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Yield Performance of Finger millet (*Eleusine coracana)* Varieties Across Different Locations of Jimma and Buno Bedele zones

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Abstract

To evaluate performance and identify high yielding and stable varieties for southwestern part of Ethiopia. Ten released finger millet varieties and one local check were tested at different locations of Jimma and Buno bedele zones. The experiment was laid out in randomized complete block design with four replication. Each finger millet genotypes was planted on plot ($8m^2$) consisting of 4 rows, each with 5m long the distance between rows was 20 cm. Spacing between plots was 1 m whereas that between replications was 1.5 m. The seed rate was 15 kg/ha. Growth parameters, phenologic and yield and yield related traits data was collected according to finger millet descriptor. All relevant field trial management practices were carried out throughout the experimentation period across all locations as per the recommendations. The results of analysis revealed that significant differences and non significant were observed among all parameters at 5% level of significance across different locations. The ultimate objective of plant breeding was to increase grain yield so as to ensure food security at the country level. Grain yield varied across locations. High grain yield was harvested from BD2018 and low from Limu kosa. Variety Gudetu showed similar performance across tested locations. Variety Gudetu was high yielding and stable across the locations, so that it was recommended for large scale production.

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Keywords

Crop Production, pregnant women, the sick, lactating mothers, children and diabetics.

Introduction

Climate change has significantly altered the biodiversity of crop pests and pathogens, posing a major challenge to sustainable crop production. At the same time, with the increasing global population, there is growing pressure on plant breeders to secure the projected food demand by improving the prevailing yield of major food crops. Finger millet (*Eleusine coracana*) is highly nutritious cereal food for the weak and people with low immunity (Takan *et al.,* 2012). It contains nutritional elements which are easy to digest thus a major source of food for pregnant women, the sick, lactating mothers, children and diabetics (Singh and Raghuvanshi, 2012). E. coracana is the most important small millet grown for subsistence in Eastern Africa and Asia. In East Africa, it is majorly used for food in form of thin porridge, malting and brewing (Mitaru *et al.,* 1993). In Ethiopia, finger millet is the sixth important crops after tef, wheat, maize, sorghum, and barley. It is produced on 456,057.31 ha of land, from which 103,082.3 tons are obtained at the national level per year (Central Statistical Agency, 2018)

The productivity of finger millet is low in Ethiopia due to different constraints, including shortage of improved varieties, non-adoption of improved technologies, diseases, and others (Solomon and Tegegn, 2020).

Finger millet was produced in Southwestern Ethiopia in very low amount. In Jimma Zone, Seka districts (Kishe) farmers produce local varieties at the marginal areas. In order to develop varieties in short period, conducting adaptation trial was important and time saving. National released finger millet varieties were tested at different locations before large scale production. The objective of the research was to evaluate performance and identify high yielding and stable variety for southwestern part Ethiopia and recommend identified varieties for large scale production.

Materials and Methods

Experimental materials

Ten finger millet varieties which were obtained from Melkassa and Bako (regional) Agricultural Research Center (Table 1) were evaluated with one local check at different locations and years of Jimma and Buno Bedele zones of southwestern Ethiopia (Table 2).

Experimental Design and Trial Management

The trial was conducted using randomized complete block design (RCBD) with four replications at all locations under rain-fed conditions. Each finger millet genotypes was planted on plot ($8m^2$) consisting of 4 rows, each with 5m long the distance between rows was 20 cm. Spacing between plots was 1 m whereas that between replications was 1.5 m. The seed rate was 15 kg/ha. All relevant field trial management practices were carried out throughout the experimentation period across all locations as per the recommendations.

Data Collection

The growth parameter, phenological, grain yield and yield related traits of the crop are recorded as according the finger millet descriptor (IBPGR, 1985).

Days to Flowering

This parameter was recorded as number of days from sowing to stage when ears emerged from 50% of the tillers per plot

Days to Physiological Maturity

It was recorded as number of days from sowing to stage when 50% of the tillers per plot had matured ears (detected by yellowing of leaves)

Plant Height

It was recorded by measuring the height of plants from ground level to the tip of inflorescence (ear), at dough stage

Number of Tillers per Plant

The number of tillers per plant was number of basal tillers that bear mature ears and recorded from five randomly taken plants of each plot at harvest

Number of Fingers per Ear

The number of fingers per ear was recorded from five randomly taken plants at harvest.

Finger Length

The finger length was recorded from the base of the ear to the tip of the finger at each five randomly taken plants of main tillers, at dough stage.

Biomass Yield

The biomass yield was recorded from weight of the aboveground parts (stem + leaves + seed) by sensitive balance at harvest after sun drying.

Grain Yield

Grain yield was determined by harvesting all plants from the five rows of each plot, since there was no space between plots to remove the border effect. Grains were weighed by sensitive balance and approximately adjusted to 10% moisture content by drying in the sun.

Table.1 Description of experimental materials used in the study

Common name	Variety name	Year of release
Boneya	(KNE#411)	2002
Bareda	(BRC-356-1)	2009
Tessema	ACC#229469	2014
Wama	(KNE#392)	2007
Padet	KNE #409	1999
Tadesse	(KNE #1098)	1999
Gudetu	(Acc.215990)	2014
Addis 01	Acc. 203544)	2015
Axum	NA	NA
Meba	NA	NA

NA=not available

Table.2 Description of experimental site

No.	Environments	Altitude (m.a.s.l.)	Rainfall (mm)	Temp (0C)
1.	Bedele	2087	1700	18
2.	Omonada	1975	1600	20
3.	Limu kosa	NA	NA	NA
4.	Gojeb (Kishe)	1370	1400	22
5.	Gooma	1,560	1764	19.7

NA=not available

Table.3 Mean plant height (cm) of finger millet varieties tested at each location.

No.	Finger millet Genotypes	Locations							Mean
		Gojeb	Omonada	Limu kosa	Gooma	Bedele 2017	Bedele 2018	Bedele 2019	
1.	Gudetu	83.03	94.1	66.5	78.9	98.0	97.3	94.0	**87.4**
2.	Bareda	98.10	103.9	69.05	92.9	93.0	103.5	98.8	**94.2**
3.	Addis 01	75.35	90.4	66.1	70.4	84.3	91.5	93.5	**81.7**
4.	Boneya	82.15	91.4	62.1	79.7	106.6	90.8	87.3	**85.7**
5.	Wama	82.83	87.9	66.85	77.8	98.2	105.8	103.8	**89.0**
6.	Tesema	89.25	101.6	61.45	89.3	90.9	113.8	102.8	**92.7**
7.	Padet	87.58	101.0	64.6	85.2	104.7	106.3	99.8	**92.7**
8.	Axum	73.90	94.7	64.15	73.9	86.3	90.8	82.8	**80.9**
9.	Tadesse	79.20	87.4	68.2	71.6	88.7	78.5	81.0	**79.2**
10.	Meba	72.65	88.9	56	72.7	94.6	98.3	94.0	**82.5**
11.	Local check	77.68	96.7	61.15	69.7	89.3	120.3	101.5	**88.0**
	Mean	**82.0**	**94.4**	**64.2**	**78.35**	**94.02**	**99.68**	**94.5**	**86.7**
	CV (%)	**10.2**	**7.5**	**7.3**	**8.54**	**8.17**	**11.22**	**10.6**	
	F test	**	*	*	***	**	***	*	

***, **,* Very highly significant, highly Significant difference at $p<0.001$, $p<0.01$ and $p<0.05$ respectively, ns=non significant and CV=coefficient of variation

Table.4 Mean Maturity date of finger millet varieties tested at each location.

No.	Finger millet Genotypes	Locations							Mean
		Gojeb	Omonada	Limu kosa	Gooma	Bedele 2017	Bedele 2018	Bedele 2019	
1.	Gudetu	132.75	144.0	142	148.5	134.5	198.5	145.3	149.4
2.	Bareda	134.75	153.0	139	148.0	141.3	200.8	146.5	151.9
3.	Addis 01	131.00	151.0	135.5	154.0	134.8	203.5	144.0	150.5
4.	Boneya	134.00	148.0	142.5	148.0	138.3	200.5	143.3	150.7
5.	Wama	132.50	140.0	144	154.0	132.5	197.0	146.5	149.5
6.	Tesema	133.00	140.8	143.5	149.0	133.3	201.3	140.0	148.7
7.	Padet	137.50	151.3	140.25	152.8	141.8	202.8	146.5	153.3
8.	Axum	134.50	144.8	138.75	151.0	138.0	201.3	147.5	150.8
9.	Tadesse	134.00	139.8	133.5	148.0	142.0	202.0	144.8	149.2
10.	Meba	134.50	145.3	137.75	152.8	138.3	204.3	147.0	151.4
11.	Local check	136.25	156.8	138.75	154.0	135.0	202.0	135.0	151.1
	Mean	**134.1**	**146.8**	**139.6**	**150.91**	**137.23**	**201.25**	**144.2**	**150.6**
	CV (%)	**1.8**	**4.6**	**3.1**	**1.02**	**2.07**	**0.96**	**3.6**	
	F test	*	*	*	***	***	***	*	

***, **,* Very highly significant, highly Significant difference at p<0.001,p<0.01 and p<0.05 respectively, ns=non significant and CV=coefficient of variation

Table.5 Mean fertile tillers of finger millet varieties tested at each location.

No.	Finger millet Genotypes	Locations							Mean
		Gojeb	Omonada	Limu kosa	Gooma	Bedele 2017	Bedele 2018	Bedele 2019	
1.	Gudetu	6.65	8.4	3.75	5.9	4.5	2.5	5.9	5.4
2.	Bareda	7.75	8.3	2.75	8.0	5.3	6.0	6.8	6.4
3.	Addis 01	6.18	8.6	3.25	5.7	4.1	5.0	6.3	5.6
4.	Boneya	7.13	7.0	3.5	6.8	3.7	4.0	6.5	5.5
5.	Wama	7.00	8.4	3.25	5.8	4.3	4.0	6.8	5.7
6.	Tesema	7.03	9.5	3.5	5.4	4.0	6.3	8.3	6.3
7.	Padet	6.68	7.9	3.75	6.4	5.0	4.0	6.0	5.7
8.	Axum	5.75	8.3	3.75	5.8	4.4	5.5	5.7	5.6
9.	Tadesse	6.60	7.9	2.5	6.6	3.8	4.3	7.0	5.5
10.	Meba	7.20	8.7	3	5.3	5.0	5.8	5.9	5.8
11.	Local check	6.23	7.9	3.5	5.7	4.1	4.8	6.8	5.6
	Mean	**6.7**	**8.3**	**3.3**	**6.13**	**4.36**	**4.73**	**6.5**	**5.7**
	CV (%)	**20.2**	**18.9**	**23.5**	**22.67**	**21.40**	**27.09**	**15.7**	
	F test	**ns**	**ns**	**ns**	**ns**	**ns**	**	**ns**	

***, **,* Very highly significant, highly Significant difference at p<0.001,p<0.01 and p<0.05 respectively, ns=non significant and CV=coefficient of variation

Table.6 Mean number of finger per ear of finger millet varieties tested at each location.

No.	Finger millet Genotypes	Locations Gojeb	Omonada	Limu kosa	Gooma	Bedele 2017	Bedele 2018	Bedele 2019	Mean
1.	Gudetu	4.75	5.9	3.75	4.8	7.5	8.6	5.8	5.9
2.	Bareda	4.93	7.5	2.75	4.9	6.3	7.4	5.2	5.6
3.	Addis 01	4.83	4.5	3.25	3.3	5.3	7.4	5.0	4.8
4.	Boneya	5.18	4.6	3.5	4.9	5.7	8.4	5.8	5.4
5.	Wama	4.15	5.3	3.25	3.9	6.4	8.5	5.5	5.3
6.	Tesema	4.50	5.5	3.5	4.5	6.6	8.4	6.1	5.6
7.	Padet	4.18	4.3	3.75	4.2	6.8	7.8	4.8	5.1
8.	Axum	5.75	5.6	3.75	5.3	6.0	7.6	5.5	5.6
9.	Tadesse	5.50	5.1	2.5	5.1	6.0	7.1	5.8	5.3
10.	Meba	4.33	4.9	3	3.3	5.4	8.2	5.0	4.9
11.	Local check	4.10	4.9	3.5	3.4	5.8	7.8	6.4	5.1
	Mean	**4.7**	**5.3**	**3.3**	**4.32**	**6.14**	**7.90**	**5.5**	**5.3**
	CV (%)	**21.7**	**15.7**	**23.5**	**22.88**	**16.01**	**15.68**	**14.1**	
	F test	**ns**	*****	**ns**	**	**ns**	**ns**	**ns**	

***, **,* Very highly significant, highly Significant difference at p<0.001,p<0.01 and p<0.05 respectively, ns=non significant and CV=coefficient of variation

Table.7 Mean finger length (cm) of finger millet varieties tested at each location

No.	Finger millet Genotypes	Locations Gojeb	Omonada	Limu kosa	Gooma	Bedele 2017	Bedele 2018	Bedele 2019	Mean
1.	Gudetu	6.33	5.2	7.4	5.8	8.6	5.8	6.2	**6.5**
2.	Bareda	8.68	6.2	6.9	8.7	7.4	5.0	8.5	**7.3**
3.	Addis 01	6.35	5.4	7	5.4	7.4	5.8	7.2	**6.4**
4.	Boneya	6.40	5.7	7	6.4	8.4	5.8	8.0	**6.8**
5.	Wama	6.73	6.0	6.85	6.7	8.5	8.9	9.2	**7.6**
6.	Tesema	8.30	8.2	7.35	8.6	8.4	10.8	11.3	**9.0**
7.	Padet	7.65	6.1	7.5	7.7	7.8	7.3	8.9	**7.6**
8.	Axum	6.98	5.9	6.9	6.5	7.6	6.0	7.0	**6.7**
9.	Tadesse	7.10	5.2	6.8	5.5	7.1	5.3	6.7	**6.2**
10.	Meba	7.25	5.3	6.75	6.3	8.2	8.3	7.5	**7.1**
11.	Local check	6.00	6.1	5.95	6.0	7.8	7.4	9.2	**6.9**
	Mean	**7.1**	**5.9**	**6.9**	**6.68**	**7.90**	**6.91**	**8.2**	**7.1**
	CV (%)	**15.3**	**15.9**	**15.1**	**12.52**	**15.68**	**25.94**	**10.2**	
	F test	**	***	**ns**	***	**ns**	***	*****	

***, **,* Very highly significant, highly Significant difference at p<0.001,p<0.01 and p<0.05 respectively, ns=non significant and CV=coefficient of variation

Table.8 Mean grain yield (qt/ha) of finger millet varieties tested across locations

No.	Finger millet Genotypes	Locations							Mean
		Gojeb	Omonada	Limu kosa	Gooma	Bedele 2017	Bedele 2018	Bedele 2019	
1.	Gudetu	19	18.9	6.25	10.7	25.0	27.5	21.9	18.5
2.	Bareda	16.93	16.7	9.55	10.8	25.2	21.7	14.1	16.4
3.	Addis 01	17.73	20.1	7.725	5.7	24.6	23.0	15.1	16.3
4.	Boneya	16.93	19.5	6.5	12.4	19.8	24.2	24.4	17.7
5.	Wama	14.33	16.3	7.425	12.6	19.9	26.5	20.0	16.7
6.	Tesema	15.33	19.4	6.875	5.9	24.1	23.5	14.5	15.7
7.	Padet	18.65	19.4	6.85	5.4	29.3	23.0	17.4	17.1
8.	Axum	18.88	15.5	7.325	12.1	21.2	27.7	13.6	16.6
9.	Tadesse	19.63	11.7	7.175	9.7	23.9	24.7	16.3	16.2
10.	Meba	19.33	19.3	5.975	6.3	22.0	22.2	14.3	15.6
11.	Local check	18.10	15.7	4.4	10.3	17.7	21.1	13.2	14.4
	Mean	**17.7**	**17.5**	**6.9**	**9.25**	**22.96**	**24.1**	**16.8**	**16.5**
	CV (%)	**11.1**	**11.6**	**23.6**	**13.39**	**9.87**	**9.56**	**15.6**	
	F test	*******	*******	*****	*******	*******	******	*******	

***, **,* Very highly significant, highly Significant difference at p<0.001,p<0.01 and p<0.05 respectively, ns=non significant and CV=coefficient of variation

Statistical Analysis

Analysis of variance (ANOVA) for grain yield and related traits for each location performed with the PROC GLM procedure using SAS (2014) versions 9.3 software. Comparison of treatment means were done by Fischer's least significant difference (LSD) at 5% probability levels.

Results and Discussion

The results of analysis (ANOVA) revealed that significant differences non significant were observed among all parameters at 5% level of significance across different locations. Plant height of varieties ranged from 79.2cm (Tadessse) to 94.2cm (Bareda) with average of 86.7cm (Table 3). The longest plant height was obtained from location Bedele 2018 and shortest from Limu kosa 2017.Finger length was minimum at Omonada location and maximum at Bedele 2019 (Table 7).

The maximum finger length was observed in the variety Tesema and minimum at variety Tadesse. Maturity date ranged from 134.1 days (at Gojeb) to 201.2 days (at Bedele 2019) with mean of 150.6days (Table 4). Maximum number of fertile tillers was observed in Omonada location (8.3) and Minimum at location Limu kosa (3.3) (Table 5).The number of fingers per ear was maximum at Bedele 2018 and minimum in case Limu kosa (Table 6). More number of fingers in the finger millet genotypes means that genotypes definitely yield higher grain yield (Haradari *et al.*, 2011). Similar results in ranges and mean values for most of the traits were reported in previous study on finger millet genotypes (Kebere *et al.*, 2006; Nirmalakumari *et al.*, 2010; Ganapathy *et al.*, 2011; Shinde *et al.*, 2014).

Analysis of variance revealed the presence of significant (P<0.05) differences in finger millet grain yield among finger millet varieties tested at Omonda, Gojeb, Limu kosa Goom, Bedele 2017, Bedele 2018 and Bedele 2019 cropping season (Table 8).This indicated the presence of performance variation among the tested varieties for grain yield and it is possible to identify high yielder varieties for possible use in these locations.

Mean yields of varieties across environments ranged from 14.3qt to 17.7qt at Gojeb,4.4 to 9.55 at Limu Kosa,5.4 to 12.6 at Gooma,17.7 to 29.3 at Bedele 2017,21.1 to 27.7 at Bedele 2018,13.2 to 24.4 at Bedele 2019 and 11.7 to 20.1qt at Omonada (Table 8).Mean yields of varieties across environments ranged from 6.9qt to 24.1qt with mean grain yield of 16.5qt/ha. The popular variety Bareda ranked first at Limu Kosa second at Bedele 2017 and third at Gooma. This rank change of the same variety over locations by the same trait is the consequence of the highly significant GxE interaction. The varieties exhibited highest mean grain yield (24.1qt/ha) at Bedele 2018 while lowest at Limu Kosa (6.9qt/ha).

Recommendation

Grain yield is one of the complex quantitative traits, which has high environmental interaction. Genotype × environment interaction (GEI) is a major obstacle for the crop to attain full genetic gain. Eleven finger millet varieties (including one local check) were tested across different locations of Southwestern Ethiopia. Varieties showed different performances across locations. In average, variety Gudetu was high yielding and Stable across the locations, so that it was recommended for large scale production.

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