EVALUATION OF CLONAL VARIATION IN BANANA *Musa* spp. (AAB GROUP) 'RASTHALI'

by

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(2016-12-008)

THESIS

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DECLARATION

I, hereby declare that this thesis entitled **"Evaluation of clonal variation in banana *Musa* spp. (AAB group) Rasthali"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, associateship, diploma, fellowship or other similar title, of any other University or Society.

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LIST OF ABBRIVATIONS AND SYMBOLS USED

Symbols	Abbreviations
AOAC	Association of Official Agricultural Chemists
BE	Bunch Emergence
BRS	Banana Research Station
C. D.	Critical difference
cm	Centimeter
cv.	Cultivar
et al.	and others
Fig.	Figure
g	Gram
GCV	Genotypic Coefficient of Variation
ha	Hectare
i.e.	That is
KAU	Kerala Agricultural University
kg	Kilogram
m	Metre
MAP	Month after planting
mm	Millimetre
MT	Metric Tons
No.	Number
NS	Non- Significant
PCV	Phenotypic Coefficient of Variation
RBD	Randomized Block Design
sp. or spp.	Species (Singular and Plural)
t	Tons
TSS	Total soluble solids
viz.	Namely

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Introduction

1. INTRODUCTION

Banana is one of the most important fruit crops grown in our country. India is the largest producer of banana contributing to 17.8 per cent of the global production (FAOSTAT, 2016). The crop is grown in an area of 8.58 lakh ha with an annual production of 291.63 lakh MT and productivity of 33.98 t/ha (AGRISTAT, 2017) in India. Banana is the foremost fruit crop of Kerala with a cultivated area of 82,000 ha with an annual production of 12.24 lakh MT and productivity of 15.02 t/ha (AGRISTAT, 2017).

Banana is a staple food crop for millions of people in developing countries, vital to food security and ranks fourth in the world's food commodity. The year-round availability, varietal range, taste and nutritive as well as medicinal value makes it a favourite fruit among all classes of people. Considering the nutritive value, it could be considered as 'poor man's apple' which provides a more balanced diet. It is a filling fruit, easy to digest, nearly fat free and rich source of carbohydrate with calorific value of 67g per 100g. Not only the fruit, almost all parts of the plant are useful in one way or the other.

Evolution of edible banana was initiated from two diploid species *Musa accuminata* contributing to A genome and *Musa balbisiana* contributing to B genome. Different combinations of these two species resulted in the development of a wide range of genomic groups varying from diploids to tetraploids (AA, AB, AAA, AAB, ABB, AAAA, AAAB, AABB, etc). India is recognized as one of the major centers of diversity of *Musa* spp. along with South East Asian countries like Thailand, Malaysia, Indonesia and Papua New Guinea. The diversity of commercial banana cultivars is also vast in India. More than 300 cultivars and clones of banana are spread across North Eastern states, Western Ghats and Andaman and Nicobar Islands. Polyclonal system of growing banana is predominant in our country due to regional preference and local adaptability. The performance of a clone in a locality is a function of its genotype and environment. Therefore, systematic evaluation and crop characterization are needed for

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identifying the adaptability features and specific characters of different clones of a cultivar.

Bananas and plantains are deeply linked with the traditional culture of Kerala and the state is known for having one of the largest biodiversity of *Musa* spp. More than ten varieties are grown in the state and many of them are under domestic cultivation. Hence, the homestead gardens are the natural gene pool for different varieties, known by different local names. Some of the important cultivars of banana grown in Kerala are Nendran, Robusta, Red banana, Palayankodan, Rasthali, Njalipoovan, Monthan etc. Clones of 'AAB' genomic group occupy major banana growing areas in Kerala. This group comprises several popular dessert types; of which, Rasthali is one of the choicest banana cultivars for table purpose. The vast difference in agro climatic conditions under which the variety is grown, is likely to generate many clones. Therefore, the cultivar grown in different parts of Kerala exhibits variation in both vegetative and reproductive characters. Stover and Simmonds (1987), reported that among the two clones of Poovan (Rasthali), Motta Poovan is having blunt tip while the Ayiranka Poovan is with long tapering bunch without male bud. Considering the yield potential and local preferences, farmers select and cultivate definite types, which perform better in that region. But, many cultivar types cannot be easily dignified, if they are closely related to a particular cultivar. However, there are no reports about a particular Rasthali clone having desirable characters. Hence there is tremendous scope for selection of superior clones of Rasthali.

Nayar (1962) stated that full exploitation of the bud variation in banana cultivars can be achieved only by extensive surveying of the banana growing tracts. A primary evaluation of the clones based on plant and yield characters would be helpful for proper identification and conservation. The study will be helpful to identify the clonal variation in vegetative, reproductive characters associated with yield. This would be useful for further selection and utilization of

promising types in crop improvement programmes. Under the circumstance the present study was undertaken with the following objectives,

- Survey of central parts of Kerala covering three districts Ernakulam, Thrissur and Palakkad to collect variable clones of Rasthali.
- Assess the natural variability among the clones with respect to morphological, vegetative, floral and bunch characters.

Review of Literature

2. REVIEW OF LITERATURE

Banana (*Musa* spp.) is an important fruit crop and considered as a food crop in developing countries. India is found to be one of the countries of origin and evolution of *Musa* along with other Asian and Pacific countries. Occurrence of wide diversity is reported in these countries, since Linnaeus period.

There is great diversity among the commercial cultivars of *Musa* in our country. Among the different cultivars of banana, Rasthali is a prime table variety and is priced high in all parts wherever it is cultivated. In Kerala, Rasthali is grown both as a homestead crop and on a commercial scale. Due to the wide ecological and climatic conditions in the state, there exists clonal variability in this variety. So far, no such studies were conducted related to clonal variation in Rasthali.

Literature relating to the clonal variations with respect to various vegetative characters, floral characters, yield studies, fruit characters, quality parameters, post-harvest management, and pest and diseases are reviewed in this chapter. Since the available information on clonal variation of Rasthali is very limited, the works related to different banana subgroups are also cited here.

2.1 BIOMETRIC CHARACTERS

Valsalakumari and Nair (1990) reported that the cultivars within each genomic group were exceedingly variable with regard to biometric characters after assessing ninety- eight banana cultivars.

2.1.1 Clonal variation in plant height

Nair and Nair (1969) examined the performance of nine varieties of banana, at Regional Agricultural Research Station, Ambalavayal. The height of these varieties ranged from 150 -165cm in 'Giant Governer' of Cavendish group to 347cm in 'Bodles Altafort'. Kothavade *et al.* (1985) observed that the height of the banana cv. Basrai increased as the number of functional leaves per plant was

increased. Rajeevan (1985) assessed twenty- four accessions of banana cv. Palayankodan and concluded that there was significant variation in height of Palayankondan clones during plant crop and throughout the growing period of first ratoon. Daniells and O' Farrel, (1988) conducted a study with different banana cultivars at North Queensland and observed a huge difference in pseudostem height (1.85m- 5.21m). Among Cavendish bananas Dwarf Cavendish and Cavendish-S had shorter Pseudostem. Sato (1988) in his studies with nineteen banana cultivars grown in Hawaii, reported that the plant height varied significantly with cultivars. George *et al.* (1991) carried out a study at the Regional Agricultural Research Station, Ambalavayal, with eight cultivars of banana *viz.*, Rasthali (AAB), Karpooravally (ABB), Chenkadali (AAA), Njalipoovan (AB), Gros Michel (AAA)Bodles Alfort (AAAA), Palayankodan (AAB) and Kunnan (AB). The study revealed that Bodles Alfort attained the maximum height of 2.88m which was on par with Gros Michel and Njalipoovan while Karpooravalli had the minimum height of 2.3m. Uthaiah *et al.* (1992) observed variations in plant height of different banana cultivars as 244.00cm in Robusta and 397.8cm in Boodibale. The cultivars Boodibale (ABB), Karibale (ABB) and Rasthali (AAB) were found to be taller and more vigorous than the cultivar Robusta (AAA). In an experiment with nine genotypes of culinary banana collected from coastal Orissa at Department of Horticulture, O.U.A.T. Bhubaneswar, Biswal *et al.* (2004) found that Batisha bantala had robust growth with respect to height. Joseph (2017) evaluated ten ecotypes of banana cv. Nendran and founded that plant height at bunch emergence was highest in Mettupalayam Nendran followed by Zanzibar and Big Ebanga while lowest in Attunendran, Perumatti and Nedunendran.

2.1.2 Clonal variation in plant girth

Sreerangaswamy *et al.* (1980) reported that banana, though clonally propagated, showed significant variation in vegetative characters such as plant girth within the population. According to Rajeevan (1985), girth of Palayankodan clones exhibited significant variation during the later stages of growth both in

plant crop and in first ratoon crop. The difference was significant at the time of shooting except in second ratoon. George *et al.* (1991) observed that among the eight cultivars of banana at the high ranges of Kerala, Njalipoovan recorded the minimum girth of 51.32cm, whereas Gros Michel and Chenkadali recorded the maximum girth of 64.14cm each. Uthaiah *et al.* (1992) assessed eight banana cultivars under Indian West coast conditions and reported a plant girth variation from 59.2cm in Karibale to 85.3cm in Boodibale. In an experiment with various ecotypes of Nendran, Devi (1996) observed that Changalikodan, Poovanchira, and Kothala recorded highest pseudostem girth at flowering stage where as there was no significant difference in girth at pre- floral vegetative stage. According to Sunilkumar (1997) also girth of pseudostem varied significantly in different accessions of Nendran. Sarkar *et al.* (2005) reported that among the ten cultivars of banana belonging to AAB genomic group under silk, mysore and pome sub groups, maximum pseudostem girth was recorded in Dudhsagar cultivar. Joseph (2017) reported girth of pseudostem to be highest in Mettupalayam Nendran followed by Big Ebanga and Zanzibar; and Chenkal Local and Nedunendran had comparatively lesser pseudostem girth.

2.1.3 Clonal variation in number of leaves

Nambisan (1980) stated that the leaf number is generally controlled by the origin of the clone. He found that among the banana clones, Poovan produced the lowest number (31.8) of leaves followed by Nendran (38.4) and Neypoovan (41.2). It showed that the number of leaves produced prior to bunch initiation varied with the variety and locality. In a study conducted with cultivars Gros Michel, Dwarf Cavendish, Gaint Cavendish, Robusta and Lacatan, the leaf number showed variation between clones and also it decreased during the dry season (Flores *et al.*, 1985). According to Rajeevan (1985) the number of leaves produced differed significantly among the Palayankodan clones. Biju and Kurien (1994) reported that the number of functional leaves retained during flower bud differentiation was lower in Red banana than in Robusta. Rajamanickam and Rajmohan (2010) observed that the mean leaf production ranged from 6.8 to 11.20

among Palayankodan accessions. Number of functional leaves varied significantly and highest number of functional leaves was observed in Changalikodan followed by Attunendran and Zanzibar (Joseph, 2017).

2.1.4 Clonal variation in leaf area

Deo *et al.* (1999) evaluated five cultivars under Akola conditions and observed that the third leaf area was the larger in Srimanti than Basrai and Ardhapuri. Hasan (2002) showed that the largest leaves were produced in Red banana and Agniswar. Hasan *et al.* (2002) stated that cooking banana type-3 was short statured with large leaf area. Batisha Bantala recorded the highest leaf area followed by Banua Bantala, among the culinary banana genotypes evaluated by Biswal *et al.* (2004).

Baruah *et al.* (2007) assessed twenty banana cultivars, and among the cultivars, Bharatmoni recorded highest leaf area followed by Simolumanohar. Kumar *et al.* (2012) observed that among different types of Monthan Banana (ABB-Banthal), leaf area varied from17.02 to 19.88m^2.

2.1.5 Clonal variation in number of suckers

According to Venkataramani (1946) sucker production varied with cultivars. He observed a greater number of suckers in derivatives of *M. balbisiana* and less number of suckers in derivatives of *M. accuminata*. Balakrishnan (1980) conducted an experiment in TNAU, Coimbatore, and observed that the sucker production efficiency of different cultivars decreased with increase in ploidy level, as Anaikomban AA (6.4), Robusta AAA (5.0), Monthan ABB (4.2), Poovan AAB (4.6), Klueteparod ABBB (2.3) and Hybrid Sawai ABBB (2.4). Variation in the mean sucker production per plant varied from 6.20 to 15.80 as observed in the variability studies in Palayankodan (AAB) ecotypes of banana by Rajamanickam and Rajmohan (2010). Joseph (2017) reported that number of suckers produced varied significantly among ecotypes at harvest and more number of suckers

produced by Zanzibar, Big Ebanga and Attunendran and less in Nedunendran, Myndoli and Perumatti Nendran.

2.1.6 Clonal variation in duration of vegetative phase

In banana, lower number of functional leaves delayed flower bud differentiation (Rammohan *et al.,* 1962). According to Devi (1996), time taken for shooting was more for Changalikodan, Puthur and Kothala than Pandaloor, Muttathukonam, Kaliethan and Poovanchira accessions. In a study conducted by Sunilkumar (1997) in Kaliethan types, it has been observed that longest duration for shooting was in the collection from Neyyatinkara, followed by Karakonam and Anad whereas shortest duration was recorded in Venniyoor, followed by Venjaramoodu and Keezhoor. Kanamadi *et al.* (2002) reported that among AAB genome, early shooting in 265.33 days was observed in Rajapuri and delayed shooting in Mysore Sugandhi (384days). Rajamanickam and Rajmohan (2010) evaluated six Palayankodan ecotypes (AAB) of banana and showed that the days taken from planting to shooting was in the range of 188.80 to 300 days. According to Joseph (2017) longest vegetative phase was observed in Myndoli whereas Perumatti Nendran had shortest vegetative phase followed by Kaliethan and Chenkal Local.

2.1.7 Clonal variation in days from shooting to harvest

According to Venkatesam *et al.* (1964), the number of days from shooting to maturity was113 - 116 days in banana cv. Poovan. Among the seven plantain clones, Plantano Enano, Congo 300 and Lacknan of French type were harvested on an average of 107 days after flowering. According to Gonzalez *et al.* (1990), Senanayake and Sirisena (1997) reported that banana cv. Mysore recorded the bunch maturity period of 102 days after flowering. Ortiz and Vuylsteke (1998) observed the range of days for fruit filling as 81 to 128 days in 93 cultivars of banana. Joseph (2017) recorded longest days for bunch maturity in Myndoli whereas duration was shortest in Zanzibar followed by Big Ebanga and Changalikodan.

2.1.8 Clonal variation in total crop duration

Jacob (1952) reported that Ayiramka Rastahli is a sport of Rasthali which took about 472 days to mature from time of planting to harvest stage. Valsalakumari (1984) reported that the total duration of crop was 264 days for Mysore Poovan, 305 days for Bodles Alfort, 342 days for Karpooravally and 358.5days for Rasthali under central zone (Vellanikkara, Thrissur) conditions of Kerala. In high ranges of Kerala, the crop duration was increased (George *et al.*, 1991). According to Rajeevan (1985), the crop duration of Palayankodan accessions varied significantly. The accessions 5, 10, 13, 15 had longer crop duration whereas accessions 2, 7, 22 took lesser number of days for harvesting. The clonal variation studies in Nendran at Banana Research Station, Kannara revealed that the crop duration varied from 332.3 to 359.3days in 1982, 207.33 to309.33days in 1983 and 291.3 to 327.6days in 1987 for the same Nendran clones (Anon., 1987). Deshmukh *et al.* (2004), in his study with various clones of banana total crop duration was observed in the range of 446 days to 562 days. Among those cultivars, Shendurni took the shortest duration of 446 days for harvesting as compared to others. According to Rajamanickam and Rajmohan (2010) among six Palayankodan clones total crop duration has varied in the range of 286.80- 407.0 days. In a study to evaluate Nendran clones, conducted at College of Agriculture Vellayani, Myndoli recorded maximum crop duration (371.83days) followed by Mettupalayam Nendran (341.17days) (Joseph ,2017).

2.2 YIELD CHARACTERS

Prasanna and Aravindakshan (1990) reported that variation in bunch and finger weight within a clone maybe due to environmental and other factors. According to Rekha and Prasad (1993) studies on genetic variability in banana indicated the importance of yield as selection criteria for improvement in banana.

2.2.1 Clonal variation in bunch weight of banana

In a study by Rajeevan (1985), with Palayankodan accessions, the Accession 21 had the heaviest bunch of 14.87 kg followed by the Accession 18 which had a bunch weight of 14.38 kg, whereas Accessions 10, 12 and 17 had low weight bunches. Based on an evaluation of 144 Nendran clones in BRS, Kannara, (Anon., 1989) it was reported that bunch weight ranged from 9.13 kg for local variety to 10.54 kg for Clone no. 123. Singh *et al.* (1996) found maximum bunch weight in Ney Poovan followed by Rajabale and Basrai. Frison and Foure (1999) reported that Ayiramkai is a natural mutant of Rasthali with far better yield of 28kg compared to 8- 14kg in Rasthali with the same quality. Kanamadi *et al.* (2002) reported that among AAB genomic group, the highest yield of 10.57 kg per bunch was recorded in Sakarballe followed by 10.53 kg per bunch in Basrai Dwarf. Yield and quality of eight clones of 'Namwa' banana was assessed by Suvittawat *et al.* (2014) and observed the highest bunch weight in 'Namwa Pak Chong50' of 30.6kg. Joseph (2017) evaluated ten Nenran clones and among the clones Mettupalayam Nendran recorded highest bunch weight (17.94kg) and Kaliethan (8.13kg) and Perumatti Nendran (8.27kg) recorded the lowest bunch weight.

2.2.2 Clonal variation in number of hands and fingers per bunch

Rajeevan and Geetha (1984) assessed the variability in ratoon crop of banana cv. Palyankodan and observed that the number of hands per bunch ranged from 3.67 to 12.10 among the accessions. A variation of 1-2 to 8-10 number of hands per bunch in some of the Nendran clones was observed by Shanmugavelu *et al.* (1992). In Palayankodan clones a variation of 10 to 12 hands per bunch was reported by Rajeevan and Mohanakumaran (1993). Among fifteen varieties studied in different growing areas, Poovan recorded more fingers per hand (Singh and Sharma, 1997). Rajamanickam and Rajmohan (2010) reported a variation of 14.30 to 18.93 in the number of hands per bunch among six clones of Palayankodan. Mettupalayam Nendran recorded largest (6.83) number of hands

per bunch whereas Zanzibar recorded lowest (2.08) among Nendran ecotypes (Joseph, 2017).

Jacob (1952) reported that Ayiramkai Rasthali produce 500 fruits per bunch as compared to Rasthali (71-120). The clonal variability studies in Nendran conducted at Banana Research Station, Kannara, showed that the number of fingers varied between 49.7 and 66.4 per bunch (Anon., 1984 and Anon., 1987). Rajamanickam and Rajmohan (2010) found that the number of fingers per bunch varied between 72.20 and 254.20 in Palyankodan clones. Joseph (2017) reported that among ten ecotypes of Nendran, Mettupalayam Nendran had largest number of fingers (92.92) and Zanzibar had the lowest (25.75).

2.2.3 Clonal variation in length, girth, and weight of fingers

Length of the finger ranged from 5.00cm to 20.20cm and girth of the finger from 5.73 cm to 12.70 cm as in different cultivars of banana by Rajeevan and Geetha (1984). Among the Nendran clones, finger length varied between 15-20cm and 33cm and finger girth ranged from 12.5cm to 15-16cm (Shanmugavelu *et al.,* 1992). Singh and Sharma (1997) reported the highest finger length in Rajabale followed by Basrai. According to Deo *et al.* (1999), Srimanti had more finger length (21.32cm) compared to other cultivars. Rajamanickam and Rajmohan (2010) observed good amount of variability in Palayankodan ecotypes in which the finger length ranged from 8.36cm to 13.60cm and finger girth ranged from 8.14cm to 10.52cm. Joseph (2017) observed that Zanzibar had the highest fruit length (37.72cm) and fruit girth(16.63cm) and lowest fruit length in Changalikodan (25.79cm), and girth in Perumatti Nendran(14.27cm).

Sunilkumar (1997) evaluated Kaliethan types and revealed that among different clones, accession from Balaramapuram recorded highest fruit weight, and that from Palode recorded lowest fruit weight. Biswal *et al.* (2004) detailed the yield attributing characters of plantains and reported that weight of individual fruit ranged from 69g to 193.33g among different plantains. A variation of 8.14g to 10.52g fruit weight was observed in Palayankodan ecotypes by Rajamanickam

and Rajmohan (2010). Zanzibar recorded highest fruit weight (268.17g) while Nedunendran recorded lowest (141.17g) among Nendran ecotypes (Joseph, 2017).

2.3 QUALITY ATTRIBUTES

2.3.1 Clonal variation in fruit peel thickness

Firmin (1991) reported that the peel thickness reduced from 3.1 mm at the matured green stage to 2.6 mm at yellow stage in banana. Ngalani and Tchango (1998) evaluated some physco- chemical characters of banana and plantain hybrids and cultivars in Cameroon and reported that peel thickness ranged from 4.0 mm to 2.5 mm in yellow stage. Suvittawat *et al.* (2014) observed that the green peel thickness was high in 'Nam Vo' clone (2.8 mm). Among Nendran clones peel thickness was highest in Zanzibar (4.7mm) and lowest in Attunendran (2.26mm) (Joseph, 2017).

2.3.2 Clonal variation in pulp/ peel ratio

Devi (1996) reported highest pulp/ peel ratio in clone collected from Poovanchira (74.10g) and lowest in Muttathukonam (43.25g). According to Sunilkumar (1997) among different Kaliethan types highest pulp/ peel ratio was observed in Krakkonam and lowest in Keezhoor. Ravi and Mustaffa (2013) recorded the highest pulp/peel ratio in Ney Poovan variety (3.09) followed by Poovan (Mysore) (2.80) and the lowest in Monthan (cooking banana) (1.46). Joseph (2017) evaluated ten ecotypes of Nendran and observed that Changalikodan recorded highest pulp/ peel ratio (3.85) followed by Zanzibar (3.32) and Perumatti Nendran (3.30). Among those ecotypes lowest pulp/ peel ratio was found in Attunendran.

2.3.3 Clonal variation in shelf life of fruit

Sarkar *et al.* (2005) observed significantly the highest shelf life in Malbhog (11days) which was on par with Rasthali (10.5 days). Uma *et al.* (2006) observed the maximum green life of 5.29days in BRS 01followed by FHIA 01

and Pachanandan. According to Joseph (2017) shelf life was lowest in Attunendran and highest in Big Ebanga.

2.3.4 Clonal variation in TSS, sugar and acid content

According to Roy and Chakraborty (1993), the quality parameters of ripe fruits were mainly contributed by genotype and nutritional status of the soil. Rajeevan and Mohanakumaran (1993) observed quality variation in Palayankodan accessions. TSS varied in the range of 22- 26.17 and acidity in the range of 0.30-0.48 per cent. Among these accessions total sugar showed 16.41 to 17.40 per cent variation and reducing and non- reducing sugar varied in the range of 15.5- 17.18 per cent and 0.14- 0.27 per cent respectively. In an experiment, Rajamony *et al.* (1994) found TSS variation of 22°Brix in Mottapoovan and 30°Brix in Kudapanilla Kunnan. Ram *et al.* (1994) observed a quality variation in banana cultivars in the range of 15.1 to 16.15 per cent, 0.22 to 0.37 per cent and 14.1 to 14.3 per cent for TSS, titratable acidity and total sugars respectively. The highest TSS was observed in Malbhog and acidity in Sakkai by Shivakumar (1999). Rajamanickam and Rajmohan (2010) reported sugar: acid ratio variation in the range of 37.53-68.53 in Palayankodan accessions. Joseph (2017) observed significant variation among different ecotypes of Nendran for qualitative parameters. TSS, total sugars, sugar/ acid ratio and reducing sugars were highest in Changalikodan whereas TSS and sugar/ acid ratio was lowest in Big Ebanga and acidity was lowest in Changalikodan.

2.3.5 Clonal variation in organoleptic evaluation

Ferris *et al.* (1997) conducted a sensory evaluation of boiled unripe plantain and found that the color was very good in Agbagba and Obino I' Ewai whereas it was poor in TMB × 612-74 hybrid. Among the varieties, taste was very good in Agbagba followed by Obino I' Ewai. Flavour was rated as good in Agbagba and Obino I' Ewai. With respect to texture, Agbagba scored high and too soft texture was observed in Valery banana. Among cultivars tested, over all acceptability was highest for Agbagba followed by Obino I' Ewai. Organoleptic

scoring revealed significant difference among different ecotypes of Nendran (Joseph, 2017). The highest score for appearance was for Changalikodan and Chenkal Local. Highest score for flavour, taste, and texture was obtained for Chengalikodan Nendran.

2.4 QUALITATIVE CHARACTERS

According to Stover and Simmonds (1987) clonal variations were more expressed in qualitative characters like plant pigmentation, male bud type, bunch shape, fruit fullness, fruit curvature and fruit apex. Among the two clones of Poovan, Motta Poovan was having blunt tip while the Ayiranka Poovan had long tapering bunch without male bud.

2.5 INCIDENCE OF DISEASES AND PESTS

The level of resistance to Sigatoka disease may vary within the cultivars depending on the environmental condition and number of infective inoculums (Brun, 1962). According to Stover and Simmonds (1987) all A genome varieties were highly susceptible to Sigatoka disease, and it was observed that Pisang lilin, cavendish group and Gros Michel were very susceptible to Sigatoka, whereas Silk, Popoulu, Maoli groups were moderately susceptible to the disease. Mysore, Cardaba and Saba were slightly susceptible to Sigatoka. Devi (1996) observed least incidence of leaf spot in Changalikodan, Kothala and Puthur types of Nendran banana. Mobambo *et al.* (1993) reported that the Black Sigatoka affected crops have yield losses from 30 per cent to complete crop failure in Africa and Tropical America. Krauss *et al.* (2001) observed that banana cultivar Bellaco was most susceptible to Cordana leaf spot followed by Inguiri and Isla whereas FHIA-03 was least susceptible to Yellow Sigatoka and Cordana leaf spot. Sarkar *et al.* (2005) recorded maximum finger infection by crown rot in Rasthali (14.2 per cent). Siddhesh *et al.* (2014) isolated a group of somaclonal variants of banana cv. *Rasthali* which showed effective resistance towards Panama wilt causing fungus *Fusarium oxysporum* f. sp. *cubense* (Foc race 1) infection, in repeated bioassays.

In an experiment Viswanath (1981) assessed the resistance of some of the banana varieties against the attack by Rhizome weevil (*Cosmopolities sordidus*) and reported that Maduranga was most susceptible whereas cultivar Lacatan was least susceptible. Banana varieties Pisang lilin, Sanna Chenkadali and Tongat showed high resistance to Rhizome weevil (Babylatha *et al.,* 1990).

2.6 CORRELATION AND PATH CO-EFFICIENT STUDIES IN BANANA

According to Kurian *et al.* (1985) the fruit yield exhibited strong positive correlation with number of hands, number of functional leaves per plant, girth of stem and total duration of the crop. Shaibu *et al.* (2012) evaluated of some banana genotypes and reported that bunch weight was positively correlated with the major components of yield like number of hands and number of fingers. Total number of fingers was negatively correlated with fruit weight and fruit length. Sunilkumar (1997) evaluated ten accessions of Kaliethan and bunch yield was found to be positively correlated with bunch length, number of hands, number of fingers, finger girth, finger length, finger weight, plant height and girth.Tak *et al.* (2014) reported that fruit yield exhibited strong positive correlation with the characters like leaf area at shooting and harvest time, psuedostem girth, PCA, number of functional leaves at shooting and harvest time, number of hands per bunch, number of fruits per 2nd hand, fruit weight, hand weight, crop duration and days taken from flowering to harvesting. Joseph (2017) evaluated ten ecotypes of Nendran banana and reported high positive correlation between bunch weight and number of hands, number of fingers, pedicel strength index, girth of plant, plant height and total crop duration. Weight of finger had significant positive correlation with plant height and girth, finger girth, fruit curvature and fullness index.

Characters exhibiting high heritability and genetic advance were governed by additive gene effects (Panse, 1957). According to Nayar (1962) high

heritability along with genetic gain and GCV and PCV were observed in number of fingers per bunch, fruit weight, hand weight, plant girth and length of pedicel in culinary banana. High heritability and GA were observed for weight of fingers, number of fingers per bunch, plant height and plant girth in fourty banana cultivars (Rajeevan and Geetha, 1984). Plant height, crop duration, leaf breadth, number of leaves at shooting and plant girth with high values of heritability and moderate values of GA was reported in Twelve different ecotypes belonging to Silk group of bananas by Uma *et al.* (2000).

The path coefficient analysis revealed high positive direct effect was contributed by weight of hands (1.6043), weight of green finger (0.6649) and weight of ripe finger (0.5885) in Palayankodan accessions (Rajeevan, 1985). According to Vijayaraghavakumar *et al.* (1984) number of fingers and hands had high positive direct effect on bunch yield in culinary varieties while weight of hands had maximum positive direct effect on bunch weight in desert varieties. Devi (1996) reported that high positive direct effect was recorded by leaf area duration followed by finger girth, time taken for flowering, number of fingers per bunch, plant height at post floral stage and plant girth at floral initiation stage. In Kaliethan types Sunilkumar (1997) reported high direct effects of finger weight, number of hands per bunch and plant height on bunch weight.

Valsalakumari *et al.* (1985) examined variability and genetic divergence among different banana cultivars. Rajamanickam and Rajmohan (2012) studied the genetic diversity of twenty- eight banana ecotypes grown in Kerala using RAPD analysis. Among diploid clones, Ilavazha (BB group) showed maximum genetic divergence. Among triploid clones, Attu Nendran, Robusta, Koonoor Ethan and Vellapalayankodan had highest variability. Among Nendran (AAB group) ecotypes, Attu Nendran and Koonoor Ethan recorded maximum divergence and among Palayankodan (AAB group) clones, Vellapalayankodan recorded the highest genetic divergence.

Materials and Methods

3. MATERIALS AND METHODS

The present study entitled "Evaluation of clonal variation in Banana *Musa* spp. (AAB group) Rasthali, was conducted at Banana Research Station Kannara, Thrissur during 2017-18. A preliminary survey was done within the central zone of Kerala specifically Palakkad, Thrissur and Ernakulam districts through the agricultural officers and progressive farmers of concerned areas to locate the Rasthali clones showing variability. A total number of three variable types of Rasthali were located from Palakkad and Thrissur districts, however, none of the variable clones other than noted from Thrissur and Palakkad districts could be identified from Ernakulam area. These three collections along with four clones maintained at Banana Research Station, Kannara were planted at 'B' block of BRS, Kannara. The details of experimental site and materials and methods adopted are discussed in this chapter.

3.1 Experimental site

The location of the experiment is situated at 10.53° North latitude and 76.33° East longitude at an altitude of 55m MSL. The predominant soil type is laterite.

3.2 Materials

Three clones of banana (*Musa* spp.) Rasthali collected from farmer's fields and four existing collections of BRS, Kannara were used for the study.

3.3 Methods

3.3.1 Experimental Design and Layout

Design - RBD

Number of treatments – 7(Different Rasthali clones)

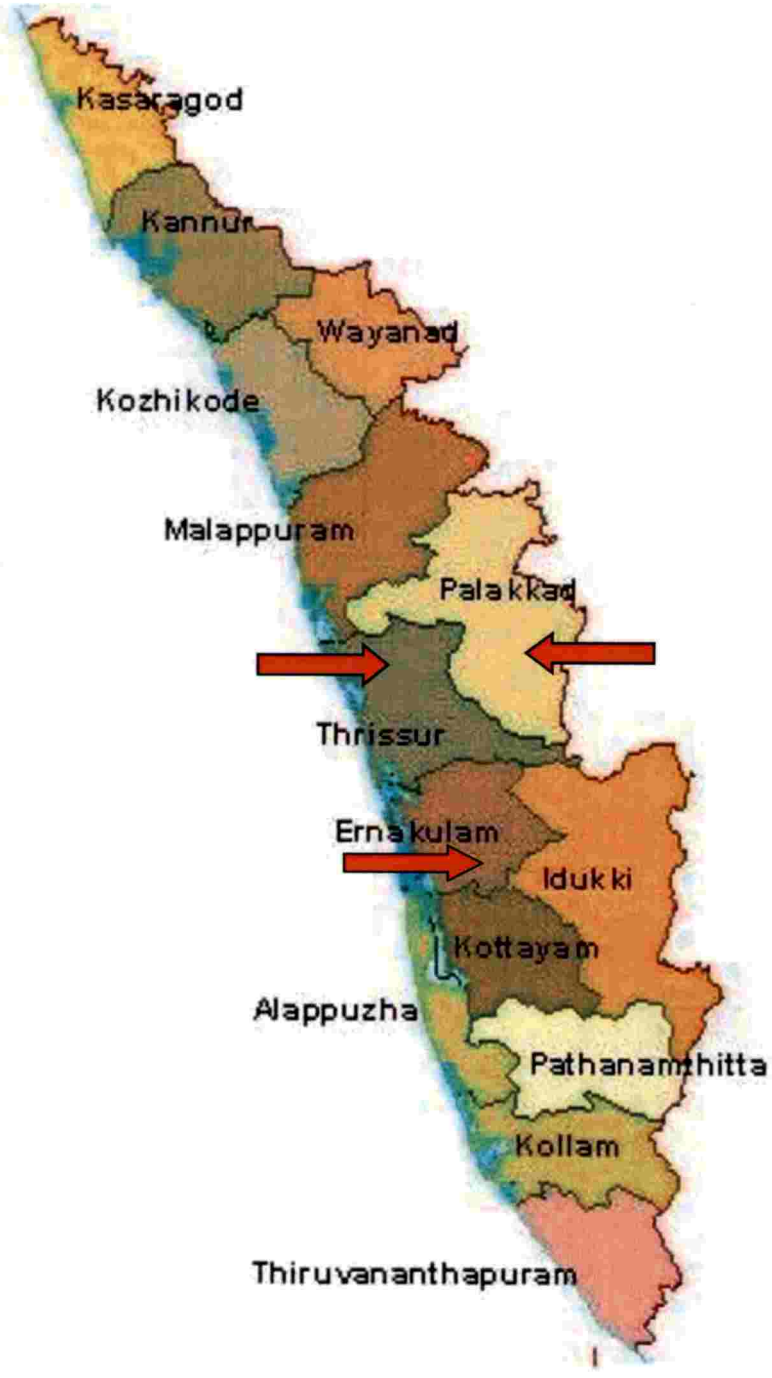

Fig. 1. Districts from where Rasthali clones were collected for the experiment

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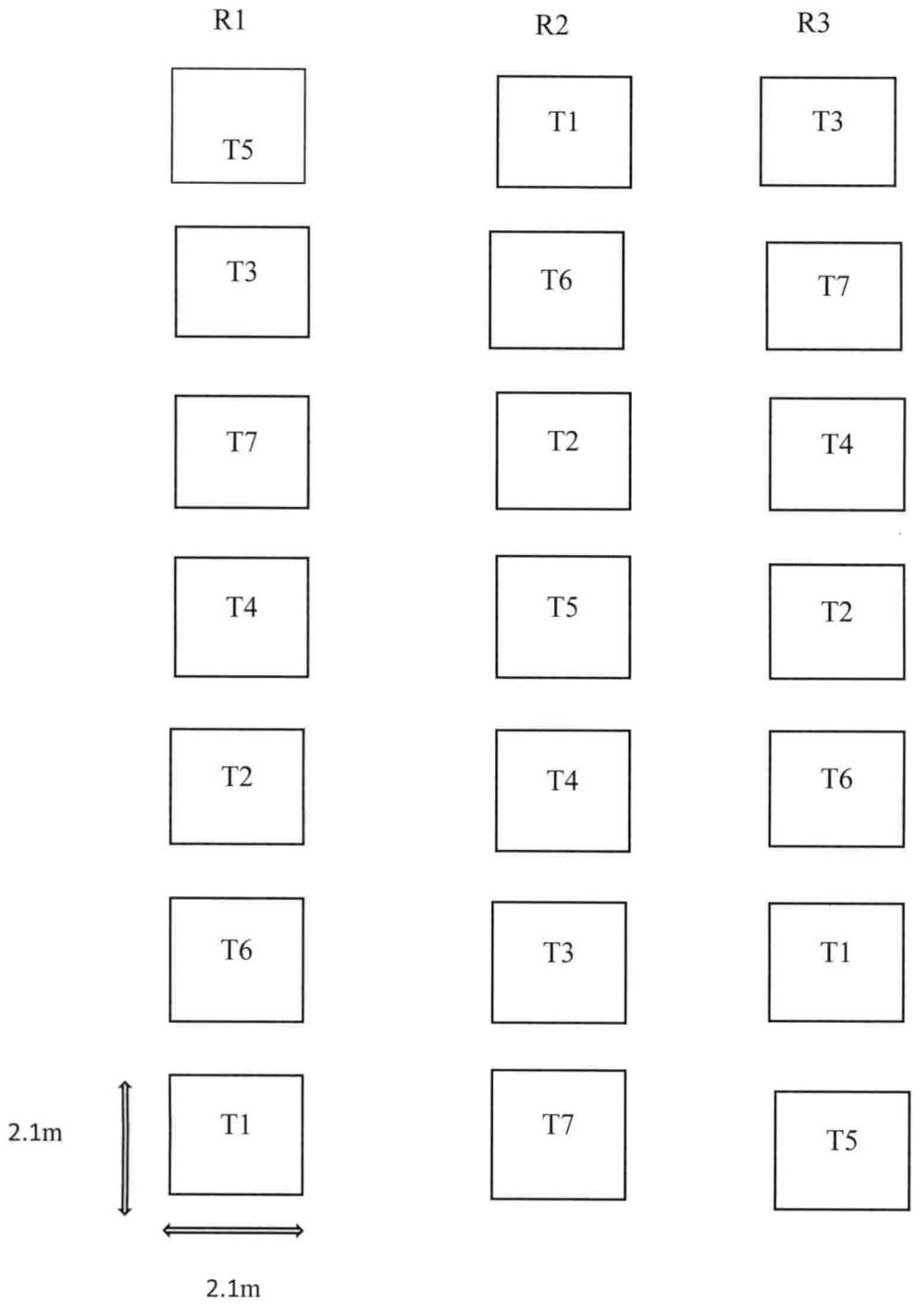

Fig. 2 Plan and layout of the experiment

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Number of replications - 3

No. of plants/ replication – 4

Spacing– 2.1m x 2.1m

The experiment was laid out with the following seven clones, planted under uniform conditions and all the management practices were given as per the Package of Practices Recommendations, Crops 2016 for 'Rasthali' (KAU, 2016).

T1Venneer Poovan

T2 Valiya Poovan

T3 Cheriya Poovan

T4 Andhra Poovan

T5 Marthaman

T6 Pullani collection

T7 Madakkathara collection

3.4 Main items of observations

Observations on various characters were recorded from all plants in each replication as per standard descriptors prescribed by IPGRI (1984).

3.4.1 PASSPORT DESCRIPTORS

The basic information regarding the clone/accession and prescribed parameters were recorded at the time of collection.

3.4.1.1 Accession number

Accession number is a unique identifier and is assigned when an accession is entered into the collection.

3.4.1.2 Acquisition date

Date on which the accession entered in the collection.

Plate 1. General field view of the experimental plot

3.4.1.3 Location of collecting site

Name of collecting site was recorded at the time of collection.

3.4.1.4 Local name

Name given by the farmer to clone was noted.

3.4.2 TAXONOMIC SCORING OF PLANTS

Taxonomic scoring of clones was done based on the 15 characters developed by Simmonds and Shepherd (1955).

3.4.3 VEGETATIVE CHARACTERS

Observations on vegetative characters were taken, four months after planting and at bunch emergence.

3.4.3.1 Plant height

Height of the plant was recorded from soil level to the base of the unopened leaf and expressed in centimeter (cm).

3.4.3.2 Plant girth

The girth of the plant was measured at 1m from base of pseudostem and expressed in centimeter (cm).

3.4.3.3 Pseudostem colour

The pseudostem colour of the plant was observed and classified into two groups namely green- yellow and medium green, without removing the external sheaths.

3.4.3.4 Length of leaf

Length of leaf was measured on the third leaf from top at its maximum point, from its base to the top and expressed in centimeter (cm).

3.4.3.5 Width of leaf

Width of leaf was measured on the third leaf at maximum point in the middle region and expressed in centimeter (cm).

3.4.3.6 Total leaf area/ plant

Leaf area was calculated by using the formula developed by Murray (1960) and expressed in square meter (m^2).

LA = L x W x 0.8

Where, LA - leaf area per leaf

L - Length of leaf

W - Width of leaf

The leaf area of all the functional leaves was taken to get total leaf area per plant.

3.4.3.7 Length of petiole

Length of petiole was recorded on the third leaf from the pseudostem to the lamina and expressed in centimeter (cm).

3.4.3.8 Number of leaves/plant

The total number of leaves present in the plant was recorded.

3.4.3.9 Wax on leaf sheath

Wax on leaf sheath was observed and grouped into two categories namely very little or no visible sign of wax and very few wax.

3.4.3.10 Blotches at the petiole base

Blotches at the petiole base was observed and classified into two groups namely sparse blotches and small blotches.

3.4.3.11 Colour of blotches

Colour of blotches was observed and grouped into two, namely brown and dark brown.

3.4.3.12 Petiole canal leaf III

Petiole canal leaf III was recorded from the third leaf counted from the last leaf produced before bunch emergence.

3.4.3.13 Leaf colour (lower and upper) surface

Colour of leaf (lower and upper) surface was observed and grouped into two categories namely green- yellow and medium green.

3.4.3.14 Wax on leaf

Wax on the leaf was recorded on the lower surface.

3.4.3.15 Leaf corrugation

Presence of ridges perpendicular to the secondary ribs on the leaf upper surface was recorded.

3.4.3.16 Colour of midrib (dorsal and ventral)

Pigmentation seen on the dorsal and ventral side of the midrib was recorded.

3.4.3.17 Number of suckers/ plant

Number of suckers was counted and recorded.

3.4.4 FLORAL CHARACTERS

3.4.4.1 Days taken from planting to shooting

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

3.4.4.2 Male bud length

Length of male bud was measured at the time of harvest and expressed in centimeter (cm).

3.4.4.3 Male bud type

Male bud type was recorded at maturity.

3.4.4.4 Male bud shape

Shape of male bud was observed and grouped into two, namely intermediate and like a top.

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3.4.4.5 Bract colour (upper and lower) face

Bract colour of the clones was observed and categorized into three groups namely red, purple, and orange- red.

3.4.5 BUNCH AND FRUIT CHARACTERS

According to Stover and Simmonds (1987) the bunches were harvested at full maturity when the fingers showed disappearance of angles. The following observations were made on bunches and fruit.

3.4.5.1 Days taken from shooting to harvest

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

3.4.5.2 Total crop duration

Total crop duration was calculated from the date of planting to the date of harvest and expressed in days.

3.4.5.3 Peduncle length

Peduncle length of the bunch was measured from the leaf crown to the first hand of fruit and expressed in centimeter (cm).

3.4.5.4 Peduncle width

Peduncle width of the bunch was measured at maximum point and expressed in centimeter (cm).

3.4.5.5 Bunch weight

Bunch weight was recorded after removing the peduncle from the bunch above the first hand and below the last hand and expressed in kilogram (kg).

3.4.5.6 Bunch length

Length of bunch was noted from the first hand to the last hand and expressed in centimeter (cm).

3.4.5.7 Bunch shape

Bunch shape was observed and recorded at the time of harvest.

3.4.5.8 Bunch appearance

Appearance of bunch was recorded at the time of harvest.

3.4.5.9 Number of hands/ bunch

Number of hands in a bunch after harvest was counted and recorded.

3.4.5.10 Number of fingers/ hand

Number of fingers on middle hand after harvest was counted and recorded.

3.4.5.11 Fruit shape

Shape of the fruit was observed and recorded.

3.4.5.12 Fruit apex

Apex of the fruit was observed at the distal end of the fruit and noted.

3.4.5.13 Fruit length

Length of the fruit was recorded on the central external fruit of the middle hand, without pedicel and expressed in centimeter (cm).

3.4.5.14 Fruit girth

Fruit girth was measured at the widest point of the fruit and expressed in centimeter (cm).

3.4.5.15 Fruit weight

Weight of fruit was taken by using a standard electronic balance and expressed in grams (g).

3.4.5.16 Fruit pedicel length

Pedicel length of the fruit was measured and expressed in centimeter (cm).

3.4.5.17 Fruit pedicel width

Pedicel width was recorded from the middle region and expressed in centimeter (cm).

3.4.5.18 Cracks in fruit peel

Cracks in the fruit peel were recorded at fruit maturity, if the peel split without mechanical damage.

3.4.5.19 Pulp colour at maturity

Colour of pulp at maturity was observed and noted on ripe, but not over - ripe, full yellow stage of fruit.

3.4.5.20 Fruit fall from hands

Fruit fall from hands was observed at fruit maturity.

3.4.5.21 Presence of seed

Presence of seed was recorded only if seed exists in the fruit.

3.4.6 QUALITY PARAMETERS

Ripe fruits were used to estimate the quality parameters.

3.4.6.1 Total soluble solids (TSS)

Total soluble solids was estimated using a hand refractometer and expressed in degree brix (° Brix) (Ranganna, 1977).

3.4.6.2 Titratable acidity

Acidity was determined according to AOAC (1998) by titrating a known volume of fruit sample against 0.1N NaOH solution using phenolphthalein as an indicator and expressed in percentage of citric acid present in the fruit.

3.4.6.3 Total sugars

Total sugar content of the sample was estimated by the procedure proposed by Ranganna (1997) and calculated using the formula,

$$\text{Total sugars (\%)} = \frac{\text{Titre value x 0.1 x Volume made up x 0.064 x 100}}{\text{Volume of the sample x Weight of the sample}}$$

3.4.6.4 Sugar- acid ratio

Sugar- acid ratio was determined after estimating the quantity of total sugars and titratable acidity.

3.4.6.5 Pulp- peel ratio

Pulp- peel ratio was recorded after taking the weight of pulp and peel of the fruit separately.

3.4.6.6 Fruit peel thickness

Peel thickness of fruit was recorded at fruit maturity, i.e. at ready to eat ripe or full yellow stage and expressed in millimeter (mm).

3.4.6.7 Shelf life of fruits at ambient conditions

Number of days from ripening to the stage when the fruits skin turns black and become unsuitable for consumption was recorded.

3.4.6.8 Organoleptic scoring of fruits

Organoleptic scoring of fruits was done with the quality attributes like texture, taste, sweetness, flavour, colour, and over all acceptability (Jellineck,1985) using a nine- point hedonic scale which vary from dislike extremely (1) to like extremely (9) as proposed by Amerine *et al.* (1965). It was carried out by a panel of 15- member panel of judges from College of Horticulture, Vellanikkara.

3.4.7 INCIDENCE OF PEST, DISEASES AND DISORDERS

Incidence of pests, diseases and disorders was observed throughout the crop period and recorded.

3.4.8 STATISTICAL ANALYSIS

The mean of the values recorded on four plants in each replication were taken for statistical analysis. Analysis of variance and co- variance with respect to biometrical and yield characters were conducted in Randomized Block design

(RBD) (Panse and Sukhatme, 1985). The data obtained were also processed for heritability, genetic advance as % mean, genotypic and phenotypic coefficient of variation, genotypic and phenotypic correlation coefficients and path coefficients by techniques suggested by Fisher (1960).

For organoleptic analysis, the scores given by 15-member panel of judges were analyzed using Kendall's coefficient of concordance to get the mean rank for all Rasthali clones. (Sidney, 1988).

3.4.8.1 Estimation of genetic parameters

a. Coefficient of variation

i. Genotypic coefficient of variation (GCV) $= (V_g/ X)^{1/2} \times 100$

ii. Phenotypic coefficient of variation (PCV) $= (V_p/ X)^{1/2} \times 100$

Where,

X = Mean of characters under study

V_g = Genotypic variance

V_p = Phenotypic variance

b. Heritability

Heritability is the proportion of genotypic variance to the total observed variance in the total population. It was calculated using the formula suggested by Burton and Devane (1953) and expressed in percentage.

$H^2 = (V_g/ V_p) \times 100$

Where,

V_g = Genotypic variance

V_p = Phenotypic variance

The range of heritability estimates were categorized as suggested by Johnson *et al.* (1955).

Low : < 30 %

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Medium : 30- 60%

High : > 60%

c. Genetic advance

Genetic advance refers to the expected genetic gain to next generation at five per cent selection pressure was calculated using the formula suggested by Johnson *et al.* (1955) with a constant K (2.06) as given by Allard (1960).

$GA = (V_g / V_p) \times K$

Where,

V_g = Genotypic variance

V_p = Phenotypic variance

K = Selection differential at 5% selection intensity

Genetic advance as % mean (genetic gain)

Genetic gain was estimated using the formula,

$GG = (GA / X) \times 100$

Where,

GA = Genotypic advance

X = Mean of character under study

The range of genetic gain was classified according to Johnson *et al.* (1955) as:

Low - 0-10%

Moderate - 10-20%

High - >20 %

3.4.8.2 Correlation analysis

Genotypic and phenotypic correlation coefficients were calculated as suggested by Al- Jibourie *et al.* (1958).

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Genotypic correlation = $r_{xy}(g) = Cov_{xy}(G)/ [V_x(G) \times V_y(G)]^{1/2}$

Phenotypic correlation = $r_{xy}(p) = Cov_{xy}(P)/ [V_x(P) \times V_y(P)]^{1/2}$

Where,

$Cov_{xy}(G)$ – Genotypic covariance between x and y

$Cov_{xy}(P)$ - Phenotypic covariance between x and y

$V_x(G)$ - Genotypic variance of character 'x'

$V_x(P)$ - Phenotypic variance of character 'x'

$V_y(G)$ - Genotypic variance of character 'y'

$V_y(P)$ - Phenotypic variance of character 'y'

The test of significance for association between characters was done by comparing table r values at n-2 degrees of freedom with estimated values.

3.4.8.3 Path coefficient analysis

Path coefficient analysis suggested by Wright (1921) and elaborated by Dewey and Lu (1959) was carried out to find direct and indirect effect of the morphological characters on bunch yield. The following equations were used for finding direct and indirect effects.

$r_{1y} = a + r_{12}b + r_{13}c + \ldots\ldots\ldots\ldots\ldots + r_{1Ii}$

$r_{2y} = a + r_{21}a + b + r_{23}c + \ldots\ldots\ldots\ldots\ldots + r_{2Ii}$

$r_{Iy} = r_{I1}a + r_{I2}b + r_{I3}c + \ldots\ldots\ldots\ldots\ldots + I$

Where,

r_{1y} to r_{Iy} = Coefficient of correlation between casual factors 1 to I with dependent variable y.

r_1 to r_I = Coefficient of correlation among casual factors

a, b,c…I = Direct effect of characters 'a' to 'I' on y.

Residual effect (R) = $1 - \sqrt{a^2 + b^2 + c^2 + \ldots\ldots\ldots i^2 + 2ab\, r_{12} + 2ac\, r_{13} + \ldots}$

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Scale for path analysis

A scale suggested by Lenka and Mishra (1973) for the importance of direct and indirect effect values is as follows:

Rate of scale	Values of direct and indirect effects
Negligible	0.00- 0.09
Low	0.10 - 0.19
Moderate	0.20- 0.29
High	0.30- 0.99
Very high	More than 0.99

Results

4. RESULTS

The present work was carried out to evaluate the effect of clonal variation on biometric characters, yield characters and quality parameters of Rasthali clones. The experiment was conducted during the period of May 2017 to July 2018 at BRS, Kannara, after collecting clones from Thrissur and Palakkad districts. The results of the work are given below;

4.1 PASSPORT DESCRIPTORS

Passport descriptor of Rasthali clones such as accession number, acquisition date, location of collected site and local name are presented in Table 1.

4.2 TAXONOMIC SCORING OF RASTHALI CLONES

Taxonomic scoring of Rasthali clones based on the 15 characters is presented in Table 2. Variations in the score were observed to be in the range of 29 to 36; thus, all the clones are included in the AAB genomic group with a score 26-46. The highest score was recorded in T1 (36) followed by T4 and T5 (33 in each), T2 (32), T3 (31) and T7 (30). The lowest score was in T6 (29).

4.3 MORPHOLOGICAL CHARACTERS IN RASTHALI CLONES

Rasthali clones showed good amount of variations with respect to morphological and fruit characters (Tables 3a, 3b, 3c).

The Pseudostem colour was found as green – yellow and medium green. Most of the clones had medium green pseudostem except TI (Venneer Poovan) which was green – yellow.

Wax on leaf sheath was very few in clones T3, T4, T5, T6 and T7, whereas, T1 and T2 had very little or no visible sign of wax on leaf sheath.

Sparse blotching was found in T1 while all other clones had small blotches at petiole base.

Table 1. Passport descriptors of Rasthali clones

Rasthali clones	Accession number	Acquisition date	Location of collecting site	Local name
T1	002	15/06/2017	Paruthipully	Venneer Poovan
T2	003	20/06/2017	Kannara, Ernakulam	Valiya Poovan
T3	004	20/06/2017	Kannara, Ernakulam	Cheriya Poovan
T4	005	20/06/2017	Kannara	Andhra Poovan
T5	006	20/06/2017	Kannara	Marthaman
T6	001	5/06/2017	Madakkathara	-
T7	007	24/06/2017	Pullani	-

T1: Venneer Poovan

T2: Valiya Poovan

T3: Cheriya Poovan

T4: Andhra Poovan

T5: Marthaman

T6: Pullani collection

T7: Madakkathara collection

Table 2. Taxonomic scoring of Rasthali clones

Characters	T1	T2	T3	T4	T5	T6	T7
1.Pseudostem colour	3	2	2	2	2	2	2
2.Petiolar canal	1	1	1	1	1	1	1
3.Peduncle	3	3	3	3	3	3	3
4.Pedicels	4	2	2	2	2	2	2
5.Ovules	1	1	1	1	1	1	1
6.Bract shoulder	2	2	2	2	2	2	2
7.Bract curling	3	1	1	1	1	1	1
8.Bract shape	4	3	3	3	3	3	3
9.Bract apex	2	2	2	2	2	1	2
10.Bract colour	4	3	3	3	3	3	3
11.Colour fading	3	3	3	3	3	3	3
12.Bract scars	1	1	1	1	1	1	1
13.Free tepal of male flower	2	2	2	3	3	2	2
14.Male flower colour	2	3	2	3	3	2	2
15.Stigma colour	1	3	2	3	3	2	2
Total score	**36**	**32**	**31**	**33**	**33**	**29**	**30**

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The blotch colour varied from brown to dark brown. All the clones were having brown blotch colour except T3.

All the clones evaluated were having straight with erect margin in the petiole canal leaf III.

The colour of leaf of all the clones were green- yellow in lower surface and medium green in upper surface except T1 which had green- yellow colour in both the surfaces.

All the clones were having very little/ no visible sign of wax on leaf and only few stripes on upper leaf surface.

All the Rasthali clones studied had light green colour on dorsal and ventral surface of mid rib.

The male bud type of all the clones was normal, and it varied from intermediate to like a top. All the collections except T1 and T2 had male bud shape like a top and T1 and T2 had an intermediate shape of male bud.

The bract colour varied from red to purple in upper surface and orange-red to red in the lower surface. All the clones except T1 had purple and red coloured bract. T1 had orange red colour in upper surface and red colour in lower surface lower surface of the bract.

All the clones evaluated were having cylindrical bunch shape and compact appearance.

Fruit shape and fruit apex were same for all clones all were having blunt tipped apex with straight in the distal part of fruit.

All the clones studied were having cracks in fruit peel and fruit fall from hands was deciduous. Seed was not present in the fruit of any of the clone.

Pulp colour at maturity was cream for all the clones.

Table 3a. Morphological characters of Rasthali clones as per IPGRI plant descriptor

Rasthali clones	Pseudostem colour	Wax on leaf sheath	Blotches at the petiole base	Colour of blotches	Petiole canal leaf III	Leaf colour (lower and upper) surface	Wax on leaf	Leaf corrugation
T1	Green-yellow	Very little/ no visible sign of wax	Sparse blotching	-	Straight with erect margin	Green- yellow Green- yellow	Very little/ no visible sign of wax	Few stripes
T2	Medium green	Very little/ no visible sign of wax	Small blotches	Brown	Straight with erect margin	Green- yellow Medium green	Very little/ no visible sign of wax	Few stripes
T3	Medium green	Very few wax	Small blotches	Dark brown	Straight with erect margin	Green- yellow Medium green	Very little/ no visible sign of wax	Few stripes
T4	Medium green	Very few wax	Small blotches	Brown	Straight with erect margin	Green- yellow Medium green	Very little/ no visible sign of wax	Few stripes
T5	Medium green	Very few wax	Small blotches	Brown	Straight with erect margin	Green -yellow Medium green	Very little/ no visible sign of wax	Few stripes
T6	Medium green	Very few wax	Small blotches	Brown	Straight with erect margin	Green -yellow Medium green	Very little/ no visible sign of wax	Few stripes
T7	Medium green	Very few wax	Small blotches	Brown	Straight with erect margin	Green -yellow Medium green	Very little/ no visible sign of wax	Few stripes

Green yellow

Medium green

Sparse blotches

Brown colour blotches

Dark brown blotches

Medium green colour

Green Yellow colour

T1- Venneer Poovan T2- Valiya Poovan T3- Cheriya Poovan

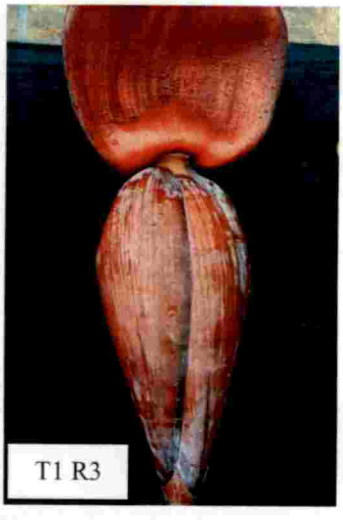
Plate 2. Variability in Pseudostem colour, blotches and leaf colour in Rasthali clones

3b. Morphological characters of Rasthali clones as per IPGRI plant descriptor

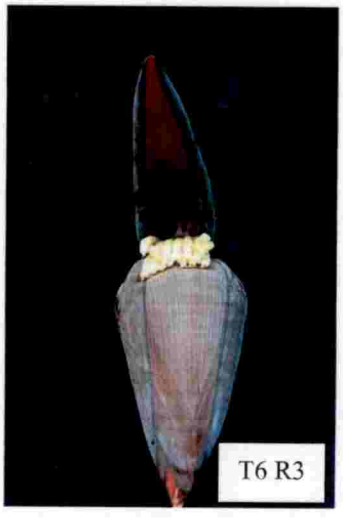
Rasthali clones	Colour of mid rib (dorsal and ventral) surface	Male bud type	Male bud shape	Bract colour (lower and upper) surface	Bunch shape	Bunch appearance	Fruit shape	Fruit apex
T1	Light green	Normal	Intermediate	Orange- red	Cylindrical	Compact	Straight	Bottle-necked
	Light green			Red				
T2	Light green	Normal	Intermediate	Red	Cylindrical	Compact	Straight in the distal part	Blunt- tipped
	Light green			Purple				
T3	Light green	Normal	Like a top	Red	Cylindrical	Compact	Straight in the distal part	Blunt- tipped
	Light green			Purple				
T4	Light green	Normal	Like a top	Red	Cylindrical	Compact	Straight in the distal part	Blunt- tipped
	Light green			Purple				
T5	Light green	Normal	Like a top	Red	Cylindrical	Compact	Straight in the distal part	Blunt- tipped
	Light green			Purple				
T6	Light green	Normal	Like a top	Red	Cylindrical	Compact	Straight in the distal part	Blunt- tipped
	Light green			Purple				
T7	Light green	Normal	Like a top	Red	Cylindrical	Compact	Straight in the distal part	Blunt- tipped
	Light green			Purple				

Intermediate shape

Like a top shape



Orange red- Red colour



Red- Purple colour

T1- Venneer Poovan T2 – Valiya Poovan T6 – Pullani collection

Plate 3. Variability in bract shape and bract colour in Rasthali clones

Table 3c. Morphological/ fruit characters of Rasthali clones as per IPGRI plant descriptor

Rasthali clones	Cracks in fruit peel	Pulp colour at maturity	Fruit fall from hands	Presence of seed
T1	Cracked	Cream	Deciduous	Absent
T2	Cracked	Cream	Deciduous	Absent
T3	Cracked	Cream	Deciduous	Absent
T4	Cracked	Cream	Deciduous	Absent
T5	Cracked	Cream	Deciduous	Absent
T6	Cracked	Cream	Deciduous	Absent
T7	Cracked	Cream	Deciduous	Absent

T1: Venneer Poovan

T2: Valiya Poovan

T3: Cheriya Poovan

T4: Andhra Poovan

T5: Marthaman

T6: Pullani collection

T7: Madakkathara collection

4.4 BIOMETRIC CHARACTERS IN RASTHALI CLONES

4.4.1 Plant height

The results showed significant variation in plant height among different treatments both at four month after planting and at bunch emergence (Table 4). At four month after planting (4MAP), the treatment T2 showed the highest mean value for plant height (158.87cm) followed by T4 (146.03cm), T3 (141.38cm) and T6 (137.07cm); and all these treatments being statistically on par. The lowest plant height was observed in T7 (111.47cm); however, T1 (116.42cm) and T5 (126.02cm) were on par with T7.

At bunch emergence, T1 (335.42cm) had the highest plant height, followed by T5 (328.59cm); which were statistically on par with each other. Least height was observed in T7 (248.13cm) which varied significantly from all other treatments. All the other treatments such as T3, T6 and T2 were found to be statistically on par.

4.4.2 Plant girth

The results of the data on plant girth at 4MAP and bunch emergence are presented in Table 4. There was a significant difference in plant girth among different treatments both at 4MAP and bunch emergence. At 4MAP, T2 (26.45cm) had maximum girth, followed by T3 (25.38cm), T6 (21.35cm) and T4 (21.22cm); all these three treatments were statistically on par with T2. Lowest plant girth was observed for T7 (16.53cm), which was statistically on par with T1 (19.33cm) and T5 (20.10cm).

T1 showed highest mean value (60.18cm) for plant girth at bunch emergence stage followed by T5 (59.45cm) which were statistically on par with each other. The treatment T7 (45.5cm) recorded the lowest plant girth, which was statistically on par with T6 (48.10cm), T3 (48.97cm) and T2 (49.28cm).

Table 4. Plant height and plant girth in Rasthali clones

Treatments	Plant height (cm)		Plant girth (cm)	
	4 MAP	At bunch emergence	4 MAP	At bunch emergence
T 1	116.42^{cd}	335.42^{a}	19.33^{c}	60.18^{a}
T 2	158.87^{a}	293.47^{bc}	26.45^{a}	49.27^{cd}
T 3	141.38^{ab}	284.50^{c}	25.38^{ab}	48.96^{cd}
T 4	146.03^{ab}	305.83^{b}	21.22^{abc}	54.00^{bc}
T 5	126.02^{bcd}	328.59^{a}	20.10^{bc}	59.45^{ab}
T 6	137.07^{abc}	288.53^{c}	21.35^{abc}	48.10^{cd}
T 7	111.47^{d}	248.13^{d}	16.53^{c}	45.50^{d}
CD (0.05)	22.81	15.87	5.48	6.14

T1: Venneer Poovan

T2: Valiya Poovan

T3: Cheriya Poovan

T4: Andhra Poovan

T5: Marthaman

T6: Pullani collection

T7: Madakkathara collection

4.4.3 Length of leaf

The statistical analysis revealed significant difference among various treatments both at 4MAP and at bunch emergence stage (Table 5) with respect to leaf length. Treatment T2 (178.86cm) showed highest leaf length at 4MAP followed by T3 (175.39cm) and T4 (160.73cm) and these two were on par with T2. The lowest leaf length was found in T1 (117.50cm) which was on par with T7 (134.07cm).

At bunch emergence, treatment T4 showed highest mean leaf length of 276.27cm, followed by T2 (260.69cm), T3 (258.04cm) and T7 (255.77cm); all four were statistically on par with each other. The lowest leaf length was recorded in T5 (237.26cm); however, it was on par with T1 (247.83cm) and T6 (253.53cm).

4.4.4 Width of leaf

Leaf width of Rasthali clones varied significantly both at 4MAP and at bunch emergence (Table 5). Mean leaf width was maximum in T2 (60.70cm) followed by T4 (57.19cm), T3 (56.35cm) and T5 (51.68cm); all three were statistically on par with T2. Lowest leaf width was observed in T7 (42.57cm) which was on par with T6 (44.33cm) and T1 (48.34cm).

Treatment T4 (69.83cm) showed highest leaf width at bunch emergence stage followed by T2 (67.44cm), T1 (66.23cm) and T3 (64.63cm); all three were on par with T4. The treatment T7 (51.59cm) which recorded the lowest leaf width, was on par with T6 (52.83cm) and T5 (59.86cm).

4.4.5 Total leaf area/ plant

Results of the data on total leaf area per plant both at 4MAP and at bunch emergence are presented in Table 5. There were significant differences in the total leaf area per plant between different treatments both at 4MAP and at bunch emergence stage. T2 (7.16m^2) showed highest total leaf area at 4MAP followed by T3 (6.08m^2) and these two were on par with each other. T7 (2.35m^2) showed

Table 5. Leaf characteristics in Rasthali clones

Treatments	Leaf length (cm)		Leaf width (cm)		Length of petiole (cm)		Total leaf area per plant (m^2)	
	4 MAP	At bunch emergence	4 MAP	At bunch emergence	4 MAP	At bunch emergence	4 MAP	At bunch emergence
T1	117.50^{d}	247.83^{bc}	48.34^{bcd}	66.23^{ab}	26.67^{d}	62.93^{bc}	3.88^{cd}	12.26^{a}
T2	178.86^{a}	260.69^{ab}	60.70^{a}	67.44^{ab}	57.03^{a}	68.77^{ab}	7.16^{a}	9.77^{abc}
T3	175.39^{a}	258.04^{abc}	56.35^{ab}	64.63^{ab}	52.99^{ab}	70.74^{a}	6.08^{ab}	8.69^{bc}
T4	160.72^{ab}	276.27^{a}	57.19^{ab}	69.83^{a}	56.43^{ab}	70.67^{a}	5.28^{bc}	11.51^{ab}
T5	141.87^{bc}	237.26^{c}	51.68^{abc}	59.86^{bc}	52.88^{ab}	59.42^{c}	3.72^{de}	7.39^{c}
T6	141.36^{c}	253.53^{bc}	44.33^{cd}	52.83^{c}	40.33^{c}	52.63^{d}	3.07^{de}	7.72^{c}
T7	134.06^{cd}	255.77^{abc}	42.57^{d}	51.59^{c}	47.28^{bc}	56.79^{cd}	2.35^{e}	7.35^{c}
CD (0.05)	19.05	21.28	9.05	8.79	9.19	6.18	1.45	2.89

lowest total leaf area per plant and it was on par with T6 ($3.07m^2$) and T5 ($3.72m^2$).

Data revealed that total leaf area at bunch emergence was highest in T1 ($12.26m^2$) which was on par with T4 ($11.51m^2$) and T2 ($9.77m^2$). The lowest leaf area at bunch emergence was recorded in T7 ($7.35m^2$) which was on par with T5 ($7.39\ m^2$) and T6 ($7.72\ m^2$).

4.4.6 Length of petiole

Data on length of petiole of various treatments at 4MAP and at bunch emergence showed significant difference (Table 5). At 4MAP, length of petiole was the highest in T2 (57.03cm) followed by T4 (56.43cm), T3 (52.99cm) and T5 (52.88cm) which were on par with one another. Lowest petiole length was recorded in T1 (26.67cm) which was significantly different from all other treatments.

Length of petiole was highest for T3 (70.74cm) followed by T4 (70.67cm) and T2 (8.77cm) and all three were statistically on par with one another, at bunch emergence stage. Treatment T6 had the lowest petiole length of 52.63cm, which was on par withT7 (56.79cm).

4.4.7 Number of leaves/ plant

The results indicated significant variation in number of leaves both at MAP and at bunch emergence stage (Table 6). At 4MAP stage, the treatment T1 (10.67) showed highest number of leaves followed by T2 (9.83) which were statistically on par with each other. This was followed by T3 (9.08) which was on par with T2. The lowest number of leaves was found in T7 (5.42) which was significantly different from all others.

Number of leaves at bunch emergence was highest in T1 (10.000) which was significantly superior to all other treatments. Even though T3 (7.39) had the lowest number of leaves it was statistically on par with all other treatments except T1.

4.4.8 Number of suckers/ plant

Results of the data on number of suckers per plant at 4MAP and at bunch emergence are presented in Table 6. There was no significant difference among treatments at both the stages. However, it varied from0.92 (T6) to 1.833 (T7) at 4MAP and from 1.75(T5) to 3.17(T1) at bunch emergence stage.

4.5 FLORAL CHARATERS IN RASTHALI CLONES

4.5.1 Male bud length

The male bud length of bunch at harvest did not show significant variation among the clones (Table 7), even though, the mean value of male bud length varied from12.30 cm to 9.17cm. The highest value of male bud length was recorded in T5 (9.17cm) followed by T3 (17.17cm) and T7 (15.03cm) while T6 (12.30cm) recorded the lowest male bud length.

4.5.2Days taken from planting to shooting

Duration of vegetative phase showed significant variation among the various treatments (Table 7). Treatment T4 (299.00days) took maximum time for shooting which was on par with T1 (296.08days). The shortest vegetative phase was observed in T7 (247.25days) which was on par with T3 (248.42days) and T2 (259.58days).

4.5.3 Days taken from shooting to harvest

Result of the data on days taken from shooting to harvest showed significant variation among various treatments (Table 7). The duration from shooting to harvest was maximum in T1 (138.83days) which was significantly different from all others. The treatment T2 (116.33days) was on par with T4 (110.75days) with regard to the duration. T6 (98.00days) recorded shortest duration which was on par with T5 (103.33days) and T6 (100.00days).

Table 6. Number of leaves and suckers in Rasthali clones

Treatments	Number of leaves		Number of suckers	
	4 MAP	At bunch emergence	4 MAP	At bunch emergence
T1	10.67[a]	10.00[a]	1.00	3.17
T2	9.83[ab]	8.42[b]	1.66	2.64
T3	9.08[bc]	7.39[b]	1.75	2.50
T4	8.25[cd]	8.50[b]	0.67	2.17
T5	7.25[de]	7.58[b]	1.25	1.75
T6	6.92[e]	8.17[b]	0.92	3.00
T7	5.41[f]	8.08[b]	1.83	2.00
CD (0.05)	1.07	1.26	NS	NS

Table 7. Male bud length and crop duration in Rasthali clones

Treatments	Length of male bud (cm)	Duration of vegetative phase (days)	Duration from shooting to harvest (days)	Total crop duration (days)
T1	13.93	296.08[a]	138.83[a]	434.92[a]
T2	14.47	259.58[bc]	116.33[c]	375.92[cd]
T3	17.17	248.42[c]	132.00[b]	379.42[c]
T4	12.77	299.00[a]	110.75[c]	409.08[b]
T5	19.17	263.00[b]	103.33[d]	366.33[de]
T6	12.30	263.25[b]	98.00[d]	361.25[e]
T7	15.03	247.25[c]	100.50[d]	347.75[f]
CD (0.05)	NS	14.35	6.76	10.28

Longest crop duration was recorded by T1 (434.92days) which was significantly different from all other treatments. Among the treatments T7 (347.75days) recorded the shortest crop duration.

4.6 BUNCH AND FRUIT CHARATERS IN RASTHALI CLONES

4.6.1 Peduncle length

Statistical analysis of the data indicated that peduncle length did not vary significantly among the clones (Table 8). However, it was observed to be the highest in T5 (46.93cm) followed by T1 (45.50cm) and T7(44.83cm). Treatment T4(38.67cm) recorded lowest peduncle length.

4.6.2 Peduncle width

Results of the data on peduncle width are presented in Table 8. There was no significant variation in the peduncle width among the clones. The mean value varied in the range of 13.37cm to 19.50cm. Treatment T1 (19.50cm) recorded maximum peduncle width followed by T3 (15.50cm) and T2 (15.50cm) while T4 (13.37cm) recorded the lowest peduncle width.

4.6.3 Bunch weight

Data on weight of bunch of various treatments are presented in Table 8 in which significant difference could be observed. The mean bunch weight ranged from 6.60kg to 9.90kg. Weight of bunch was found to be the highest for T1 (9.90kg) followed by T2 (9.10kg) and T5 (8.30kg) which were significantly on par with T1. The lowest bunch weight was recorded in T4 (6.60kg) which was on par with all other treatments except T1and T2.

4.6.4 Bunch length

Results of the study indicated variation in bunch length among the various clones of Rasthali (Table 8). The bunch length ranged from 34.07cm to 41.83cm. The highest bunch length was recorded in T1 (41.83cm) followed by T2(39.20cm) which was on par with T1. The lowest bunch length was observed in T6(34.07cm)

Table 8. Bunch characters in Rasthali clones

Treatments	Peduncle length (cm)	Peduncle width (cm)	Bunch length (cm)	Bunch weight (kg)	No. of hands per bunch	No. of fingers per hand
T1	45.50	19.50	41.83[a]	9.90[a]	8.44[a]	15.83[a]
T2	42.17	15.50	39.20[ab]	9.10[ab]	7.17[bc]	13.50[c]
T3	41.67	15.67	35.00[bc]	7.97[bc]	8.17[ab]	15.00[ab]
T4	38.67	13.37	35.67[bc]	6.60[c]	6.05[c]	14.50[bc]
T5	46.97	14.40	37.50[bc]	8.30[abc]	7.22[bc]	15.50[ab]
T6	43.50	13.80	34.07[c]	6.65[c]	6.39[c]	13.50[c]
T7	44.83	15.27	35.67[bc]	7.60[b]	6.09[c]	13.50[c]
CD (0.05)	NS	NS	4.11	1.88	1.21	1.17

which was on par with all treatments except T1 and T2.

4.6.5 Number of hands/ bunch

Analysis of data on number of hands showed significant variation among clones (Table 8). The mean number of hands ranged from 6.05 to 8.44. T1 (8.44) recorded the highest number of hands per bunch, followed by T3 (8.17) which were statistically on par with each other. The lowest number of hands was recorded in T4 (6.05) which was on par with T7 (6.09), T6 (6.39) and T2 (7.17).

4.6.6 Number of fingers/ hand

Data on number of fingers per hand of various treatments are presented in Table 8. The number of fingers per hand showed significant difference among the treatments. The mean number of fingers per hand ranged from 13.50 to15.83. Treatment T1 (15.83) has recorded maximum number of fingers per hand followed by T3 (15.5) and T5 (15); all three were statistically on par. The lowest number of fingers per hand was observed in T2, T6 and T7 (13.50in each) which was on par with T4 (14.50).

4.6.7 Fruit length

Fruit length varied significantly among the treatments (Table 9). The mean value of fruit length was observed in the range of 8.50cm - 13.93cm. Highest fruit length was recorded in T1 (13.93cm) which was significantly superior from all others. T3 (12.97cm) was on par with T1 (12.43cm) and T5 (12.07cm). The lowest fruit length was recorded in T4 (8.50cm) and T6 (9.47cm) was on par with T4.

4.6.8 Fruit girth

Statistical analyzed data on girth of fruit are presented in Table 9. The mean value of fruit girth ranged from 7.5cm to 12.47cm. Girth of fruit was highest for T2 (12.47cm) followed by T5 (11.30cm), T3 (11.13cm) and T1 (10.83cm) which were on par with T2. The lowest fruit girth was observed in T4 (7.50cm) which was statistically on par with T6 (8.90cm).

Venneer Poovan

Valiya Poovan

Cheriya Poovan

Andhra Poovan

Marthaman

Pullani collection

Madakkathara collection

Plate 4. Bunches of Rasthali clones

Venneer Poovan

Valiya Poovan

Cheriya Poovan

Andhra Poovan

Marthaman

Pullani collection

Madakkathara collection

Plate 5. Middle hands of Rasthali clones

4.6.9 Fruit weight

Data on weight of fruits showed significant variation among the various treatments (Table 9). The mean weight of fruits varied from 42.36g to 92.60g. The treatment T2 (92.60g) recorded the highest weight of fruits which was on par with T7 (85.37g) and T5 (83.90g). The lowest fruit weight was observed in T4 (42.36g) which varied significantly from all other treatments.

4.6.10 Fruit pedicel length

Pedicel length of fruit did not show significant variation among different treatments. However, the mean value of pedicel length varied from 1.27cm to 2.40cm. The highest mean value of pedicel length was recorded in T1 (2.40cm) followed by T2 (2.03cm) while T7 (1.27) recorded the lowest pedicel length; whereas followed by T4 and T5 (1.43cm).

4.6.11 Fruit pedicel width

Analysis of data on fruit pedicel width did not show significant variation among treatments (Table 9). However, the value varied in the range of 0.68cm to 1.30cm. Treatment T2 (1.30cm) recorded the highest pedicel width followed by T6 (1.23cm), T1 and T3 (each with 1.20cm). Lowest pedicel width was observed in T5 (0.68cm).

4.7 QUALITY PARAMETERS IN RASTHALI CLONES

Data on quality parameters of different treatments are presented in Table 10.

4.7.1 Total soluble solids (TSS)

The treatments showed significant variation in TSS content of the fruits. TSS was maximum in T5 (26.83°Brix) which was significantly superior to all other treatments. The treatments T2 (24.97°Brix) was on par with T1 (23.97°Brix). Minimum TSS was recorded in T3 (20.23), which was significantly different from all others.

Table 9. Fruit characteristics in Rasthali clones

Treatments	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Fruit pedicel length (cm)	Fruit pedicel width (cm)
T1	12.43^{b}	10.83^{abc}	60.87^{c}	2.40	1.20
T2	13.93^{a}	12.47^{a}	92.60^{a}	2.03	1.30
T3	12.97^{ab}	11.13^{ab}	72.62^{bc}	1.70	1.20
T4	8.50^{d}	7.50^{d}	42.36^{d}	1.43	0.93
T5	12.07^{b}	11.30^{ab}	83.90^{ab}	1.43	0.68
T6	9.47^{cd}	8.90^{cd}	71.52^{bc}	1.70	1.23
T7	10.57^{c}	10.17^{bc}	85.37^{ab}	1.27	0.80
CD (0.05)	1.14	1.94	16.71	NS	NS

Table 10. Fruit quality parameters in Rasthali clones

Treatments	TSS (°Brix)	Titratable acidity (%)	Total sugars (%)	Sugar-acid ratio	Pulp-peel ratio	Fruit peel thickness (mm)	Shelf life (days)
T1	23.97^{bc}	0.32^{bcd}	20.16^{b}	64.89^{bc}	3.92^{a}	1.53^{de}	6.56^{ab}
T2	24.97^{b}	0.27^{cd}	20.59^{b}	75.17^{ab}	3.48^{bc}	1.60^{cd}	4.83^{d}
T3	20.23^{e}	0.42^{a}	16.29^{e}	39.35^{d}	3.47^{c}	1.77^{abc}	5.87^{bc}
T4	22.37^{d}	0.38^{ab}	17.07^{d}	44.44^{d}	2.96^{d}	1.91^{a}	6.96^{a}
T5	26.83^{a}	0.24^{d}	22.88^{a}	83.42^{a}	3.83^{a}	1.42^{e}	5.13^{cd}
T6	21.73^{d}	0.40^{ab}	18.69^{c}	46.41^{d}	3.40^{c}	1.85^{ab}	5.89^{bc}
T7	23.80^{c}	0.34^{abc}	18.35^{c}	55.69^{cd}	3.79^{ab}	1.67^{bcd}	5.32^{cd}
CD (0.05)	1.11	0.090	0.75	16.75	0.32	0.18	0.81

4.7.2 Titratable acidity

Statistical analysis of the data revealed that there was significant difference among Rasthali clones with regard to titratable acidity. It was highest in T3 (0.42 per cent). Treatments T6 (0.40 per cent), T4 (0.38 per cent) and T7 (0.34 per cent) were on par with T3. The lowest value for acidity was recorded in T5 (0.24 per cent) which was on par with T2 (0.27 per cent).

4.7.3 Total sugars

Significant variation was observed with regard to total sugar content of fruits among different treatments. T5 recorded the highest total sugar content (22.88per cent) which was significantly different from other treatments. Treatment T3 (16.29per cent) recorded the lowest sugar content, which was significantly different from all others. T4 (17.07per cent) and T7 (18.35per cent) were on par with each other with respect to the total sugar content.

4.7.4 Sugar- acid ratio

The highest sugar- acid ratio in fruit was observed in T5 (83.42) which was significantly superior to all others. This was followed by T2 (75.17) and T1 (64.89), which were on par. The lowest sugar/ acid ratio was observed in T3 (39.35); however, T4 (44.44) and T6 (46.41) were statistically on par with T3.

4.7.5 Pulp- peel ratio

Pulp- peel ratio varied significantly between the clones of Rasthali. The highest pulp/ peel ratio of ripe fruits was found in T1 (3.92) followed by T5 (3.83) and T7 (3.79); all three were significantly on par. The lowest pulp/ peel ratio was observed in T4 (2.96), which was significantly different from all others. T6 (3.40) and T3 (3.47) were on par with each other.

4.7.6 Fruit peel thickness

Clones of Rasthali showed significant variation in fruit peel thickness. The lowest peel thickness was observed in T5 (1.42mm) which was on par with

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treatment T1 (1.53mm). The highest fruit peel thickness was seen in T4 (1.91mm) followed by T6 (1.85mm) and T3 (1.77mm) and all three were on par.

4.7.7 Shelf life of fruits at ambient condition

Clones of Rasthali significantly influenced the shelf life of fruits. The highest shelf life of fruits (6.96days) was recorded in T4 followed by T1 (6.56days), T6 and T3 (each with 5.89days). The treatment T1 was on par with T6 and T3. T2 (4.83days) recorded the lowest shelf life which was on par with T5 (5.13days) and T7 (5.32days).

4.7.8 Organoleptic scoring of ripe fruits

Organoleptic evaluation for taste, texture, sweetness, flavour, colour and overall acceptability of fruits indicated significant variation among the clones of Rasthali. (Table 11).

i. Taste

The mean score for taste was highest in T5 (6.3) followed by T2 (5.9) and T1 (4.43). The lowest mean score was observed in T3 (1.93). Score for T6 was 2.4 and for T4 it was 3.23.

ii. Texture

Treatment T5 (6.3) recorded the highest score for texture followed by T2 (5.3) and T7 (5.03). The mean score for texture was lowest in T1 (1.47), lower scores were also observed in T3 (3) and T6 (3.37).

iii. Sweetness

Treatment T5 (6.37) recorded maximum score for sweetness followed by T2 (5.57) and T1 (5.3) while T3 (1.07) recorded lowest; lower scores were also observed in T4 (2.37) and T6 (2.77).

Table 11. Organoleptic scoring of Rasthali clones

Treatments	Taste	Texture	Sweetness	Flavour	Colour	Overall acceptability	Total score
T1	7.33 (4.43)	5.75 (1.47)	8.13 (5.30)	8.22 (5.97)	5.24 (1.17)	8.08 (4.93)	42.75 (23.27)
T2	8.07 (5.90)	7.67 (5.03)	8.24 (5.57)	7.48 (3.93)	7.77 (5.10)	8.44 (5.93)	47.67 (31.46)
T3	6.20 (1.93)	6.58 (3.00)	6.19 (1.07)	6.57 (1.33)	7.53 (4.37)	7.08 (1.77)	40.15 (13.47)
T4	6.87 (3.23)	6.80 (3.53)	7.06 (2.37)	7.22 (2.87)	7.28 (3.67)	7.44 (2.80)	42.67 (18.47)
T5	8.40 (6.30)	8.33 (6.30)	8.55 (6.37)	8.48 (6.50)	8.26 (6.77)	8.66 (6.33)	50.68 (38.57)
T6	6.40 (2.40)	6.32 (3.37)	7.28 (2.77)	7.22 (2.87)	7.59 (4.53)	7.46 (2.93)	42.27 (21.64)
T7	7.07 (3.80)	7.53 (5.30)	7.99 (4.57)	7.70 (4.53)	6.71 (2.40)	7.62 (3.30)	44.62 (23.90)
K W Value	0.71	0.61	0.86	0.78	0.75	0.69	

Value in parenthesis – rank obtained through statistical analysis

iv. Flavour

The highest value for flavour was observed in T5 (6.5) followed by T1 (5.97) and T7 (4.53). Treatment T3 (1.33) recorded lowest score. T4 and T6 also scored low (2.87 for each) for flavour.

v. Colour

T5 (6.77) recorded maximum value for colour whereas, the mean score for colour was lowest in T1 (1.17), and lower score was also observed in T7 (2.4).

vi. Overall acceptability

Overall acceptability was highest for T5 (6.33). This was followed by T2 (5.93) and T1 (4.93). The lowest mean score was seen in T3 (1.77); T4 (2.80) and T6 (2.93) also scored lower values in overall acceptability.

4.8 INCIDENCE OF PEST, DISEASES AND PHYSIOLOGICAL DISORDERS IN RASTHALI CLONES

During the crop period, incidence of Sigatoka disease was noticed for all clones but it was not severe. Panama wilt is one of the major diseases in Rasthali, but, only T3 clone showed slight symptoms and which could be controlled.

4.9 GENETIC PARAMETERS

Genetic parameters like, genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance as % mean were computed for different characters and presented in Table 12.

4.9.1 Genotypic Coefficient of Variation (GCV)

Genotypic coefficient of variation (GCV) was highest in fruit weight (22.24). Moderate GCV values were observed in fruit length (15.54), fruit girth (15.28), bunch weight (12.84), number of hands per bunch (12.24) and plant girth (10.49). Total crop duration (6.34), bunch length (6.42) and the number of fingers per hand (7.96) showed comparatively lower GCV values.

4.9.2 Phenotypic Coefficient of Variation (PCV)

Coefficient of phenotypic variation (PCV) also showed the same trend as that of GCV. The highest PCV was recorded in fruit weight (25.72). Moderate PCV values were observed in fruit length (18.69), bunch weight (18.03) fruit girth (17.49), number of hands per bunch (16.03) and plant girth (12.13). Characters like number of fingers per hand (7.95), total crop duration (8.07) and bunch length (8.96) showed low PCV values.

4.9.2 Heritability

Most of the characters had high heritability values. Highest heritability was recorded in total crop duration (97. 37per cent) followed by plant height (91.32 per cent) and fruit weight (76.29). Number of hands per bunch, bunch length and bunch weight recorded medium heritability of 58.21, 51.43, and 50.74 per cent respectively.

4.9.3 Genetic advance as % mean

High genetic gain was observed for the characters like, fruit weight (39.59), fruit length (26.63) and fruit girth (27.49). Characters like number of hands per bunch (19.23), plant height (19.12), bunch weight (18.84), plant girth (18.69) and total crop duration (16.18) showed moderate genetic gain. Low genetic gain was observed for characters like bunch length (9.49) and number of fingers per hand (10.42).

Table 12. Estimates of components of coefficient of variation, heritability and genetic advance as % mean for various characters in Rasthali clones

Characters	Coefficient of variation		Heritability	Genetic advance as % mean
	GCV	PCV		
Plant height (cm)	9.71	10.16	91.32	19.12
Plant girth (cm)	10.49	12.14	74.77	18.69
Total crop duration (days)	7.96	8.07	97.37	16.18
Bunch length (cm)	6.42	8.96	51.43	9.49
Number of fingers/ hand	6.34	7.95	63.62	10.42
Number of hands/ bunch	12.24	16.04	58.21	19.23
Fruit length (cm)	15.54	18.69	69.15	26.63
Fruit girth (cm)	15.28	17.49	76.29	27.49
Fruit weight (g)	22.24	25.72	74.74	39.59
Bunch weight (kg)	12.84	18.03	50.74	18.84

GCV: Genotypic coefficient of variation

PCV: Phenotypic coefficient of variation

4.10 CORRELATION ANALYSIS

Correlation studies revealed the nature of relation among different characters. The traits that are positively correlated with bunch weight are considerably important to plant breeder for crop improvement programme. The results obtained are presented in Table 13 (Genotypic correlation) and 14 (Phenotypic correlation).

4.10.1 Genotypic correlation

Plant height had positive significant correlation with plant girth (0.975), number of fingers per hand (0.855), total crop duration (0.689), bunch length (0.684), bunch weight (0.535) and number of hands per bunch (0.526). However, it was positively but non-significantly correlated with fruit length (0.147) and fruit girth (0.107).

Positive and significant association was found for plant girth with plant height (0.975), number of fingers per hand (0.946), total crop duration (0.681), bunch length (0.713), and bunch weight (0.552). It was positively but non-significantly correlated with number of hands per bunch (0.423), fruit length (0.013) and fruit girth (0.080).

Total crop duration had significant and positive correlation with plant height (0.689), plant girth (0.681), bunch length (0.671), number of fingers per hand (0.663), bunch weight (0.449) and number of hands per bunch (0.493), but it was significantly and negatively correlated with fruit weight (-0.777).

Bunch length was positively and significantly associated with bunch weight (0.947), plant girth (0.713), plant height (0.684), total crop duration (0.671), number of hands per bunch (0.626), fruit girth (0.557), fruit length (0.548) and number of fingers per hand (0.473).

Number of fingers per hand had positive and significant correlation with plant girth (0.946), plant height (0.855), total crop duration (0.663), number hands per bunch (0.736), bunch weight (0.528) and bunch length (0.473). But it was

significant and negatively correlated with fruit weight (-0.509). It was positively but non-significantly associated with fruit length (-0.177) and fruit girth (-0.197).

Number of hands per bunch had positive and significant association with bunch weight (0.902), fruit length (0.779), number of fingers per hand (0.736), fruit girth (0.733), bunch length (0.626), plant height (0.526) and total crop duration (0.493). It was positive non-significant association with plant girth (0.423).

Positive and significant correlation was found for fruit length with fruit girth (1.017), bunch weight (0.833), number of hands per bunch (0.779), fruit weight (0.655) and bunch length (0.548). But it had positive non-significant association with plant girth (0.013), number of fingers per hand (0.177), plant height (0.147).

Fruit girth was positively and significantly associated with fruit length (1.017), fruit weight (0.870), bunch weight (0.846), number of hands per bunch (0.733), and bunch length (0.557). It had positive significant association with number of fingers per hand (0.197), plant height (0.107) and plant girth (0.080).

Positive and significant correlation was found for fruit weight with fruit girth (0.870) and fruit length (0.655). But it was significantly and negatively correlated with total crop duration (-0.777).

Bunch weight was significantly and positively correlated with bunch length (0.947), number of hands per bunch (0.902), fruit girth (0.846), fruit length (0.833), plant girth (0.552), plant height (0.535), number of fingers per hand (0.528) and total crop duration (0.449). It had positive and non-significant association with fruit weight (0.261).

4.10.2 Phenotypic correlation

At phenotypic level, plant height had positive and significant association with plant girth (0.904), total crop duration (0.685), number of fingers per hand (0.671), bunch length (0.542), number of hands per bunch (0.514).

Table 13. Genotypic correlation coefficient of important characters of Rasthali clones

	C1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	C 10
C 1	1									
C 2	0.975**	1								
C 3	0.689**	0.681**	1							
C 4	0.684**	0.713**	0.671**	1						
C 5	0.855**	0.946**	0.663**	0.473*	1					
C 6	0.526*	0.423NS	0.493*	0.626**	0.736**	1				
C 7	0.147NS	0.013NS	-0.012NS	0.548*	0.177NS	0.779**	1			
C 8	0.107NS	0.080NS	-0.192NS	0.557**	0.197NS	0.733**	1.017**	1		
C 9	-0.383NS	-0.418NS	-0.777**	-0.013NS	-0.509*	-0.027NS	0.655**	0.870**	1	
C 10	0.535*	0.552**	0.449*	0.947**	0.528*	0.902**	0.833**	0.846**	0.261NS	1

C1: Plant height (cm)

C2: Plant girth (cm)

C3: Total crop duration (days)

C4: Bunch length (cm)

C5: Number of fingers per hand

C6 : Number of hands per bunch

C7 : Fruit length (cm)

C8 : Fruit girth (cm)

C9 : Fruit weight (g)

C10: Bunch weight (kg)

* significant at 5% level

** significant at 1% level

It had positive but non-significant association with bunch weight (0.406), fruit length (0.156) and fruit girth (0.074).

Positive and significant correlation was found for plant girth with plant height (0.904), number of fingers per hand (0.753), total crop duration (0.639), bunch length (0.563), bunch weight (0.456) and number of hands per bunch (0.537). It was positive but non-significant correlation with fruit length (0.171) and fruit girth (0.058).

Total crop duration had significant and positive correlation with plant height (0.685), plant girth (0.639), bunch length (0.544), number of fingers per hand (0.571) and number of hands per bunch (0.451). It was negatively and significantly correlated with fruit weight (-0.627). Crop duration was positively and non-significantly correlated with bunch weight (0.383) and fruit length (0.046).

Bunch length was positively and significantly correlated with bunch weight (0.876), fruit length (0.566), plant girth (0.563), number of hands per bunch (0.562), total crop duration (0.544), plant height (0.542), number of fingers per hand (0.508) and fruit girth (0.487). It had positively and non-significantly associated with fruit weight (0.179).

Number of fingers per hand was positively and significantly correlated with plant girth (0.753), plant height, number of hands per bunch (0.671 in each), total crop duration (0.571), bunch weight (0.526) and bunch length (0.508). It was positively but non-significantly associated with fruit length (0.253) and fruit girth (0.085).

Positive and significant correlation was found for number of hands per bunch with bunch weight (0.684), fruit length (0.722), number of fingers per hand (0.671), bunch length (0.562), plant girth (0.537), plant height (0.514), fruit girth (0.471) and total crop duration (0.451). It was positively but non-significantly correlated with fruit weight (0.180).

Fruit length was positively and significantly associated with fruit girth (0.876), number of hands per bunch (0.722), bunch weight (0.752), fruit weight (0.568) and bunch length (0.566). It was non-significantly but positively associated with number of fingers per hand (0.253), plant girth (0.171), plant height (0.156) and total crop duration (0.046).

Fruit girth was positively and significantly associated with fruit length (0.876), fruit weight (0.648), bunch weight (0.671), bunch length (0.487) and number of hands per bunch (0.471). It was positively and non-significantly associated with number of fingers per hand (0.085), plant height (0.074) and plant girth (0.058).

Positive and significant correlation was found for fruit weight with fruit girth (0.648) and fruit length (0.568). It had positive and non-significant correlation with number of hands per bunch (0.180) and bunch weight (0.358). But negative and significant association was observed for fruit weight with total crop duration (-0.627).

Bunch weight was significantly and positively associated with bunch length (0.876), fruit length (0.752), number of hands per bunch (0.684), fruit girth (0.671) number of fingers per hand (0.526) and plant girth (0.456). It was positive non-significant association with plant height (0.406), total crop duration (0.383) and fruit weight (0.358).

4.11 PATH CO-EFFICIENT ANALYSIS

The correlation coefficient would reveal the association of independent traits with dependent variable without pointing out the effect. But using path coefficient analysis, it is able to resolve the correlations, by portioning the correlation values into direct and indirect effect through alternate ways. The results obtained by path analysis on bunch weight per plant are presented in Table 15.

Table 14. Phenotypic correlation coefficient of important characters of Rasthali clones

	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	C 10
C 1	1									
C 2	0.904**	1								
C 3	0.685**	0.639**	1							
C 4	0.542*	0.563**	0.544*	1						
C 5	0.671**	0.753**	0.571**	0.508*	1					
C 6	0.514*	0.537*	0.451*	0.562**	0.671**	1				
C 7	0.156NS	0.171NS	0.046NS	0.566**	0.253NS	0.722**	1			
C 8	0.074NS	0.058NS	-0.157NS	0.487*	0.085NS	0.471*	0.876**	1		
C 9	-0.288NS	-0.238NS	-0.627**	0.179NS	-0.139NS	0.180NS	0.568**	0.648**	1	
C 10	0.406NS	0.456*	0.383NS	0.876**	0.526*	0.684**	0.752**	0.671**	0.358NS	1

C1: Plant height (cm)

C2: Plant girth (cm)

C3: Total crop duration (days)

C4: Bunch length (cm)

C10: Bunch weight (kg)

C6 : Number of hands per bunch

C7 : Fruit length (cm)

C8 : Fruit girth (cm)

C9 : Fruit weight (g)C5: Number of fingers per hand

* significant at 5% level

** significant at 1% level

4.11.1 Direct effect on bunch weight per plant

Plant girth (0.67115), total crop duration (1.95372), number of fingers per plant (1.13419), fruit girth (0.30603), fruit length (1.87073) and fruit weight (0.69772) have shown positive direct effects on bunch weight per plant while, plant height (-1.00957) bunch length (-0.70532) and number of hands per bunch (-1.86919).

4.11.2 Indirect effect on bunch weight per plant

Plant height had high positive indirect effect on bunch weight per plant through total crop duration (1.34615), number of fingers per hand (0.96968), plant girth (0.65454), fruit length (0.27432), fruit girth (0.03259).

Plant girth had positive indirect effect on bunch weight per plant through total crop duration (1.32957), number of fingers per hand (1.07249), fruit girth (0.02441) and fruit length (0.02385).

Total crop duration had positive indirect effect on bunch weight per plant through number of fingers per hand (0.75198) and plant girth (0.45674).

Bunch length had positive indirect effect on bunch weight per plant through total crop duration (1.31133), fruit length (1.02553), number of fingers per hand (0.5363), plant girth (0.47864) and fruit girth (0.17056).

Number of fingers per bunch had positive indirect effect on bunch weight through total crop duration (1.29534), plant girth (0.63463), fruit length (0.33089) and fruit girth (0.06039).

Number of hands per bunch had positive indirect effect on bunch weight through fruit length (1.45777), total crop duration (0.9623), number of fingers per hand (0.83452), plant girth (0.28374) and fruit girth (0.22431).

Fruit length had positive indirect effect on bunch weight per plant through fruit weight (0.45679), fruit girth (0.31118), number of fingers per hand (0.20062) and plant girth (0.05353).

Table 15. Path coefficient analysis for bunch weight and its components in Rasthali clones

	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	rG
C1	-1.00957	0.65454	1.34615	-0.48253	0.96968	-0.98314	0.27432	0.03259	-0.26737	0.535*
C2	-0.9846	0.67115	1.32957	-0.50301	1.07249	-0.79025	0.02385	0.02441	-0.29149	0.552**
C3	-0.69562	0.45674	1.95372	-0.47341	0.75198	-0.92066	-0.02255	-0.05885	-0.54192	0.449*
C4	-0.69067	0.47864	1.31133	-0.70532	0.5363	-1.16985	1.02553	0.17056	-0.00907	0.947**
C5	-0.86314	0.63463	1.29534	-0.33351	1.13419	-1.37531	0.33089	0.06039	-0.35525	0.528*
C6	-0.53101	0.28374	0.9623	-0.44143	0.83452	-1.86919	1.45777	0.22431	-0.01904	0.902**
C7	-0.14804	0.00856	-0.02355	-0.38666	0.20062	-1.45657	1.87073	0.31118	0.45679	0.833**
C8	-0.10753	0.05353	-0.37571	-0.3931	0.2238	-1.37009	1.90225	0.30603	0.6072	0.846**
C9	0.38687	-0.28038	-1.51745	0.00917	-0.57749	0.05101	1.22474	0.26632	0.69772	0.261

Legends -ve direct effect; + ve direct; -ve indirect; +ve indirect

Diagonal indicates direct effect *significant at 5% **significant at 1%

rG - Genotypic correlation with bunch weight per plant Residual = 0.0474

C1: Plant height (cm)

C2: Plant girth (cm)

C3: Total crop duration (days)

C4: Bunch length (cm)

C5: Number of fingers per hand

C6 : Number of hands per bunch

C7 : Fruit length (cm)

C8 : Fruit girth (cm)

C9 : Fruit weight (g)

Fruit girth had positive indirect effect on bunch weight per plant through fruit length (1.90225), fruit weight (0.6072), number of fingers per hand (0.2238) and plant girth (0.06353).

Fruit weight had positive indirect effect on bunch weight per plant through fruit length (1.22474), plant height (0.38687), fruit girth (0.26632), number of hands per bunch (0.05101) and bunch length (0.00917).

Discussion

5. DISCUSSION

Banana is one of the important fruit crops grown in India and having socio- economic significance. It could be considered as 'Poor man's apple', as it is full of health promoting nutrients and is cheaper compared to many other fruits and also referred to as '*Kalpatharu*' which means plant of virtues. India has a number of banana cultivars with high amount of clonal variations which are being grown under varied environmental conditions and the performance of each clone vary with the varying agro- climatic situations. A systematic evaluation of the cultivars and their clonal variations with yield potentialities is required to suggest a particular clone for a particular location. Variability among African plantains has been studied in detail by Vuylsteke and Swennen (1993). Ecotype variation with respect to biometric, yield and quality characters in Nendran has been reported by Joseph (2017).

Present work was done to characterize different clones of Rasthali with respect to qualitative characters, biometric characters, yield potential and fruit quality. The different observations recorded and results obtained are discussed hereunder.

5.1 TAXONOMIC SCORING OF RASTHALI CLONES

Taxonomic scoring of the seven Rasthali clones based on the 15 characters indicated a range of 29 to 36; thus all the clones could be included in the AAB genomic group with a score 26-46. According to taxonomic scoring technique proposed by Simmonds and Shepherd (1955), the score ranged from 26 to 46 for AAB genomic group. The finding of the present work is in conformity with this, for including all the seven clones in the genomic group AAB. The highest score was recorded in Venneer Poovan (36) followed by Andhra Poovan and Marthaman (33 in each). Collection from Pullani (29) recorded the lowest score among the different clones studied.

5.2 MORPHOLOGICAL/FRUIT CHARACTERS IN RASTHALI CLONES

According to Stover and Simmonds (1987) clonal variations were more expressed in qualitative characters like plant pigmentation, male bud type, bunch shape, fruit fullness, fruit curvature and fruit apex. The results of present study also revealed variations in qualitative characters among clones. Variations could be observed in pseudostem colour, wax on leaf sheath, blotches at petiole base, colour of blotches, leaf colour (lower surface), male bud shape and bract colour.

5.3 BIOMETRIC CHARACTERS IN RASTHALI CLONES

5.3.1 Plant height in Rasthali clones

The present work indicated that height of the plants varied significantly among different clones assessed. Among the different clones, plant height at 4MAP was highest in Valiya Poovan followed by Andhra Poovan and Cheriya Poovan while Venneer Poovan recorded maximum height at bunch emergence followed by Marthaman. Collection from Madakkathara recorded minimum plant height both at 4MAP and bunch emergence stage (Fig. 3). Plant height and crop duration were positively and significantly correlated. Clones from Madakkathara had lower value for plant height had shorter crop duration. Higher crop duration was observed for Venneer Poovan which was the tallest among all the clones.

Variations in height were earlier reported in different varieties and clones of banana. Ram *et al.* (1994) reported variation in height among different ecotypes of banana. According to Rajeevan (1985) significant variation existed in height of different accessions of Palayankodan. In a study conducted at BRS, Kannara, Manjeri Nendran recorded maximum height (3.19 m) followed by Nedunendran (3. 00 m) (ICAR, 2017).

5.3.2 Plant girth in Rasthali clones

All the clones varied significantly at 4MAP and at bunch emergence stages with respect to plant girth. Valiya Poovan recorded maximum plant girth at 4MAP while Venneer Poovan recorded the highest girth at bunch emergence stage and collection from Madakkathara recorded the lowest girth at both the stages (Fig. 3). Plant height and plant girth of plant were found to be positively correlated. Similar findings were also reported by Joseph (2017) in Nendran

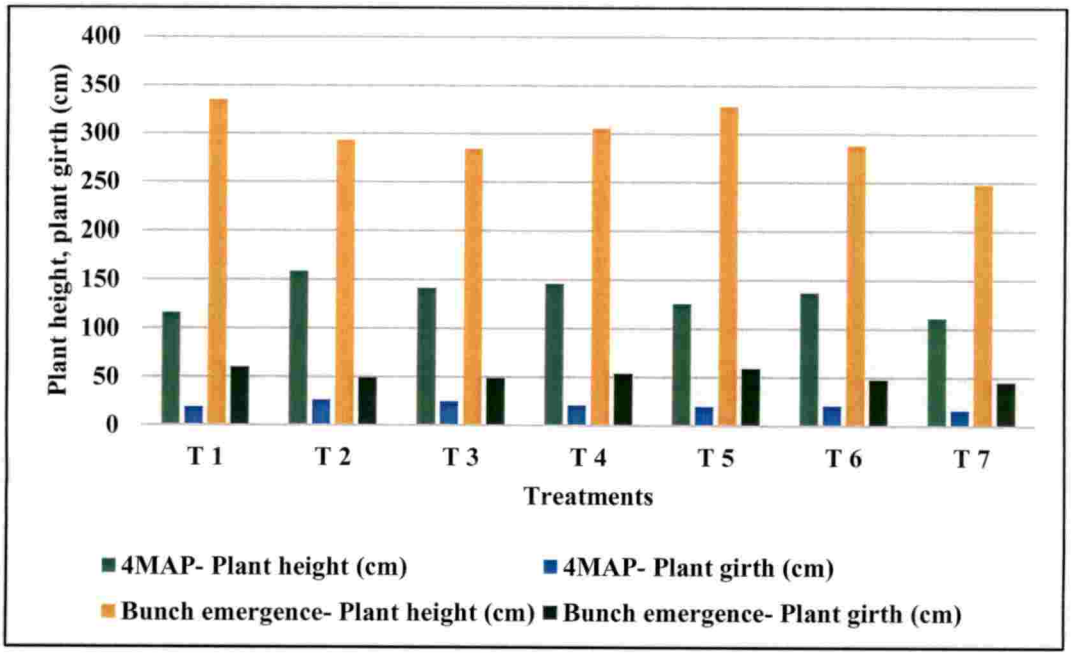

Fig 3. Plant height and plant girth at 4 MAP and bunch emergence stage in Rasthali clones

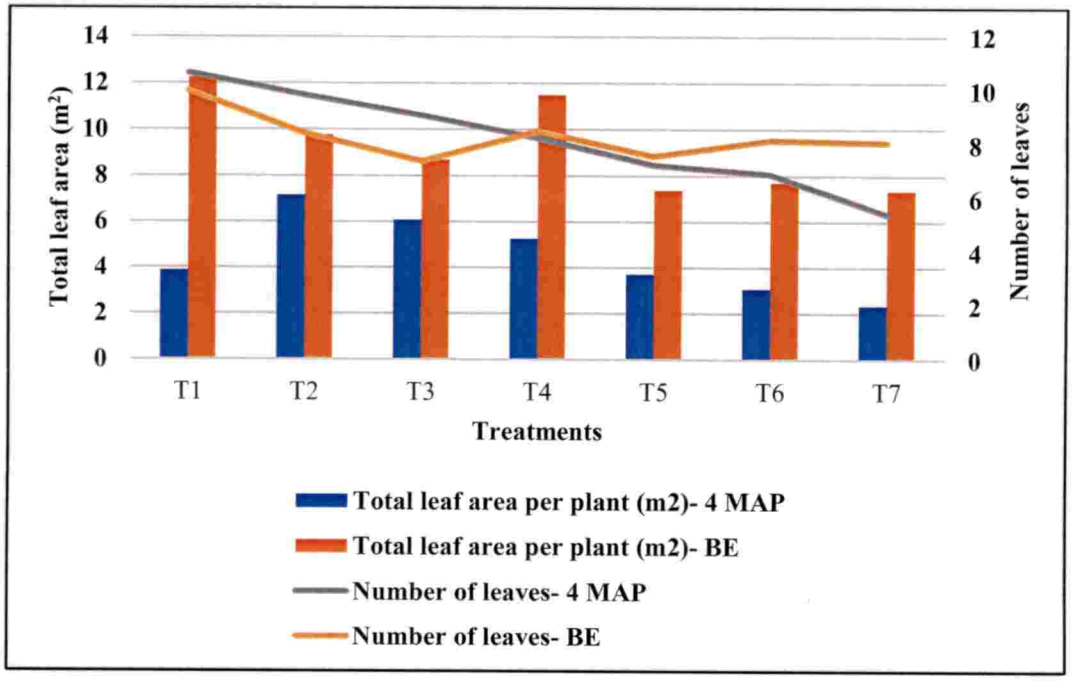

Fig 4. Total leaf area per plant and number of leaves at 4 MAP and bunch emergence stage in Rasthali clones

ecotypes. Venneer Poovan which had the maximum plant girth was also the tallest (335.42cm). Jacob (1952) reported variations in plant girth and height among clones of banana. According to Rajamanickam (2003), among triploid bananas the lowest plant girth was recorded in Changalikodan (55.44cm) and maximum girth in Vellapalayankodan (96.00cm).

5.3.3 Leaf characters in Rasthali clones

Present study revealed that leaf length, leaf width, petiole length and leaf area varied significantly in the seven clones of Rasthali. Leaf length, width and length of petiole are the important attributes to attain maximum leaf area. Length and width of leaf and length of petiole were highest in Valiya Poovan followed by Cheriya Poovan and Andhra Poovan at 4MAP while at bunch emergence Andhra Poovan recorded highest leaf length and leaf width followed by Venneer Poovan. Cheriya Poovan recorded maximum petiole length followed by Valiya Poovan at bunch emergence stage. Venneer Poovan recorded lowest leaf length at 4MAP while, Marthaman recorded lowest leaf length at bunch emergence stage. Collection from Madakkathara showed minimum leaf width at both the stages of growth. Variation in the leaf characters has been reported in other banana varieties also. Rajamanickam and Rajamohan (2010) observed variations in leaf length and width among Palayankodan clones.

Leaf area varied significantly among the clones at 4MAP and at bunch emergence stage. At 4MAP Valiya Poovan (7.16m^2) showed highest mean value at 4MAP followed by Cheriya Poovan (6.08m^2). However, at bunch emergence stage the leaf area was highest for Venneer Poovan (12.26m^2). Collection from Madakkathara showed lowest leaf area both at 4MAP and bunch emergence (Fig. 4). Leaf area is an important parameter determining the efficiency of photosynthesis which in turn contributes to yield and returns. Venneer Poovan and Valiya Poovan which recorded higher leaf area also yielded high. Venneer Poovan which had highest leaf area had longest crop duration. It has been reported that the plants which had longer crop duration, possessed higher leaf area (Shanmugavelu *et al.,* 1992), thus confirming to the findings of the present work.

5.3.4 Number of leaves in Rasthali clones

Data on number of leaves at, 4MAP and bunch maturity stage showed significant variation among different clones of Rasthali. During active vegetative stage and bunch emergence stage highest number of leaves were seen in Venneer Poovan whereas, lowest number of leaves was seen in Madakkathara collection (Fig. 4). Significant differences in number of leaves have been reported among the ecotypes of Kaliethan (Sunilkumar, 1997). Similar results were observed in ecotypes of Nendran by Joseph (2017). Also, where in, highest number of leaves had been recorded in Changalikodan (12.61) followed by Attunendran (12.58). The results obtained were also confirmatory with the findings of Sunilkumar (1997) who reported variation in number of functional leaves in Kaliethan types.

5.3.5 Number of suckers per plant in Rasthali clones

The study revealed that there was no significant variation among the clones with respect to number of suckers produced both at 4MAP and bunch emergence stage. Results of similar works revealed that the factors influencing sucker production is ploidy level of the cultivar (Balakrishnan, 1980). According to Venkataramani (1946) sucker production varied with cultivars in banana. He observed a greater number of suckers in derivatives of B genome than in derivatives of A genome. The present study showed that the extent of variability may not be strong enough to create significant change in sucker production among the clones.

5.3.6 Duration of vegetative phase, shooting to harvest and total crop duration in Rasthali clones

The present study indicated that the time taken for shooting, shooting to harvest and total crop duration varied significantly among the treatments. The time taken for shooting was shortest in Madakkathara collection followed by Cheriya Poovan. The longest duration was observed in Andhra Poovan followed by Venneer Poovan. The shooting to harvest and total crop duration were highest in Venneer Poovan and shortest in collection from Madakkathara while, Madakkathara collection recorded the shortest total crop duration (Fig.5). Total

crop duration was positively correlated with bunch weight. Venneer Poovan which had higher crop duration had higher bunch weight also.

Significant variation in the duration of Palayankodan accessions was reported by Rajeevan (1985). Similar studies were reported from BRS, Kannara (Anon.,1989) in Nendran clones. In which crop duration varied in the range of 332.3 days to 359.3 days among clones. Joseph (2017) reported variation in crop duration among Nendran ecotypes and in the same study clones Myndoli and Mettupalayam Nendran with maximum crop duration produced heaviest bunches. According to Valsalakumari (1984) seasonal variation and environmental conditions affect crop duration in banana. Thus, the variation in crop duration observed among clones of Rasthali in the present study also could be explained.

5.3.7 Male bud length in Rasthali clones

Significant difference could not be observed in the length of male bud at harvest stage. This is because of the fact that the extent of variation may not be strong enough to change in the length of male bud among different treatments. No reports on such effect could be noted in early studies also.

5.4 YIELD CHARACTERS IN RASTHALI CLONES

5.4.1 Length and width of peduncle in Rasthali clones

The studies revealed that there was no significant variation among the clones of Rasthali. The mean value varied in the range of 46.93cm to 42.17cm with respect to peduncle length and 13.37cm to 19.50cm with respect to peduncle width. The intraclonal variations need not necessarily produce differences in peduncle length and peduncle width.

5.4.2 Bunch weight in Rasthali clones

There was a significant variation in the bunch weight of different treatments. The treatment T1 (Venneer Poovan) recorded highest bunch weight followed by T2 (Valiya Poovan) and T5 (Marthaman). Among the clones T4 (Andhra Poovan) and T6 (Pullani collection) recorded lowest bunch weight (Fig.6). It was positively and significantly associated with bunch length and number of hands per bunch.

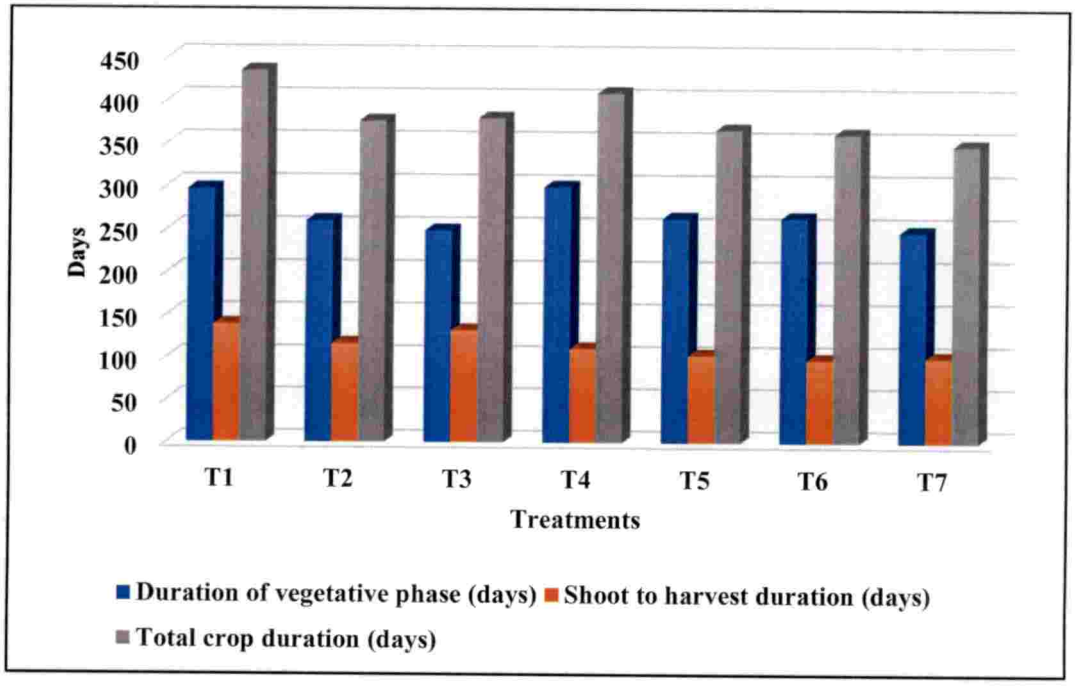

Fig 5. Vegetative phase duration, shooting to harvest duration and total crop duration in Rasthali clones

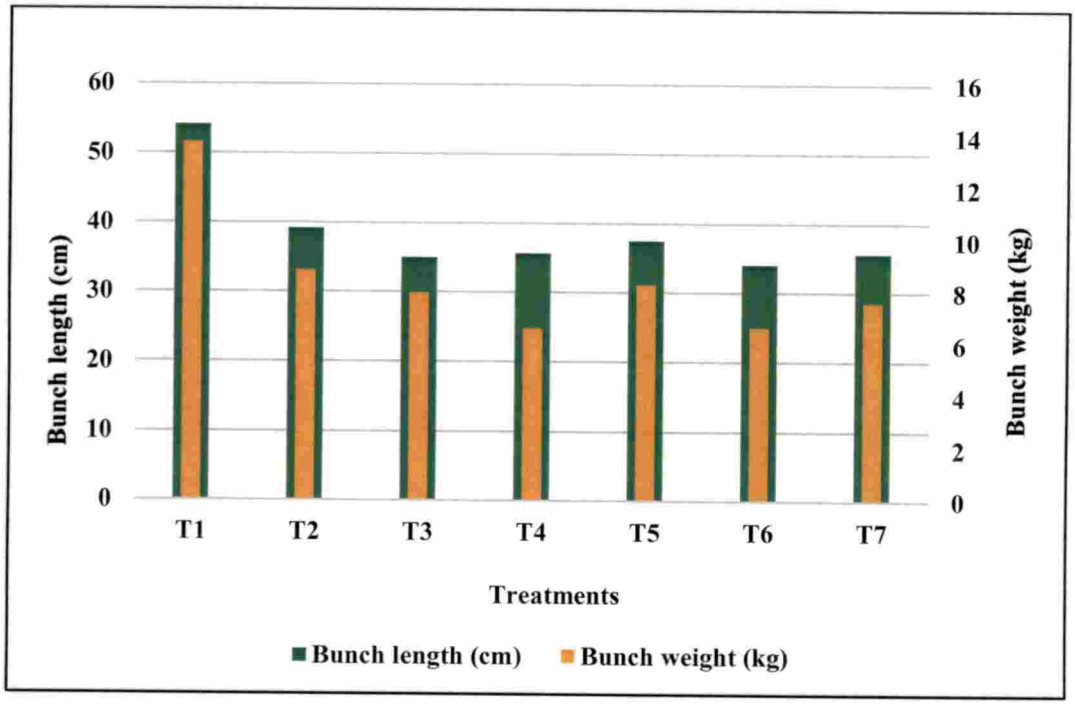

Fig 6. Bunch length and bunch weight in Rasthali clones

Frison and Foure (1999) found that Ayiramkai is a natural mutant of Rasthali with far better yield of 28kg compared to 8- 14kg in Rasthali with the same quality. Similarly, Rajeevan (1985) reported variation in bunch weight of Palayankodan accessions. Babu (2001) reported that variation in the bunch weight was due to changes in the genetic and environmental conditions. Joseph (2017) evaluated ten Nendran clones and among the clones Mettupalayam Nendran recorded highest bunch weight (17.94kg) and Kaliethan (8.13kg) and Perumatti Nendran(8.27kg) recorded lower bunch weights. Joseph (2017) also reported that weight of bunch was positively correlated with bunch length and number of hands per bunch, which is in conformity with the findings in present study with respect to weight of bunch.

5.4.3 Bunch length in Rasthali clones

Results of present studies showed that there was variation in the length of bunch of different clones of Rasthali. The highest bunch length was recorded in Venneer Poovan (41.83cm) followed by Valiya Poovan (39.2cm) and the shortest in Pullani collection (34.07cm) (Fig.6). Length of bunch was positively correlated with bunch weight, number of hands per bunch and number of fingers per hand. Since Venneer Poovan and Valiya Poovan had higher number of hands per bunch these clones had heaviest bunches too.

In a study to evaluate the performance of Nendran ecotypes, Joseph (2017) recorded significant variation in bunch length among clones. Accordingly, bunch length was highest in Mettupalayam Nendran (41.17cm) and shortest in Zanzibar (25.63cm); Mettupalayam Nendran which had the maximum bunch weight also had more number of hands per bunch.

5.4.4 Number of fingers per hand and hands per bunch in Rasthali clones

In the present study the number of hands per bunch and number of fingers per hand varied significantly among treatments. Venneer Poovan (8.44) recorded the highest number of hands per bunch and fingers per hands (15.83) while lowest number hands per bunch was recorded in Andhra Poovan (6.05) and lowest number of fingers per hand was found in Valiya Poovan, collections from Madakkathara and Pullani (13.50 in each). There was a positive and significant

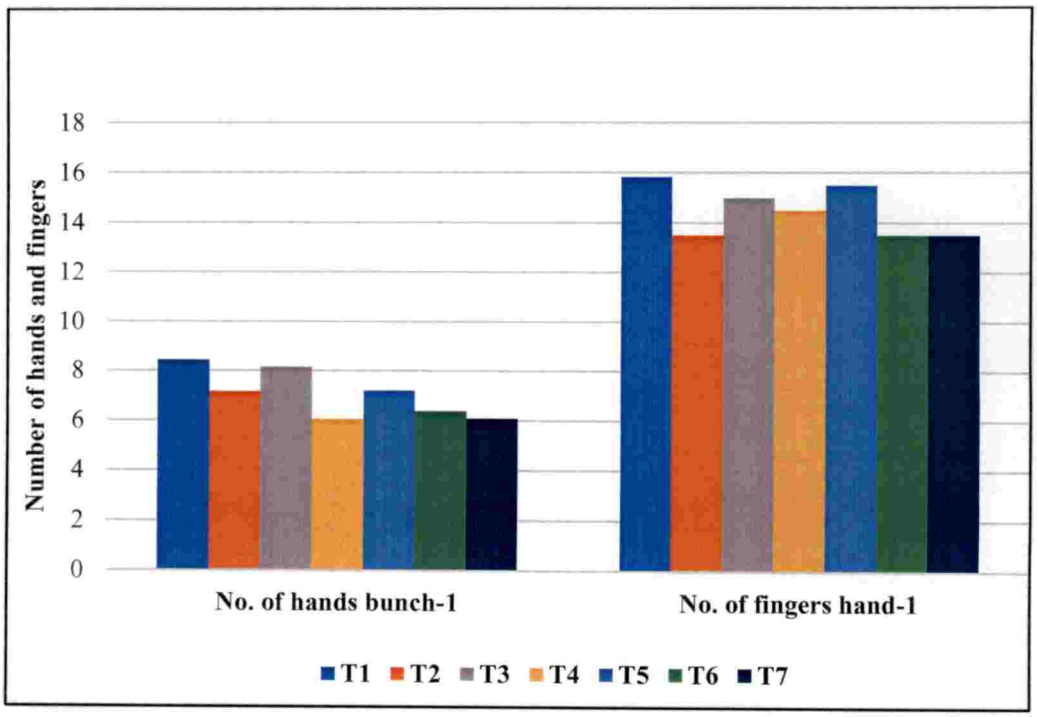

Fig 7. Number of hands per bunch and number of fingers per hand in Rasthali clones

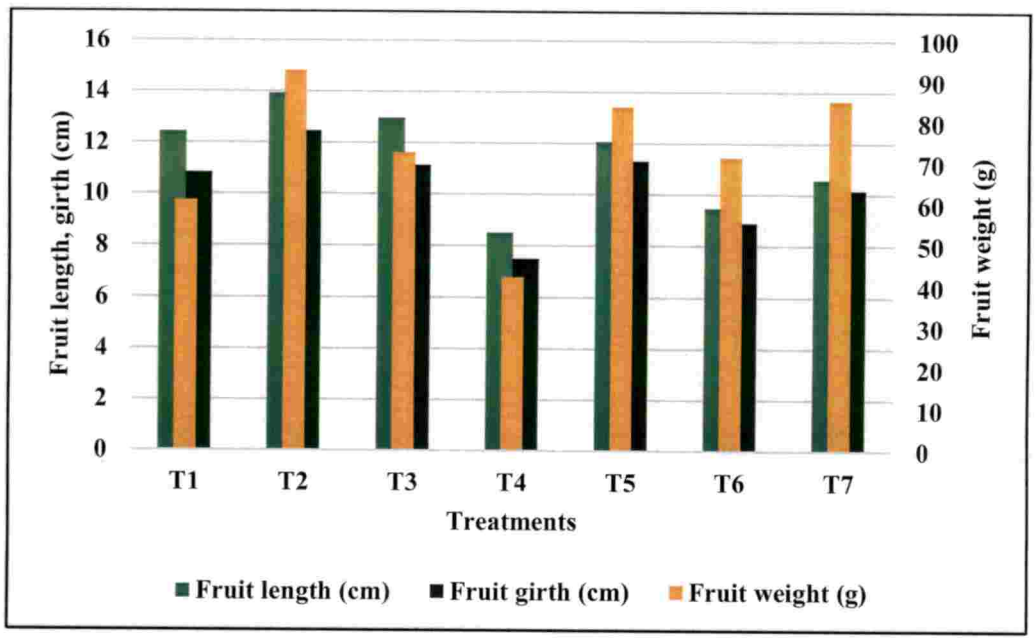

Fig 8. Fruit length, girth and fruit weight in Rasthali clones

correlation with number of fingers per hand and number of hands per bunch. Venneer Poovan which had more number of hands per bunch, had more number of fingers per hand also (Fig. 7).

Experiment in similar lines with Palayankodan clones (Rajamanickam and Rajamohan 2010) revealed that the number of hands per bunch ranged from 3.67 to 12.10 among the accessions. Mettupalayam Nendran recorded largest (6.83) number of hands per bunch whereas Zanzibar recorded lowest (2.08) among Nendran ecotypes and also observed a positive and significant association with number of fingers per hand and number of hands per bunch (Joseph, 2017). Jacob (1952) found that Ayiramkai Rasthali, a mutant of Rasthali produced 500 fruits per bunch as compared to Rasthali (71-120).

5.4.5 Length, girth and weight of fruits in Rasthali clones

Present study showed that there was a significant difference in length, girth and weight of fruits. The highest fruit length was recorded in Venneer Poovan (13.93cm) followed by Cheriya Poovan (12.97cm). Lowest fruit length was recorded in Andhra Poovan (8.50cm). Fruit girth and weight were maximum in Valiya Poovan and minimum in Andhra Poovan (Fig. 8).

Present study is in line with earlier research works on the length, girth and weight of fruits, Venkatarayappa *et al.* (1975) observed variation in fruit length and girth in Dwarf Cavendish banana. Variation in fruit length, girth and weight was reported in Palayankodan accessions by Rajeevan (1985). Variation of 8.14g to 10.52g in fruit weight, 8.36cm to 13.60cm in fruit length and 8.14cm to 10.52cm in fruit girth were observed in Palayankodan ecotypes by Rajamanickam and Rajmohan (2010).

5.4.6 Fruit pedicel length and width of fruits in Rasthali clones

No significant variation could be observed in the length and width of fruit pedicel among different clones of Rasthali. However, the mean value of pedicel length varied from 1.27cm to 2.4cm and width varied in the range of 0.68cm to 1. 30cm. Intraclonal variation might not have occurred in Rasthali banana in fruit pedicel length and width of fruits.

5.5 QUALITY PARAMETERS IN RASTHALI CLONES

5.5.1 TSS, acidity, total sugars and sugar/ acid ratio of fruits in Rasthali clones

Results of present study revealed that there was significant variation among various clones of Rasthali in TSS, titratable acidity, total sugars and sugar/ acid ratio (Fig.9). Titratable acidity among clones varied significantly. It was highest in Cheriya Poovan (0.416 per cent) and the lowest value for acidity was recorded in Marthaman (0.236 per cent). TSS, total sugars and sugar/ acid ratio was highest in Marthaman followed by Valiya Poovan while, Cheriya Poovan recorded the lowest TSS, total sugars and sugar/ acid ratio.

Studies in similar lines with Nendran clones (Anon.,1984) indicated that there were significant variations in total sugars and sugar- acid ratio among the clones. In an experiment, Rajamony *et al.* (1994) reported a variation in TSS of 22°Brix in Mottapoovan and 30°Brix in Kudapanilla Kunnan. Ram *et al.* (1994) conducted an experiment with different banana cultivars for finding quality difference among cultivars and observed variations in the range of 15.1 to 16.15 per cent, 0.22 to 0.37 per cent and 14.1 to 14.3 per cent for TSS, titratable acidity and total sugars respectively.

5.5.2 Peel thickness, pulp/peel ratio and shelf life of fruits in Rasthali clones

The data on fruit peel thickness, pulp/peel ratio and shelf life showed significant variation among different treatments. The highest pulp/peel ratio of ripe fruits were found in Venneer Poovan (3.92) followed by Marthaman (3.83) and lowest ratio was seen in Andhra Poovan (2.96). The lowest peel thickness was observed in Marthaman (1.42mm) and highest in Andhra Poovan (1.91mm) Highest shelf life was observed in Andhra Poovan and lowest in Marthaman. This might be due to variation in the fruit peel thickness among different clones. Andhra Poovan which had highest peel thickness had the maximum shelf life (Fig. 10).

5.5.3 Organoleptic evaluation

Organoleptic evaluation provides an indication for the palatability and in turn the consumer acceptance of any fruit. Results of organoleptic evaluation in

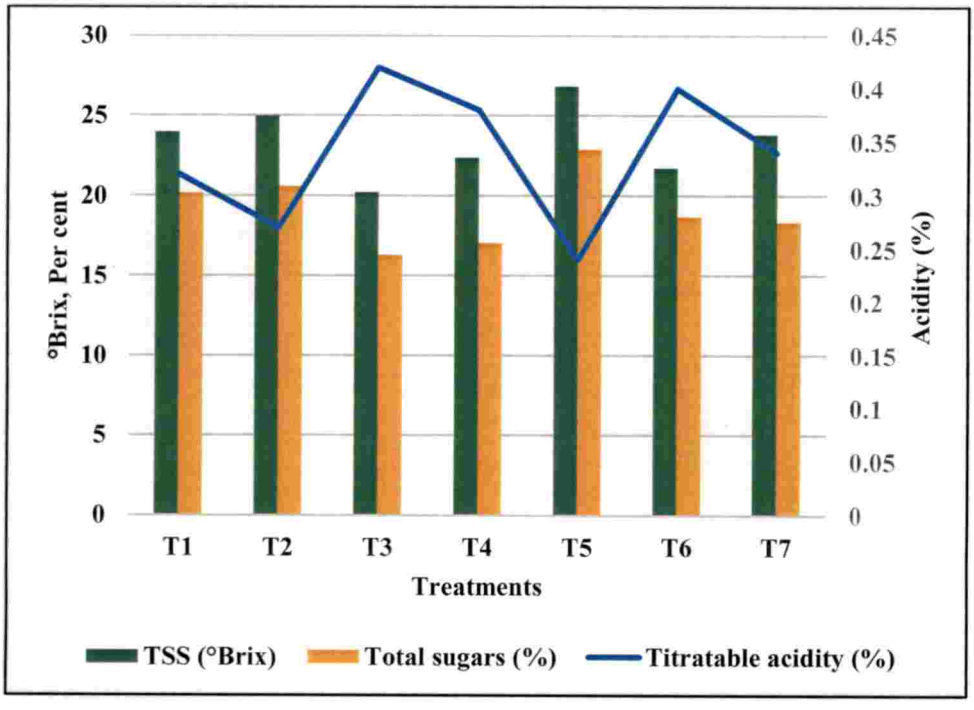

Fig 9. TSS, total sugars and titratable acidity in Rasthali clones

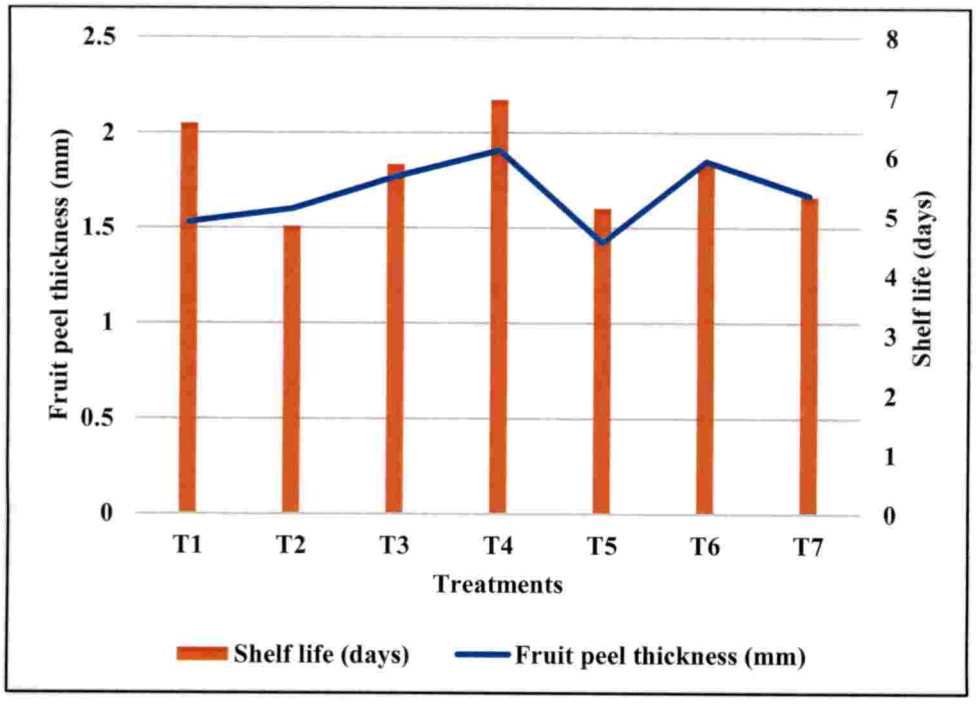

Fig 10. Shelf life and fruit peel thickness in Rasthali clones

the present study shown that taste, texture, sweetness, flavour, colour and overall acceptability of fruits varied significantly between the clones. The mean score for all the characters were highest in Marthaman. Lowest mean score for sweetness, flavour, overall acceptability and taste were seen in Cheriya Poovan. Colour and texture were minimum in Venneer Poovan. Joseph (2017) reported significant variation in organoleptic analysis of Nendran ecotypes.

5.6 GENETIC PARAMETERS

5.6.1 Coefficient of variation, heritability and genetic advance as % mean

Genotypic and phenotypic coefficients of variation help to compare the amount of variability present among different characters. This gives an idea regarding the variability that exists in a population. Genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance as % mean were assessed in the present study and the results are discussed below:(Fig. 11).

The present investigation revealed that GCV and PCV was high for fruit weight. Moderate values were obtained for number of hands per bunch, fruit length, fruit girth, bunch weight and plant girth. However, number of fingers per hand, total crop duration, plant height and bunch length showed low GCV and PCV values. According to Rajamanickam and Rajmohan (2010) number of fingers per bunch had very high of PCV and GCV values. Similar findings were reported by Rajeevan and Geetha (1984) in a study including forty banana cultivars.

Heritability suggests the role of genetic traits in expression of phenotypes. Characters which possess high heritability can be improved directly through selection, as these are relatively less changed by environment. In the present work most of the characters except number of hands per bunch, bunch length and bunch weight had high heritability values Highest heritability was recorded in total crop duration (97. 37 per cent) followed by plant height (91.32 per cent) and fruit girth (76.29 per cent). Present study is agreement with the findings of Rajeevan and Geetha (1984) who reported that plant height had high heritability value. High heritability values for number of fingers per bunch and plant height obtained in

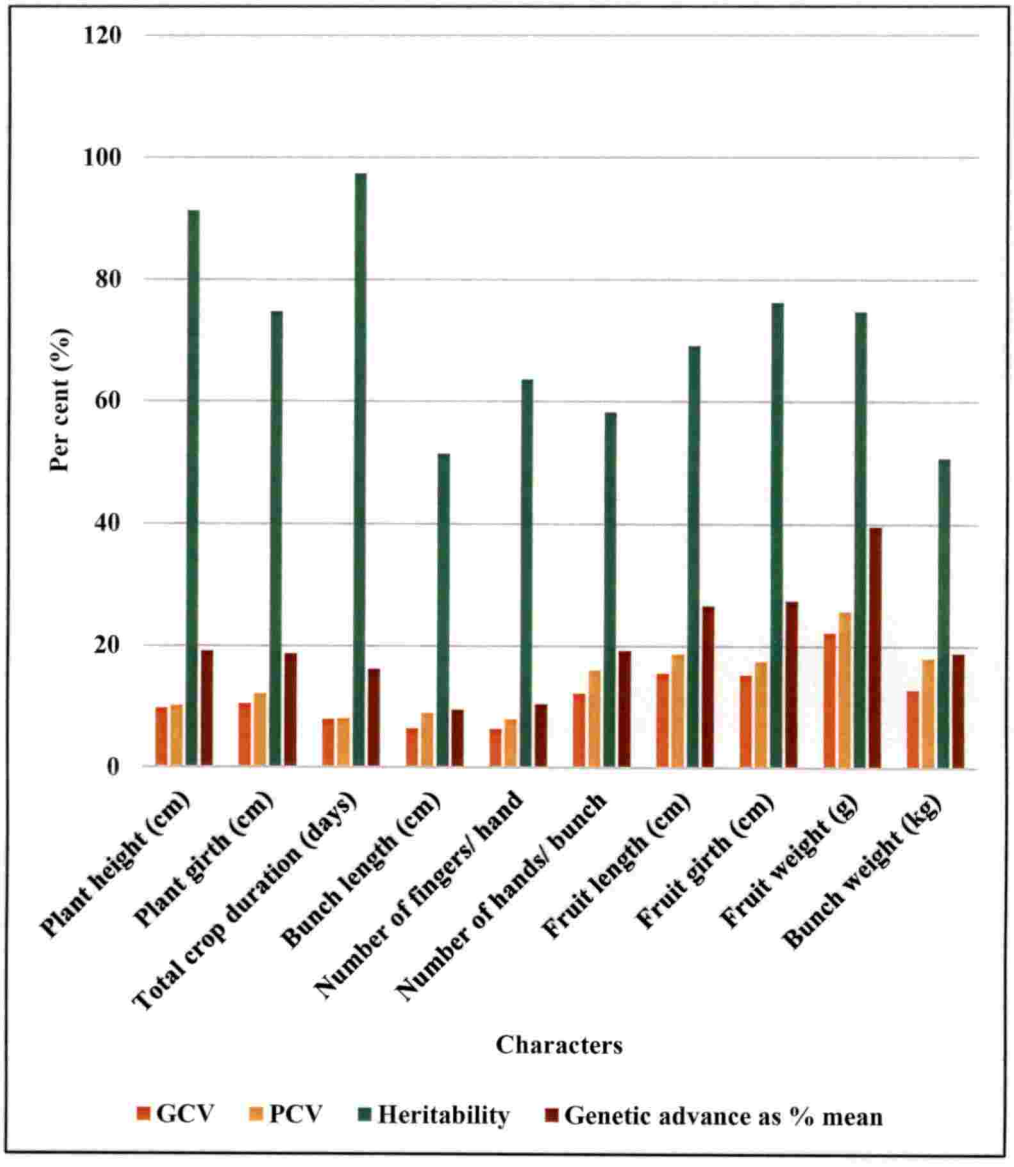

Fig.11 Estimates of genetic parameters for biometric and yield characters in Rasthali clones

the present study are in agreement with findings of Sreerangaswamy *et al.* (1980) in banana. Characters like plant height and crop duration in banana had high heritability values as reported by Uma *et al.* (2000).

In the present study, there was wide variation among characters for genetic gain. Genetic advance as per cent of mean, varied from 9.49 per cent for bunch length to 39.59 per cent for fruit weight. Characters like fruit length (26.63per cent), and fruit girth (27.49 per cent) showed high genetic gain along with heritability. Lowest genetic gain was obtained for bunch length (9.49 per cent) followed by number of fingers per hand (10.42per cent) and total crop duration (16.18per cent).

According to Panse (1957) characters exhibiting high heritability and genetic advance were governed by additive gene effects. In the present study the character, fruit weight had high value for GCV, PCV and heritability, coupled with genetic gain suggest that the character is predominantly controlled by additive gene action. Similarly, fruit length and fruit girth with high heritability and genetic gain with moderate GCV and PCV revealed relatively low effect of environment on the characters. Studies in similar lines with Palayankodan clones (Rajamanickam and Rajmohan,2010) observed that fruit length and fruit girth, with high values of heritability and moderate value of genetic gain thus revealing comparatively low effect of environment on those characters. The characters with high heritability and genetic advance can be utilised for further crop improvement programmes.

5.7 CORRELATION ANALYSIS

Correlation analysis revealed the degree of association of characters for improvement of yield in any crop improvement programs. In the present study it was found that in most of the characters genotypic correlation coefficients were higher than phenotypic correlation coefficients.

Plant height had positive significant correlation with plant girth, number of fingers per hand, total crop duration, bunch length, bunch weight and number of hands per bunch. Similar results were also reported by Joseph (2017) in Nendran ecotypes.

Positive and significant association was found for plant girth with plant height, number of fingers per hand, total crop duration, bunch length and bunch weight and total crop duration had significant and positive correlation with bunch length, plant height, plant girth, bunch weight, number of fingers per hand and number of hands per bunch. The above findings are in agreement with earlier report on Kaliethan types (Sunilkumar, 1997, Tak *et al.*, 2014).

Bunch length was positively and significantly correlated with bunch weight, total crop duration, plant girth, number of hands per bunch, plant height, fruit length, fruit girth and number of fingers per hand and bunch weight was significantly and positively associated with bunch length, number of hands per bunch, plant girth, total crop duration, number of fingers per hand, fruit length, plant height. The bunch length (Sunilkumar, 1997), number of hands (Kurien *et al.* 1985), finger length (George 1994) and plant height (Krishnan and Shanmugavelu, 1983) had positive correlation on bunch weight and the results of the present study are in agreement with these reports.

Number of fingers per hand was positively and significantly correlated with plant girth, plant height, number of hands per bunch, bunch length, and total crop duration, bunch weight. Positive and significant correlation was found for number of hands per bunch with bunch weight, fruit length, number of fingers per hand, bunch length, plant height, fruit girth and total crop duration. Fruit length was positively and significantly associated with fruit girth, number of hands per bunch, bunch weight, bunch length and fruit weight. Fruit girth was positively and significantly associated with fruit length, fruit weight, bunch length, bunch weight and number of hands per bunch. Positive and significant correlation was found for fruit weight with fruit weight and fruit girth. Similar findings were reported by Devi (1996), Sunilkumar, (1997) and Joseph (2017).

5.8 PATH COEFFICIENT ANALYSIS

Path coefficient analysis helps to resolve the correlations, by portioning it into direct and indirect effects.

Plant height exhibited significant positive correlation with bunch weight per plant. But had high negative direct effect through plant height. The positive

association might be mainly due to its positive indirect effect through total crop duration, plant girth, fruit girth, fruit length and number of fingers per hand.

Plant girth had positive correlation with bunch weight per plant and it had a positive direct effect on bunch weight. The positive correlation might be the result of positive indirect effect through number of fingers per hand, fruit girth, fruit length and total crop duration. Similar results were reported by Devi (1996) in Nendran clones.

Total crop duration exhibited positive significant correlation with bunch weight and had a positive direct effect on bunch weight, might be due to the positive indirect effect through number of fingers per hand and plant girth.

Bunch length had positive association with bunch weight and had negative direct effect on bunch weight. This might be due to positive indirect effect through fruit length, plant girth, number of fingers per hand, fruit girth and total crop duration.

Number of fingers per hand had positive association with bunch weight and it had positive direct effect on bunch weight. The positive association might be because of positive indirect effect through plant girth, fruit girth, fruit length and total crop duration. In banana Kurien *et al.*, (1985) reported the positive direct effect of number of hands on bunch yield. The present results are in agreement with the above findings.

Number of hands per bunch had positive correlation with bunch weight and it had negative direct effect. The positive correlation and direct effect might be due to the positive indirect effect through number of fingers per hand, plant girth, fruit length, fruit girth and total crop duration.

Fruit length had positive direct effect on bunch weight per plant along with positive correlation. It had the positive indirect effect through number of fingers per hand, fruit girth, fruit weight and plant girth.

Fruit girth had positive direct effect on bunch weight per plant and had positive significant correlation. It had he positive indirect effect through number of fingers per hand, fruit length, fruit weight and plant girth. Similar results were reported by Devi (1996) in Nendran clones.

Fruit weight had positive direct effect on bunch weight per plant with positive non-significant correlation with bunch weight. It might be due to the positive indirect effect on bunch weight through fruit length, fruit girth, plant height and number of hands per bunch and bunch length. The findings of Rajeevan (1985) are in conformity with the results obtained in the present study.

From this study, it is clear that selection for bunch yield can be achieved by employing the characters which had high direct and indirect effects like, bunch length, Plant girth, total crop duration, number of hands per bunch, fruit girth, fruit length, fruit weight, plant height, number of fingers per hands.

Summary

6. SUMMARY

The study entitled 'Evaluation of clonal variation in banana Musa spp. (AAB group) 'Rasthali'' was undertaken at Banana Research Station, Kannara during May 2017- July 2018 with the objective to conduct survey in central parts of Kerala and assess the natural variability in Rasthali clones of banana. Clones collected from Palakkad and Thrissur districts along with clones maintained at BRS, Kannara were planted and performance of clones was evaluated. The important findings are summarized in this chapter.

Seven clones of Rasthali were collected and evaluated for different qualitative and quantitative characters. Rasthali clones were characterized vegetative, floral, bunch and fruit characters based on IPGRI descriptor. The seven clones differed significantly for all characters except number of suckers per plant, male bud length, length and width of peduncle and length and width of fruit pedicel. So, the results indicate the presence of variability among the clones of Rasthali.

Among different clones, plant height, plant girth and total leaf area per plant at bunch emergence were highest in Venneer Poovan while lowest in Madakkathara collection. Length of petiole was lowest in Pullani collection which was, highest in Cheriya Poovan. The highest number of leaves was recorded in Venneer Poovan followed by Andhra Poovan and lowest number was in Cheriya Poovan.

Andhra Poovan took maximum time for shooting followed by Venneer Poovan. The shortest duration of vegetative phase was observed in Madakkathara collection. The shooting to harvest duration was higher in Venneer Poovan followed by Valiya Poovan. Collection from Pullani recorded the shortest duration. Venneer Poovan was recorded the longest crop duration and collection from Madakkathara recorded shortest crop duration.

Bunch characters varied significantly among treatments. The length and weight of bunches was highest in Venneer Poovan followed by Valiya Poovan and Marthaman and lowest in Andhra Poovan. Venneer Poovan exhibited highest number of hands per bunch followed by Cheriya Poovan and Andhra Poovan the lowest. Number of fingers per hand was higher in Venneer Poovan and lowest in Valiya Poovan, collection from Pullani and Madakkathara.

Fruit characters also showed variation among clones. Valiya Poovan had the highest length, girth, and weight of fruit and Andhra Poovan the lowest. TSS, total sugars and sugar- acid ratio were highest in Marthaman and it was lowest in Cheriya Poovan. The highest pulp/ peel ratio of ripe fruits was found in Venneer Poovan (3.92) followed by Marthaman (3.83) and Madakkathara collection (3.79). The lowest peel thickness was observed in Marthaman (1.42mm) and highest was seen in Andhra Poovan (1.91mm) followed by Pullani collection. The highest shelf life of fruits (6.96days) was recorded in Andhra Poovan followed by Venneer Poovan (6.56days). Valiya Poovan (4.83days) recorded the lowest shelf life and which was on par with Marthaman (5.13days).

Organoleptic analysis revealed that mean score for taste, texture, sweetness, flavour, colour and overall acceptability of fruits were highest in Marthaman. Lowest mean score for sweetness, flavour, overall acceptability and taste were observed in Cheriya Poovan. Colour and texture were minimum in Venneer Poovan.

Genotypic and phenotypic coefficient of variation helps to compare the amount of variability present among different characters. GCV and PCV high for fruit weight and moderate values were obtained for fruit length, fruit girth, bunch weight, number of hands per bunch, and plant girth which will be useful in further selection.

High estimates of heritability along with high genetic gain were observed for fruit weight, fruit length and fruit girth and which can be used for crop improvement.

Bunch weight was significantly and positively associated with bunch length, number of hands per bunch, plant girth, total crop duration, number of fingers per hand, fruit length, fruit girth and plant height it indicating the possibility of direct selection for these characters for increasing the yield.

The path analysis revealed that plant girth, total crop duration, number of fingers per hand, fruit length, fruit girth and fruit weight have shown positive direct effect on bunch weight per plant while, plant height, number of hands per bunch and bunch length showed negative direct effect on bunch weight.

Present study revealed that, based on yield, quality parameters and organoleptic evaluation, Marthaman was found to be the best.

Future line of work

- The evaluation is to be repeated to get conclusive result.
- Confirmation of variability in clones can be done by molecular studies.
- Surveying can be done in other parts of Kerala for identifying more clones.

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Appendices

APPENDIX- I

SCORE CARD FOR ORGANOLEPTIC EVALUVATON

Name of student : Dhanyasree K. (2016-12-008)

Title of thesis : Evaluation of clonal variation in Banana *Musa* spp. (AAB group) 'Rasthali'.

PARTICULATES	TREATMENTS						
	T1	T2	T3	T4	T5	T6	T7
Taste							
Texture							
Sweetness							
Flavour							
Colour							
Overall acceptability							

Kindly indicate your rating between 1-9

9 point hedonic scale

9 – like extremely

8 – like very much

7- like moderately

6- like slightly

5- neither like nor dislike

4- dislike slightly

3- dislike moderately

2- dislike very much

1-dislike extremely

Name :

Signature :

APPENDIX- II

MONTHLY WEATHER DATA (MAY 2017- JULY 2018)

Months	Temperature		Relative humidity
	Mean Maximum	Mean Minimum	
May (2017)	34.6	24.9	72
June (2017)	30.4	23.5	87
July (2017)	30.8	22.8	85
August (2017)	30.1	23.3	87
September (2017)	31.3	22.9	84
October (2017)	31.7	22.9	81
November (2017)	33.0	21.8	73
December (2017)	32.4	21.1	63
January (2018)	33.5	20.9	53
February (2018)	35.7	22.5	97
March (2018)	36.7	24.0	59
April (2018)	36.1	24.8	69
May (2018)	33.2	22.6	79
June (2018)	29.7	24.1	87
July (2018)	28.5	22.7	89

EVALUATION OF CLONAL VARIATION IN BANANA *Musa* spp. (AAB GROUP) 'RASTHALI'

by

Dhanyasree K.
(206-12-008)

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement for the degree of

Master of Science in Horticulture
(FRUIT SCIENCE)

Faculty of Agriculture
Kerala Agricultural University

DEPARTMENT OF FRUIT SCIENCE
COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR – 680 656
KERALA, INDIA
2018

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ABSTRACT

The study entitled 'Evaluation of clonal variation in banana *Musa* spp. (AAB group) 'Rasthali'' was carried out at Banana Research Station, Kannara during May 2017- July 2018 with the objective to conduct survey in central parts of Kerala and assess the natural variability in Rasthali clones of banana. Clones collected from Palakkad and Thrissur districts along with clones maintained at BRS, Kannara were planted in randomized block design with three replications.

The clones were characterized based on IPGRI descriptor for banana. The analysis of variance revealed that significant variation for characters like plant height, plant girth, length of leaf, width of leaf, total leaf area/ plant, length of petiole, number of leaves and functional leaves, duration of vegetative phase, shoot to harvest duration, total crop duration, bunch length, bunch weight, number of hands/ bunch, number of fingers/ hands, fruit weight, fruit length, fruit girth, TSS, total sugars, sugar-acid ratio, fruit peel thickness, pulp-peel ratio and shelf life of ripe fruits at ambient conditions.

Plant height, plant girth, total leaf area/ plant at bunch emergence stage and total crop duration were highest for Veneer Poovan and highest yield was obtained for Veneer Poovan, Valiya Poovan and Marthaman. Valiya Poovan recorded greatest fruit length, fruit girth and fruit weight. The quality parameters like TSS, total sugars and sugar- acid ratio were recorded highest in Marthaman whereas fruit peel thickness and shelf life were high in Andhra Poovan and, highest pulp- peel ratio in Veneer Poovan.

Highest genotypic and phenotypic coefficients of variation were observed for fruit weight. High heritability coupled with genetic gain was observed in all characters except number of hands per bunch, bunch length and bunch weight. The character fruit weight with high value for GCV, PCV and heritability, coupled with genetic gain can be used for direct selection and further breeding programmes.

Total crop duration, fruit length, number of fingers per hand, fruit weight, plant girth and fruit girth had showed positive direct effect on bunch weight per plant while, plant height, bunch length and number of hands per bunch showed negative direct effect on bunch weight.

Organoleptic evaluation revealed that highest mean score for taste, texture, sweetness, flavour, colour and overall acceptability of fruits was in Marthaman which also recorded high TSS, total sugars, sugar- acid ratio and less acidity. Lowest mean scores for sweetness, flavour, overall acceptability and taste were observed in Cheriya Poovan. Score for colour and texture were minimum in Veneer Poovan.

The present study revealed that, based on yield, quality parameters and organoleptic evaluation, Marthaman was the best.

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