treatments being statistically on par. This was followed by T_1 (35.283 kg), T_6 (27.250 kg), T_5 (25.890 kg) and T_2 (24.627 kg); the latter three treatments being statistically on par. The lowest fresh weight of pseudostem was recorded in T_4 (21.260 kg) which was significantly inferior to other treatments.

Fresh weight of the leaves was the highest in T_1 (6.300 kg) which was superior to all other treatments. This was followed by T_2 (4.490 kg) and T_7 (4.450 kg); both the treatments being statistically on par. The lowest fresh weight of leaves recorded in T_6 (2.257 kg) was on par with T_4 (2.420 kg), T_5 (2.470 kg) and T_3 (2.567 kg).

Fresh weight of the fruits was the highest in T_7 (12.883 kg) and this treatment was significantly superior to

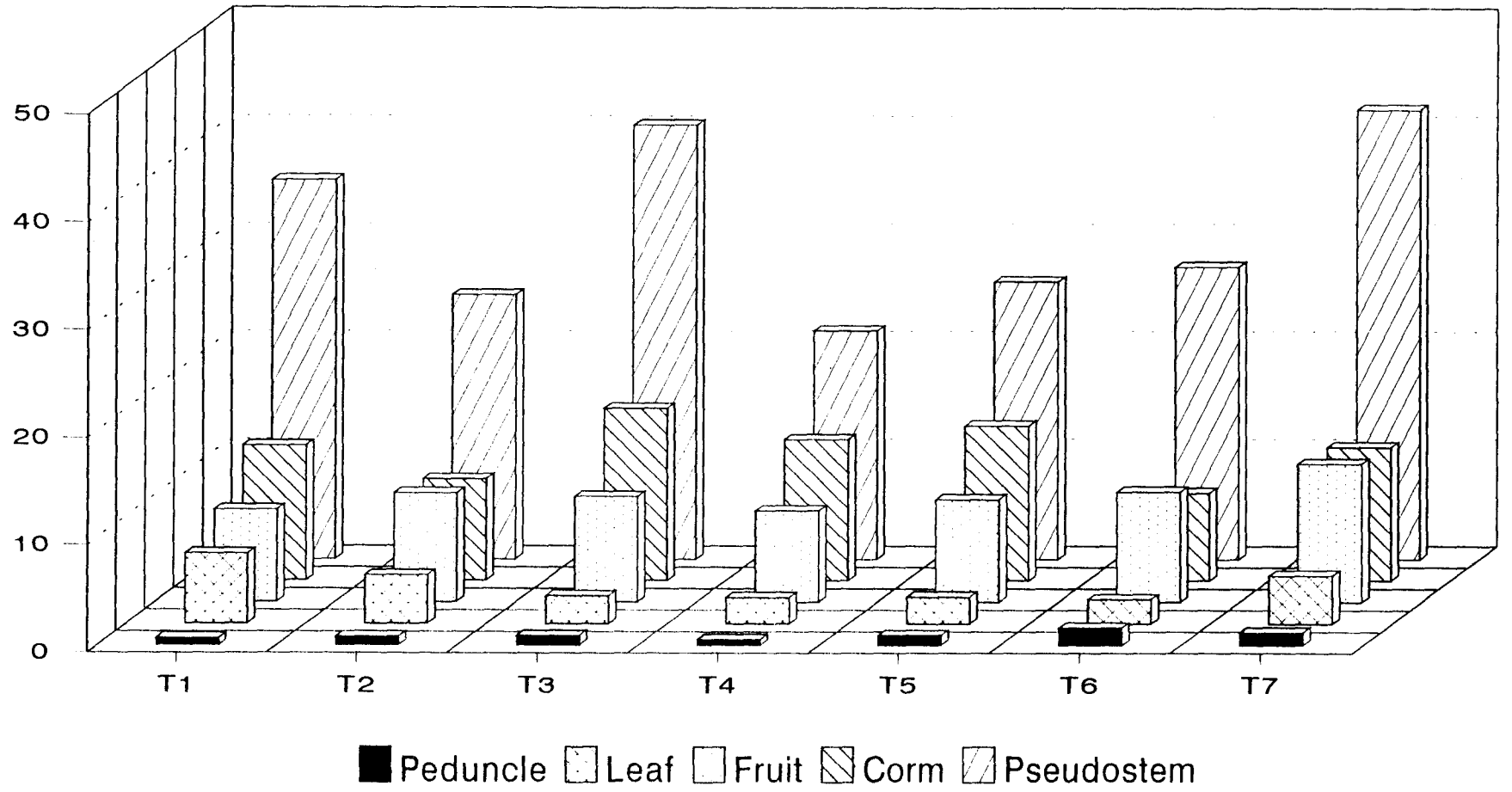


Fig. 7. Effect of ecotype variation on the biomass production of banana cv. Nendran at harvest stage

all other treatments. The treatment T_6, T_2, T_3 and T_5 followed T_7 with the mean fresh weight of 10.300, 10.173, 9.850 and 9.590 kg respectively; the former four being statistically on par. The lowest fruit weight was recorded in T_4 (8.543 kg) and T_1 (8.617 kg); the two treatments being on par with T_5 and T_3.

The peduncle fresh weight was also significantly influenced by various treatments. The treatment T_6 recorded the highest mean value of 1.623 kg followed by T_7 (1.200 kg); the two treatments being statistically different and superior to all other treatments. This was followed by T_5 (0.910 kg) and T_3 (0.877 kg); the two treatments being statistically on par. However T_2 (0.800 kg) did not differ significantly from T_3. The lowest peduncle fresh weight was recorded in T_4 (0.530 kg) followed by T_1 (0.643 kg); the two treatments being statistically different and inferior to all other treatments.

Total plant fresh weight was also influenced by treatments. The highest plant weight was recorded in T_7 (72.813 kg) followed by T_3 (69.727 kg), T_1 (63.423 kg) and T_5 (53.317 kg); the four treatments being statistically

different and superior to other treatments. The lowest plant weight was observed in T_4 (45.900 kg) followed by T_6 (49.097 kg) and T_2 (49.573 kg); the latter two treatments being statistically on par.

It was observed from the data that the fresh weight of corm, pseudostem, leaves, fruits and peduncle were significantly influenced by variation in ecotypes. The data thus indicated that in general, fresh weight of vegetative parts such as corm, pseudostem and leaves was higher in Kothala and Kaliethan and low in Pandaloor, Puthur and Chengazhikodan types while an intermediary level was observed in Poovanchira and Muttathukonam types. The bunch comprising of peduncle and fruits in Kaliethan and Chengazhikodan had higher fresh weight and Muttathukonam and Pandaloor had low fresh weight while Puthur, Kothala and Poovanchira were intermediate. The total fresh weight production was higher in Kaliethan followed by Kothala and lower in Puthur, Chenghazhikodan and Pandaloor while an intermediate level was observed in Muttathukonam and Poovanchira types.

4.5.2 Effect of ecotypes variation on the dry matter production of banana cv. Nendran

Data on the influence of ecotypes variation on the dry matter production are presented in Table 15.

Table 15. Effect of ecotype variation on the dry matter production of banana cv. Nendran

Treatment	Plant parts (Dry weight)					Total Dry weight (Kg plant^{-1})
	Corm (kg)	Pseudo-stem (kg)	Leaf (g)	Fruit (kg)	Peduncle (g)	
T_1	1.297	1.380	959.850	3.120	48.257	6.805
T_2	0.966	1.071	614.770	3.440	62.847	6.154
T_3	0.699	1.4691	464.393	3.357	55.110	6.043
T_4	0.771	1.088	383.370	2.427	45.400	4.714
T_5	1.344	1.074	421.610	2.927	72.077	5.839
T_6	0.499	1.450	350.350	2.893	115.547	5.308
T_7	1.246	1.768	663.627	3.507	84.567	7.269
F-test	**	**	**	**	**	**
CD(0.05)	0.1152	0.0718	29.0409	0.2252	5.8658	0.4009

** Significant at 1% level

The dry weight of the corms was found to be influenced significantly by the treatments; the highest value being 1.344 kg (T_5) followed by 1.297 kg (T_1) both being statistically on par. However T_1 did not differ significantly from T_7 (1.246 kg). Lower values were recorded in T_6 (0.499 kg) followed by T_3 (0.699 kg), T_4 (0.771 kg) and T_2 (0.966 kg), the four treatments being statistically different.

The pseudostem dry weight was influenced significantly by the treatments; the highest being in T_7 (1.768 kg) which was significnatly superior to other treatments. This was followed by T_3 (1.469 kg), T_6 (1.450 kg); the two treatments being statistically on par. However, T_6 did not differ significantly from T_1 (1.380 kg). The lowest values were recorded in T_2 (1.071 kg) followed by T_5 (1.074 kg) and T_4 (1.088 Kg) and these three treatments were statistically on par.

The leaf dry weight was also significnatly influenced by the treatments. The mean values followed the order T_1 (959.850 g), T_7 (663.627 g), T_2 (614.770 g), T_3 (464.393 g), T_5 (421.610 g), T_4 (383.370 g) and T_6

(350.350 g); all the treatments being statistically different from one other.

The dry weight of the fruit computed showed significant variation in different ecotypes. The highest fruit dry weight was recorded in T_7 (3.507 kg) followed by T_2 (3.440 kg) and T_3 (3.357 kg) and all these treatments were statistically on par and superior to other treatments. This was followed by T_1 (3.120 kg), and T_5 (2.927 kg); the two being statistically on par. However, the treatment T_6 (2.893 kg) did not differ significantly from T_5. The lowest fruit dry weight was observed in T_4 (2.427 kg); significantly inferior to all other treatments.

The dry weight of the peduncle was also found to be influenced significantly by the treatments. The mean values followed the order 115.547 g (T_6), 85.567 g (T_7), 72.077 g (T_5), 62.847 g (T_2), 55.110 g (T_3), 48.257 g (T_1), and 45.400 g (T_4); the former five treatments being significantly superior to others and the latter two being statistically on par.

Total dry weight of plants was also influenced by the treatments. The highest dry weight per plant was

observed in T_7 (7.269 kg) and T_1 (6.805 kg); the two treatments being statistically superior to other treatments. The three treatments T_2 (6.154 kg), T_3 (6.043 kg) and T_5 (5.859 kg) that followed T_1 were statistically on par. The lowest values recorded in T_4 (4.714 kg) followed by T_6 (5.308 kg) differed significantly from one another.

In general, it was observed that the dry matter production by different plant parts as well as the whole plants varied with ecotypes.

The dry matter production in the vegetative parts such as corm, pseudostem and leaf was higher in Kaliethan and Muttathukonam, low in Chengazhikodan and Pandaloor while at an intermediate level in Poovanchira, Puthur and Kothala types.

In the bunch, comprising of fruits and peduncle, Kaliethan had higher while Pandaloor had lower dry weight accumulation and the other types were intermediary.

When the total dry weight was considered, Kaliethan and Muttathukonam types had higher level of dry matter accumulation and Chengazhikodan and Pandaloor had lower level

while Puthur, Kothala and Poovanchira types were intermediary.

4.6 Effect of ecotype variation on the incidence of major diseases and pests of banana cv. Nendran

4.6.1 Effect of ecotype variation on sigatoka leaf spot and bunchy top disease in banana cv. Nendran

The data on the incidence of sigatoka leaf spot and bunchy top are presented in Table 16.

The data revealed that the incidence of sigatoka leaf spot was not significant in the different treatments tried. At all stages of plant growth the leaf spot incidence was non significant indicating that the tolerance level of all the ecotypes evaluated was more or less the same. However, the mean values are indicative of a lower level of leaf spot incidence in Chengazhikodan, Kothala and Puthur types compared to others.

All the seven ecotypes evaluated were unaffected by the bunchy top disease. This may be due to the effectiveness of eradication measures adopted.

Table 16. Effect of ecotype variation on sigatoka leaf spot and bunchy top disease in banana cv. Nendran

Treatment	Sigatoka leaf spot disease index				Bunchy top (percentage)
	Juvenile stage	Adult pre floral vegetative stage	Floral initiation stage	Post floral stage	
T_1	negligible	2.000	2.000	2.000	0.000
T_2	negligible	1.667	2.000	2.000	0.000
T_3	negligible	1.333	1.333	1.667	0.000
T_4	negligible	2.333	1.333	2.667	0.000
T_5	negligible	3.000	2.000	2.000	0.000
T_6	negligible	0.333	1.667	1.667	0.000
T_7	negligible	3.000	1.667	1.667	0.000
F-test	---	NS	NS	NS	--
CD (0.05)	---	--	--	--	--

NS Not Significant

4.6.2 Effect of ecotype variation on the rhizome weevil and nematode population in banana cv. Nendran

From the data presented in Table 17, it was noted that the number of banana rhizome weevil (*Cosmopolitus sordidus*) varied significantly among the treatments. The highest weevil count was recorded in T_6 (9.017) which was on par with T_4 (8.833). The incidence of weevil attack was intermediate in T_1 (3.083) and T_5 (1.750). No weevils were observed in three treatments viz, T_2, T_3 and T_7. Thus, the data indicated that rhizome weevil attack was lower in Puthur, Kothala and Kaliethan and higher in Chengazhikodan and Pandaloor types.

The data on the nematode infestation noticed in different ecotypes of Nendran are presented in Table 17.

Statistical analysis of the data showed significant difference in the nematode population between the different ecotypes evaluated.

The population of nematodes in soil was the highest in T_1 (2365.993) followed by T_6 (2169.000), T_2 (1971.000), T_4

Table 17. Effect of ecotype variation on the rhizome weevil and nematode population in banana cv. Nendran

Treatment	Number of rhizome weevils per plant	Nematode population		
		Soil	Root	Total
T_1	3.083	2365.993	1379.993	3745.987
T_2	0.000	1971.000	955.330	2962.330
T_3	0.000	657.000	1587.493	2244.493
T_4	8.833	1873.830	702.330	2576.160
T_5	1.750	1868.663	454.663	2323.330
T_6	9.017	2169.000	623.00	2792.000
T_7	0.000	1548.490	542.330	2090.820
F-test	**	**	**	*
CD (0.05)	0.8403	697.2548	284.3395	802.7885

* Significant at 5 % level

** Significant at 1 % level

(1873.830) and T_5 (1868.663). These five treatments were statistically on par. However, the treatment T_7 (1548.490) did not differ significantly from the latter four treatments. The lowest population of nematodes in the soil was observed in T_3 (657.000) which was significantly different from all other treatments.

The highest nematode population in root samples (1587.493/10 g roots) was observed in the treatment T_3 which was on par with T_1 (1379.993). This was followed by T_2 (955.330) which was on par with T_4 (702.330). However, T_4 did not differ significantly from T_6 (623.000), T_7 (524.330) and T_5 (454.663).

Considering the total count in soil and the roots, the nematode population was the highest in T_1 (3745.987) which was significantly different from all other treatments. The treatment T_7 recorded the lowest total nematode population of 2090.820 which was on par with T_3 (2244.493), T_5 (2323.330), T_4 (2576.160) and T_6 (2792.000). However, the treatment T_2 (2962.330) did not differ significantly from the latter four treatments T_6, T_4, T_5, and T_3. The data indicated that the nematode association and infestation

varied significantly between the different ecotypes. The total nematode count was the lowest in Kaliethan and the highest in Muttathukonam types. The extent of root infetation was low in Poovanchira, Kaliethan and Changazhikodan, intermediate in Pandaloor and Puthur and high in Muttathukonam and Kothala types.

4.7 Correlation studies in `Nendran' ecotypes

The estimates of correlations between bunch yield and nine biometric characters in `Nendran' ecotypes are given in Table 18.

The height of the plant at the post floral stage though showed a positive correlation with all the biometric characters except leaf area duration (-o.0721), the effect was not significant.

The girth of the pseudostem at floral initation stage showed a negative association though not significant with the biometric characters and bunch yield (-0.0430) of the Nendran ecotypes.

Table 18. Phenotypic correlation matrix of different biometric characters in `Nendran' ecotypes

Sl. No.	Characters height	Girth	LAD	Time taken for flowering	Crop duration	No. of hands/ bunch	No. of fingers/ bunch	Girth of fingers	Weight of fingers	Bunch yield
1.	Height (post floral stage)	0.0432	-0.0721	0.2343	0.2390	0.0732	0.2811	0.0800	0.3949	0.1715
2.	Girth (floral initiation stage)		-0.1138	-0.1138	-0.2441	0.0839	-0.0441	-0.2531	-0.0910	-0.0430
3.	LAD			0.0730	0.2152	-0.1430	-0.4010	0.6341**	0.679**	0.8097**
4.	Time taken for flowering				0.9592**	0.6296**	0.5333*	0.3267	0.1683	0.0613
5.	Crop duration					0.6090**	0.4938*	-0.1742	0.3071	0.1716
6.	No. of hands/bunch						0.7974**	-0.1529	0.1322	-0.0185
7.	No. of fingers/ bunch							0.3149	0.0233	-0.1095
8.	Girth of fingers								0.6258**	0.7050**
10.	Bunch yield									0.6736**

* Significant at 5 per cent level ** Significant at 1 per cent level

Highest positive correlation with bunch yield was shown by leaf area duration (+0.8097). The girth of the fingers (+0.6341) and weight of the fingers (+0.6790) were also positively associated with leaf area duration. The association of leaf area duration with time taken for flowering (+0.0730) and crop duration (+0.2152) though positive was not significant. LAD was negatively correlated with number of hands/bunch (-0.1430) and number of fingers/bunch (-0.4010).

Time taken for flowering though showed a significant positive association with crop duration (+0.9592) and number of hands per bunch (+0.6296) and number of fingers per bunch (+0.5333), its association was not significant with bunch yield (+0.0613).

Another character that significantly influenced number of hands per bunch and number of fingers per bunch was crop duration (+0.6090 and +0.4938 respectively). Association of crop duration with bunch yield though positive (+0.1716), did not attain the level of significance.

Number of hands per bunch showed a highly significant positive association with number of fingers per

bunch (+0.7974) but was negatively correlated with girth of fingers (-0.1529) and bunch yield (-0.0186).

Total number of fingers per bunch was seen to have a negative association with bunch yield (-0.1905), but its association was positive with girth of fingers (+0.3149) and weight of fingers (+0.0233), though not significant.

Next to leaf area duration, the characters that showed highly significant positive correlation with weight of finger and bunch yield was girth of finger (+0.6258 and +0.7050 respectively). This was followed by weight of fingers (+0.6736).

The results indicated highly significant positive correlation between yield of banana on one hand and three biometric characters viz. leaf area duration, girth of fingers and weight of fingers.

Path analysis in `Nendran' ecotypes

Path coefficient is a standardised regression coefficient and it indicates the changes in the dependent

variable for a given changes in the appropriate independent variable with all the remaining variable controlled and held constant.

Path analysis at the phenotypic level was carried out using the characters like height of the plant at post floral stage, girth of the plant at floral intiation stage, leaf area duration, time taken for flowering, crop duration, number of hands per bunch, number of fingers per bunch, girth of fingers and weight of finger as causes with bunch yield as the effect.

The phenotypic correlation coefficient of the above component characters with bunch yield were partitioned into direct and indirect effects.

The direct and indirect effect of different biometric characters on bunch yield were estimated by path analysis technique and the results are presented in Table 19.

The results indicated that leaf area duration was the most important factor contributing to variation in yield of banana (0.7758). The direct effect of this factor on yield was very high. This was followed by finger girth

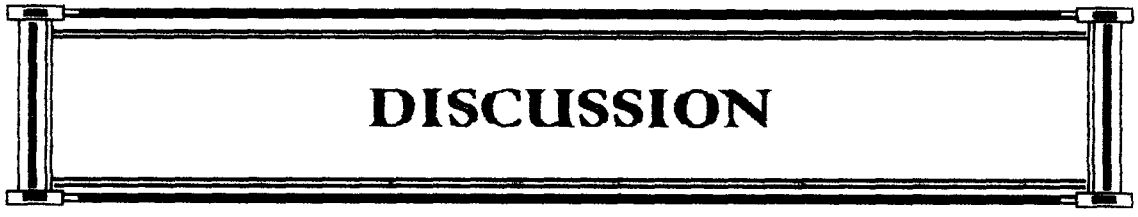
Table 19. Direct (Diagonal) and indirect effects (columns) of different biometric characters of yield of `Nendran' ecotypes

Sl. No.	Characters	Height	Girth	LAD	Time taken for flowering	Crop duration	No. of hands/ bunch	No. of fingers/ bunch	Girth of fingers	Weight of fingers	Total
1.	Height	0.1740	0.0058	-0.0560	0.0729	-0.0565	-0.0064	0.0704	0.0376	-0.0703	0.1715
2.	Girth	0.0075	0.1339	-0.0856	-0.0354	0.0577	-0.0073	-0.0110	-0.1190	0.0162	-0.0430
3.	LAD	-0.1226	-0.0148	0.7758	0.0227	-0.0509	0.0125	-0.1004	0.2983	-0.1209	0.8097
4.	Time taken for flowering	0.0408	-0.0152	0.0566	0.3110	-0.2267	-0.0551	0.1336	-0.1537	-0.0300	0.0613
5.	Crop duration	0.0416	-0.0327	0.1669	0.2983	-0.2363	-0.0533	0.1237	-0.0819	-0.0547	0.1716
6.	No. of hand/ bunch	0.027	0.0112	-0.1110	0.1958	-0.1439	-0.0876	0.1997	-0.0719	-0.0235	-0.0185
7.	No. of fingers/ bunch	0.0489	-0.0059	-0.3111	0.1658	-0.1167	-0.0698	0.2505	-0.1481	-0.0041	-0.1905
8.	Girth of fingers	0.0139	-0.0339	0.4919	-0.1016	0.0412	0.0134	0.0789	0.4704	-0.1114	0.7050
9.	Weight of fingers	0.0687	-0.0122	0.5268	0.0523	-0.0726	-0.0116	0.0058	0.2944	-0.1780	0.6736

(0.4704), time taken for flowering (0.3110), number of fingers par bunch (0.2505), height of the plant (0.1740) and girth of the plant (0.1339). The direct effects on bunch weight and components such as crop duration (-0.2363), number of hands per bunch (-0.0876) and weight of fingers (-0.1780) were negative. The positive indirect effects of these traits through other characters are high thereby explaining the high genotypic correlation with bunch weight. Crop duration was found to have a positive indirect effect on bunch yield through time taken for flowering (0.2983), LAD (0.1669), number of fingers per bunch (0.1237) and height of the plant (0.0416). Similarly, number of hands per bunch is having positive indirect effect on bunch weight through number of fingers per bunch (0.1997), time taken for flowering (0.1958), height of the plant (0.0127) and girth of the plant at floral initiation stage. The positive indirect effect of weight of fingers on bunch weight is through LAD (0.5268), number of fingers per bunch (0.2944), height of the plant (0.0687), time taken for flowering (0.0523) and number of hands per bunch (0.0058).

The other positive indirect effects include :

The above results indicate that improvement in leaf area duration, girth of finger, time taken for flowering, number of fingers per bunch, height of the plant at post floral stage and girth of the plant at floral initiation will result in increased bunch weight in banana.


DISCUSSION

DISCUSSION

Banana is grown under varying soil and climatic conditions exploiting the wide varietal variability that exists in the crop. In south India, the cultivation of `Nendran' is concentrated mainly in the state of Kerala. Nendran banana is reported to exhibit clonal and ecotype variation with respect to growth and yield. Nayar (1962) reported several ecotypes of `Nendran' in different parts of Kerala. These ecotypes showed slight difference in their growth and yield. (Anon., 1990b).

The clonal variation studies in Nendran in progress at Banana Research Station, Kannara show that the ecotypes selected from Muttathukonam, Kothala, Pandaloor, Puthur, Poovanchira area are superior to 139 other clones selected from different parts of Kerala. (Anon., 1987 and Anon., 1990c). Further studies to evaluate the performance of different `Nendran' ecotypes have proved the superiority of six of them in central region of Kerala over Kaliethan which is the conventional ecotype of southern parts of Kerala viz. Thiruvananthapuram and Kollam districts.

The present investigation was carried out to study the effect of ecotype variations on growth, yield and quality of `Nendran' banana, so as to determine the ecotype suitable for the southern tracts of Kerala. The different characters were critically observed and the results obtained are discussed below:

5.1 Vegetative characters

5.1.1 Effect of ecotype variation on the height of banana cv. Nendran

The present studies revealed that the height of the plants varied significantly among the different `Nendran' ecotypes evaluated. Among the various ecotypes, plant height at flowering was the lowest in Pandaloor, Muttathukonam, Chengazhikodan and Kaliethan while the highest plant height was recorded in Kothala, Poovanchira and Puthur types.

Variation in growth characters such as plant height, girth etc. among different clones of banana was reported by Jacob (1952), Malik *et al.* (1966), Singh *et al.* (1977), Kothawade *et al.* (1985), Danniells and O' Farrel (1988), Sato (1988), Valsalakumari and Nair (1990), George

et al. (1991) and Ram *et al.* (1994) under different agroclimatic situations. However, there are only limited information available on the extent of variation on growth and yield characters of different ecotypes within a clone.

The ecotypes of `Nendran' showed slight differences in their growth and yield characters. (Anon., 1990b). In `Palayankodan', Rajeevan and Geetha (1984a and b) and Rajeevan (1985) observed significant differences in morphological characters among the accessions evaluated. The above two reports are in agreement with the results of the present study indicating possibility of ecotype variation with respect to vegetative characters such as plant height.

5.1.2 Effect of ecotype variation on the girth of banana cv. Nendran

The present studies revealed that till the adult pre-floral vegetative stage, the ecotypes did not show significant difference in plant girth. Among the types studied, Chengazhikodan, Poovanchira and Kothala recorded the highest plant girth compared to other types at flowering time.

Inter clonal variations in girth of plants in banana was reported by Balakrishnan (1980), George *et al.* (1991) and Uthiah *et al.* (1992) in different agro-climatic regions. Ram *et al.* (1994) have observed genomic differences in the growth of banana plants. However, there are only a few reports available in relation to intra clonal variations with respect to plant girth in banana.

Nayar *et al.* (1979) and Sreerangaswamy *et al.* (1980) reported that banana, though clonally propagated shows significant variation in vegetative characters such as plant girth within the population.

Slight variations in growth characters in `Nendran' banana due to intraclonal variations was reported by Anon. (1990b). Rajeevan (1985) also observed significant variations in plant girth of accessions of banana variety `Palayankodan' during the later stages of growth both in plant crop and the first ratoon. The differences were significant at the time of shooting. These reports are in agreement with the results of the present studies supporting variation in plant girth under the influence of ecotype differences during the period till shooting.

5.1.3 Effect of ecotype variation on the number of leaves of banana cv. Nendran

The data revealed that though during different stages of growth there was difference in the leaf production, the total number of leaves produced did not vary significantly among the treatments. However, the total number of leaves produced in various treatments showed only a range of 28.080 to 31.303.

Summerville (1939), Turner (1971), Champion (1961) and Jagirdir *et al.* (1963) have found that leaf production in banana is influenced by environmental factors and nutrition. Champion (1961), Barker and Steward (1962) and Turner (1970) reported that the number of leaves emerged before the onset of flowering may be subject to variation whereas the leaves remained in the pseudostem was fairly constant. There was varietal variation in the total number of leaves produced. Clonal variation with respect to the number of leaves produced in Cavendish sub group was observed by Flores *et al.* (1985). These reports support the variation in the number of leaves produced during various stages of growth observed in the present studies. It was also observed from the present

studies that though there was no significant difference in the number of leaves, about three additional leaves on an average were produced in Kothala type which had the highest number of total leaves compared to Muttathukonam type which recorded the lowest number. From the studies on similar lines in the accessions of banana cv. `Palayankodan', Rajeevan (1985) observed significant difference in total number of leaves produced. Studies on variation within Cavendish subgroup by Flores *et al.* (1985) also showed difference in the number of leaves produced among different clones. Thus the present findings are in agreement with earlier studies in similar lines.

5.1.4 Effect of ecotype variation on the *phylacron* of banana cv. Nendran

The studies indicated that in Chengazhikodan, Poovanchira, Puthur and Kothala types, the interval of leaf production was lower during the juvenile stage and adult pre-floral vegetative stage showing significant difference between the various treatments. During floral initiation stage and thereafter till flowering, there was no significant difference in the phylacron among the various types.

In a healthy banana plant, one leaf per 7-10 days may be taken as a rough general figure for the rate of leaf production in tropical region (Anon, 1951). The rate of leaf production may vary with temperature (Ticho, 1960 and Turner, 1970), plant age (Champion, 1961), wind speed and relative humidity (Turner, 1971) and genome constitution (Nambisan, 1972). One or more of the above factors might have influenced the rate of leaf production during the different growth stages of the ecotypes as observed in the present studies. Significant differences in phylacron of `Palayankodan' accessions were observed by Rajeevan (1985) also, as observed in the present studies during juvenile and adult pre-floral vegetative phases. However, during the flower initiation stage and thereafter till flowering, there was no significant difference in phylacron among the various treatments. The interval of leaf production recorded in the present studies was roughly a week which is in agreement with the earlier reports.

5.1.5 Effect of ecotype variation on leaf longevity of banana cv. Nendran

The longevity of leaves varied significant among the treatments. Longevity of leaves was the highest in

Chengazhikodan and Muttathukonam types; the latter being statistically on par with Pandaloor type; The shortest longevity of leaves was recorded in Kothala and Poovanchira types which were statistically on par with leaf longevity of other types.

In the tropics, the leaf longevity of banana is reported to vary between 55 to 165 days depending on varietal and environmental variation (Charpentier and Martin-Prevel, 1965, Turner, 1970).

Rajeevan (1985) observed that in different accessions of `Palayankodan', leaf longevity did not differ significantly and this observation does not agree with the results of the present study. In the present study, it was observed that the total number of leaves though did not differ significantly among the ecotypes, was lower in Chengazhikodan, Pandaloor and Muttathukonam types, indicating lower leaf area. At the same time, the longevity of leaves was higher in them. Thus it appears that in general there may be an inverse relationship between the leaf area present and the longevity of leaves in banana. This is supported by the reports of Bindhu (1995) who observed that the longevity of leaves, increased with decrease in leaf area in banana.

5.1.6 Effect of ecotype variation on the leaf area duration of banana cv. Nendran

The results indicated that there was significant difference in the leaf area duration (LAD) among the ecotypes studied. Kaliethan had higher LAD followed by Puthur type. Muttathukonam had the lowest (LAD) followed by Pandaloor, Poovanchira, Chengazhikodan and Kothala types were intermediary with respect to LAD.

According to Nambisan and Rao (1980), LAD is influenced by the genomic constitution of the variety and ploidy level. Nendran variety used in the present study being a triploid and having contribution of balbisiana genome may have higher LAD compared to diploid accuminata. However ecotype variations in LAD had not been studied in detail in the variety. In the present experiment, correlation studies indicated that girth and height of plants are negatively correlated with LAD in `Nendran'. In general, Kaliethan had low height and girth in the floral initiation stage while Muttathukonam had high plant height and girth at this stage. These influence may be the reason for higher LAD in Kaliethan compared to Muttathukonam type.

5.1.7 Effect of ecotype variation on the leaf area index of banana cv. Nendran

The studies indicated that during the early vegetative growth phase there was no significant difference between treatments with respect to the leaf area index. It was also observed that LAI varied among the ecotypes in different stages of growth. In the later stages of growth Chengazhikodan and Kothala recorded the highest LAI values while Kaliethan, Pandaloor and Puthur types recorded low LAI.

Varietal level variation in LAI in banana was reported by Balakrishnan (1980), Rao and Edmunds (1985). However, ecotype level variation in LAI is not found reported in banana. In the present studies it was observed that there is variation in the number of leaves produced among the ecotypes in different stage of growth. Since the land area occupied by each plant is the same, the variation in LAI may be due to the changes in the number of leaves produced in different stages of growth. This view is supported by the earlier findings by Balakrishnan (1980) who observed that high LAI coincide with the stages of growth when the plant produced high leaf area and number.

5.1.8 Effect of ecotype variation on the monthly growth rate of banana cv. Nendran

The results indicated that the ecotypes evaluated showed significant variation in the growth rate in terms of height during early and late stages of growth. However there was no significant difference in the growth rate from fourth to sixth months after planting Kaliethan had higher growth rate during late vegetative growth stage. Similar variation in growth rate of banana in different stages of growth was reported by Stover and Simmonds (1987). These variations are expressed in terms of height, girth and number of leaves produced. In banana, increment in height and girth are related to production of new leaves and phylacron (Stower and Simmonds, 1987). In the present studies, it was observed that the number of leaves produced vary significantly in early vegetative growth stage and later stages of growth till flowering while there was no significant difference in leaves per plant in the floral initiation stage. These variations in leaf production might have influenced the monthly rate of increase in height as observed in the early studies. Kaliethan had shorter phylacron and more number of leaves at the early growth stages. This might have resulted in high growth rate at these stages.

5.1.9 Effect of ecotype variation on the number of suckers produced in banana cv. Nendran

The studies revealed that there was no significant difference among the ecotypes with respect to the number of suckers produced. The mean number of suckers produced varied from 7.36 to 9.33 among the ecotypes.

According to Venkataramani (1946), Gregory (1954) and Shanmugavelu and Balakrishnan (1980) the factors influencing sucker production are genome and ploidy level. According to Stover and Simmonds (1987) acuminata cultivars produced more number of suckers compared to balbisiana. The results of the present studies thus indicate that ecotype variations are not strong enough to bring out variation in sucker production. The number of suckers recorded per plant in various treatments in the present study is in agreement with the results of several studies in Nendran on sucker production.

5.1.10 Effect of ecotype variation on time taken for flowering and harvest of banana cv. Nendran

The studies indicated that the time taken for flowering varied significantly among the treatments. The

time for flowering was the shortest in Pandaloor, followed by Muttathukonam, Kaliethan and Poovanchira types. The longest duration for flowering was observed in Chengazhikodan followed by Kothala and Puthur types.

Von Loesecke (1950), Simmonds (1959) and Sanchez (1971) have reported the influence of varietal characters and growing conditions on the time taken for flowering in banana. Emergence of a fixed number of leaves (Ticho, 1960, Champion, 1963 and Wardlaw, 1972) and number of leaves remaining within the pseudostem (Summerville, 1944 and Champion, 1961) and attainment of a specific Ts value (Summerville, 1944, Pillai and Shanmugavelu, 1976) have been correlated with flower emergence in banana. Flower initiation was delayed in banana plants with decrease in functional leaves (Hartman and Bailey, 1929, Pillai and Shanmugavelu, 1977 and Sathyanarayana, 1985).

In the present studies, uniform growing conditions were provided for the plants in different treatments. Therefore, these factors might not have influenced flower initiation. The vegetative growth in terms of plant height and leaf area duration did not significantly influence the

time taken for flowering as observed in correlation studies. Girth of the plants was negatively correlated with time for flowering. From the above observations, it appears that differences in growth and flowering in the treatments is brought about by the differences in their growth and development physiology apparently influenced by variation in their genetic make up rather than the external factors.

The results of time taken for harvest indicated that there was no significant difference between the treatments. Muttathukonam, Pandaloor, Kaliethan and Poovanchira type took comparatively lesser duration for harvest compared to Chengazhikodan, Kothala and Puthur types. The bunch maturity period varied by only about eight days between the highest and the lowest values recorded.

Eventhough varietal variations are reported with respect to bunch maturity time leading to differences in the time taken for harvest (Warner *et al.*, 1974, Singh 1976, Daniells and O'Farrel 1988) not much information is available on the intra clonal variations on time for bunch maturity in banana.

The present studies showed no significant variation in bunch maturity period due to ecotype variation. The values recorded for the time for bunch maturity in the different ecotypes tally with the general value of 80 to 90 days for maturity of `Nendran' bunches. Thus the present studies indicate that the ecotype variations are not strongly reflected in the time taken for bunch maturity.

5.1.11 Effect of ecotype variation on crop duration of banana cv. Nendran

The results of the study indicated that the total crop duration was the shortest in Muttathukonam followed by Pandaloor, Kaliethan and Poovanchira types and longest in Chengazhikodan followed by Puthur and Kothala types.

Variation in crop duration due to varietal differences is a well established fact, but within the clones, there are not much information available on such variations. In the present studies, it was observed that the bunch maturity period did not vary significantly among the various types evaluated. However, it was observed that the crop duration followed more or less the trend observed with

respect to time taken for flowering. This indicated that the factors influencing the time for shooting might have influenced the crop duration also. This is evidenced by the highly positive correlation observed between the above two factors. Studies on clonal variation in `Nendran' conducted at Banana Research Station, Kannara also showed variation in crop duration (Anon, 1984a&b and 1987). In the banana variety Palayankodan, Rajeevan (1985) observed difference in crop duration among the accessions collected from different localities. The results of the present studies are therefore in agreement with the above findings.

5.2 Yield characters

5.2.1 Effect of ecotype variation on the bunch weight of banana cv. Nendran

Among the different ecotypes, Kaliethan recorded significantly higher bunch weight. This was followed by Kothala, Puthur, Poovanchira and Chengazhikodan and there was no significant difference in bunch weight among these four types. The lowest bunch weight recorded in Muttathukonam type did not differ significantly from that of Pandaloor type.

The studies in clonal variation in Nendran (Anon., 1987) revealed that the clones show difference in their performance in changes agroclimatic situations. Under Trissur conditions, Chengazhikodan, a type of the locality showed better performance than others. Manjeri Nendran was suggested as suited for humid tracts of the state. In the present studies, Kaliethan being a local type better adopted to the agro-climatic situations of Thiruvananthapuram had out yielded the other ones. Puthur, Poovanchira and Chengazhikodan types belonging to Trissur and close by localities showed more or less same yield trend. Kothala type belonging to Quilon district closer to Thiruvananthapuram has shown better yield potentialities next to Kaliethan. The above types were more or less uniform in bunch weight. This indicates that though Kaliethan had better adaptability to Thiruvananthapuram area the other types can also possibly perform well in this tract once they become better adapted to the local agro-climatic situations. Similar variations in bunch weight were reported earlier in `Nendran' (Anon., 1982, 1984a and b) and in `Palayankodan' (Rajeevan, 1985).

In other crops such as apple, dahlia and chrysanthemum (Chandrasekharan and Parthasaradhy, 1975)

observed similar variations due to environmental factors. Prasanna and Aravindakshan (1990) also attributed such variations to environmental factor. Thus the present variations observed in bunch weight may be due to the environmental effects rendering an advantageous position to the local type which is better adapted to the local situation. It is also note worthy that Poovanchira, Puthur, Chengazhikodan and Kothala types, under continued cultivation in the locality may be able to perform equally to Kaliethan.

5.2.2. Effect of ecotype variation on the number of hands per bunch in banana cv. Nendran

The highest number of hands per bunch recorded in Chengazhikodan was significantly higher than all other treatments. This was followed by Kothala, Pandaloor, Poovanchira and Puthur types; the four being statistically on par. The lowest number of hands recorded in Muttathukonam type did not differ significantly from Kaliethan.

Similar studies conducted on `Nendran' banana showed that there is no significant difference in the number of hands per bunch among the different types (Anon., 1984a,

1987, 1989). However, Shanmugavelu *et al.* (1992) has reported variation in number of hands per bunch in `Nendran' clones and Rajeevan and Mohanakumaran (1993) in accessions of `Palayankodan'. The variation in the response of ecotype variations observed in the present study seem to be due to the difference in the environment in the place of growing and the places of their origin. This view is supported by Simmonds (1960) also, who has reported that the number of hands per bunch in banana is affected by environmental factors.

5.2.3 Effect of ecotype variation on the number of fingers in banana cv. Nendran

The present studies revealed that the number of fingers per bunch differed significantly among the ecotypes of `Nendran'. Chengazhikodan and Poovanchira types had significantly higher number of fingers per bunch while Kaliethan and Muttathukonam types had significantly lower number of fingers per bunch and the other types studied were intermediary on the number of fingers per bunch.

Clonal variation studies on `Nendran' conducted at Banana Research Station, Kannara (Anon., 1984a, 1987) also

showed such variations in the number of fingers per bunch. A comparative evaluation of Cavendish banana mutants (George *et al.*, 1978) showed variation in the number of fingers per bunch. In a similar study on `Palayankodan' accessions, Rajeevan and Mohanakumaran (1993) also observed that the number of fingers per bunch varied. Thus, the above findings support the results obtained from the present studies.

5.2.4 Effect of ecotype variation on the fruit characters of banana cv. Nendran

The present study revealed significant variation in all the fruit characters studied except length of fruits. Among the various types, mean values for fruit girth, fruit weight, peel weight and pulp weight were higher in Kaliethan, Kothala and Poovanchira types. Muttathukonam and Pandaloor types in general, recorded the lowest mean values with respect to the above characters. The pulp/peel ratio was lower in Kaliethan, Pandaloor and Chengazhikodan while higher in Poovanchira and Puthur types.

Variation in fruit characters such as length and girth of fingers due to changes in ecological situation on

Dwarf Cavendish banana was observed from the studies of Lodh *et al.* (1971) and Venkatarayappa and Narisimhan (1975). Studies on clonal variation in `Nendran' (Anon., 1984b and 1989) also showed variation in finger weight and pulp/peel ratio among the different types. Similar variation in length, girth and weight of fingers in different accessions of `Palyankodan' was observed by Rajeevan (1985) and Rajeevan and Mohankumaran (1993). The above findings are in agreement with the results of the present study indicating possibility of variation in different fruit characters due to ecotype variation.

5.3 Quality characteristics of fruits

5.3.1 Effect of ecotype variation on the fruit quality of banana cv. Nendran

The present studies indicated significant difference in the fruit quality of different ecotypes. Chengazhikodan followed by Kothala, Muttathukonam and Pandaloor types had higher TSS content compared to other types. Chengazhikodan, Kothala and Poovanchira types had significantly lower acidity. Total sugar, reducing sugar and

non reducing sugar content of the fruits were significantly higher in Kothala, Chengazhikodan and Puthur types. Sugar/acid ratio was significantly lower in Kothala, Poovanchira and Kothala types compared to others. The green life of fruits was significantly high is Kothala and Pandaloor types. Thus an over all assessment of fruit quality projected the superiority of Kothala and Chengazhikodan type over the others.

Studies on similar lines conducted at Banana Research Station, Kannara, have indicated variation in fruit quality in terms of TSS, acidity, total sugars, sugar/acid ratio among the `Nendran' types collected from different localities and grown under uniform conditions (Anon, 1984 a). In the accessions of `Palayankodan', variation in TSS, total sugars and reducing sugars was reported by Rajeevan (1985) and Rajeevan and Mohanakumaran (1993). The results of the present study are thus supported by the findings from research works in similar lines.

5.4 Effect of ecotype variation on the leaf nutrient status (N, P and K) of banana cv. Nendran at flowering and harvest

The present studies did not show any significant difference in the leaf nitrogen content of flowering or

harvest stage. The phosphorus content also did not show any significant difference at flowering time. The phosphorus content at harvest and potassium content at both the above stages showed significant variation among the treatments. In general, it was observed that Poovanchira, Puthur and Kothala types had higher levels of N, P and K at flowering time though Changazhikodan had the highest potassium content. However, during harvest stage Kothala and Chengazhikodan had higher N, P and K content compared to other types.

Research reports on ecotype variation in nutrient uptake in banana is very scanty. However, there are several reports on the leaf nutrient status of banana in various stages of growth . The present studies indicated that in general the nitrogen content of leaves decreased from flowering to harvest stage while phosphorus and potassium content increased irrespective of ecotype variation. Similar trends were observed by Croucher and Mitchell (1940), Summer Ville (1944), Hewitt (1955) and Sheela and Aravindakshan (1990) in different banana varieties such as Poovan, Lacatan Robusta and Palayankodan thus supporting the changes in the content of major nutrients observed on the present study. The present study also showed that among the three major

nutrients, uptake of potassium was the highest in all the ecotypes. This finding is supported by the study of Sheela and Aravindakshan (1990) in `Palayankodan'. The nutrient levels recorded in different stages of growth of the ecotypes thus follow the pattern observed by earlier workers. In general, it was observed that Puthur, Poovanchira and Chengazhikodan which are from nearby locations of Trissur district have higher content of major nutrients in the sample leaves indicating some amount of similarity in the tissue content of major nutrients suggesting the possibility of an uptake pattern characteristic of similar types.

5.5 Effect of ecotype variation on the dry matter production of banana cv. Nendran

The present studies revealed that dry matter production in vegetative parts such as pseudostem, corm and leaf was high in Kaliethan and Muttathukonam, low in Chengazhikodan and Pandaloor and the other types were intermediary. In fruits, the dry matter was the highest in Kaliethan followed by Puthur and Kothala. The total dry matter production was higher in Kaliethan and Muttathukonam, low in Pandaloor and Chengazhikodan while other types were intermediary.

Dry matter production is considered to be a reliable measure for judging the pattern of distribution and re-distribution of weight between different plant parts. Eventhough information is available about the dry matter distribution of different varieties of banana (Nambisan, 1972; Vadivel, 1976; Stover, 1985; Sheela and Aravindakshan, 1990), but variations within a variety are very little.

In the present studies it was observed that Kaliethan had higher dry matter production in both vegetative parts and bunch leading to high total dry matter production. This type also recorded higher fresh weight accumulation in vegetative part as well as bunch. The bunch weight of this particular type was observed to be higher than the other types studied.

It was observed that Puthur, Kothala and Chengazhikodan had higher biomass partitioning efficiency compared to other types. In Kaliethan and Muttathukonam types the conversion efficiency was lower while the other types were intermediary. Thus, it appears that in an adapted situation, the first three types have better production efficiency than Kaliethan and the superiority of the latter

in the present investigation may be mainly due to its adaptability to the location of the experiment. Stover and Simmonds (1987) have also observed that in banana, a sturdy vegetative growth is required for high productivity. However a partitioning tendency to divert more biomass and dry matter to the economical part is desirable. Thus Kaliethan had higher efficiency for total biomass and dry matter accumulation in vegetative and economic parts.

The correlation studies had shown that LAD, girth of fingers and weight of fingers are directly correlated with yield in the different ecotypes of Nendran. Kaliethan had recorded the highest values for the characters gaining consequent superiority in bunch weight. Thus the higher dry matter in fruits as well as vegetative parts have contributed to higher dry matter production in Kaliethan.

5.6.1 Effect of ecotype variation on leaf spot and bunchy top disease in banana cv. Nendran

The studies indicated that the extent of incidence of sigatoka leaf spot did not differ significantly among the `Nendran' ecotypes during the different stages of growth.

This indicates that the tolerance level of the disease is not influenced by variation in ecotypes. Even though varietal level difference in reaction to this disease is reported by Simmonds (1966), Meredith and Lawrence (1970), Firman (1972), Gopimony (1977) and several other scientists, information on ecotype variation in the extent of incidence is not well studied. In similar studies conducted in `Palayankodan', Rajeevan (1985) observed slight variation in the incidence of leaf spot as observed in the present studies.

From the present studies, it was observed that there was no incidence of bunchy top in any of the treatment plants. This may be due to the proper selection of suckers from disease free clumps and the appropriate control measures adopted for the control of vectors. It can thus be assumed that if appropriate management strategies are adopted, bunchy top disease can be controlled in all the ecotypes evaluated. In similar studies, Rajeevan (1985) observed 0 to 33 per cent incidence of bunchy top incidence in `Palayankodan' accessions. This may be due to the reason that some of the suckers collected from the farmers fields already had virus infection. In the present studies, since the suckers collected from Banana Research Station, Kannara maintained

under proper disease management conditions, healthy suckers could be obtained.

5.6.2 Effect of ecotype variation on the nematode population and rhizome weevil in banana cv. Nendran

The data indicated that the nematode association and infestation varied significantly between the different ecotypes. The total nematode count was the lowest in Kaliethan and highest in Muttathukonam types. The extent of root infestation was low in Poovanchira, Kaliethan and Chengazhikodan, intermediate in Pandaloor and Puthur and high in Muttathukonam and Kothala types. Varietal level variation in tolerance to nematodes was reported by Charles *et al.* (1983), and Subramanyan and Selvaraj (1990). However, information on such variation among types within a variety of banana is not available. The present studies indicated that the level of nematode influence vary among the ecotypes.

In the present studies, it was observed that the extent of incidence of banana rhizome weevil was lower in Puthur, Kothala and Kaliethan and higher in Chengazhikodan and Pandaloor types. Varietal level variation in the

incidence of rhizome weevil was reported by Babylatha *et al.* (1990). However, studies on the extent of incidence of rhizome weevil among the types within a variety is not available. The present studies indicate the possibility of such variation among the ecotypes. However, detailed studies are required to confirm the present findings.

5.7 Correlation and Path analysis in `Nendran' ecotypes

The study indicated that LAD, girth of the fingers, time taken for flowering, number of fingers per bunch, plant height at post floral initiation stage and girth of plant at floral initiation time had a positive correlation with bunch weight in `Nendran' banana.

The weight of hands (Rao, 1961), girth of plants (Teaotia *et al.*, 1970), number of fingers per bunch (Gopimony and Marykutty, 1980), plant height (Sreerangaswamy *et al.*, 1980) number of leaves per plant (Nayar *et al.*, 1980) and time taken for shooting (Krishnan and Shanmugavelu, 1983) were reported to influence the yield of different banana varieties as observed in the present studies. The yield was influenced by both phenotypic and genotypic characters. Thus

the variation in growth and yield in the different ecotypes observed in the present studies appears to be due to the effect of both environment and the genetic make up. Similar genotypic variations at varietal level were observed in culinary bananas by Sreerangaswamy *et al.* (1980) in respect to number of fruits and number of fingers. High heritability along with genetic advance and genotypic coefficient variation for hand weight, fruit weight, girth of plants and number of leaves in banana varieties were reported by Nayar *et al.*, (1980) and Rajeevan and Geetha (1984a and b) and Rosamma and Namboodiri (1990) also.

The present study revealed that there is variation among the ecotypes of `Nendran' banana with respect to growth, yield and quality attributes. Among the ecotypes studied, Kaliethan was superior in bunch weight and other characters such as leaf area duration, finger girth, finger weight, peel weight, pulp weight, leaf phosphorus at harvest stage and total dry matter production. Second came Chengazhikodan, Poovanchira and Puthur belonging to closeby localities and hence they had similarity in certain characters like yield, biomass partitioning and nutrient uptake. Kothala of Kollam district which was on par with

Chengazhikodan, Poovanchira and Puthur with an yield of 11.517 kg showed better adaptability at the location of the experiment next to Kaliethan. The superiority of Kaliethan may be due to its adaptability to the location of the experiment. However, the other types such as Chengazhikodan, Poovanchira, Puthur and Kothala also can be promising in the locality once they become more adapted to this agroclimatic zone.

SUMMARY

SUMMARY

The present investigation "Evaluation of `Nendran' (*Musa* AAB group) ecotypes" was conducted at the Department of Horticulture, College of Agriculture, Vellayani, Thiruvananthapuram during 1994-95 to find out the ecotype(s) suitable for the southern tracts of Kerala. The effect of ecotype variation on the growth, yield and quality were studied in detail and important findings are summarised below :

The different ecotypes evaluated showed significant difference in height during the various stages of plant growth namely juvenile stage, floral initiation stage and post floral stage. Among the various ecotypes, plant height at flowering was the lowest in pandaloor, Muttathukonam, Chengazhikodan and Kaliethan while the highest plant height was recorded in Kothala, Poovanchira and Puthur types.

The treatments did not have any significant influence on the growth of the plants till adult pre-floral vegetative stage. Significant differences were shown during later stages of plant growth. The types Chengazhikodan,

Poovanchira and Kothala that showed lower plant girth during early and mid growth stages recorded the higher plant girth at shooting time. The ecotypes, Muttathukonam, Pandaloor and kaliethan had comparatively lower plant girth.

Number of leaves produced per plant varied significantly with the different stages of growth except during floral initiation stage. In general, the leaf production was lesser in Chengazhikodan, Puthur, Kothala and Poovanchira types while it was higher in Kaliethan, Pandaloor and Muttathukonam. However, there was no significant difference in the total number of leaves produced per plant. The total number of leaves ranged from 28.080 to 31.303 among the seven ecotypes evaluated.

The interval of leaf production in Chengazhikodan, Poovanchira, Puthur and Kothala types was lower during the juvenile stage and adult pre floral vegetative stage showing significant difference among the various ecotypes with respect to this character. During floral initiation stage and there after till flowering, there was uniformity in phylacron among all the types.

The leaf longevity and leaf area duration varied significantly among the ecotypes. The longevity of leaves was the highest in Chengazhikodan, Muttathukonam and Pandaloor and the lowest in Kotala, Poovanchira, Kaliethan and Puthur. Leaf area duration was the highest in Kaliethan and Puthur and lowest in Muttathukonam.

With regard to leaf area index, the effect was not significant during the early stages of growth, but was highly significant during the later stages. During the later stages of growth, Chengazhikodan and Kothala recorded the highest LAI while Kaliethan, Pandloor and Puthur types recorded lower LAI. The other types were intermediary with respect to LAI.

The different ecotypes showed significant influence on the monthly growth rate only during the early stages of vegetative growth. The difference was not significant in the later part of growth. However, Kaliethan and Puthur had continued to put forth higher growth rate even during late vegetative growth stage.

No significant difference was observed among the different ecotypes with regard to the number of suckers produced per plant.

The time taken for flowering and total crop duration were significantly influenced by the different ecotypes. Pandaloor, Muttathukonam, Kaliethan and Poovanchira types took comparatively lesser time for flowering and harvest. Chengazhikodan, Kothala and Puthur types took more time for flowering and harvest.

Mean bunch weight, number of hands per bunch and number of fingers per bunch differed significantly among the various ecotypes. Kaliethan was significantly superior to all other treatments. Kothala, Puthur, Poovanchira and Chengazhikodan followed kaliethan in the bunch weight. Muttathukonam and Pandaloor recorded the lowest bunch weight. Chengazhikodan recorded the maximum number of hands and fingers per bunch while Muttathukonam and Kaliethan had significantly lower number of hands and fingers per bunch. The number of fingers per hand did not show any significant difference with respect to different ecotypes.

The different fruit characters varied significantly among the different ecotyes except for the length of fruits. The mean value for fruit girth, weight, peel weight and pulp weight were higher in Kaliethan, Kothala and Poovanchira

types while Muttathukonam and pandaloor types recorded the lowest mean values. The pulp/peel ratio was lower in Kaliethan, Pandaloor and Chengazhikodan while higher in Poovanchira and Puthur types.

The quality aspects of the different ecotypes showed significant differences with respect to total soluble solids, acidity, total sugars, reducing sugars, non reducing sugars, sugar/acid ratio and green life of fruits. Among the seven ecotypes analysed Kothala and Chengazhikodan were superior in fruit quality compared to the other types and Kaliethan was comparatively inferior.

Among the three major plant nutrients, nitrogen content of the leaf did not show any significant difference at flowering and harvest stage. The phosphorus content of the leaf showed significant variation with ecotypes at harvest stage but not at flowering stage. Potassium content of the leaf varied significantly among the ecotypes at flowering and at harvest. In general, it was observed that Poovanchira, Puthur and Kothala types had higher levels of NPK at flowering time, though Chengazhikodan had the highest K content. However, during harvest stage, Kothala and

Chengazhikodan had higher NPK content compared to other types.

The dry matter production in vegetative parts such as corm, pseudostem and leaf was higher in Kaliethan and Muttathukonam, low in Chengazhikodan and Pandaloor and the other types intermediary. In fruits, the dry matter production was the highest in Kaliethan followed by Puthur and Kothala. The total dry matter production was high in Kaliethan and Muttathukonam, low in Pandaloor and Chengazhikodan while the other types were intermediary.

Incidence of sigatoka leaf spot disease was not significant at various stages of plant growth indicating that the tolerance level of all the ecotypes tried was more or less the same. All the seven ecotypes tried were unaffected by the bunchy top disease.

The incidence of pests like rhizome weevil and nematodes were significantly influenced by the different ecotypes. The attack of rhizome weevil was lower in Puthur, Kothala and Kaliethan and higher in chengazhikodan and Pandaloor types. With regard to the nematode population, Kothala type recorded minimum soil nematode population but

the population was higher in the root samples. The total nematode population was the lowest in Kaliethan and the highest in Muttathukonam types.

Among the different characters studied, leaf area duration, girth of fingers and weight of fingers showed highly significant positive correlation with bunch yield. The characters like height of the plant (post floral stage), time taken for flowering and crop duration though showed a positive correlation with bunch yield,the effect was not significant. Growth of the plant (floral initiation stage), number of hands per bunch and number of fingers per bunch showed a negative correlation with bunch yield.

The path analysis indicated that the maximum positive direct effect was recorded by leaf area duration (0.7758), followed by girth of fingers (0.4704), time taken for flowering (0.3110), number of fingers per bunch (0.2505), height of the plant at post floral stage (0.1740) and girth of the plant at floral initiation stage (0.1339).

The results of the present investigations thus indicated that the ecotypes of `Nendran' showed variation

with respect to growth, yield and fruit quality. Among the various ecotypes evaluated, Kaliethan was found to perform better under the agro-climatic conditions of Thiruvananthapuram district. This was followed by Chenzazhikodan, Poovanchira and Kothala types.

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* Originals not seen

APPENDIX

Appendix I

Weather data during the growth and development period of banana cv.'Nendran'

Month		Temperature (^{O}C)		Relative humidity (%)	No. of rainy days	Rainfall (mm)
		Maximum	Minimum			
October	1994	28.70	23.43	85.56	18	366.00
November	1994	30.41	23.39	83.27	11	352.00
December	1994	31.21	22.21	81.85	1	9.00
January	1995	31.35	22.60	77.03	1	8.40
February	1995	31.98	23.57	71.70	--	--
March	1995	32.74	23.73	72.05	3	5.00
April	1995	32.44	24.89	76.58	8	137.40
May	1995	32.04	24.84	78.32	13	365.40
June	1995	30.15	24.42	84.08	13	228.60
July	1995	28.88	23.91	82.16	13	143.70

EVALUATION OF 'NENDRAN' (*MUSA* AAB GROUP) ECOTYPES

By

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ABSTRACT OF A THESIS
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ABSTRACT

The investigation "Evaluation of `Nendran' (*Musa* AAB group) ecotypes" was conducted at the Department of Horticulture, College of Agriculture, Vellayani, Thiruvananthapuram during 1994-`95 inorder to study the effect of ecotype variation on growth, yield and fruit quality of `Nendran' banana. The results obtained are presented below :

Vegetative characters like plant height, girth at later stages, number of leaves per plant, phylacron at early stages, leaf longevity, leaf area duration, leaf area index at later stages and monthly growth rate at early stages showed variation among the different ecotypes. The number of suckers per plant were almost uniform for all the ecotypes. The time taken for flowering and total crop duration varied with ecotypes but the maturity period of the bunches was uniform for all the ecotypes.

Eventhough bunch yield was maximum in Kaliethan, the number of hands and fingers per bunch were the lowest in

this type. Fruit characters like finger length, finger weight, peel weight and pulp weight were high in Kaliethan where as the pulp/peel ratio was high in Poovanchira. Chengazhikodan and Kothala were superior in fruit quality compared to Kaliethan.

The leaf nutrient status at flowering stage varied only in the case of potassium where as both phosphorus and potassium varied at harvest stage. Poovanchira, Puthur and Kothala types had higher levels of NPK at flowering time though Chengazhikodan had the highest potassium content. During harvest stage, Kothala and Chengazhikodan had higher NPK content compared to others types.

The dry matter production was higher in Kaliethan and Pandaloor in both vegetative part and fruits.

The extent of sigatoka leaf spot did not differ significantly among the `Nendran' ecotypes during the different stages of growth. There was no incidence of bunchy top in any of the treatment plants. Nematode infestation in root was low in Poovanchira, Kaliethan and Chengazhikodan and high in Muttathukonam and Kothala types where as the rhizome

weevil incidence was low in Puthur, Kothala and Kaliethan and high in Chengazhikodan and Pandaloor types.

Correlation and path analysis studies in `Nendran' ecotypes indicated that leaf area duration (LAD), girth of fingers, time taken for flowering, number of fingers per bunch, plant height at post floral initiation stage and girth of plant at floral initiation stage had a positive correlation with bunch weight. So these characters can be considered for selecting superior ecotypes.

In general, Kaliethan can be considered as the most suitable ecotype of `Nendran' for commercial cultivation in Thiruvananthapuram and nearby areas. However, the other types such as Kothala, Chengazhikodan and Poovanchira types can also perform well in this tract once they become adapted to the agroclimatic conditions of the zone.