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Asian Journal of Plant Science and Research, 2018, 8(1):40-43

ISSN : 2249-7412
CODEN (USA): AJPSKY

Evaluation of Early Maturing Sorghum (*Sorghum bicolor* (L.) Moench) Varieties, for Yield and Yield Components in the Lowlands of Eastern Hararghe

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ABSTRACT

Seven varieties of sorghum were tested for their adaptability at moisture stress areas of Fedis and Babile districts in Eastern Hararghe during 2013 main seasons to evaluate the performance and adaptability of released sorghum varieties for the study area. The varieties used were seven namely Melkam, Meko, Teshale, Gambela 1107, Dhaqaba, Macia and Birhan laid out in RCBD using three replications. The analysis of variance revealed that highly significant (P<0.01) difference in parameters of days to 50% flowering, days to maturity, plant height and panicle length at both locations. Panicle diameter and yield were highly significant at (P<0.01) only at Babile (Erer) and significant difference (P<0.05) were seen for thousand seed weight at both locations during the study. Meko variety were the earliest in days to 50% flowering at both locations taking The earliest days to flowering were observed on Meko variety on both locations with 68.67 and 66.67 days at Fedis and Erer, respectively and late flowering were observed by Dhaqaba variety with 78.33 and 76.67 days at Fedis and Erer, respectively. Again Meko were the earliest in terms of maturity taking only 110.3 and 106.3 days at Fedis and Erer, respectively. The highest grain yield were obtained from Melkam (6122 kg ha^{-1}) variety followed by Macia (5751 kg ha^{-1}), Gambela 1107 (5700 kg ha^{-1}) and Dhaqaba (5537 kg ha^{-1}) at Erer. Concurrently, the lowest yield was obtained from Meko and Birhan yielding 3759 and 4255 kg ha^{-1}, respectively. Overall, all the varieties has showed consistency over locations in this study and recommended for further demonstration to be evaluated under farmer's management.

Keywords: Sorghum, Grain yield, Early maturity

INTRODUCTION

Sorghum grows in a wide range of agro ecologies most importantly in the drought prone parts where other crops can least survive and food insecurity is rampant [1] which make sorghum preferable by farmers in drought prone areas due to its tolerance to drought and harsh environments. Sorghum (*Sorghum bicolor*) is an essential to diets of poor people in the semi-arid tropics where droughts cause frequent failures of other crops [2]. Eastern Ethiopia is generally characterized by different agro-ecology where different sorghum varieties are cultivated in highland, mid-highland and lowland parts.

In Eastern Hararghe zone out of the total grain cropped area of 252,561.08 ha, cereals account for about 80% (202,717.60 ha), of which sorghum accounts lion's share of about 56.25% (114,028.52 ha) of the annually cropped land [3]. In eastern Ethiopia sorghum is an important food crop and staple local diet. It is produced not only for its grains but also for its use as a source of animal feed, fuel wood and construction material. It is grown mainly under rain fed condition [2]. Fedis and Babile districts of Eastern Hararghe are characterized by low, erratic and poorly distributed rainfall pattern and high temperature. Sorghum grown in eastern lowland areas of Fedis and Babile are subject to unpredictable drought, either at the beginning or, in the middle or towards the end of the growing season. Because drought causes major yield constraint in the eastern Ethiopia, farmers are forced to look for local and released

genotypes that can give relatively high yield under drought conditions. The average yield in East Hararghe is currently 2.26 ton ha^{-1} [3] while the potential of improved and early maturing sorghum varieties is over 3 ton ha^{-1}.

Efforts have been made previously to adapt, introduce, demonstrate and disseminate early maturing sorghum varieties released by national sorghum program of the country. However, breeding program continuously select new varieties to add superior varieties than older ones and to give alternatives for farmers. Thus it was important to evaluate newly released and previously untested sorghum varieties with the objective of evaluating for their adaptability, yield and yield components.

MATERIALS AND METHODS

Description of the study areas

The experiment was conducted at Fedis Agricultural Research Center in Fedis district, Boko research station and Erer sub-station at Babile of eastern Hararghe Zone of Oromia region.Fedis district has latitude between 8°22' and 9°14'N and longitude between 42°02' and 42°19'E, in middle and low land areas: altitude range is from 1200-1600 m.a.s.l, with a prevalence of low lands. The district receives average annual rain fall of 400-804 mm. the minimum and maximum air temperature of 20-25°C and 30-35°C, respectively. The experiment was conducted during the main cropping season of 2013/2014 under rain fed conditions.

Treatments and experimental design

OPV sorghums Melkam, Macia, Gambella 1107 and Dhaqaba along with standard check Teshale and Meko was collected from Melkassa Agricultural Research Center. The varieties were planted in a plot size of 3.75 m × 3 m. The varieties were laid out with Randomized Complete block design with three replications. Each variety was planted at the spacing of 75 cm and 20 cm between rows and plants respectively**.** Seed rate 8-10 kg/ha and fertilizer rate DAP 100 kg/ha and Urea 100 kg/ha were applied. Weeding of non-striga weeds and earthening up were accomplished at different growth stage sorghum starting from early growth.

Statistical data analysis

Analysis of variance for the design was carried out using Genstat 15th edition software for the parameters studied following the standard procedures outlined by Gomez and Gomez [4]. When the treatment effects were found to be significant, the means were separated using the least significant difference (LSD) test at 5% level of probability.

RESULTS AND DISCUSSION

Phenological parameters

Days to 50% emergence were non-significant at P<0.05 for both locations (Table 1). Days to 50% flowering and days to physiological maturity were highly significant at P<0.01 at both locations during the cropping season of 2013. The earliest days to flowering were observed on Meko variety on both locations with 68.67 and 66.67 days at Fedis and Erer respectively and late flowering were observed by Dhaqaba variety with 78.33 and 76.67 days at Fedis and Erer respectively. Samuel et al. [2] reported 67.67 and 71.67 days to flowering for Meko and Teshale variety respectively and 110 days to maturity for both varieties which is almost the same with this finding. In another study conducted 104.667, 115.667 and 110 days to maturity were reported for Meko, Gambela 1107 and Teshale, respectively [5].

Table 1: Days to 50% emergence, days to 50% flowering and days to maturity of sorghum grown at Fedis and Erer in 2013

Location	Fadis			Erer		
Treatment	**DE**	**DE**	**DM**	**DE**	**DF**	**DM**
Meko	8.00	68.67^{a}	110.3^{a}	7.66	66.67^{a}	106.3^{a}
Birhan	9.33	70.67^{b}	117.0^{b}	7.33	68.67^{b}	112.7^{b}
Macia	10.00	71.33^{bc}	121.7^{de}	7.66	71^{c}	117.7^{d}
Teshale	9.33	74.33^{d}	120.3^{c}	7.33	71^{c}	114.7^{bc}
Melkam	11.00	72.33^{c}	122.7^{e}	7.33	72.67^{cd}	118.7^{d}
Gambela 1107	10.00	74.67^{d}	122.3^{e}	7.33	73^{d}	116.7^{cd}
Dhaqaba	11.67	78.33^{e}	121.0^{cd}	7.00	76.67^{e}	117.3^{d}
LSD (0.05)	Ns	**	**	Ns	**	**
CV (%)	14.0	1.3	0.6	6.2	1.4	1.1

**=significant at P=0.01
Ns=Not Significant, LSD (0.05)=Least Significant Difference at 5% level
Means in column followed by the same letters are not significantly different at 5% level of significance
DE: Days to 50% Emergence; DF: Days to 50% Flowering; DM: Days to Maturity

Growth parameters

Plant height and panicle length were highly significant (P<0.01) at both locations while panicle diameter were highly significant (P<0.01) only at Erer and it did not show significant difference at Fedis (Table 2). The highest panicle length were observed on Macia (28.67 cm), Dhaqaba (27.07 cm) and Birhan (26.47 cm) varieties at Fedis and Macia (30.33 cm), Birhan (29.33 cm) and Dhaqaba (27.67 cm) at Erer. While the shortest panicle recorded from the tested varieties were Teshale (20.13 cm) and Gambela 1107 (22.40 cm) at Fedis and 21.56 and 22 cm by Gambela 1107 and Teshale varieties, respectively. In regard to panicle diameter the difference observed at Fedis were non-significant and at Erer the highest panicle diameter were observed by Teshale, Macia and Gambela 1107 varieties with values of 11, 9.67 and 9.33 cm, respectively, while the shortest panicle diameter were observed on Birhan at both locations.

Table 2: Panicle length, panicle diameter and plant height of sorghum grown at Fedis and Erer in 2013

Location	Fedis			Erer		
Variety	PL	PD	PH	PL	PD	PH
Gambela 1107	22.40^{ab}	7.93	138.3^{c}	21.56^{a}	9.33^{b}	152.7^{d}
Teshale	20.13^{a}	8.67	150.9^{d}	22.00^{ab}	11.00^{c}	169.7^{e}
Meko	23.20^{b}	8.27	129.4^{c}	22.11^{ab}	9.00^{b}	132.2^{c}
Melkam	22.60^{b}	8.2	132.3^{c}	23.78^{b}	9.00^{b}	146.1^{cd}
Dhaqaba	27.07^{c}	9.00	86.2^{a}	27.67^{c}	9.22^{b}	104.3^{ab}
Birhan	26.47^{c}	6.2	90.9^{a}	29.33^{cd}	7.00^{a}	90.3^{a}
Macia	28.67^{c}	9.13	101.6^{b}	30.33^{d}	9.67^{b}	109.3^{b}
LSD (0.05)	**	Ns	**	**	**	**
CV (%)	5.3	12.9	4.3	4.7	6.5	7.1

**=significant at P=0.01
Ns=Not Significant, LSD (0.05)=Least Significant Difference at 5% level
Means in column followed by the same letters are not significantly different at 5% level of significance
PL: Panicle Length; PD: Panicle Diameter; PH: Plant Height

At the same time, plant height has shown variation between varieties at both locations. The highest plant height was measured from Teshale (150.9 cm), Melkam (132.3 cm) and Meko (129.4) at Fedis and again Teshale were the tallest variety at erer measuring 169.7 cm followed by Gambela 1107 (152.7 cm) and Melkam (146.1 cm). Plant height is one of the major growth parameter considered by sorghum growers in eastern Hararghe because of high demand for above ground biomass needed for animal feed. Conversely, the shortest plant height was recorded from Dhaqaba and Birhan measuring 86.2 and 90.9 cm and 104.3 and 90.3 cm at Fedis and Erer respectively. The difference observed on panicle length, panicle diameter and plant height between varieties were due to difference in genetic makeup of the varieties. Tekle and Zemach reported 19.00 cm, 21.867 cm and 18.467 cm panicle length for Meko, Gambela 1107 and Teshale, respectively, which is in the same range.

Yield and yield components

Although non-significant difference were seen at Fedis for yield Gambella 1107 (5067 kg ha^{-1}) were high yielder followed by Macia (4385 kg ha^{-1}), Meko (4063 kg ha^{-1}) and Melkam (4037 kg ha^{-1}). At the mean time lower yield were obtained from Birhan and Dhaqaba giving 3196 and 3378 kg ha^{-1}. On the other hand, highly significant difference was obtained at Erer for grain yield among varieties. The highest grain yield were obtained from Melkam (6122 kg ha^{-1}) variety followed by Macia (5751 kg ha^{-1}), Gambela 1107 (5700 kg ha^{-1}) and Dhaqaba (5537 kg ha^{-1}) which are statistically at par between them. Concurrently, the lowest yield was obtained from Meko and Birhan yielding 3759 and 4255 kg ha^{-1}, respectively.

In study conducted in Kamash, Benishangul-Gumuz [6] reported grain yield of 1833.3 and 2500 kg ha^{-1} for Meko and Gambela 1107 variety; which is low compared to this study which might due be variation in environment. Similarly, 4166.7 kg ha^{-1} of grain yield were reported by the same person which is in the same range with this finding which might be due stability of the variety over different environment. In another study conducted 3700 and 4000 kg ha^{-1} grain yield were reported for Meko and Teshale varieties in eastern Hararghe which is in the same range with this study [2].

Thousand seed weight was significant (P<0.05) at both locations and grain yield in kg ha^{-1} obtained were non-significant at Fedis while highly significant (P<0.01) difference were observed at Erer during the study. The maximum and minimum TSW recorded were 36 and 26.67 g at Fedis while 40 and 37 g were obtained from Birhan and Dhaqaba, respectively (Table 3).

Table 3: Yield and thousand seed weight of sorghum grown at Fedis and Erer in 2013

Location	Fedis		Erer	
Treatment	**Yield (kg ha^{-1})**	**TSW (g)**	**Yield (kg ha^{-1})**	**TSW**
Meko	4063	34.67^{bc}	3759^{b}	38.33^{ab}
Birhan	3196	36.00^{c}	4255^{b}	40.00^{b}
Teshale	3904	28.00^{a}	5318^{a}	38.00^{a}
Dhaqaba	3378	26.67^{a}	5537^{a}	37.00^{a}
Gambela 1107	5067	30.67^{ab}	5700^{a}	38.67^{ab}
Macia	4385	28.00^{a}	5751^{a}	38.67^{ab}
Melkam	4037	30.67^{ab}	6122^{a}	37.33^{a}
LSD (0.05)	Ns	*	**	*
CV (%)	18.5	9.3	9.2	2.5

**=Significant at P=0.01
*=Significant at P=0.05
Ns=Not Significant, LSD (0.05)=Least Significant Difference at 5% level
Means in column followed by the same letters are not significantly different at 5% level of significance
TSW: Thousand Seed Weight

CONCLUSION AND RECOMMENDATION

The experiment was conducted in 2013 main cropping season at two locations of Fedis and Babile districts to select sorghum varieties that have a good performance in terms of yield and other different parameters to the area. Overall, improved sorghum varieties Melkam, Macia, Gambela 1107, Dhaqaba and Teshale was found superior over all other varieties tested at Babile, whereas there were non-significant difference among tested varieties in terms of yield at Fedis. However, there were highly significant differences in days to maturity in both location although it was a little in practical conditions. Thus, these varieties are recommended for on-farm demonstration and popularization to be evaluated under farmer's condition to inculcate farmer's perception and outreach the high demand in the area.

ACKNOWLEDGEMENT

The authors would like to thank the Oromia Agricultural Research Institute, Fadis Agricultural Research Center for financing and providing working facility. A deep gratitude is extended to Integrated Striga Control (ISC) project for financing the activity and National Sorghum program for providing seeds of these varieties. Finally we would like to thank Adane Ashebir and Hamsalu Ayana for their support during data collection.

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