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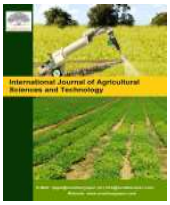

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Adaptation of Desert Banana (*Musa spp.*) Varieties in the Low Land of East Hararghe Zone, Oromia, Ethiopia

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Abstract

Banana (*Musa* sp.) is one of the most important tropical fruits. It is the fourth most important global food commodity, as well as a notable rise in production and productivity in Ethiopia. However, the primary production constraint in the study area is the lack of improved and adapted varieties of this crop. The objective of the study was to identify adaptable, high-yielding, and disease-tolerant desert banana varieties for the study area and similar agro ecology. Two years of field trial was carried out on farmers' fields in Erer during the 2021 and 2022 cropping seasons. Six desert banana varieties along with a local control were used in the trial, which was set up in a randomized complete block design with three replications. The result of the study showed significant differences among varieties for all the recorded traits except girth pseudo-stem, hand per bunch, and fruit per bunch. Among the varieties, William-I provided about 75.14% yield advantages over the local check. As a result, the William-I variety was recommended for further demonstration and popularization in test locations and areas with similar agro-ecologies.

Keywords: *Adaptation, Desert Banana, Varieties*

1. Introduction

Banana (*Musa sp.*) is one of the most important tropical fruits and evolved in the humid tropical regions of South East Asia with India as one of its centers of origin. It ranks as the fourth most important global food commodity after rice, wheat, and maize in terms of gross value of production (Scott, 2021). About 70 million people are estimated to depend on banana fruit for a large proportion of their daily carbohydrate intake (Oyeyinka and Afolayan, 2020). Banana is a source of potassium, magnesium, copper, manganese, and vitamin C, but is low in iron and vitamin A (Wall, 2006). Dessert bananas, usually eaten fresh when ripe, and cooking bananas, which are starchier when ripe and are boiled, fried or roasted, constitute 43 and 57% of the world production respectively (Jones, 2000). Cavendish bananas, which are dessert bananas constitute the most commercially important component of world banana production, accounting for 47% of global banana production (Arias *et al*., 2003).

The major staple food in developing countries. The fact that it produces fruit throughout the year adds to its importance as a food security crop in Africa. It is a primary food and cash crop for over 30 million people in East Africa (Rosegrant *et al*., 2005). Banana is now a major food crop in Africa estimated to meet more than a quarter of the food energy requirements in the continent (Robinson, 1996). It is a staple food and a good source of income for a number of African countries, especially East and Central Africa (Viljoen, 2010).

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In Ethiopia, the dessert banana is the most consumed and produced horticulture crop (Alemu, 2017). Banana is the fruit crop with the highest area coverage (67,387 ha) and production (539,443 t) (FAOSTAT, 2019). Banana has a significant socioeconomic impact on food security and income generation in rural communities across the country (Natnael, 2016). Kinde (2021) states that the highest level of banana production is found in the former Southern Nations, Nationalities, and Peoples Region, followed by Oromia, Amhara, and Benishangul-Gumuz in Ethiopia. Despite its importance, the national average banana production is estimated at 8.0 t ha-1, significantly lower than the global average (22.6 t ha^{-1}) (FAOSTAT, 2019). There are several factors that limit banana production and productivity. Lack of improved varieties is a critical problem for banana production in Ethiopia.

Even existing improved banana varieties were limited to the specific agro-ecology of the country. In addition, there is not sufficient scientific documentation about banana production, including improved technologies, in eastern Ethiopia, particularly in Hararghe areas. This crop/banana received less attention from research institutes as compared to other crops due to the long-term research procedure and the necessity for large resources. Therefore, in Ethiopia, numerous research institutes have developed and introduced banana cultivars, and a few of them are promised and under production at various sites. Therefore, evaluating and selecting enhanced varieties that are highly productive, disease resistant, and adaptable is a quick and inexpensive breeding technique. This study was done with the objective of identifying high yielding, adaptable, and disease tolerant banana varieties for the study area and similar agro ecologies.

2. Materials and Methods

2.1. Description of Experimental Site

The experiment was conducted in Erer Valley on farmers' land. Erer is located 17 km away from Harar town in the eastern direction. The altitude of the study area was 1350 meters above sea level. The district receives a mean annual rainfall of 600–900 mm, which is bimodal and erratic in distribution. The small rainy season starts in February/March and extends to mid-May, while the main rainy season stretches between July and August. The mean annual minimum and maximum temperatures are 13.8 and 24.4°C, respectively (Kibebew, 2014).

3. Experimental Materials

3.1. Treatments and Experimental Design

The treatments consisted of six desert banana varieties and were evaluated with local checks (Table 1). The trial was carried out in a randomized complete block design (RCBD) with three replications in a gross plot size of 4.5 m^2 (1.5 m and 3 m) with a spacing of 2 m between replications and 2 m between plots. All treatments were assigned randomly to the experimental plots. The experimental field was prepared following the conventional tillage practice of using a tractor plow. Suckers of medium size were planted by hand in rows 1.5 m apart, with 1.5 m between plants in the rows. All agronomic practice was done as a recommendation.

Table 1: Description of Six Desert Banana Varieties and One Local Check Selected for the Trial

No.	Varieties	Year of released	Breeder/Maintainer
1.	Dwarf Cavendish	2006	Melkasa Agricultural Research Center/EIAR
2.	Giant Cavendish	2006	Melkasa Agricultural Research Center/EIAR
3.	Butuzua	2006	Melkasa Agricultural Research Center/EIAR
4.	William-I	2006	Melkasa Agricultural Research Center/EIAR
5.	Poyo	2006	Melkasa Agricultural Research Center/EIAR
6.	Grand Nain	2006	Melkasa Agricultural Research Center/EIAR
7.	Local	-	Farmers of study area

Source: Ministry of Agriculture, Crop Variety Register, 2020

4. Data Collection and Analysis

All agronomic data, like plant height, girth of pseudo stem, hand per bunch, finger per bunch, fruit per hand, bunch weight, hand weight, fruit weight, fruit diameter, fruit length, and fruit yield, were recorded. Analysis of variance was carried out using GenStat 18th edition software for the parameters studied following the standard procedures (Gomez and Gomez, 1984). Means that showed significant differences were compared using Least Significant Difference (LSD) test at a 5% significant level.

5. Results and Discussion

The result mean squares from analysis variance showed that there is highly significant ($p < 0.01$) variation due to varieties for plant height, bunch weight, average finger weight, average fruit length, average fruit diameter and fruit yield and significant ($p < 0.05$) variation for hand weight and fruit per hand while there is no significance difference for girth pseudo stem, hand per bunch and fruit per bunch (Table 2).

Table 2: Mean Squares from Analysis Variance of Improved Banana Varieties at Erer

Traits	Rep (2)	Varieties (6)	Residual (12)	CV (%)
Plant height (cm)	252.3	3682.7**	216.4	7
Girth Pseudo stem (cm)	7.5	8.05ns	32.63	10.7
Bunch weight (kg)	17.808	24.439**	2.885	16.1
Hand per bunch	1.376	0.39ns	1.248	17.7
Hand weight (kg)	0.768	0.204*	0.079	18.9
Fruit per bunch	659.5	275.9ns	345.4	23.4
Fruit per hand	0.542	2.203*	1.149	8.3
Average fruit weight (g)	57.19	1605.799**	9.283	2.5
Average fruit length (cm)	1.5755	13.441**	0.432	4.3
Average fruit diameter (cm)	2.2394	16.103**	0.881	2.5
Fruit yield (t/ha)	197.86	271.54**	32.06	16.1

Note: Significant at $p < 0.05$, ** highly significant $p < 0.01$, Numbers in parentheses indicates degrees of freedom. Rep = replication, CV (%) = coefficient of variation in percent.

5.1. Plant Height

The result of the ANOVA revealed that the plant height was found highly significant ($p < 0.01$) (Table 2). The tallest plant height was recorded from local check (249.2 cm) whereas the shortest was from Dwarf Cavendish variety (143.6 cm) (Table 3). The current finding is in agreement with Kinde (2021) reported Dwarf Cavendish has short plant height. Similarly, Tesfa and Mekias (2015) reported significant difference of plant height among banana varieties.

Table 3: Mean of Phonological Parameters of Desert Banana Varieties at Erer

Varieties	Plant Height (cm)	Girth of Pseudo Stem (cm)
Dwarf Cavendish	143.6d	54.83
Giant Cavendish	228.7ab	53.37
Butuzua	235.9ab	55.7
William-I	196.3c	50.8

Table 3 (Cont.)

Varieties	Plant Height (cm)	Girth of Pseudo Stem (cm)
Poyo	215bc	53.51
Grand Nain	195.9c	52.56
Local	249.2a	54.69
LSD (5%)	26.17	NS
CV (%)	7	10.7

Note: NS = Not significant, CV = Coefficient of Variation, LSD = Least Significant Difference; Means followed by different letters within columns are significantly different by Duncan's new multiple range test (p = 0.05).

5.2. Fruit per Hand

The ANOVA result showed significantly ($p < 0.05$) difference among banana varieties for Fruit per hand. The highest fruit per hand recorded from William-I (14.3) and the lowest was from Giant Cavendish (11) (Table 2). The result is in line with Kinde (2021) who reported significance variation for fruit per hand among banana cultivars. The current finding is in contrast with Asmare *et al*. (2021) who report non-significant variation of finger per hand among banana cultivars.

5.3. Bunch Weight

Bunch weight significantly ($p < 0.01$) varied among banana cultivars (Table 2). The highest bunch weight was recorded from William-I (15.47 kg) while the lowest bunch weight was recorded from Poyo variety (7.43 kg) (Table 4). The current finding is in agreement with the previous findings (Asmare *et al.*, 2021; Kinde 2021) who reported significance variation for bunch weight among banana cultivars.

Table 4: Mean of Yield and Yield Component Parameters of Desert Banana Varieties at Erer

Varieties	HPB	FPB	FPH	BW(kg)	HW(kg)	FW(g)	FD(cm)	FL(cm)	FY(t/ha)
Dwarf Cavendish	6.47	85.11	13.91^{a}	12^{b}	1.478^{ab}	116.9^{e}	36.16^{d}	15.28^{b}	40^{b}
Giant Cavendish	5.96	69.44	11.8^{b}	9.33^{bc}	1.533^{a}	123.8^{d}	38.14^{bc}	16.28^{b}	31.11^{bc}
Butuzua	6.13	79.11	12.82^{ab}	8.33^{c}	1.433^{ab}	130.7^{bc}	37^{cd}	15.61^{b}	27.78^{c}
William-I	7	97.33	14.03^{a}	15.47^{a}	1.763^{a}	146.9^{a}	40.21^{a}	18.11^{a}	51.56^{a}
Poyo	6.36	70.11	12.17^{ab}	7.43^{c}	1.533^{a}	133.8^{b}	38.3^{bc}	16.28^{b}	24.78^{c}
Grand Nain	5.99	76.17	13.42^{ab}	12.43^{b}	1.733^{a}	126.9^{cd}	39.1^{ab}	15.28^{b}	41.44^{b}
Local	6.17	78.11	12.55^{ab}	8.83^{c}	0.973^{b}	73.8^{f}	33.11^{e}	11.17^{c}	29.44^{c}
LSD (5%)	NS	NS	1.907	3.022	0.5015	5.42	1.67	1.169	10.07
CV (%)	17.7	23.4	8.3	16.1	18.9	2.5	2.5	4.3	16.1

Note: NS = Not significant, CV = Coefficient of Variation, LSD = Least Significant Difference; Means followed by different letters within columns are significantly different by Duncan's new multiple range test ($p = 0.05$). HPB = hand per bunch, FPB = Fruit per bunch, FPH = Fruit per hand, BW = Bunch weight, HW = Hand weight, FW = Fruit weight, FD = Fruit diameter, FL = Fruit length, FY = Fruit yield.

5.4. Hand Weight

The Analysis of variance result showed that significantly ($p < 0.01$) variation for hand weight among banana varieties. The highest hand weight was recorded from William-I variety (1.763 kg) while the lowest hand weight from Local check (0.973 kg)

5.5. Average Fruit Weight (g)

The current result showed that fruit weight was significantly ($p < 0.01$) different among banana varieties for fruit weight (Table 2). The highest fruit weight was recorded from William-I variety (146.9 g) while the lowest fruit weight from local check (73.8g) (Table 4). The current result is in agreement with several authors (Tilahun *et al.*, 2021; Kinde, 2021; Asmare *et al.,* 2021).

5.6. Average Fruit Length (cm)

The current result showed significant ($p < 0.01$) difference for fruit length among banana varieties. The highest fruit length was recorded from William-I variety (18.11 cm) while the lowest fruit length from local check (11.17 cm) (Table 4). This result is in line with Tilahun *et al.* (2021) who reported significant variation for fruit diameter among tasted banana varieties. The result is in contrast with the finding of Kinde (2021) reported non-significant variation among banana varieties on fruit length.

5.7. Average Fruit Diameter (mm)

Significantly, the highest fruit diameter was recorded from William-I (40.21 cm) followed by Grand Nain (39.1cm) while the lowest fruit diameter was recorded from local check (33.11 cm) (Table 4). This result is in line with Tesfa and Mekias (2015) who reported significant variation for fruit diameter among tasted banana varieties. This result is in contrast with the finding of Kinde (2021) reported non-significant variation among banana varieties on fruit diameter.

5.8. Fruit yield

The current result showed that there is a significant variation among the varieties in Fruit yield (Table 2). The highest Fruit yield was recorded from William-I variety (51.56 t/ha) while the lowest fruit yield from Butuzua variety (27.78 t/ha). The current result showed the fruit yield increment by 75.14% via use of William–I variety over local check. The present findings are consistent with previous results Asmare *et al*. (2021) who reported the lowest marketable yield was recorded from 'Chinese Dwarf' while the highest was obtained from 'Williams-I'. This results near with Kinde (2021) reported the highest yield from Giant Cavendish, which is statistically at par with Robusta and Williams-I.

6. Conclusion and Recommendation

The study's findings revealed significant variations among varieties in all metrics except girth pseudo stem, hand per bunch, and fruit per bunch. The maximum grain yield was obtained from the William-I variety, with a 75.14% yield advantage over the local check. As a result, William-I variety was recommended for further demonstration and popularization in test locations and areas with similar agro-ecologies.

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