The Pharma Innovation Journal 2023; 12(12): 299-306

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(12): 299-306

www.thepharmajournal.com
Received: 03-10-2023
Accepted: 12-11-2023

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Evaluation of triploid banana genotypes (Musa ABB and AAB) for bunch traits and postharvest quality attributes

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DOI: https://doi.org/10.22271/tpi.2023.v12.i12d.24400

Abstract
Most research efforts in India have focused on table bananas belonging to the AAA genetic group and not much research has been done on the ABB and AAB genotypes with respect to postharvest quality parameters in India. In this background, the performance of sixteen banana genotypes belonging to ABB genomic group and two genotypes belonging to AAB genomic group were evaluated for bunch traits and postharvest quality attributes. The experiment was laid out in a complete randomized block design with three replications. The genotypes displayed significant variations in bunch yield and postharvest quality attributes. The bunch weight varied from 12.00 kg/plant in Nendran to 28.50 kg/ plant in NRCB-8. The genotype Popoulu recorded higher finger weight (417.00 g). With respect to postharvest attributes, the pulp weight of the fruit ranged from 54.33 to 292.33 g in Karibale and Popoulu respectively. Popoulu and Dakshin Sagar recorded maximum and minimum pulp to peel ratios respectively. The peel thickness Ranged from 1.65 to 3.27 mm. Fruit firmness was higher in Monthan (21.09 kg/cm^2) at harvest while Nendran registered better firmness at ripened stage. Shelf-life of ripened fruits ranged between 3.44 to 6.00 days and Nendran recorded the longest shelf-life. Significantly the highest TSS content of 27.33^0 Brix was recorded in Karpooravalli. Total sugars and titratable acidity varied from 13.87 to 24.37 and 0.30 to 0.97 percent respectively. Sugar acid ratio ranged from 16.64 to 74.96 with a coefficient of variation of 49.08 percent. The reducing and non-reducing sugar content differed significantly and ranged from 12.06 to 22.18 and 1.34 to 2.51 percent respectively. Significant variation witnessed among the genotypes indicated a huge potential for selection among the genotypes for breeding programs.

Keywords: Cooking bananas, plantains, ABB genome, Popoulu, bunch traits, quality attributes

1. Introduction

Bananas are monocotyledonous plants that originated in Southeast Asia and belong to the section Eumusa within the genus *Musa* of the family *Musaceae*. Bananas and plantains are the major staple food and serve as the economic backbone for many countries including India. Bananas are cultivated commercially for both dessert and cooking in tropical and subtropical regions of the world (Kumara *et al.*, 2020) [13]. Bananas are the most consumed fruit in the world accounting for 29.4% of total fruit consumption. Bananas can be broadly classified as dessert bananas for fresh consumption, culinary or cooking types which are starchy and along with plantains are cooked and consumed or processed. Banana fruits are the cheapest and most affordable source of carbohydrates for people in majority of the underdeveloped and developing countries. Most of the present-day genotypes of bananas are evolved by the domestication of landraces which have earlier evolved through natural hybridization between the two ancestral species, *M. acuminata* Colla and *M. balbisiana* Colla (Simmonds, 1962; Heslop-Harrison and Schwarzacher, 2007) [24, 8]. The relative genomic contribution of these two ancestral species is represented as A and B respectively. Most of the important cultivated bananas and plantains are triploids and may belong to AAA, AAB or ABB genomic groups. In India, most of the commercial dessert genotypes belong to AAA and AAB genomic groups and cooking-type genotypes belong to the ABB genomic group (Uma *et al.*, 2007) [30].

India is the largest producer of bananas in the world, contributing 26.74% to the global production with an annual production of 35.13 million MT from an area of 9.6 lakh ha (Anonymous, 2022) [2]. The physiological stage and compositional changes of harvested banana vary for each individual variety and may depend on factors such as climate, cultivation practices, postharvest handling storage condition, etc. Moreover, the stage of ripeness of fruit after harvest is an important aspect in determining its suitability for processing and the development of better products (Patil and Shanmugasundaram, 2015) [19].

Information on agronomic, physical and chemical characterization of banana genetic resources is useful both for the choice of parents for hybridization and the development of improved hybrids. Banana improvement work in India has not been given much attention to postharvest and processing quality evaluation. Most of the research efforts in India with respect to banana has been so far mainly concerned with increasing productivity through management approaches in cultural practices. Only recently aspects related to postharvest utilization are drawing the attention of researchers very much. Evaluation of postharvest characteristics, including fruit shelf-life and ripening patterns are considered important to ensure the successful introduction of the new genotypes to the farmers and food processors. To date, except for a few studies, not much research efforts have been taken up in ABB and AAB genotypes to screen and characterize the postharvest and chemical parameters in India. Compared to culinary bananas, most available reports are restricted to changes in the chemical composition of dessert banana genotypes during ripening (Khawas *et al.*, 2014) [11]. In this background, the present study was taken up to evaluate bunch attributes and postharvest qualities in select ABB and AAB genotypes of banana.

2. Materials and Methods
2.1 Materials
The present study entitled 'Evaluation of triploid banana genotypes (Musa ABB and AAB) for bunch traits and postharvest quality attributes' was conducted at the Horticultural College and Research Institute, Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu, India. Sixteen genotypes belonging to the ABB genomic group *viz*., Bhoodibale, Kanchkela, Chakkiya, Dakshin Sagar, Monthan, Pacha Monthan, Pidi Monthan, Karibale, Nattu Peyan, Kothiah, Singalal, Gouria, Karpooravalli, Saba, Kovvur Bontha, NRCB-8 and two genotypes belonging to AAB genomic group *viz*., Nendran and Popoulu were selected and evaluated. The genotypes were maintained at a spacing of 1.8 m x 1.8 m in the same homogenous block in the field under a drip irrigation system. Regular cultural practices and plant protection measures recommended by TNAU for the cultivation of garden land bananas were followed.

2.2 Methodology
2.2.1 Yield and yield attributes
Fruit bunches were harvested as and when they matured. Hands were separated from the bunch and representative fruit samples were collected from the second and third hands from the basal end of the bunch. The bunch and finger characters were recorded in all selected plants and their mean values were computed. Five middle fingers in the top and bottom rows of the second hand were selected as representative fingers at harvest to record the average weight of fingers and expressed in grams.

2.2.2 Post-harvest qualities
Fruit peel and pulp weight at ripened stage was measured by weighing peel and pulp separately and expressed in grams. The firmness of the fruits was measured using a digital fruit penetrometer (Model: GY-4, Wenzhou Sundo Industries Co., Ltd China) with a 7.9 mm diameter cylinder probe and mean values were expressed as kilogram per square centimeter (kg/cm^2). Peel thickness is measured at ripened stage with a digital micro-caliper and expressed in millimeters (mm). Physiological loss in weight (PLW) of fruits was computed at the end of full ripening stage by weight/weight basis by adopting the following formula and the value expressed in percentage.

$$\text{PLW (\%)} \frac{\text{Initial weight} - \text{Weight after storage}}{\text{Initial weight}} \text{X } 100$$

Green-life and shelf life of the fruits were recorded as the period between harvest to commencement of ripening and the period between commencements of ripening to end of edible life of the fruit on the shelf respectively, and expressed in days.

2.2.3 Quality attributes
Fully matured representative fingers were allowed for natural ripening under ambient temperature. The appearance of fruit hands at ripen stage in different genotypes is depicted in Figure 2. The total soluble solids were determined by using a hand refractometer (ERMA®) having prism reading bar wiath a 0-32 scale. Titratable acidity was estimated by adopting the method of A.O.A.C. (1960) [1] and expressed in terms of percentage of malic acid. The sugar to acid ratio was calculated by dividing total sugar by the titratable acidity. Total sugars were estimated by the method suggested by Hedge and Hofreiter (1962) [7]. Reducing sugars were estimated by the method suggested by Somogyi, (1952) [25]. Non-reducing sugars were calculated by arriving the difference between the total sugars and reducing sugars.

2.3 Statistical analysis
The statistical parameters were computed by adopting the procedure suggested by Panse and Sukhatme (1961) [18]. In the field germplasm, the genotypes are maintained row-wise, hence mean comparisons with standard error estimates were used to differentiate the performance of genotypes for yield attributes and the selection for better performers was done based on mean ± standard deviation values, as well as by computing the overall coefficient of variation. Since sufficient finger samples were available, the processing attributes were subjected to analyses in Completely Randomized Block Design (CRD) with samples drawn from three replicates. Each replication constitutes 2 kg of raw fruits from each of the varieties studied. The mean comparisons were made for postharvest qualities by computing ANOVA and testing the significance of computed critical differences.

3. Results and Discussion
3.1 Yield attributes
Significant differences were observed among the genotypes for various parameters. The bunch weight among the genotypes varied from 12.00 ±0.46 kg/plant in Nendran to 28.50 ±0.48 kg/ plant in NRCB-8 (Figure 1). The population mean for bunch weight was 18.63 kg/plant. Based on population mean + SD values (22.67 kg/plant), the genotype NRCB-8 was found to register higher bunch weight, followed by Bhoodibale and Kovvur Bontha. Lower bunch weights (<population mean – SD, 14.59 kg/plant) were registered in cvs. Nendran and Kothiah, whereas the remaining genotypes recorded bunch weight on par with the population mean. The population mean for finger weight of the genotypes was 215.61 g (Fig. 1) which ranged from 89.00 ±2.48 g to 417.00

±3.85 g. Higher finger weight (>population mean +SD, 310.05 g) was recorded in Popoulu (417.00 ±3.85 g), followed by Kovvur Bontha (351.00 ±4.18 g), NRCB-8 (338.25 ±4.96 g) and Bhoodibale (321.50±4.01 g), while lower finger weight (<population mean – SD, 107.32 g) was observed in Karibale (89.00 ±2.48 g), followed by Dakshin Sagar (117.75± 1.11 g) and Kothiah (117.75± 1.55 g).

The major economic criteria for successful cultivation of bananas are bunch yield and consumer preference even in the genotypes which are comparatively low to medium yielding. The bunch yield varied from 12.00 to 28.50 kg indicating huge potential for selection among the genotypes evaluated. Results from the data revealed that the genotypes NRCB-8, Bhoodibale and Kovvur Bontha can be adjudged as high yielders in the ABB genomic group. Between the two AAB genotypes 'Popoulu' registered higher bunch yield than Nendran and also over other genotypes. With respect to finger characteristics also significant variations were observed. The AAB genotype 'Popoulu' performed better among all the genotypes screened for finger weight and finger girth. The genotypes NRCB-8, Kovvur Bontha and Bhoodibale also recorded higher finger weight and finger length. Improved finger attributes in terms of size and weight are advantageous for processing. For dessert purposes, genotypes with a medium finger weight, finger length and higher number of fingers per bunch are preferred, while large fingers of higher finger weight, finger girth and finger length are the main criteria for suitability to cooking and processing into flour and chips. The genotypes with a low number of fingers per bunch and low finger weight are not economically suitable for processing but may be suitable for fresh markets. Though the number of hands and fingers per bunch was medium in NRCB 8, Kovvur Bontha, Bhoodibale, Popoulu and Monthan, bunch yield was found to be higher because of relatively higher finger size and weight. The results obtained in the present study with respect to variation in yield and yield attributes are in similar lines with the findings of Rajmanickam and Rajmohan (2010) [20], Tushemereirwe *et al.* (2014) [29], Kumar *et al.* (2014) [12], Reynoso *et al.* (2014) [22], Martinez *et al.* (2015) [15], Ssali *et al.* (2016) [26], Tumuhimbise *et al.* (2016) [28], Nayak *et al.* (2020) [16], Joseph and Simi (2020) [10], Jena *et al.* (2020) [9], Eshbel *et al.* (2022) [4] in similar and other banana genotypes.

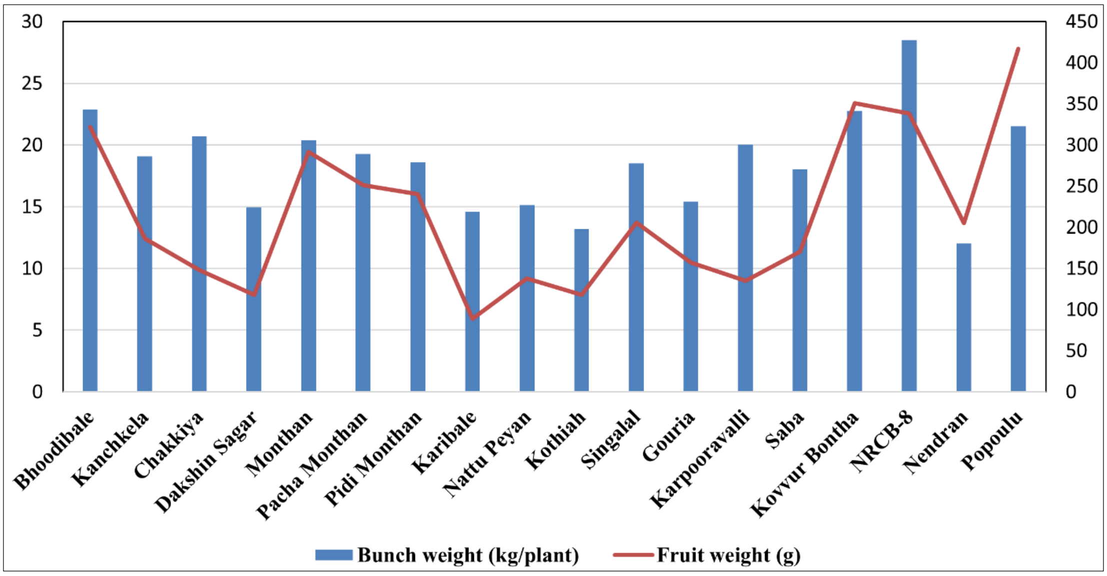


Fig 1: Performance of select banana genotypes for yield attributes

3.2 Post-harvest quality attributes

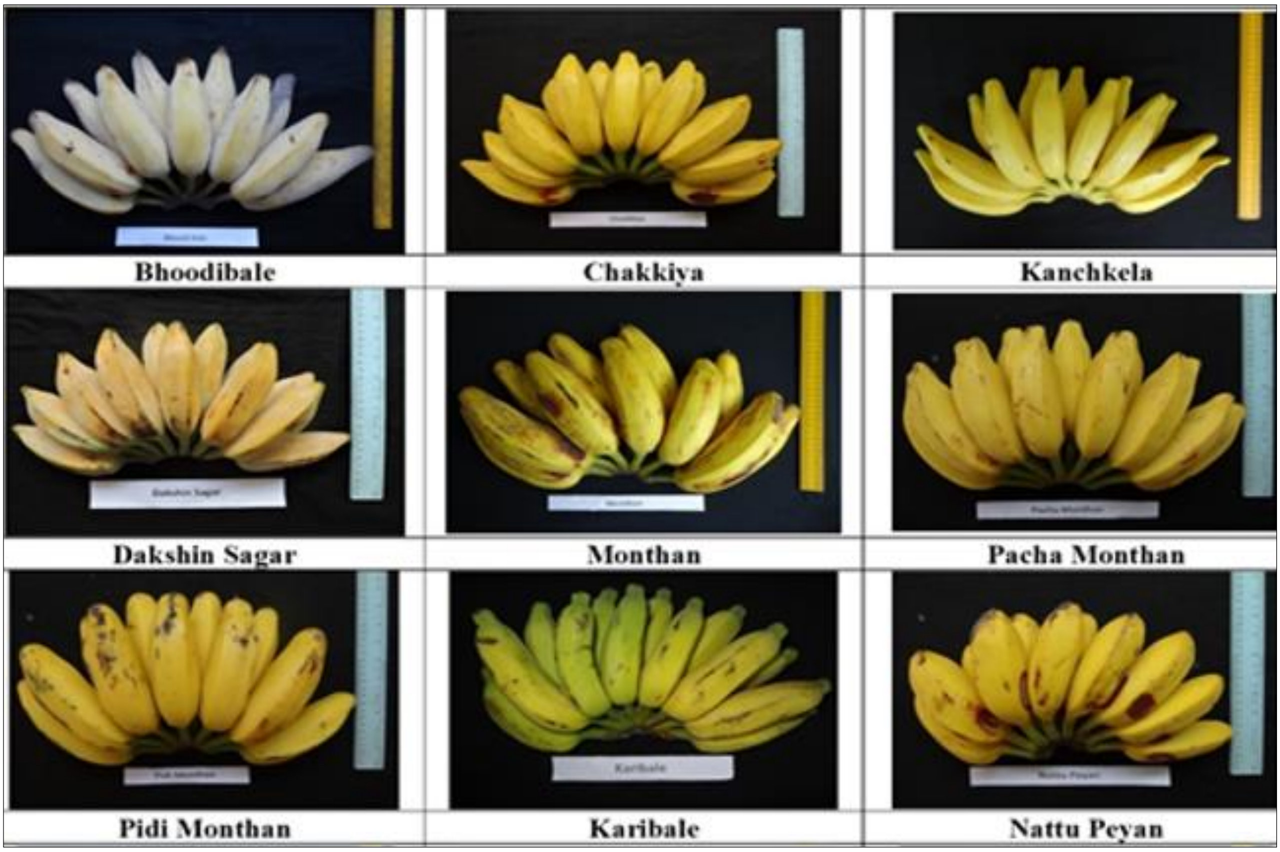
The peel weight of ripened fruits ranged from 22.33 to 101.00 g (Table 1). The genotype Bhoodibale recorded a higher peel weight (101.00 g) which was on par with Kovvur Bontha (96.67 g). Lower peel weight was registered in Karibale (22.33 g) which was followed by Karpooravalli (31.33 g). The coefficient of variation for peel weight of the fruit at ripened stage was 37.39 percent (Table 3). The pulp weight of the fruit ranged from 54.33 to 292.33 g (Table 1) with a coefficient of variation of 49.45 percent (Table 3). Among the genotypes evaluated, the highest pulp weight was recorded in Popoulu (292.33 g), while Karibale (54.33 g) recorded a lower pulp weight and was followed by by Dakshin Sagar (58.67 g) and Kothiah (61.33 g). Pulp to peel ratio of the fruits significantly differed among the genotypes and it ranged between 1.34 and 4.14 (Table 1). A higher pulp-to-peel ratio of 4.14 was recorded in Popoulu, followed by Nendran (3.30). Dakshin Sagar recorded the lowest (1.34) pulp: peel ratio and it was on par with Kothiah (1.40). The coefficient of variation for pulp to peel ratio was 31.00 percent (Table 3).

In the present study, pulp weight and pulp-to-peel ratio among the genotypes ranged from 54.33 to 372.33 g and 1.34 to 4.14, respectively. Generally high pulp weight or recovery as well as high pulp-to-peel ratio are important traits in bananas preferred for processing. Newiliah *et al.* (2009) [17], have also reported that higher finger girth and pulp-to-peel ratio can be considered as an advantageous attribute. Among the genotypes evaluated, 'Popoulu' performed significantly superior for both pulp weight as well as pulp to peel ratio. Kovvur Bontha, NRCB-8 and Bhoodibale also recorded higher pulp weight. "Popoulu' recorded a higher pulp weight of 292.33 g and the pulp-to-peel ratio of 4.14. The 'Popoulu' cultivar has also performed better under Kerala conditions and its potential for cooking as well processing as chips was earlier indicated by Rema *et al.*, (2014) [21]. The promising performance of Popoulu at Coimbatore where the humidity levels are much lower than Kerala indicates its broader adaptability. Similar findings were also observed by Jena *et* *al.* (2020) [9] and Dagnew *et al.* (2021) [3] in various genotypes of plantains and cooking bananas.

The peel thickness differed significantly and ranged from 1.65 to 3.27 mm (Table 1). Higher peel thickness was recorded in Singalal (3.27 mm), Bhoodibale (3.26 mm), Pacha Monthan (3.20 mm). Karpooravalli recorded lower peel thickness (1.65 mm) and was on par with Popoulu (1.79 mm) and Karibale (1.93 mm). The coefficient of variation for peel thickness was 19.59 percent (Table 3). The firmness of the fruit differed significantly among the genotypes at both harvest and ripened stage (Table 1). Fruit firmness at harvest ranged from 10.41 to 21.09 kg/cm^2. Higher fruit firmness was exhibited by Monthan (21.09 kg/cm^2) followed by Pacha Monthan (18.57 kg/cm^2) and Pidi Monthan (18.20 kg/cm^2). Kothiah recorded the lowest fruit firmness (10.41 kg/cm^2). Fruit firmness at edible ripened stage ranged from 1.46 to 8.27 kg/cm^2. Nendran exhibited significantly higher fruit firmness of 8.27 kg/cm^2 followed by Monthan (7.49 kg/cm^2) and Popoulu (7.16 kg/cm^2) whereas Kanchkela recorded lower fruit firmness (1.46 kg/cm^2) which was on par with Karibale (1.50 kg/cm^2) and Dakshin Sagar (1.50 kg/cm^2). The coefficient of variation for fruit firmness at harvest and ripened stage, was 18.06 and 50.58 percent, respectively (Table 3).

High fruit firmness is related to withstanding ability against damages that may occur during handling, transportation or storage. Firmer fruits are ideal for processing as they can be easily handled minimizing the risks associated with less firm fruits. Fruit firmness at harvest and ripened stage varied from 10.41 to 21.09 kg/cm^2 and 1.46 to 8.27 kg/cm^2, respectively. The reduction in fruit firmness from the harvest stage to ripened stage can be attributed to physiological and biochemical changes associated with ripening. According to Thompson (1996) [27], the softening of banana fruit during ripening is associated with the conversion of starch to sugar, breakdown of pectin substances and the movement of water from the rind of the banana to pulp during ripening and consequent decrease in mechanical properties of banana. Unripe bananas contain a large amount of starch and banana genotypes vary in the amount of starch at harvest stage. The differences in firmness levels could be also attributed to the differences in starch levels at harvest and ripened stages in the present study. Monthan, Pacha Monthan and Pidi Monthan recorded comparatively higher fruit firmness at harvest in the present study. Nendran and Popoulu recorded higher fruit firmness at ripened stage too.

Significant differences were observed with respect to physiological loss in weight (PLW) which ranged from 6.61 to 13.47 percent (Table 1). The lower PLW of 6.61 percent was observed in Dakshin Sagar and it was on par with Kothiah (7.77%). The higher PLW was recorded in Nendran (13.47%) which was on par with Monthan (12.86%). The coefficient of variation for this trait was 19.49 percent (Table 3). The green life of the fruits under ambient temperature varied significantly from 2.89 to 5.89 days. The longest green life was recorded in Popoulu (5.89 days) which was on par with NRCB-8 and Nendran (Table 1). Nattu Peyan recorded the shortest green life of 2.89 days, and it was on par with Singalal, Gowria, Karpooravalli, Saba and Kothiah. The coefficient of variation for green life was 21.15 percent (Table 3). Shelf-life of banana fruits ranged between 3.44 and 6.00 days (Table 1). Nendran recorded the longest shelf-life of 6.00 days which was on par with Karibale (5.22 days). The shortest shelf-life (3.44 to 3.67 days) was observed in Kovvur Bontha, Pacha Monthan, Monthan, Pidi Monthan, Nattu Peyan, Kothiah, NRCB-8, Kanchkela, Gowria, Singalal and Popoulu and were statistically on par with each other. The coefficient of variation for shelf-life was 17.19 percent (Table 3).



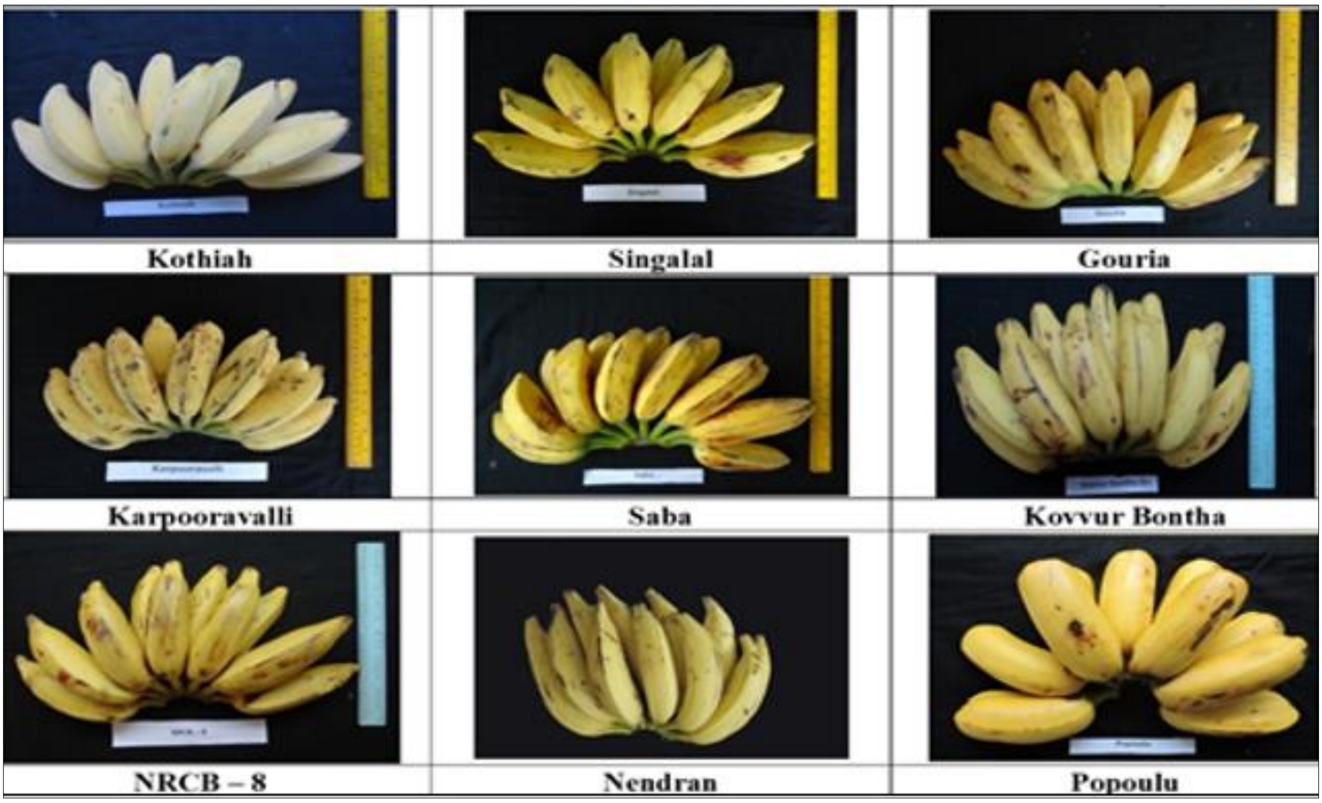


Fig 2: Fruits appearance of different genotypes at ripen stage

Table 1: Performance of select banana genotypes for fruit attributes

S. No.	Genotypes	Peel weight (g)	Pulp weight (g)	Pulp: peel ratio	Firmness (kg/cm^2)		Peel thickness (mm)	PLW (%)	Green life (days)	Shelf life (days)
					At harvest	At ripe				
1	Bhoodibale	101.0 ± 2.1	193.6 ± 2.03	1.92 ± 0.03	16.84 ± 0.31	4.83 ± 0.32	3.26 ± 0.14	8.97 ± 0.97	3.89 ± 0.11	4.78 ± 0.22
2	Kanchkela	48.5 ± 2.08	122.6 ± 1.86	2.54 ± 0.14	14.59 ± 0.51	1.46 ± 0.15	2.62 ± 0.06	9.77 ± 0.17	3.66 ± 0.19	3.89 ± 0.11
3	Chakkiya	47.0 ± 2.31	81.6 ± 2.33	1.75 ± 0.14	17.41 ± 0.65	4.73 ± 0.30	2.93 ± 0.09	8.27 ± 0.47	3.67 ± 0.33	4.44 ± 0.29
4	Dakshin Sagar	43.8 ± 1.36	58.6 ± 2.33	1.34 ± 0.03	14.49 ± 0.35	1.50 ± 0.12	2.09 ± 0.07	6.61 ± 0.38	4.44 ± 0.29	4.11 ± 0.11
5	Monthan	68.6 ± 1.45	183.3 ± 2.03	2.67 ± 0.07	21.09 ± 0.69	7.49 ± 0.15	3.06 ± 0.28	12.86 ± 0.54	4.66 ± 0.19	3.44 ± 0.22
6	Pacha Monthan	75.0 ± 1.73	146.3 ± 1.45	1.95 ± 0.04	18.57 ± 0.24	6.33 ± 0.16	3.20 ± 0.06	12.17 ± 0.30	4.22 ± 0.22	3.44 ± 0.29
7	Pidi Monthan	79.3 ± 2.03	161.6 ± 2.33	2.04 ± 0.08	18.20 ± 0.65	5.82 ± 0.29	3.08 ± 0.12	11.57 ± 0.33	3.89 ± 0.48	3.55 ± 0.29
8	Karibale	22.3 ± 1.20	54.3 ± 2.03	2.45 ± 0.17	13.95 ± 0.27	1.50 ± 0.03	1.93 ± 0.04	8.69 ± 0.30	3.78 ± 0.22	5.22 ± 0.4
9	Nattu Peyan	41.6 ± 1.45	80.6 ± 1.45	1.94 ± 0.09	11.94 ± 0.24	1.77 ± 0.03	3.07 ± 0.09	7.89 ± 0.30	2.89 ± 0.11	3.55 ± 0.29
10	Kothiah	44.0 ± 1.15	61.3 ± 2.33	1.40 ± 0.09	10.41 ± 0.56	1.84 ± 0.12	2.87 ± 0.19	7.77 ± 0.34	3.11 ± 0.11	3.66 ± 0.19
11	Singalal	62.3 ± 2.03	120.3 ± 2.03	1.94 ± 0.09	12.89 ± 0.36	4.39 ± 0.16	3.27 ± 0.27	9.63 ± 0.38	3.44 ± 0.29	4.0 ± 12.0
12	Gouria	51.5 ± 0.87	92.0 ± 1.85	1.78 ± 0.01	11.73 ± 0.33	3.50 ± 0.60	2.90 ± 0.04	8.93 ± 0.73	3.44 ± 0.29	3.89 ± 0.11
13	Karpooravalli	31.3 ± 2.03	91.3 ± 1.76	2.93 ± 0.16	15.24 ± 0.49	2.72 ± 0.12	1.65 ± 0.06	8.22 ± 0.09	3.11 ± 0.11	4.89 ± 0.11
14	Saba	57.0 ± 1.53	95.5 ± 1.04	1.68 ± 0.05	16.56 ± 0.32	5.82 ± 0.29	2.97 ± 0.12	8.20 ± 0.38	3.66 ± 0.19	4.55 ± 0.22
15	Kovvur Bontha	96.6 ± 0.88	218.6 ±1.20	2.26 ± 0.02	16.60 ± 0.32	5.61 ± 0.16	3.16 ± 0.09	9.18 ± 0.17	4.66 ± 0.19	3.44 ± 0.22
16	NRCB-8	88.0 ± 4.01	218.0 ± 2.89	2.49 ± 0.15	16.77 ± 0.36	4.49 ± 0.31	3.04 ± 0.06	10.0 ± 0.25	5.44 ± 0.29	3.67 ± 0.33
17	Nendran	41.6 ± 1.76	137.0 ± 2.31	3.30 ± 0.08	13.57 ± 0.31	8.27 ± 0.26	2.30 ± 0.06	13.47 ± 0.47	5.44 ± 0.22	6.0 ± 0.19
18	Popoulu	70.6 ± 1.45	292.3 ± 2.33	4.14 ± 0.12	13.29 ± 0.54	7.16 ± 0.08	1.79 ± 0.01	9.88 ± 0.10	5.89 ± 0.11	4.0 ± 0.10
	S.Ed	2.65	2.87	0.14	0.62	0.34	0.18	0.60	0.34	0.32
	CD (p=0.05)	5.38*	5.82*	0.28*	1.26*	0.69*	0.36*	1.22*	0.69*	0.65*

PLW= Physiological Loss in Weight; CD stands for critical difference; * - Significant at 5% level
Data presented are mean value of triplicates ± standard deviation (n = 3)

Lower weight loss of fingers during storage is advantageous for the consumer and as well as for the processors. The PLW among the genotypes ranged from 6.61 to 13.47 percent in the present study. PLW is accompanied by moisture loss and associated quality deterioration. Further, green-life and shelf-life are the other important postharvest criteria that would play a significant role in the overall acceptability. Green life is the most important parameter for culinary and processing industries. Variety should have a longer green life or remain green for a long time after harvest, or ripen slowly, which would facilitate marketing of the fruit and reduce postharvest losses. On the other hand, shelf-life is important for dessert genotypes to enable proper and adequate storage and handling. Variation in post-harvest attributes in various genotypes of plantains and cooking bananas were also observed by Jena *et al.* (2020) [9] and Dagnew *et al.* (2021) [3].

3.3 Biochemical Quality attributes

Significant differences in total soluble solids (TSS) content were recorded among the genotypes and it ranged from 15.67 to 27.33 ^{0} Brix (Table 2). The highest TSS content of 27.33^0 Brix was recorded in Karpooravalli and it was followed by Nendran, Karibale, Popoulu and Kothiah. Kanchkela and NRCB-8 registered lower TSS of 15.67 and 16.17 ^{0}Brix respectively. The coefficient of variation for TSS was 12.98 percent (Table 3). The titratable acidity of the fruits ranged from 0.30 to 0.97 percent (Table 2). The lower acidity of 0.30 percent was recorded in Kothiah and it was found to be on par with Kovvur Bontha (0.35%) and Nendran (0.37%), while Monthan recorded a higher titrable acidity of 0.97 percent and it was on par with Nattu Peyan (0.92%). The coefficient of variation for titrable acidity was 30.86 percent (Table 3). Sugar acid ratio showed significant variation among the genotypes evaluated and ranged from 16.64 to 74.96 (Table 2) with a coefficient of variation of 49.08 percent (Table 3). The higher ratio of 74.96 was recorded in Kothiah, followed by Nendran (55.96) and Kovvur Bontha (55.62), while Kanchkela recorded lower sugar acid ratio of 16.64 which was on par with NRCB-8 (17.90) and Monthan (19.68). Total sugar content significantly varied from 13.87 to 24.37 percent (Table 2). The highest total sugar content of 24.37 percent was registered in Karpooravalli. The cultivar Kanchkela recorded the minimum total sugar content of 13.87 percent which was on par with NRCB-8 (14.56%). The coefficient of variation for total sugar was 13.40 percent (Table 3). The reducing sugar content differed significantly among the genotypes and ranged from 12.06 to 22.18 percent (Table 2). The coefficient of variation for this trait was 14.56 percent (Table 3). Karpooravalli registered higher reducing sugars (22.18%) followed by Kothiah (20.21%) and Karibale (20.04%). Lower reducing sugar content of 12.06 and 12.53 percent were recorded in Kanchkela and NRCB-8 respectively which were statistically on par with each other. The non-reducing sugars ranged from 1.34 to 2.51 percent (Table 2). Chakkiya recorded the lowest amount of non-reducing sugar (1.34 percent) which was on par with Dakshin Sagar (1.38%) while Kothiah recorded the highest non-reducing sugar content of 2.51 percent followed by Karpooravalli (2.19%). The coefficient of variation for this trait was 15.29 percent (Table 3).

Fruit quality in banana is mainly attributed to the amount of total sugars and acidity present in the pulp. An appropriate combination of TSS, total sugars, titratable acid and ascorbic acid decides the ultimate palatable and nutritional quality of banana. Significant difference in the fruit biochemical quality parameters were observed among the banana genotypes screened. Higher amount of total soluble solids, total sugars with a low acidity are desirable for dessert purpose and are also for processing into various products such as banana fig, jam, juice, etc. In the present study, the genotypes Karpooravalli and Kothiah were found to be better in total soluble solids, total sugars, reducing sugars and non-reducing sugars among all the genotypes evaluated. While Karpooravalli is known for dessert quality, the suitability of culinary variety 'Kothiah' for dessert purpose as ripened fruit requires further confirmation. Sugar to acid ratio significantly varied from 16.64 to 74.96 in the study. The genotypes Kothiah, Nendran and Kovvur Bontha recorded the highest sugar acid ratio. Varying levels of differences in the quality traits as observed in the present study were in similar lines as of the findings of Shivashankar (1999) [23], Gibert *et al.* (2009) [5], Kunchala (2012) [14] and Gogoi *et al.* (2015) [6], Jena *et al.* (2020) [9] and Dagnew *et al.* (2021) [3] with other genotypes of banana.

Table 2: Performance of select banana genotypes for post-harvest quality attributes

S. No.	Genotypes	Total soluble solids (°Brix)	Titratable acidity (%)	Sugar: Acid ratio	Total sugars (%)	Reducing sugars (%)	Non-Reducing sugars (%)
1	Bhoodibale	22.2 ± 0.23	0.68 ± 0.01	29.0 ± 0.07	19.8 ± 0.41	17.9 ± 0.47	1.86 ± 0.08
2	Kanchkela	15.6 ± 0.33	0.83 ± 0.01	16.6 ± 0.35	13.8 ± 0.24	12.1 ± 0.20	1.81 ± 0.05
3	Chakkiya	21.9 ± 0.30	0.69 ± 0.01	26.3 ± 0.55	18.2 ± 0.34	16.8 ± 0.29	1.34 ± 0.07
4	Dakshin Sagar	22.0 ± 0.58	0.70 ± 0.01	29.9 ± 1.05	20.8 ± 0.30	19.4 ± 0.34	1.38 ± 0.05
5	Monthan	21.1 ± 0.44	0.97 ± 0.04	19.6 ± 0.98	18.9 ± 0.32	16.8 ± 0.37	2.13 ± 0.10
6	Pacha Monthan	20.0 ± 0.58	0.83 ± 0.01	20.5 ± 0.44	16.9 ± 0.24	15.0 ± 0.27	1.85 ± 0.04
7	Pidi Monthan	20.1 ± 0.44	0.70 ± 0.01	25.6 ± 0.85	17.8 ± 0.29	15.8 ± 0.29	2.01 ± 0.04
8	Karibale	24.5 ± 0.29	0.42 ± 0.03	52.5 ± 2.50	22.1 ± 0.39	20.0 ± 0.35	2.06 ± 0.05
9	Nattu Peyan	23.3 ± 0.33	0.92 ± 0.08	21.9 ± 2.24	19.7 ± 0.44	18.1 ± 0.49	1.62 ± 0.20
10	Kothiah	24.0 ± 0.58	0.30 ± 0.01	74.9 ± 1.41	22.7 ± 0.24	20.2 ± 0.29	2.51 ± 0.06
11	Singalal	21.1 ± 0.17	0.70 ± 0.01	27.1 ± 0.44	18.8 ± 0.29	16.7 ± 0.24	2.08 ± 0.11
12	Gouria	22.0 ± 0.29	0.69 ± 0.02	29.1 ± 0.58	20.0 ± 0.34	18.4 ± 0.26	1.60 ± 0.10
13	Karpooravalli	27.3 ± 0.44	0.71 ± 0.02	34.4 ± 1.68	24.3 ± 0.51	22.1 ± 0.49	2.19 ± 0.05
14	Saba	21.2 ± 0.37	0.83 ± 0.01	22.9 ± 0.77	19.1 ± 0.54	17.2 ± 0.59	1.94 ± 0.05
15	Kovvur Bontha	21.2 ± 0.18	0.35 ± 0.02	55.6 ± 2.86	19.1 ± 0.12	17.3 ± 0.13	1.83 ± 0.02
16	NRCB-8	16.1 ± 0.17	0.81 ± 0.01	17.9 ± 0.43	14.5 ± 0.32	12.5 ± 0.32	2.03 ± 0.09
17	Nendran	24.6 ± 0.44	0.37 ± 0.01	55.9 ± 0.70	20.5 ± 0.58	18.5 ± 0.52	1.99 ± 0.08
18	Popoulu	24.3 ± 0.44	0.41 ± 0.01	51.4 ± 1.79	21.2 ± 0.45	19.5 ± 0.32	1.71 ± 0.14
	S.Ed	0.55	0.03	1.90	0.52	0.51	0.12
	CD (p=0.05)	1.12*	0.07*	3.86*	1.06*	1.04*	0.25*

Data presented are mean value of triplicates ± standard deviation (n = 3); CD stands for critical difference; * - Significant at 5% level

Table 3: Variability in fruit attributes and postharvest quality parameters among select banana genotypes

S. No.	Parameters	Range	Mean	SD	CV (%)
1	Peel weight	22.30 - 101.00	59.48	22.24	37.39
2	Pulp weight	54.33 - 292.33	133.86	66.19	49.45
3	Pulp: peel ratio	1.34 - 4.14	2.25	0.70	31.00
4	Fruit firmness (Green)	10.41 - 21.09	15.23	2.75	18.06
5	Fruit firmness (Ripe)	1.46 - 8.27	4.40	2.23	50.58
6	Peel thickness	1.65 - 3.27	2.73	0.54	19.59
7	PLW	6.61 - 13.47	9.56	1.86	19.49
8	Green-life	2.89 - 5.89	4.07	0.86	21.15
9	Shelf-life	3.44 - 6.00	4.14	0.71	17.19
10	Total soluble solids	15.67 - 27.33	21.84	2.83	12.98
11	Titrable acidity	0.30 - 0.97	0.66	0.20	30.86
12	Total sugar	13.87 - 24.37	19.39	2.60	13.40
13	Sugar: acid ratio	16.64 – 74.96	33.98	16.6	49.08
14	Reducing sugar	12.06 - 22.18	17.51	2.55	14.56
15	Non-reducing sugar	1.34 - 2.51	1.89	0.29	15.29

4. Conclusion
The banana genotypes tested in this study revealed a high degree of diversity for yield and post-harvest attributes, showing a great potential for selection among the genotypes evaluated. The genotypes, NRCB-8, Bhoodibale and Kovvur Bontha can be adjudged as high yielders in the ABB genomic group which can be used for culinary purposes and in crop improvement programs. Among the two AAB genotypes ‘Popoulu’ which registered higher bunch yield, finger weight and pulp recovery than Nendran could be explored for crop improvement programs and processing chips and green banana flour preparation. Information on the physical and chemical characterization of banana genotypes in the current study are useful for determining the choice of parents for crossing and development of improved hybrids and could also be recommended for large cultivation.

5. Acknowledgment
The author would like to express gratitude to the Indian Council of Agricultural Research, New Delhi, India for the award of Junior Research Fellowship (ICAR-JRF) as well as Tamil Nadu Agricultural University, Coimbatore, India for their support of this study.

6. Funding
The authors declare that no funds, grants, or other support were received research and preparation of this manuscript.

7. Competing Interests
The authors have no relevant financial or non-financial interests to disclose

8. Author contribution statement
“All authors contributed to the study conception and design. Conceptualization, Formal analysis, Data curation, Writing - original draft by Naveena Kumara K T: Resources, Supervision, Writing- review and editing by C.K Kavitha: Conceptualization, Methodology, Validation, Writing - review & editing, Project Administration by Soorianathasundaram: The first draft of the manuscript was written by [Naveena Kumara K T] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.”

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