Evaluation of improved lowland sorghum (Sorghum Bicolor (L.) Moench) varieties in Southern Ethiopia

Selamawit Markos¹*, Tariku Simion¹ and Tamirat Samuel¹

Abstract: In Ethiopia, there are several sorghum production constraints, among which shortage of high yielding varieties is the major one. The objective of this experiment was to select superior lowland sorghum varieties in Basketo special and Melokoza districts. An experiment was conducted in the 2017 main cropping season with seven improved varieties (Teshale, Melkam, Dekebe, Meko, Seredo, Gubiye, 76T1#23) and one local check arranged in randomized complete block design with three replications. The result of the study revealed that the effect of variety was significant for all the measured traits. Among the varieties, the highest average grain yield (2945 kg ha⁻¹) was obtained from Teshele variety. Thus, this variety would be recommended for further demonstration and pre-scaling up in Melokoza and Basketo special districts and other similar agro ecologies.

Subjects: Agriculture & Environmental Sciences; Botany; Plant & Animal Ecology

Keywords: sorghum; grain yield; varieties

1. Introduction
Sorghum (Sorghum bicolor (L.) Moench) grows in a wide range of agro ecologies most importantly in the drought-prone parts where other crops can least survive (Adugna, 2007). This makes sorghum preferable by farmers in drought-prone areas due to its tolerance to drought and harsh environments. It is one of the important indigenous food crops and is only second to tef as injera (leavened local flatbread) making cereal. Sorghum is the fifth most important cereal crop in the world (FAO (Food and Agricultural Organization), 2005).
In Ethiopia, sorghum is the third most important cereal crop after tef and maize in terms of area coverage and total production (CSA (Central Statistical Authority), 2018). It accounts for 18.53% of the total area allocated to cereals and it also accounts for 19.3% of the area covered by cereals (CSA (Central Statistical Authority), 2018). Likewise, sorghum is the dominant crop in the low land areas of southern Ethiopia. It ranks fourth in area cultivated (12%) and in total production (12.69) among cereals (CSA (Central Statistical Authority), 2018). In spite of the importance of the crop to the farmers in the target area, lack of improved varieties, non-adoption of improved technologies, diseases and pests are major series production constraints in the study area. Some varieties of sorghum were released by different national and regional research centers. However, most of them were not evaluated in Basketo special and Melokoza district of Southern Ethiopia. Therefore, the objective of this study was to evaluate and select better performing lowland sorghum varieties in the study area.

2. Materials and methods

2.1. Description of study area
An experiment was conducted at Basketo special district (Angla-3 and Angla-4 in 2017) and Melokoza district (Mender-1 and Mender-3 in 2018) during the main cropping season (March to July) (Table 1).

2.2. Experimental design and procedures
An experiment was conducted by using seven sorghum varieties namely; Gubiye, Seredo, Teshale, Meko, 76T1#23, Melkam and Dekeba from Melkessa Agricultural Research Centers and one local check. The field experiment was arranged in a randomized complete block design with three replications. During planting, the seeds were manually drilled at a seed rate of 10 kg/ha. The plot with 5 m long and 4.5 width was used. Six rows with inter-row spacing of 75 cm and 20 cm spacing between plant were used. Fertilizer, 100 kg/ha of NPS was applied at the time of planting (as basal application) and 50 kg/ha urea was applied in the form of split application; half of it at planting and the rest as top dressing before heading. Hand weeding was used.

2.3. Data collection and analysis
Data were collected on plant and plot basis for different traits. For the data collection on plot bases, five plants from the four central rows of each plot were randomly tagged and plant height, spike length and tiller number per plant were recorded. All plants from the four central rows of each plot were subjected to yield evaluation. Analysis of variance (ANOVA) was computed using statistical packages and procedures outlined by Gomez and Gomez (1984) to randomized complete block design using Genstat computer software (Genstat 16th edition). Mean separation was made

| Locations  | Altitude (masl) | Geographical location | Soil type | Av. tem.(°C) | Ave. rain fall (mm) |
|------------|----------------|----------------------|-----------|-------------|---------------------|
|            |                | Latitude (N) | Longitude (E) |             |                     |
| Mender-1   | 818            | 06°25.9 N | 36°28.1 E | Clay loam | 21.3 | 1125 |
| Mender-3   | 817            | 06°25.9N | 36°27.3 E | Clay loam | 21.5 | 1200 |
| Angla-3    | 883            | 06°15.5 N | 36°33.1 E | Clay loam | 21.5 | 1200 |
| Angla-4    | 916            | 06°17.35N | 36°33.12E | Clay loam | 21.5 | 1200 |

Source: Basketo special and Melokoza districts, 2017.
by Least Significant Difference (LSD) for the comparison among the experimental varieties at 5% probability level.

3. Results and discussion

Combined analysis of variance was computed for the locations, genotypes and location by genotype interaction for the traits studied. Accordingly, combined analysis of variance indicated there were significant (P < 0.05) differences among genotypes, locations and location by variety interaction for plant height, spike length, tiller number and grain yield (Table 2). Firew., Mekbib, and Asfaw (2016) and other authors also reported considerable variation in plant height, panicle length, tiller number and grain yield of different sorghum varieties which coincides with the current result.

Among tested varieties, Teshele and 76T1#23 were better performed at Angla-3 and Angla-4 with yield advantage of 29.52%, 28.72 and 48.6%, 29.24 over the check, respectively (Table 3).

At mender-3, angla-4 and angla-3, Teshele was better yielder than the check and other varieties (Table 3). The highest grain yield over the locations was obtained from variety Teshele (2945kg/ha) (Table 3) with yield advantage of 28.6% over the local check in the study area. From these, it could be suggested that the use of improved sorghum varieties had brought a proportional yield increment than the local check. The current result was in line with Fuad Abduselam, Tegene, Fikadu, Alemayehu, and Taye (2018) and Yoseph and Zemach (2014) who reported significant difference for grain yield in sorghum varieties.

Variety, Teshele had better average spike length than the other varieties which is positively related to high yield (Table 4). From these, it could be suggested that productive and high number of spike lengths can bring a proportional yield increment. The current result was in line with Fuad Abduselam et al. (2018) who reported significant contribution of yield-related traits for grain yield in sorghum varieties.

4. Conclusion and recommendation

Sorghum (Sorghum bicolor (L). Moench) grows in a wide range of agro ecologies most importantly in the drought-prone areas. The studied varieties were significantly different for most studied traits. From the tested varieties, the highest grain yield (2945kg/ha) was recorded for Teshele over the local check in the study area. Thus, it could be demonstrated before large-scale production in the study areas and area with similar agro ecologies.

Table 2. Combined analysis of variance for yield and other agronomic traits of sorghum genotypes

| Source of variation | DF | GY   | PH   | TN   | SL  |
|---------------------|----|------|------|------|-----|
| Replication         | 2  | 38415| 1011.5| 0.011| 12.75|
| Locations           | 3  | 1430732**| 14009.3**| 1.867*| 80.23**|
| Genotypes           | 7  | 2608711**| 9234.6**| 0.294**| 48.84**|
| Location x varieties| 21 | 365936**| 1229.7*| 0.204**| 19.81*|
| Residual            | 52 | 33655714417| 580.6| 0.045| 10.69|

* and **= Significant at the 0.05 and 0.01 probability level, DF = degree freedom, GY = grain yield, PH plant height, TN = tiller number and SL = spike length.
Table 3. Mean values for grain yield and plant height for sorghum genotypes across locations

| Genotypes | Grain yield (kg/ha) | Plant height (cm) |
|-----------|---------------------|------------------|
|           | Locations           | Average          | Locations          | Average          |
|           | Angla-3 | Angla-4 | Mender-1 | Mender-3 | Angla-3 | Angla-4 | Mender-1 | Mender-3 | Angla-3 | Angla-4 | Mender-1 | Mender-3 |
| Teshele   | 2897a    | 2933a   | 2471     | 3480a   | 2945a    | 229.5a  | 230.8a   | 233.3    | 226.7a   | 230.1a |
| Meko      | 1410d    | 2413c   | 2133     | 2690b   | 2325c    | 135.4c  | 156.3bcd | 181.7    | 164.6c   | 159.5cd |
| 76T1f23   | 2883a    | 2900ab  | 2787     | 2537bc  | 2800a    | 124.5cd | 136.3d   | 172.1    | 180.3bcd | 153.3cd |
| Seredo    | 2623b    | 2650bc  | 2880     | 2627b   | 2624b    | 118.1de | 179.1bc  | 216.1    | 207.8abcd | 180.3b |
| Melkam    | 1280e    | 1877de  | 2597     | 2270cd  | 1928e    | 116.9de | 186.6b   | 197.7    | 227.1a   | 182.1b |
| Dekebe    | 1210f    | 1587f   | 2284     | 2710b   | 1953e    | 105.0e  | 164.8bcd | 165.6    | 163.3c   | 150.2d |
| Gubiye    | 1320e    | 1770ef  | 2307     | 1733e   | 1625f    | 106.9e  | 157.5bcd | 157.8    | 150.2c   | 142.6d |
| Local     | 2040c    | 2067d   | 1677     | 2200d   | 2110d    | 168.3b  | 143.5cd  | 211.7    | 167.9bcd | 172.8bc |
| Mean      | 1958.0   | 2275    | 2392.    | 2531    | 2289.    | 138.10  | 169.4    | 192.0    | 186.0    | 171.4  |
| LSD (0.05)| 46.59    | 587.1   | 464.4    | 292.6   | 299.4    | 14.32   | 39.42    | Ns       | 41.20    | 39.33  |

Note: LSD = least significant difference.
Table 4. Mean values for spike length and number of tiller per plant across four environment

| Genotypes | Spike length (cm) | Tiller number per plant | Average | Locations | Average | Locations |
|-----------|-------------------|-------------------------|---------|-----------|---------|-----------|
|           | Angla-3 | Angla-4 | Mender-1 | Mender-3 | Angla-3 | Angla-4 | Mender-1 | Mender-3 | Angla-3 | Angla-4 | Mender-1 | Mender-3 |
| Teshele   | 29.27a   | 27.13   | 29.27    | 29.53    | 28.80a   | 0.33de  | 0.333    | 0.933bc  | 0.867bc  | 0.62c   |
| Mekoa     | 21.67cd  | 21.80   | 21.67    | 23.33    | 22.12d   | 0.40cde | 0.433    | 1.200ab  | 0.800c   | 0.71bc  |
| 76T1#23   | 19.47d   | 26.33   | 28.00    | 27.60    | 25.35bc  | 0.33de  | 0.367    | 0.667c   | 0.800c   | 0.54c   |
| Seredo    | 19.60d   | 26.47   | 25.67    | 25.60    | 24.33cd  | 1.47a   | 0.300    | 0.600c   | 1.067ab  | 0.85b   |
| Melkam    | 27.67ab  | 26.40   | 29.00    | 26.13    | 27.30ab  | 0.67c   | 0.333    | 0.733bc  | 0.800c   | 0.60c   |
| Dekebe    | 25.53b   | 22.73   | 28.20    | 28.40    | 26.22abc | 0.20e   | 0.367    | 1.067abc | 1.000abc | 0.65c   |
| Gubiye    | 28.07ab  | 19.80   | 26.73    | 27.47    | 25.52bc  | 0.533cd | 0.400    | 1.000bc  | 0.867bc  | 0.70bc  |
| Local     | 22.53c   | 23.13   | 30.80    | 30.87    | 26.83abc | 1.067b  | 0.400    | 1.533a   | 1.133a   | 1.033a  |
| LSD(0.05) | 2.78     | NS      | 7.076    | NS       | 5.34     | 0.33    | NS       | 0.497    | 0.224    | 0.35    |
| Grand mean| 24.22    | 24.22   | 27.42    | 27.37    | 25.8     | 0.63    | 0.367    | 0.967    | 0.917    | 0.7     |
Acknowledgements
The authors thank Southern Agricultural Research institute, Arba Minch Agricultural Research Center for financing and providing working facilities. They also express their great gratitude to researchers for devoting their time to support this work.

Funding
The authors received no direct funding for this research.

Competing Interests
The authors declare no competing interests.

Author details
Selamawit Markos¹
E-mail: selammark2011@gmail.com
Tariku Simion¹
E-mail: trk2011smn@gmail.com
ORCID ID: http://orcid.org/0000-0001-5502-8834
Tamirat Samuel¹
E-mail: tamiratsame@gmail.com
¹ Arba Minch Agricultural Research Center, South Agricultural Research Institute, Arba Minch, Ethiopia.

Citation information
Cite this article as: Evaluation of improved lowland sorghum (Sorghum Bicolor (L.) Moench) varieties in Southern Ethiopia, Selamawit Markos, Tariku Simion & Tamirat Samuel, Cogent Food & Agriculture (2020), 6: 1727624.

References
Adugna, A. (2007). The role of introduced sorghum and millets in Ethiopian agriculture. Journal of SAT Agricultural Research, 3(1), 25–31.
CSA (Central Statistical Authority). (2018). Agricultural sample survey, area and production of crops (pp. 14–63). Addis Ababa: Central Statistical Authority. Statistical Bulletin 532, Volume I.
FAO (Food and Agricultural Organization). (2005). Food and agricultural organization statistical data base for agriculture pocketbook. Rome, Italy: Food and Agriculture Organization of the United Nations.
Firew, Y., Mekbib, F., & Asfaw, A. (2018). Performance evaluation and participatory varietal selection of highland Sorghum (Sorghum bicolor (L.)Moench) genotypes in western part of Ethiopia. American-Eurasian Journal of Agricultural & Environmental Sciences, 16(10), 1641–1647.
Fuad Abduselam, S., Tegene, Z., Fikadu, T., Alemayehu, B., & Toye, T. (2018). Evaluation of early maturing Sorghum (Sorghum bicolor (L.)Moench) varieties, for yield and yield components in the lowlands of Eastern Hararghe. Asian Journal of Plant Science and Research, 8(1), 40–43.
Gomez, K. A., & Gomez, A. A. (1984). Statistical procedures for agricultural research (2nd ed., pp. 95–109). New York, USA: John Wiley and Sons. Inc.
Yoseph, T., & Zemach, S. (2014). Evaluation of Sorghum (Sorghum bicolor (L.) Moench) varieties, for yield and yield components at Kako, Southern Ethiopia. Journal of Plant Sciences, 2(4), 129–133. doi:10.11648/j.jps.20140204.12

© 2020 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.
You are free to:
Share — copy and redistribute the material in any medium or format.
Adapt — remix, transform, and build upon the material for any purpose, even commercially.
The licensor cannot revoke these freedoms as long as you follow the license terms.
Under the following terms:
Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made.
You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.
No additional restrictions
You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.

Cogent Food & Agriculture (ISSN: 2331-1932) is published by Cogent OA, part of Taylor & Francis Group.
Publishing with Cogent OA ensures:
- Immediate, universal access to your article on publication
- High visibility and discoverability via the Cogent OA website as well as Taylor & Francis Online
- Download and citation statistics for your article
- Rapid online publication
- Input from, and dialog with, expert editors and editorial boards
- Retention of full copyright of your article
- Guaranteed legacy preservation of your article
- Discounts and waivers for authors in developing regions
Submit your manuscript to a Cogent OA journal at www.CogentOA.com