Evaluation of finger millet (Eleusine coracana (L.) Gaertn.) varieties for grain yield in lowland areas of southern Ethiopia

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Abstract: Finger millet (Eleusine coracana L. Gaertn.) is a staple food crop in drought-prone areas. An experiment was conducted in Konso zone and Dirashe districts, Southern Ethiopia, in order to obtain high yielding varieties using eight improved and one local finger millet varieties in 2018. The experiment was laid down in a randomized completely block design with three replications. The combined analysis of variance for grain yield revealed a significant effect (P < 0.05) due to varieties, locations, and their interactions. Combined mean yield of varieties indicated that Bonaya (2992 kg/ha), Padet (2909 kg/ha), Wama (2733 kg/ha), and Tessama (2727 kg/ha) had the highest grain yield without significant difference among the four and had yield advantage of 41.8%, 38.7%, 31.9%, and 31.7% compared to the local check (1899 kg/ha), in the given order. The present study revealed that Bonaya, Padet, Wama, and Tessama varieties could be recommended for further pre-extension and dissemination in the study areas and similar agro-ecologies.

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

Keywords: lowland; grain yield; Eleusine coracana

1. Introduction
Finger millet (Eleusine coracana (L.) Gaertn.) is a small-seeded cereal grown in low rainfall areas of the world. Its wide adaptability to drought-prone areas and diverse cultural conditions makes it an important food security crop. 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 moisture stress (Tsehaye et al., 2006; Degu et al., 2009). In Ethiopia, finger millet is the sixth important crop 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 [CSA], 2018).

Finger millet is one of the important staple food crops in Southern Ethiopia including Konso zone and Derashe district, and most of the time, it has been produced by marginal farmers. In southern Ethiopia, finger millet is the sixth important crop after tef, wheat, maize, sorghum, and barley. It is produced on 4,485.63 ha of land, from which 72.0 tons are obtained at the regional level per year (Central Statistical Agency [CSA], 2018). The current productivity of the commodity is below national average productivity, which is (2260 kg/ha). Shortage of improved varieties, non-adoption of improved technologies, diseases, and moisture stress are major constraints (Degu et al., 2009).

Since variety development takes a longer time, as an immediate solution, it is advisable to avail the existing improved varieties to the farmers. However, the new improved varieties should not be directly disseminated to the farming communities for wide-scale production before they are evaluated for their performance. The present study was initiated to select high grain-yielding finger millet varieties for low land areas of Konso zone and Derashe district and areas with similar agro-ecologies.

2. Materials and methods
An experiment was conducted on farmers’ fields during the 2018 main cropping season at Konso zone (Arfaide and Sorobo Kebeles) and Derashe district (Gato Kebele) in Southern Ethiopia. Gato (Altitude: 1252 m.a.s.l and soil type: sandy loam), Arfaide (Altitude: 1312 m.a.s.l and soil type: sandy), Sorobo (Altitude: 1350 m.a.s.l and soil type: sandy). Average rainfall distribution of the areas is 700–1025 mm. Eight finger millet varieties and one local cultivar were grown in randomized complete block design with three replications. Planting was done by hand drilling at a seed rate of 10 kg/ha. Each experimental plot had six rows with five-meter length and 45 cm inter-row spacing. Intra-row spacing was maintained at 10 cm after thinning. Nationally recommended fertilizer rate was applied at the rate of 50 kg/ha of NPS at planting and 100 kg/ha of urea (50 kg at planting and 50 kg at 35–40 days after weeding). Data were collected for plant height (taken at maturity) and finger length on the basis of five sample plants randomly taken from the four central rows, whereas grain yield was taken on a plot basis. Genstat (16th edition 2014) software was used for statistical analysis.

3. Results and discussion
The combined analysis of variance over locations indicated that there were a significant difference (P < 0.05) among varieties for plant height, finger length, and grain yield (Table 1). Over locations, mean grain yield of the varieties indicated that Bonaya, Padet, Wama, and Tessama had the highest grain yield advantage without significant difference among the four in the given order (Table 2). The result reported by (Hailegebrial et al., 2017) for grain yield in finger millet varieties suggested that the contribution of environment and varieties to the observed variation of yield was large. This suggested testing of varieties in different localities is must before recommending for large-scale production.

The highest grain yield was obtained for variety Padet (3592 kg/ha), and most of the varieties had the lowest grain yield performance at Gato (Table 3). The varieties Wama (3567 kg/ha), Bonaya (3189 kg/ha), and Tessama (3065 kg/ha) were high grain yielders without statistical difference among the three at Sorobo (Table 4), whereas Tessama (2991 kg/ha), Padet (2991 kg/ha), Bonaya (2981 kg/ha), Meba (2858 kg/ha), Axum (2788 kg/ha), and Wama (2525 kg/ha) recorded highest grain yields at Arfaide without statistical difference among them (Table 5). The mean values of finger length over locations ranged from 7.2 cm (local) to 9.7 cm (Axum) (Table 2). The mean plant height values range from 96.3 cm (Gudetu) to 133.9 cm (Tessema) (Table 2).

4. Conclusion and recommendation
The combined analysis of variance showed that the effect of environments, varieties, and their interactions for grain yield was significant (P < 0.05). The environment played a significant role
**Table 1. Combined analysis of variance for yield and agronomic traits of nine finger millet varieties**

| Source of variation | DF  | GY  | PH  | FL   |
|---------------------|-----|-----|-----|------|
| Replication         | 2   | 305.822 | 46.46 | 0.334 |
| Location            | 2   | 553.665* | 1058.84** | 2.880ns |
| Variety             | 8   | 877.380** | 1351.59* | 7.200** |
| Location × Variety  | 16  | 88.167** | 248.56** | 3.074* |
| Residual            | 52  | 714.417 | 40.28 | 1.689 |
| CV (%)              |     | 11.4 | 5.6 | 15.3 |

*and **Significant at 0.05 and 0.01 probability levels. DF: degree of freedom; GY: grain yield; PH: plant height; FL: finger length; CV (%): coefficient of variation in percentage.

**Table 2. Combined mean values for yield and agronomic traits of nine finger millet varieties**

| Varieties | GY (kg/ha) | PH (cm) | FL (cm) |
|-----------|------------|---------|---------|
| Axum      | 2554b      | 123.7 c | 9.667d  |
| Wama      | 2727ab     | 125.9 c | 9.489cd |
| Bonaya    | 2992 a     | 110.4b  | 8.422abc|
| Addis 01  | 2549b      | 109.4b  | 7.778ab |
| Padet     | 2909a      | 114.9b  | 8.022ab |
| Local     | 1899c      | 99.1a   | 7.289a  |
| Gudatu    | 2562b      | 96.3a   | 7.711ab |
| Tessama   | 2733ab     | 133.9d  | 9.600cd |
| Meba      | 2574b      | 113.9b  | 8.578bcd|
| Grand mean| 2611       | 114.17  | 8.51    |
| LSD (0.05)| 486.5      | 10.398  | 2.129   |

GY: grain yield; PH: plant height; FL: finger length; LSD (0.05): least significant difference. Means in the same column followed by the same letter are not significantly different at 5% level of significance.

**Table 3. Mean values of yield and agronomic traits of nine finger millet varieties at Gato**

| Varieties | GY (kg/ha) | PH (cm) | FL (cm) |
|-----------|------------|---------|---------|
| Axum      | 2084 c     | 120.7a  | 7.27    |
| Wama      | 2088 c     | 120.7a  | 8.40    |
| Bonaya    | 2546bc     | 108.6b  | 8.40    |
| Addis 01  | 2415 c     | 110.4b  | 8.20    |
| Padet     | 3592a      | 104.7b  | 8.27    |
| Meba      | 2337 c     | 107.1b  | 8.67    |
| Gudatu    | 2942b      | 86.6 c  | 7.93    |
| Tessama   | 2143 c     | 122.7a  | 10.53   |
| Local     | 2336 c     | 123.1a  | 8.33    |
| Grand mean| 2498       | 111.6   | 8.44    |
| LSD (0.05)| 487.7      | 9.70    | NS      |

GY: grain yield; PH: plant height; FL: finger length; LSD: least significant difference. Means in the same column followed by the same letter are not significantly different at 5% level of significance.
Table 4. Mean values of yield and agronomic traits of nine finger millet varieties at Sorobo

| Varieties   | GY (kg/ha) | PH (cm) | FL (cm) |
|-------------|------------|---------|---------|
| Axum        | 2777bc     | 132.0bc | 12.000c |
| Wama        | 3567a      | 151.5a  | 9.867b  |
| Bonaya      | 3189ab     | 124.1bc | 8.867ab |
| Addis 01    | 3105b      | 93.0f   | 7.267a  |
| Padet       | 2404c      | 123.2bcd| 7.867ab |
| Local       | 1705d      | 112.0de | 7.867ab |
| Gudatu      | 2611c      | 101.5ef | 8.333ab |
| Tessama     | 3065a      | 134.3b  | 9.200ab |
| Meba        | 2526c      | 120.5cd | 8.467ab |
| Grand mean  | 2772       | 121.3   | 8.86    |
| LSD (0.05)  | 446.8      | 11.75   | 2.066   |

GY: grain yield; PH: plant height; FL: finger length; LSD: least significant difference. Means in the same column followed by the same letter are not significantly different at 5% level of significance.

Table 5. Mean values of yield and agronomic traits of nine finger millet varieties at Arfaide

| Varieties   | GY (kg/ha) | PH (cm) | FL (cm) |
|-------------|------------|---------|---------|
| Axum        | 2788a      | 132.0bc | 9.267abc|
| Wama        | 2525ab     | 134.3b  | 10.260a |
| Bonaya      | 2981a      | 124.1bc | 7.933cd |
| Addis 01    | 2141b      | 93.0f   | 7.067de |
| Padet       | 2991a      | 123.2bcd| 8.000cd |
| Local       | 657c       | 101.5ef | 6.267e  |
| Gudatu      | 2133b      | 120.5cd | 7.067de |
| Tessama     | 2991a      | 151.5a  | 9.533ab |
| Meba        | 2858a      | 112.0de | 8.600bc |
| Grand mean  | 2452       | 121.3   | 8.21    |
| LSD (0.05)  | 641.0      | 11.75   | 1.424   |

GY: grain yield; PH: plant height; FL: finger length; LSD: least significant difference. Means in the same column followed by the same letter are not significantly different at 5% level of significance.

in influencing the expression of studied traits, which suggests the varied performance of the varieties across environments. This is indicative of the necessity of testing finger millet varieties at multiple locations for large-scale production. An ideal finger millet genotype should have a high mean yield combined with a low degree of fluctuation under different environments. The combined mean grain yield value of varieties over environments indicated that Bonaya (2992 kg/ha), Padet (2909 kg/ha), Wama (2733 kg/ha) and Tessama (2727 kg/ha) had the highest grain yield performance. Hence, these varieties could be recommended for further pre-extension and demonstration in the study areas and area with similar agro-ecologies.

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The authors declare no competing interests.

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