Int.J.Curr.Res.Aca.Rev.2021; 9(04): 73-79

EXCELLENT PUBLISHERS

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 9 Number 04 (April-2021)

Journal homepage: http://www.ijcrar.com

doi: https://doi.org/10.20546/ijcrar.2021.904.008

Evaluation of Improved Dessert Banana (*Musa* spp.) Varieties in West Hararghe Zone, Eastern Ethiopia

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Abstract

Banana is the second an important fruit crop in terms of food and cash crop in eastern Ethiopia including DaroLabu District of West Hararghe Zone. However, the yield potential of the existed local variety has low as compared the average national productivity of the crop. The present study was undertaken to evaluate seven cultivars of banana belonging to similar genomic groups (AAA) for growth, yield and quality attributes. The experiment was established in 2008-2012 at Mechara Agricultural Research Center by using a randomized complete block design with three replications and analysis of variance was carried out to examine the morphological adaptability and yield related characters of the cultivars. The cultivars in the study showed a significant difference ($p < 0.005$) for all characters studied in the experiment except that fruit number per hand and diameter. The highest hand weight (2.55kg) was recorded from William-1, which par each other for the cultivars, Robusta and Butuzua), while Poyohad the lowest hand weight (1.35kg). William-1 had significantly heaviest fruit weight (200.02gm), whereas, the lowest fruit weight was recorded from Poyo variety with 130.02gm, which were on par with Butuzua and Grande nine. Regarding yield attributes, the maximum fruit length (18.91cm) and fruit diameter (12.46cm) were recorded from William-1 followed by Giant Cavendish for fruit diameter (12.35cm). However, heavier bunch weight (20.8kg) and total fruit yield (103.52qt/ha) were obtained from Giant Cavendish followed by William-1 with bunch weight (20kg) and total fruit yield (100.32qt ha). Generally, from the study concluded that Giant Cavendish showed 29.31% yield advantage than over national average productivity of the Banana crop hence, the variety Giant Cavendish was highly recommended to growers in the study area and similar agro ecology.

Article Info

Accepted: 18 March 2020
Available Online: 20 April 2021

Keywords

Banana, Genetic variation, Yield related traits.

Introduction

The genus Musa is originated in South East Asia where the wild species of *M. accuminata* occurred. *M. accuminata* was originated in Malaysia and *M. balbisiana* in India. Dessert banana and plantain (*Musa spp*.) are the fourth most important staple food crops in the world after rice, wheat and maize (Frison and Sharrock, 1999).

In the highlands of East Africa, consumption of banana reaches 250 kg/head per year, the highest consumption rate in the world. In West Africa, plantain and desert bananas contribute up to 25% of the carbohydrate intake

of 60 million people. Banana fruit are similar to potato in consumption but contains more potassium than other plant species. Protein contents is 1% and starch content is 11- 20 %. Starch content reduces to 2% during repining while sugar content rises up to 20%. The starch content at full ripeness is always much higher in plantains than desert bananas; the opposite is true for their sugar content. They are rich in ascorbic acid or vitamin-C and vitamin B6.

Dessert banana in particular is a commercially important crop in the global trade, both by volume and value, as a leading fruit El-Sherbiny AH (1987).Bananas are predominantly produced in Asia, Latin America and Africa. The biggest producers are India, which produced 29 million tonnes per year on average between 2010 and 2017, and China at 11 million tonnes. Approximately 5.6 million hectares of land are dedicated to banana production globally, according to the latest available data from 2017 (FAOSTAT).

Banana (*Musa* spp.) is one of the most important foods and cash crops in Ethiopia. However, most of the cultivars grown particularly the local ones are low yielders and are thus not very suitable for commercial production. Productivity levels of banana production differ from country to country and from variety to variety. In general, within commercial banana production of the Cavendish variety, the average yield per hectare ranges between 40 and 50 tonnes. Some of the large producers in countries with well-established industries such as the Philippines and India can reach average yields of around 60 tonnes per hectare, while smaller producers, like Ethiopia, produce around 30 tonnes per hectare.

In Ethiopia, suitable conditions are found at Rift Valley, while the cultivation of Ensete dominates in highlands of Ethiopia. It is produced throughout the country wherever there is adequate rainfall or irrigation opportunity.

Banana, especially the dessert banana is the major fruit crop in Ethiopia leading both in area and production. In addition, it's the major fruit crop that is most widely grown and consumed in Ethiopia. It is cultivated in several parts of the country where the growing conditions are favorable. Especially in the south and southwestern as well as south eastern parts of the country, it is of great socioeconomic importance contributing significantly to the overall wellbeing of the rural communities including food security, income generation and job creation.

In Ethiopia about 67,387 ha is covered by Banana and 205,394,426.48 quintals are harvested annually. Central Statistical Agency [CSA (2020)] also reported as the national yield potential of the crop is 80.05 quintals per hectare.

On the other hand, in 2020 Meher cropping season 1,275,593 house holders were participated in banana production and about 16,461.73 hectares of land was covered with this crop, where 1,106,215.19 quintals were harvested annually in Oromia Regional state.

The average yield potential of banana in Oromia regional state is 67.20 quintals per hectare and is lower than that of the national yield potential of the crop (CSA, 2019/20).

Moreover, In 2020 Meher cropping season about 21,985 house holders were participated in banana production and about 732.20 hectares of land was covered with this crop, where 54,813.05 quintals were harvested annually in West Hararghe Zone. The average yield potential of banana in region is 74.86 quintals per hectare and is lower than that of the national yield potential of the crop (CSA, 2019/20).

In Ethiopia, but over the years a number of problems tend to faced against the production of this crop in the country. Out of these, lack of improved varieties is the critical problem to banana. This is due to banana varieties available at the hands of farmers in the major growing areas are low yielder, poor quality and susceptible to diseases which have been under production for many years. However, improved varieties of banana can give higher yield than the mentioned yield potential.

West Hararghe zone is known as Chat producing belt. However, the Zone has high potential for other crops like Sorghum, pulse and oil crops, horticultural and lowland seed spices. Banana is one of the most important fruit crops grown in Hararghe low land area like, DaroLabu and Mi'eso districts and some part of Habro and Chiro even if local cultivars of banana were under cultivation for long period of times. These local varieties are low yielder and less demand on market and planting material is mostly from local and they get low yield due to lack of high yielding and lack of sufficient quantity of suckers of improved Banana varieties. Hence, this experiment was conducted with the objective of evaluating the adaptability of improved desert type banana varieties to DaroLabu districts of West Hararghe zone.

Materials and Methods

Seven Improved dessert banana cultivars were established at Mecharaonstation in 2008-2012. Mechara Agricultural Research Center is located between 8.34' N latitude and 40.20' E longitude *m.a.s.l*. The altitude of the area is about 1760 *m.a.s.l*. It has a warm climate with annual mean maximum and minimum temperature is 31.8^{o}c and 14^{o}c, respectively. The mean annual rainfall is 1100mm. DaroLabu district is characterized mostly by flat and undulating land features and the rainfall is erratic; onset is unpredictable, its distribution and amount are also quite irregular. The pattern of rainfall is bimodal and its distribution is mostly uneven in district. Generally, there are two rainy seasons: the short rainy season ''*Belg*'' lasts from mid-February to April whereas the long rainy season ''*Kiremt*'' is from June to September. The soil of the experimental site is well-drained slightly acidic *Nitsol*.

The experiment was established using a randomized complete block design with three replications. Four plants were maintained on each plot with spacing of 2.5 m between the rows and 2.5 m within rows, total giving a planting density of 1600 plant per hectare. All management practices were carried out following standard recommendations for the crop.

Data collection

Data were taken for two consecutive cropping cycles on bunch weight (kg), hands per bunch, fruit number, fruit weight per bunch (kg), fruit diameter (cm), fruit length (cm), average weight of single fruit (gm), marketable fruit number and weight, yield per hectare (estimated from plot yield) in ton ha^{-1}. The number of hands per bunch and total number of fingers per bunch was counted. Three individual middle fingers of the second hand were used to measure average fruit weight as recommended by Alvarez *et al.,* (2001). Total yield (kg/ha/cycle) was calculated based on bunch weight and the number of plants per hectare (1,600 plants/ha).

Data Analysis

The data were subjected to analysis of variance (ANOVA) using Gen-Stat release 16th Edition software (Gomez, 1984). The result interpretations were made following the procedure of Gomez and Gomez and means of significant treatment effects were separated using the Fishers' Protected Least Significant Difference (LSD) test at 5% probability level of significance.

Results and Discussion

Analysis of variance showed that Bunch weight, number of hands per bunch, Mean weight of hand, Mean weight of fingers, Fruit length and number of finger per bunch were significantly different at 5% level due to variety. Whereas, there were no significance difference recorded on Fruit diameter and mean number of finger per hand (Table 1 and Fig, 1and 2). Accordingly, Giant Cavendish had the highest mean of bunch weight (20.8kg) and followed by William I(20 kg). Whereas, the lowest weight of bunch (8 kg) was recorded from the Dwarf Cavendish (Fig. 1). This may be due to genetic variability of the variety. Similarly, Getachew *et al.*, (2019) reported that the highest mean of bunch weight (24.37kg) was recorded from Giant variety. In addition to, Asfaw *et al.*, (2016) reported that, Giant Cavendish had the highest mean of bunch weight (22.41kg) at DaroLabu district. However, this is in contrary with Tesfa and Mekias, 2015) who indicated that, Dwarf Cavendish is highest mean of bunch weight (15.9kg) was recorded over Giant Cavendish with (14.1kg). This may be due to environmental conditions of study area which possess low altitude.

Similarly, there was significance difference among varieties from mean of hand weight. The highest mean of hand weight was recorded from Williams 1(2.55kg) which were par with each other Robusta (2.55kg) and Butuzua (2.55kg) varieties. Whereas, the lowest mean of hand weight (1.35 kg) was recorded from Dwarf Cavendish (Table 1).

These results could be due to hand weight as believed to be somatic clonal variants with only some detectable changes between the group at DNA level (Heslop-Harrison and Schwarzacher, 2007).On the other hand, Grande nine had the highest number of fruit per hand. However, the lowest number of fruit per hand (9.01) and 9.04) was recorded fromPoyo and Dwarf Cavendish varieties respectively (Table 1).This may related to effect of genetic variation among the varieties.

Based on from analysis of results, significant variation ($P<0.05$) was obtained among the varieties. Accordingly, the heaviest mean finger weight (200gm) was obtained from William -I variety followed by Giant Cavendish by (170gm).

Whereas the lowest weight of finger (100 gm) was recorded for Dwarf Cavendish variety (Table 1). Likewise, fruit number per bunch was also determined.

Table.1 Mean yield and different agronomic parameter of bananas in conducted from 2008 - 2012 cropping season

Variety	HWT(kg)	NFH	FWT(gm)	NFB	FL(cm)	FD(cm)	Total yield(qt/ha)
Giant Cavendish	2.25	9.70	170.71	120.86	18.13	12.35	103.52
William -I	2.55	10.70	200.02	120.07	18.91	12.46	100.32
Robusta	2.55	10.31	170.00	116.93	18.12	12.33	97.95
Butuzua	2.55	10.32	130.09	126.11	18.11	12.25	97.12
Grande nine	2.40	11.71	130.06	140.32	18.57	12.26	95.58
Poyo	1.80	9.01	130.02	90.41	16.75	11.78	93.08
Dwarf Cavendish	1.35	9.04	100.04	58.33	17.21	11.82	50.52
Mean	2.25	10.11	147	110.01	17.91	12.12	76.76
P value	0.020	Ns	0.53	0.0059	0.5	Ns	0.0032
Cv%	17.48	15.13	35.19	17.43	5.16	4.44	16.92
Lsd (5%)	0.41	2.73	0.09	9.21	1.67	1.01	0.57

NS=non-significant, ***=highly significant, **=significant, NFH = number of fruits per Hand, NFB = number of fruits per Bunch, HWT = Hand weight (kg), FD= fruit diameter (cm), FL= fruit length (cm), FWT = average weight of single fruit (gm), YLD = yield (Quntal ha^{-1})

Fig.1 Bunch weight of different banana varieties

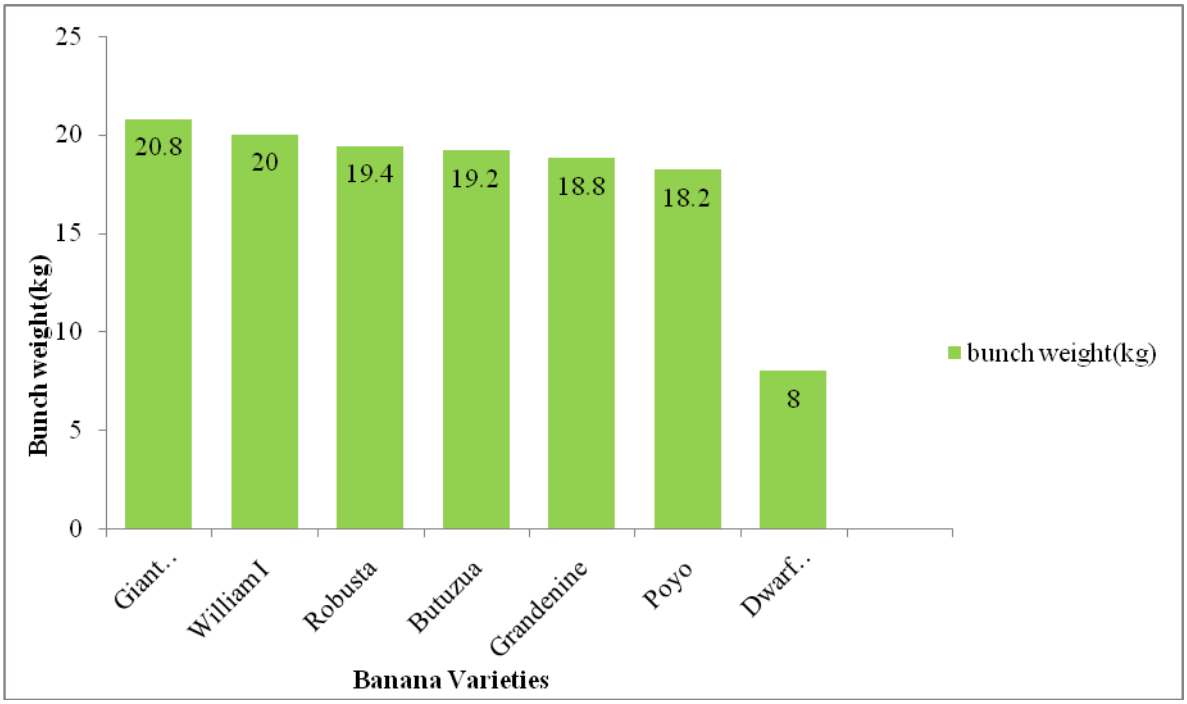
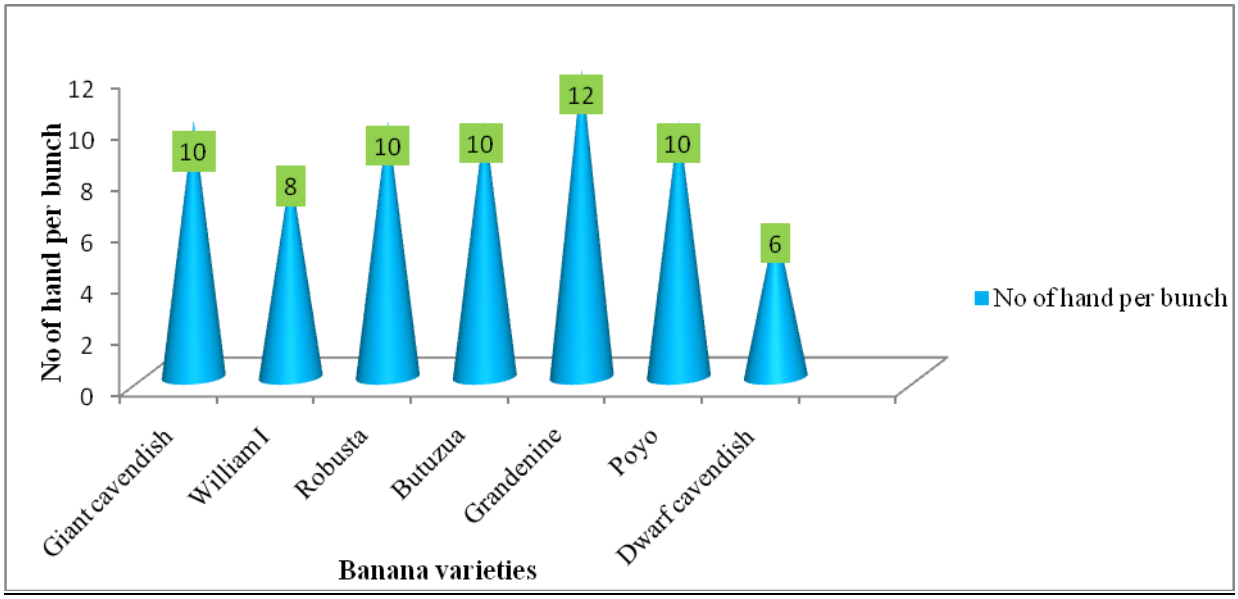


Table.2 Banana Variety selection by farmer's preferences

No	Variety	Rank	Selection criteria
1	Gaint Cavendish	1st	• Plant height • Bunch weight • Fruit length, diameter and number • Leaf color • Hands per bunch • Number fruit and yield potential
2	Williams -I	2nd	
3	Robusta	3rd	
4	Poyo	6th	
5	Dwarf Cavendish	7th	
6	Butuzua	4th	
7	Grande nine	5th	

Fig.2 Number of hand per bunch on different Banana varieties



However, the maximum fruit number per bunch (140.32) was recorded for Grande nine followed by Butuzua and Giant Cavendish by 126.11 and 120.86respetively. However, the minimum average weight of fruit number per bunch was obtained from Dwarf Cavendish by (58.33). It is observed from this result that mean fruit weight and number are the major variables influenced by biologically. This study has contrary with that Tesfa and Mekias (2015); Getachew *et al.,* (2019) and Tekle *et al.,* (2014) reported that highest mean of fruit weight and number are recorded from Dwarf Cavendish variety.

The above graph shows that there is statistical highly significant difference among varieties, due to bunch weight; Giant Cavendish (20.8kg), Williams -I (20kg) and Robusta (19.4kg) were gave higher bunch weight. Whereas, Dwarf Cavendish had gave lower bunch weight (8kg). The differences in the genetics with respect to yield attributing characters were controlled by genetic makeup of the varieties. Similarly, yield variations were also reported by Tekle *et al.,* (2014).

The number of hand per bunch also showed significant ($p<0.05$difference among the mean of varieties (Fig.2). The varieties Grande nine had the heaviest number of hand per bunch (12) was recorded followed by Giant Cavendish, Robusta, Butuzua and Poyo with (10). While, the lowest mean of hand per bunch was recorded from Dwarf Cavendish variety.

On the other hand, significantly tallest and wider fruit were showed from William -I with 18.91 cm and 12.46cm, respectively. Whereas, the shortest fruit length and diameter were recorded from Poyo variety with 16.75cm and 11.78cm, respectively (Table 1).

The differences between varieties for fruit length and diameter could be attributed to differences in genetic constitution of the varieties. The results obtained in the present study with respect to fruit length and diameter attributes corroborate with the results of Tesfa and Mekias (2015) reported that the longest fruit and diameter was recorded from William -I variety.

The average fruit yield also showed significant ($p<0.05$) difference among the mean of varieties. Accordingly, maximum yield was recorded from Giant Cavendish (103.52 qt ha^{-1}) followed by William -I (97.95 qt ha^{-1}) whereas the fruit lowest yield was obtained from Dwarf Cavendish and Poyo variety with 50.52 and 93.08 qt ha^{-1}, respectively (Table 1). Generally, Giant Cavendish showed 29.31% yield advantage than over national average productivity of the Banana crop. Therefore, it can be concluded that use of the improved banana.

Farmer's preference and field day

The experiment was conducted for four successive years at DaroLabu district of West Hararghe Zone. Mini Field day was organized Horticulture and spice research team, to selected good varieties of banana at Mechara on station; a total of three PA's/*kebeles* were invited to select the higher yielder banana (Table 2).

Farmer's feedback results revealed that fruit size, fruit length, diameter and bunch weigh than other varieties. On other hand, William -I variety was accepted in the market because of good fruit size and not easily perishable as compared to other varieties. Therefore based on farmer's preference Giant Cavendish and William I were ranked as 1st and 2nd, respectively (Table 2).

From the study results Giant Cavendish, gives higher hands, bunch weight, mean number of fingers per hand, mean weight of finger, good in fruit length and diameter. Similarly, Williams -I variety has good yielder and good performance in Mechara and similar agro ecology.

Therefore, Giant Cavendish was recommended for further demonstration and evaluation in order to make the technologies to adopt by end users.

Acknowledgement

The authors would like to acknowledge the financial support by Oromia Agricultural Research Institute. The authors also would like to acknowledge Mechara Agricultural Research Centre for the support in facilitating the field work and allocating the required labour and materials for field work.

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How to cite this article:

Gezahegn Assefa, Sintayehu Girma and Kinde Lamessa. 2021. Evaluation of Improved Dessert Banana (*Musa* spp.) Varieties in West Hararghe Zone, Eastern Ethiopia. *Int.J.Curr.Res.Aca.Rev*. 9(04), 73-79.
doi: https://doi.org/10.20546/ijcrar.2021.904.008