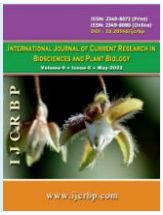
International Journal of Current Research in
Biosciences and Plant Biology

Volume **9** • Number **5** (May-2022) • ISSN: 2349-8080 (Online)

Journal homepage: www.ijcrbp.com



Original Research Article **doi:** https://doi.org/10.20546/ijcrbp.2022.905.004

Evaluation of improved plantain type of banana (*Musa* spp.) varieties at Mechara on Station, Eastern Ethiopia

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Article Info

Keywords:
Banana
Cooking
Plantain varieties
Musa acuminata
Musa balbisiana

Abstract

Fruit crops are widely grown in west Hararghe by small households and plays significant role for income generation and nutrition. Plantains are cooking type's banana producing fruits that remain starchy at maturity and need processing before consumption. Even though the environment is suitable for the production of fruit, the productivity of the crop is highly influenced by low yielding variety and low moisture. Therefore, the trail was conducted to evaluate high yielding, drought and disease resistant/tolerant Plantain types of Banana varieties at Mechara onstation. Four plantain varieties were brought from Melkasa Agricultural Research Center and evaluated for agronomic and yield and yield related traits using Completely Randomized Block Design in three replications. The Analysis of variance results revealed significant variation among plantain varieties for all traits over both harvesting cycles except Fruit diameter (cm), number of fruit per bunch and unmarketable yield. The highest bunch weight, number of hands per bunch, number of fruits per bunch, marketable yield and total yields had recorded from Nijiru variety followed by kardaba. Nijiru variety was resistance to banana disease (sigatoka and panama disease) as compared to the other varieties. Whereas the lowest bunch weight, number of fruits per bunch, marketable yield, total yields was observed from Matokke variety. The Pearson correlation coefficient showed that average bunch weight, Fruit diameter, number of finger per hand and Marketable yield were positively correlated to total yield. It is, therefore, concluded that Nijiru variety was well performed and can be recommended for the growers for Mechara and similar agro ecology of the area.

• *Received: 22 January 2022* • *Revised: 27 March 2022* • *Accepted: 20 April 2022* • *Published Online: 6 May 2022*

Introduction

Bananas and plantains (Musa spp.) are considered as the world's most important fruit and the fourth most important staple food crop (Swennen and Vuylsteke, 2001). They provide a starch staple across some of the poorest parts of the world in Africa and Asia. The all year round fruiting habit of banana and plantains puts the crop in a superior position in bridging the hunger gap' between crop harvests. Nearly all edible plantain cultivar are derived from two wild species, *Musa acuminata* and *M.balbisiana* (Robinson, 1996). These wild species are classified on the basis of the proportion of the genetic constitution contributed by each parental source (Robinson, 1996). Plantains are always cooked before consumption and are higher in starch than

bananas. These are known as plantains are plants producing fruits that remain starchy at maturity (Marriot and Lancaster, 1983, Robinson, 1996) and need processing before consumption.

Banana and plantain is contributes significantly to food and income security of people engaged in its production and trade, particularly in developing countries. The plantain fruit is nutritional and contains high levels of calories, potassium, vitamin C, magnesium and vitamin B6 (Robinson, 1996). There are two types of bananas: the sweet dessert and the cooking banana (including plantains). The dessert banana is left to ripen and then eaten raw, while the cooking banana is peeled and cooked into a dish (Robinson, 1996). Plantains are usually cooked and not eaten raw unless they are very ripe. It is similar to unripe dessert bananas in exterior appearance, although often larger; the main differences in the former being that their flesh is starchy rather than sweet, they are used unripe and require cooking (Valmayor et al., 2006).

Plantain is drought and disease tolerant fruits than desert banana (M. *balbisiana*). The plantain cultivars containing the B-genome have been reported to exhibit higher tolerance to a biotic stresses (Hu et al., 2015). The cultivars grown vary with altitude. For instance, at lower elevations below 1,200 meters above sea level (masl) plantains are mainly cultivated (Dheda et al., 2011; Ocimati et al., 2013).

Fruit crops are widely grown in Ethiopia from low to highland agro ecologies. The dessert banana is the major fruit crop grown in different parts of the country and leading both in area and production among the fruit crops. About 104,421.81 hectares of land is under fruit crops in Ethiopia; Bananas contributed about 56.79% of the fruit crop area. More than 7,774,306.92 quintals of fruits was produced in the country; Bananas, took up 63.49% of the fruit production (CSA, 2018). Like other agricultural commodities banana and plantain production faces several biotic and abiotic constraints and poor provision of production technologies. In resource poor production system, productive varieties that are resistant to pests, diseases and drought are highly suitable for increasing productivity.

In Ethiopia, Ethiopian Institute of Agricultural Research (EIAR) introduced some banana germplasm and the collection of local cooking banana clones. These materials were evaluated by different Agricultural Research Centers. Among these, four cooking type banana varieties were released in 2006 by Melkassa Agricultural Research Centre based on their better agronomic performance as well as increased disease resistance.

Varieties often interact with the environment in an unpredictable manner and as a result evaluating varieties that are tested across locations and/or years to study their adaptation and stability of performance before recommendation is crucial. Therefore, breeding programs should focus on evaluating and selecting varieties that are high yielding, disease resistant, a biotic stress resistant and altered agronomic performance for target areas. In this study, four plantain varieties were evaluated at Mechara Agricultural Research Center on station for four consecutive cropping season. Therefore, this experiment was conducted with the **objective** to evaluate high yielding, disease resistant/tolerant plantain varieties to the area.

Materials and methods

Description of the study sites

The experiment was conducted in Mechara Agricultural Research Center on station during the main cropping season, in 2016 to 2019. Mechara Agricultural Research Center is situated in the Eastern part of the country at about 434 km away from Addis Ababa, the capital city of Ethiopia and it is located in Eastern part of country lying between 8.34 N latitude and 40.20' E longitude. 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. The area receives mean annual rainfall of about 1100mm. The major soil of the area is well-drained slightly acidic Nitosol (McARC, 2010).

Experimental Treatments and Design

Four plantain varieties of suckers; Matoke, Nijiru, Cardaba and Kitawira were collected from Melkasa Agricultural Research Center and used as experimental materials. The trail was laid out in Completely Randomized Block Design (RCBD) with three replications. Six plantain suckers were planted in a single plot with the spacing between plots 3.5m and between row and plant 2.5 m was used for the trail. Agronomic practice was applied uniformly for all treatments.

The plants were spaced at 2.5m x 2.5m (Seifu, 1999), providing a population of 1600 plants ha^{-1} in the first year, and three different aged plants (parent, first ratoon and second ratoon) per mat in the remaining three years. Weeds were controlled by hand hoeing. All management practices were given for all experimental plots. Nutrition of 150 g urea and 70 g Diammonium phosphates (DAP) were given to each plant in the orchard. From this experimental orchard, bunches were examined about 3 months before harvest in order to make propping as per the requirement of the plant.

Data Collection

The traits evaluated included bunch weight, number of hands per bunch, number of fingers per hand, fruit length, fruit diameter, fruit weight, and marketable and total fruit yields. Bunch and finger weights were measured using balances. Fruit length was measured using a measuring tape while fruit diameter was measured at the middle of each fruit, perpendicular to its large axis, with a digital caliper (Orjeda, 1998; Aquino et al., 2017). Marketable and total fruit yields were estimated from plot yields and expressed as t ha^{-1} per year.

Data Analyses

Analysis of variance was conducted using Genstat statistical software package (16^{th} edition). The mean separation for any significant effect of the varieties was done with least significant difference test (LSD) at 5% and Correlation Coefficients among the traits were carried out using procedure of SAS software Version 9.0.

Results and discussion

Mean performance of plantain varieties

The results of analysis of variance (ANOVA) showed the presence of significant difference among the varieties for all traits in the first and second harvesting cycle except Unmarketable yield (Table 1 and 2). All the parameters were significantly increased with the harvesting cycle/crop cycle of plantain varieties. This result is in agreement with Tenkouano and Baiyeri (2007) reported that both genotypes and cropping cycle significantly influence the yield and other growth trait of the banana cultivars. The result of combined mean data analysis showed significance difference among the varieties for most of the traits except fruit diameter (cm), number of fruit per bunch and unmarketable yield in ton ha^{-1}(Table 3).

Average bunch weight

Varieties showed significant difference on Average bunch weight. The highest bunch weight was shown on Nijiru (6.1kg) followed by kardaba (4.78kg) variety, while the lowest bunch weight had recorded for Kitawira (3.8kg) variety.

Number of finger per hand and number of finger per bunch

The results of analysis of variances showed that the presence significant difference among varieties for number finger per bunch while non-significant difference for number of finger per hand. This may due to. Varietal difference causes significant difference in number of finger per bunch. The Nijiru variety produced more number of finger per hand (54.2) and number of finger per bunch (8.4) and was statistically superior to the other varieties. Nevertheless, Cardaba variety produced the less number of finger per hand (39.5) and finger per bunch (6.2). However, Beleyneh et al., (2014) stated that Cardaba contained 88 % more edible portions per unit fresh weight than the peel. The highest number of finger per hand in Nijiru variety was most likely due to the fruit bearing capacity of the variety and more fruit per bunch nature which leads to contain high number of finger per hand. These results in agreement with the reports by other workers indicate average number of fingers per bunch ranges from 27 to 80 (Tekle et al., 2014).

Marketable yield and Total yield (ton ha^{-1})

There was significant difference ($P \leq 0.05$) among plantain varieties for marketable yield and total yield. Nijiru variety had the highest mean values for marketable yield(25.6 ton ha^{-1}) and total yield (27.9 ton ha^{-1}) followed by Cardaba variety; 20.3 ton ha^{-1} for marketable yield and 22.7 ton ha^{-1} for total yield. The lowest mean value of marketable yield **(**16.4 ton ha^{-1}) and total yield **(**18.2 ton ha^{-1}) was shown on Matoke variety.

Table 1. Mean yield and yield components of plantain varieties at Mechara on station, 1st harvesting cycles in 2017/18 cropping season.

Varieties	FD	ABW	NFH	NHB	MY	UMY	TTY
Nijiru	3.4[ab]	5.7[a]	53[a]	5.67[a]	19.37a	0.66	20.02[a]
Cardaba	3.2[b]	4.5[ab]	47[b]	3.67[b]	13.79[c]	0.48	14.26[c]
Matoke	3.23[b]	3.4[b]	34.33[c]	4[b]	12.59[c]	0.38	12.97[c]
Kitawira	3.63[a]	3.2[b]	50.67[a]	4[b]	16.49b	0.8	17.29[b]
Mean	3.4	4.1	47	4.3	15.56	0.58	16.14
LSD	0.25	1.4	3.35	0.67	1.54	ns	1.43
CV%	3.7	16.8	3.6	7.7	15	50.4	4.4

Note: TTY=Total Yield (ton ha^{-1}), MY=marketable yield (ton ha^{-1}), UM=unmarketable yield (ton ha^{-1}), FD=fruit diameter (cm), ABW=average bunch weight (kg), NFH=Number fruit per bunches, NHB=Number of hands per bunches.

Table 2. Mean yield and yield components of plantain varieties at Mechara on station, 2nd harvesting cycles in 2018/19 cropping season.

Varieties	FD	ABW	NFH	NFB	UMY	MY	TTY	DR
Nijiru	3.7ab	6.5a	55a	5a	3.8	32.4a	36.2a	1c
Cardaba	4.2a	5.1bc	31.7c	4b	4.2	27.1ab	31.3ab	5a
Matoke	3.2b	4.34c	47ab	4.3ab	3.3	20.3b	23.6b	1c
Kitawira	4ab	5.83	35bc	3.67b	2.4	20.1b	22.5b	2b
Mean	3.8	5.4	42.7	4.25	3.4	26	29.5	2
LSD	0.8	1.4	14.5	0.9	1.9ns	11.3	10.8	0.6
CV%	10.3	16.8	17.4	11.1	28.3	21.6	18.4	15.1

Note: TTY=Total Yield (ton ha^{-1}), MY=marketable yield (ton ha^{-1}), UM=unmarketable yield (ton ha^{-1}), FD=fruit diameter (cm), ABW=average bunch weight (kg), NFH=Number fruit per bunches, NHB=Number of hands per bunches

Table 3. Mean yield and yield components of plantain varieties over two harvesting cycles at Mechara ARC 2017-2019 cropping season.

Varieties	FD	ABW	NFH	NFB	MY	UMY	TTY	DR
Nijiru	3.5	6.1a	54.2	8.4a	25.6a	2.3	27.9a	1c
Cardaba	3.8	4.78ab	39.5	6.2b	20.3ab	2.4	22.7ab	5a
Kitawira	3.7	3.8b	42.7	7ab	18ab	1.6	19.6b	2b
Matoke	3.4	4.5b	40.8	7.8ab	16.4b	1.8	18.2b	1c
Mean	3.56	4.8	45.8	7.4	20	2	22	2.3
LSD	0.5ns	1.49	26.9ns	1.9	7.8	0.9ns	7.7	0.6
CV%	10.6	28.5	38.7	21.8	32	37.3	28.9	24.3

TTY=Total Yield (ton ha^{-1}),MY=marketable yield(ton ha^{-1}), UM=unmarketable yield (ton ha^{-1}), FD=fruit diameter (cm), BW=bunch weight(kg), NFH=Number fruit per bunches, NHB= Number of hands per bunches.

Table 4. Phenotypic (above diagonal) and genotypic (below diagonal) correlation coefficients among different characters of Plantain varieties.

Traits	ABW (kg)	NFB	NFH	FD (cm)	MY (ton ha^{-1})	UY (ton ha^{-1})	TY (ton ha^{-1})
ABW	1	0.750*	0.295*	-0.007ns	0.998*	0.659ns	0.995*
NFB	0.064*	1	0.853*	-0.614*	0.782*	0.244*	0.754**
NFH	-0.075*	-0.3224*	1	-0.875*	0.354*	-0.178*	0.306*
FD	-0.185*	-0.266*	0.465*	1	-0.009*	0.089*	0.020*
MY	0.3134*	-0.381*	0.638*	0.379*	1	0.536ns	0.998*
UY	-0.123*	-0.561ns	0.709*	0.537ns	0.612ns	1	0.588ns
TY	0.263*	-0.432*	0.708*	0.4398*	0.992**	0.705ns	1

TTY= Total Yield **(ton ha^{-1})** MY= marketable yield **(ton ha^{-1})**, UM= unmarketable yield **(ton ha^{-1})** FD= fruit diameter (cm), BW= bunch weight (kg), NFB=Number fruit per bunches, NHB= Number of hands per bunches

The significant variation in marketable yield and total yield among the plantain varieties could be due to their difference in genetic characteristics and adaptability to the environmental condition of the study area. This result was supported by the findings of Tekle et al., (2014) who reports average banana yield range from 45.333 ton ha^{-1} to 18.533 ton ha^{-1}.

There was no disease reaction on Nijiru variety which was resistance to panama and sigatoka banana disease, whereas Cardaba variety was susceptible to these diseases. Generally, Nijiru variety had significantly the highest average bunch weight, number of fruit per bunch, number of fruit per hand, marketable yield, and total yield than the other varieties. This result was in agreement with Betewulegn and Yetinayet, (2014) reported that Nigiru fruits were the largest in size than other plantain banana types, Kitawira. While the lowest total yield was recorded from Matoke variety.

Correlation analysis

Phenotypic and genotypic correlation analysis showed that most of the traits have significant correlation with total yield and among themselves except unmarketable yield (Table 4). Average bunch weight, Fruit diameter, number of finger per hand and marketable yield were showed positive and significant correlation both at phenotypic and genotypic level.

These results in agreement with finding of Baiyeri et al., (2000) found that most of fruit characters were related to the yield but with varied magnitude and the correlation was affected by the genomic group and environment; these effects might explain the consistent and significant low magnitude correlation of plant height with other growth characters and yield. Average bunch weight, Fruit diameter, number of finger per hand and marketable yield had significant correlation among themselves. Average bunch weight showed significant and positive correlation with number of fingers per bunch both at genotypic and phenotypic correlation (Table 4). This result was disagree with other correlation studies on various banana cultivars were reported by Asmare et al., 2021; Shaibu et al., (2012), Kumar et al., (2014) and Tak et al., (2015).

Recommendation

The results of analysis of variance showed all the yield and yield related parameters were significantly affected by varieties except fruit diameter, number of fruit per hand and unmarketable yield. Nijiru Variety was superior over all varieties for average bunch weight (6.1kg), number of finger per bunch (54.2), marketable yield (25.6) and total yield (27.9 ton ha^{-1}). Moreover, Nijiru variety gave high yield over other varieties in both harvesting cycle, indicating that the Nijiru variety is stable and can sustain reasonable amount of yield regularly. Therefore, it can be concluded that Nijiru variety is recommended for further demonstration in Daro Lebu and similar agro- ecologies.

Conflict of interest statement

The authors declare that there is no conflict of interest regarding the publication of this article.

Acknowledgements

The authors gratefully thank to Oromia Agricultural Research Institute for financial support and Mechara Agricultural Research Center for facilitating the working conditions throughout the research Period.

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How to cite this article:
Assefa, G., Girma, S., Deressa, D., 2022. Evaluation of improved plantain type of banana (*Musa* spp.) varieties at Mechara on Station, Eastern Ethiopia. Int. J. Curr. Res. Biosci. Plant Biol., 9(5): 41-46.
doi: https://doi.org/10.20546/ijcrbp.2022.905.004