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Full Length Research Paper

Participatory Evaluation of Banana (*Musa paradisiaca L var. sapiertum*) Production Constraints and Scaling up of Improved Banana Cultivars in Gedeo Zone Southern Ethiopia

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Abstract
On station field experiment containing seven improved banana (Musa paradisiacal var. sapiertum) varieties and one local variety as a check was carried out at Gedeo Zone during the 2013 to 2015 cropping seasons under rain fed conditions to identify the best performing variety to the target areas of Gedeo Zone. Banana varieties included in the field experiment were seven improved (Poyo, Dwarf Cavendish, Giant Cavendish, Butuzua, Grand Naine, Williams-1, Williams-2) and a local check. The experimental design was a randomized complete block design (RCBD) with three replications. Phenological and growth parameters, bunch yield and yield components were studied. The result showed that days to flowering were significantly affected by variety while days to maturity were not significantly influenced by variety. Psedostem height was significantly affected by variety; whereas, variety had brought no significant effect on psedostem circumference. All the yield and yield components studied were significantly affected by variety except finger diameter. Bunch yield advantages of 56.34%, 53.49% and 44.69%, were obtained from the improved banana varieties Dwarf Cavandish, Giant Cavandish and Poyo, respectively over the local check. The highest bunch yields of (43.211 t ha-1) and (40.212 t ha-1) were recorded for the varieties Dwarf Cavendish and Giant Cavendish, respectively. Therefore, it can be concluded that use of the improved banana varieties such as Dwarf Cavendish or Giant Cavendish is advisable and could be appropriate for banana production in the test area even though further research testing is required to put the recommendation on a strong basis.

Keywords: *Banana Variety, Bunch Yield, Growth Parameters, Phenological Parameters, Yield Components*

Introduction

Banana (*Musa* spp.) is amongst the most important food crops in the world and evolved in the humid tropical regions of South East Asia with India as one of its centers of origin. Banana represents the world's second largest fruit crop with an annual production of 129,906,098 metric tons (FAOATAT 2010). It ranks as the fourth most important global food commodity after rice, wheat and maize in terms of gross value of production (INIBAP 1992). About 70 million people are estimated to depend on banana fruit for a large proportion of their daily carbohydrate intake (Swennen R, Wilson GF 1983). Banana is 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. 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, J.C., 1996). It is a staple food and good source of income for a number of African countries especially East and Central Africa (Viljoen, A. 2010).

Banana is a source of potassium, magnesium, copper, manganese and vitamin C, but is low in iron and vitamin A (Wall, M.M. 2006). Uganda is Africa's largest producer while Rwanda and Burundi are the second and third largest producers in East Africa, respectively (FAOSTAT, 2009). Banana has been cultivated for several years in Ethiopia as a garden plant. In Ethiopia, the major banana producing regions are Southern, Oromia and the Amhara regions (MoA 2011). During the 2010/2011 production season about 31, 885.86 hectares of land has been covered with banana and the estimated annual production was about 270571.516 tones (CSA 2011). The actual yields are less than 40 t ha-1year-1at farmers level (Wairegi, L.W.I., Van Asten P.J.A., 2010); whereas, the potential yield of banana is greater than 70 t ha-1 year-1 at research level (Van Asten P.J.A., *etal* 2005). The poor productivity of banana has been attributed to a number of biophysical factors such as lack of improved varieties pest, disease and poor extension (Gold, C.S., *etal 1999*). Banana is the most important crop 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. It is the most important cash crop in some parts of Southern Ethiopia, especially in Arbaminch Gamo Gofa Zone. But, banana production is also familiar in Gedeo Zone of Southern Ethiopia. Though, the crop is important in the target area, a number of factors constrained productivity of the crop. Lack of improved varieties has been appreciated as one of the primary sources of lower banana production in Gedeo zone. There had no trend

of using improved of banana varieties in the existing production system, so that it was the number one problem in the study areas. Hence; there is need to introduce improved banana varieties to the study area is crucial for banana production and productivity. Therefore, this study is aimed at and initiated with the objective of selecting the best performing banana varieties to the target area.

Materials and Methods

Description of the Study Area

The study was conducted in the Southern Nations Nationality and People's Region (SNNPR); at Gedio Zone. Dilla is located at 5.84 - 6.43 latitudes and 38.08 - 38.44 longitudes. The altitude of the experimental sites is about 1470 masl. The area is characterized by Wet/Moist Kolla is highly recognized by its agro-forestry cropping system (CSA, 2005).

Treatments and Experimental Design

The experiment was conducted by using seven improved banana varieties and one local check. The field experiment was laid out in a randomized complete block design (RCBD) with three replications. Four banana plants were used in a single plot basis by using square planting method to make a unit plot area in spacing of 2.0 m between rows and 2.0 m between plants within a row making a gross plot area of 20 m^2.

Data Collection

Phenological Parameters and Growth Parameters

Phenological parameters such as days to flowering and days to maturity were recorded. Days to flowering was recorded by counting the number of days after establishment when 50% of the plants per plot had the first open flower. Days to maturity were recorded when 90% of flowers perplot was matured. At mid flowering stages crop growth parameters such as psedostem height and Psedostem Circumference were measured.

Bunch Yield and Yield Components

The matured bunch of the crop was harvested for determination of bunch yield. Number of hands per bunch, number of fingers per hand, bunch weight, finger weight per hand and finger diameter was measured. All the phenological, growth, yield and yield components were recorded at every harvest of the growing period. All the data recorded throughout the growing periods were averaged over every harvest in the growing seasons for data analysis and computation. The weight of a bunch is determined by the total number of hands per bunch and fingers produced per hand, therefore, the weight of bunch is a function of the total number of hands and fingers obtained from the entire bunch. During data collection local farmers are participating on harvesting measuring evaluating and screening of the varieties based on the trend on the target area banana farming system. More over field visit were arranged by participating key informants, local farmers, woreda administrative leaders, agronomist/expertise and extension workers to observe the visible difference between improved varities and the local check.

Statistical Analysis

Analysis of variance was performed using the GLM procedure of SAS Statistical Software Version 9.1 (SAS 2007). Effects were considered significant in all statistical calculations if the P-values were < 0.05. Means were separated using Fisher's Least Significant Difference (LSD) test.

Results and Discussion

The analysis of variance results for mean squares revealed that days to flowering and days to maturity were significantly (P< 0.01) influenced by varieties The analysis of variance result for mean squares also depicted that psedostem height was significantly (P< 0.001) affected by varieties while; psedostem circumference was not significantly affected by varieties (Table 1).

The maximum number of days to flowering (237.91) was recorded for the improved banana variety Giant Cavendish the minimum number of days to flowering (139.36) was recorded for the Williams-1 (Table 2). The maximum days to maturity (580.98), (488.05) and (424.87) were recorded for the improved banana varieties local, Giant Cavendish and Williams-1, respectively and the minimum number of days to maturity (316.65) was noted for the Dwarf Cavendish (Table 2). The highest psedostem height of (3.711) and (2.543) was obtained from the local check and improved banana varieties Poyo respectively and the least psedostem height of (1.534) was recorded from the Dwarf cavandish (Table 2). The maximum psedostem circumference of (45.677) and (41.12) was recorded from the improved banana varieties Giant Cavendish and Poyo respectively and the minimum psedostem circumference (32.654) was noted from the local check. According to the above findings, the local check varieties had resulted in greater days to maturity and psedostem height than the rest improved varieties (Table 2).

The result of analysis of variance for mean squares depicted that bunch weight was significantly (P< 0.001) affected by varieties, finger weight was significantly affected (P< 0.01) by varieties (Table 3). This finding has confirmed the previous report by Shaibu et al., (2012). According to the result of analysis of variance for mean squares; number of hands per bunch was significantly (P< 0.05) affected by varieties, number of fingers per hand was significantly (P< 0.001) influenced by varieties whereas; varieties had not

brought a significant effect on finger diameter (Table 4). The maximum number of hands per bunch of (7.145) was recorded for the improved banana variety Dwarf cavandish and the minimum number of hands per bunch of (4.132) was recorded for the local check (Table 4).

Table 1. Mean square values of crop phenology and growth parameters of banana at Gedeo Zone, in 2013 to 2015

Source	DF	Days to flowering	Days to maturity	Psedostem Height	Psedostem circumference
Replication	2	425.201^{ns}	2980.078^{ns}	0.863^{ns}	2.045^{ns}
Variety(VAR)	7	2146.361**	15466.54**	1.512***	6.023^{ns}
Error	14	553.208	43.08.0804	0.654	10.125

*** and*** indicates significant at P<0.05,,P<0.01 and P<0.001 respectively and ns indicates non significant*

Table 2. Mean square values of crop phenology and growth parameters of banana at Gedeo Zone, in 2013 to 2015

Treatments	Days to flowering	Days to maturity	Psedostem Height	Psedostem circumference
Poyo	192.98^{b}	358.54^{cd}	2.543^{b}	41.12^{bc}
Dwarf Cavandish	232.27^{ab}	316.65^{d}	1.534^{e}	39.33^{cd}
Giant Cavandish	237.91^{a}	488.05^{ab}	1.992^{bcd}	45.677^{a}
Butuzua	193.23^{b}	404.78^{bcd}	1.923^{bcd}	36.33^{cd}
Grand Nain	211.98^{ab}	420.98^{bcd}	1.876^{bcde}	44.667^{ab}
Williams -1	217.69^{ab}	424.87^{bcd}	1.682^{de}	35.776^{cd}
Williams -2	139.36^{c}	368.86^{bcd}	1.693^{de}	36.774^{cd}
Local check	219.19^{ab}	580.98^{a}	3.711^{a}	32.654^{cd}
LSD (5%)	44.546	116.23	1.167	5.34
CV (%)	16.87	15.84	27.46	7.43

Note: Means with the same letters within the columns are not significantly different at P<0.05

The maximum number of fingers per hand of (81.120), (80.213) and (78.231) were recorded for the improved banana varieties Dwarf Cavendish, Giant Cavendish and Poyo, respectively and the minimum number of fingers per hand of (28.001) was noted for the local check (Table 4). The highest finger weights of (9.786 kghand-1), (9.231 kg hand-1) and (8.321 kg hand-1) were noted from the improved banana varieties Dwarf Cavendish, Giant Cavendish and Grand Nain respectively and the least finger weight of (3.152 kg hand-1) was recorded from the local check (Table 4). The maximum bunch yields of (43.211 t ha-1), (40.212 t ha-1) and (33.211 t ha-1) were recorded from the improved banana varieties Dwarf Cavendish, Giant Cavendish and Poyo, respectively and the minimum bunch yield of (17.324 t ha-1) was noted from the local check (Table 4). The bunch yield advantages of 57.01%, 53.81% and 45.87% were obtained from the improved banana varieties Dwarf Cavendish, Giant Cavendish and Poyo, respectively over the local check in this research. The bunch yield advantage obtained from the improved banana varieties is related with the increased number yield attributing parameters such as number of fingers per hand in improved banana varieties than the local check.

According to the above findings, the improved banana varieties had resulted in greater bunch yield than the local check. This finding has confirmed the previous reports that indicate the potential of improved banana varieties over the local check [15 and 16]. From the above findings it could be suggested that use of the improved banana varieties had brought a proportional yield increment than the local check.

During the study period on the study area insect pests and disease which are known to cause considerable loss were not observed in banana varieties. However, the fungus (Black Sigatoka) was observed on the varieties William-1 and William-2 which grows on the leaves producing dark spots and caused the fruits to ripen prematurely. In this experiment Banana Xanthomonas Wilt (BXW) incidence frequently observed in local check but it was not significant and Sevier. Almost all varieties of Musa species are prone to Banana Xanthomonas Wilt (BXW) which can destroy the fruits and devastating the crop (Biruma et al., 2007). It was first identified in Ethiopia in the 1970s, but spread rapidly to other parts of the Great Lakes region after reaching Uganda in 2001 (FAO, 2007). The major banana and insect pests are the burrowing nematode and the banana weevil. Nematode species attack the plant's roots, resulting in whole plant toppling or reduced yield. The banana weevil, *Cosmopolites sordidus*, attacks the plant's underground corm, weakening the plant and causing stem breakage but in this research insect or nematode attack was neither Sevier nor economically important.

Table 3. Mean Square Values for Yield and Yield Components of Banana at Gedeo Zone, in 2013 to 2015.

Source	DF	Bunch Yield (t ha-1)	Finger Weight (kg hand-1)	Number of Hands (bunch-1)	Number of Fingers (hand-1)	Finger Diameter (cm)
Replication	2	32.501^{ns}	5.011^{ns}	3.923^{ns}	270.194^{ns}	0.354^{ns}
Variety(VAR)	7	232.978***	15.209**	2.898*	645.876***	0.125^{ns}
Error	14	36.901	5.387	1.632	107.987	0.120

, ** and * indicates significant at P<0.05,,P<0.01 and P<0.001repectivlyand ns indicates non significant.*

Table 4. Yield and Yield Components of Banana as Affected By Variety at at Gedeo Zone, in 2013 to 2015

Treatments	Bunch Yield (t ha-1)	Finger Weight (kg hand-1)	Number of Hands (bunch-1)	Number of Fingers (hand-1)	Finger Diameter (cm)	Yield increment (%)
Poyo	33.211^{abc}	6.324^{abc}	4.615^{bc}	78.231^{a}	3.707	44.69
Dwarf Cavandish	43.211^{a}	9.786^{a}	7.145^{ab}	81.120^{a}	3.072	56.34
Giant Cavandish	40.212^{ab}	9.231^{ab}	5.132^{abc}	80.213^{a}	3.456	53.49
Butuzua	20.663^{efg}	6.784^{ab}	6.456^{ab}	47.001^{b}	3.178	26.94
Grand Nain	31.212^{bcde}	8.321^{ab}	5.999^{abc}	59.022^{b}	3.523	40.695
Williams -1	20.999^{fg}	7.987^{ab}	5.012^{bc}	46.222^{b}	3.134	27.37
Williams -2	20.002^{fg}	6.023^{abc}	5.012^{bc}	50.111^{b}	3.321	26.078
Local check	17.324^{g}	3.152^{d}	4.132^{c}	28.001c	3.312	
LSD (5%)	8.786	3.879	1.71	18.92	NS	
CV (%)	18.784	23.451	18.50	19.91	9.53	

Note: Means with the same letters within the columns are not significantly different at P<0.05

Conclusion and Summary

Using improved varieties of banana could make an important contribution to increase agricultural production and productivity in areas like Gedeo zone where there is low practice of using improved technologies such as improved crop varieties. To this end, use of improved banana technologies such as improved varieties could be one of the alternatives to improve productivity by small farmers.

However, the use of improved banana varieties is not yet studied in the area. Thus, this research work is initiated to investigate the impact of including improved banana varieties on the existing production system is of paramount important. Study on banana variety was conducted at Gedeo zone under rain fed conditions in 2013 to 2015. The objective of the study was to determine the best performing banana varieties that will improve banana production and productivity in the study area. The experiment was carried out using the randomized complete block design (RCBD) with three replications at Gedeo zone in 2013 to 2015. During the field implementation, seven improved banana varieties and one local check were used.

According to the results of analysis of variance, all the phenological and growth parameters were significantly affected by varieties except psedostem circumference. Days to flowering and days to maturity are also phonological determinants of yield including psedostem height at flowering which is almost the time for plant to use all the growth traits to produce their food especially during photosynthesis. All the yield and yield components studied in this experiment such as bunch yield, number of hands per bunch, number of fingers per hand and finger weight were significantly affected by varieties; whereas, variety had not brought a significant effect on finger diameter. The highest bunch yields of (43.211 t ha-1) and (40.212 t ha-1) were recorded for the banana varieties Dwarf Cavendish and Giant Cavendish, respectively. Therefore, it can be concluded that use of the improved banana varieties such as Dwarf Cavendish or Giant Cavendish is advisable and could be appropriate for banana production in the target area even though further research testing is required to put the recommendation on a strong basis.

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