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Evaluation of durum wheat varieties for yield and yield related traits in highland areas of southern Ethiopia

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ABSTRACT

Durum wheat productivity in Ethiopia is hindered by different factors mainly lack of improved adapted varieties for specific locations. This experiment was done to identify the most performing durum wheat varieties in the tested environment. The average productivity of the tested genotypes were evaluated at two locations (Alichu and Analimo) using randomized complete block design with four replication for two consecutive years (2016 and 2017). The experimental material consists of seven improved durum wheat genotypes. The Combined analysis of variance showed significant ($P < 0.05$) difference among tested genotypes on collected parameter indicating the presence of adequate variability. The highest average grain yield recorded was 4446 kg ha⁻¹ from Hitosa variety while the lowest obtained was 3634 kg ha⁻¹ from Denbi variety. Grain yield had strong positive correlations ($P < 0.01$) with plant height, number of seed spike⁻¹ and biomass.

Keywords: Variety, Grain yield, Durum wheat, Genetic variability.

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Introduction

Wheat (*Triticum* spp.) cultivation reaches far back into history. It was one of the primary domesticated food crops and for 8000 years, it has been the basic staple food of the major civilizations of Europe, West Asia and North Africa. Today, the crop is grown on a huge land area than any other commercial crop and remains to be the most important food grain source for humans. Its production became prior to all crops, including rice, maize and potatoes (Curtis, 2002).

Most of the tetraploid wheat varieties, grown in Ethiopia are landraces consisting of a large number of different genetic lines. Purseglove (1975) reported the presence of genetic diversity of durum wheat in Ethiopia and Zohary (1970) identified Ethiopia as the center of origin for tetraploid wheat. However, the absence of ancestral forms and wild relatives ruled-out Ethiopia as the center of origin of cultivated wheat (Pecetti *et al.*, 1992).

In spite of cultivating wheat in most parts of Ethiopia, the country is not self-sufficient in production and consequently a large quantity of durum wheat is imported every year. The domestic average yield of the crop in the country, which is 1379 kg ha⁻¹, is 24% below the average of African yields and 48% below that of the world's (FAO, 1994). Food production and eventually

human survival depends on land, soil and water and on the methods used to exploit these resources in a sustainable manner. The regions of highest food production have been those with favorable climatic conditions, relatively fertile soils and an adequate supply of water, among others (Getachew, 2004). The major breeding objective in durum wheat is to create new improved genotypes with features that contribute to greater yield potential, increased yield stability and improved product quality (Poehlman and Sleper, 1995).

In Ethiopia, there are different varieties of improved durum wheat varieties released from research center. However, seed of this cultivar and other cultivars were multiplied and distributed all over the region on limited scale by the research centers and some farmers. The objective of this study was to select the most adaptable durum wheat varieties for highland areas and to select the varieties that have good agronomic performance to the area.

Materials and Methods

Experimental design and methods

Seven durum wheat varieties were evaluated at two locations (Alichu and Analimo). The varieties were released from federal agricultural research centers (Deberzeit Agricultural Research Center).

The experiment was conducted using randomized complete block design with four replications in the two main cropping seasons in the years of 2016 and 2017. The size of experimental plot is 1.2 m x 2.5 m (3 m²), with six rows which are 20 cm apart each other. Recommended seed rate (125 kg ha⁻¹) and fertilizer rate (100 kg ha⁻¹ urea and 100 kg NPS) were used in the experiment. The whole amount of NPS was applied at planting while urea was split in to half at planting and the remaining half at tillering stage. All agronomic managements were applied equally as per the recommendation.

Data collected

Data on plant height, spike length and number of tillers per plant were recorded from five randomly taken plants from the central four rows, which were tagged ahead of heading. Data for the rest of the characters were recorded from the whole plots.

Statistical analysis

A significance test was adopted by analysis of variance (ANOVA) for Randomized Complete Block Design. The ANOVA was carried out using the General Linear Model of the SAS Version 9.4 procedure. For factors showing significant effects, mean comparisons were made using Least Significance Difference (LSD) at 5% level of significance.

Results and Discussions

There were highly significant differences ($P < 0.05$) among tested varieties for many of the characters considered, revealing the existence of substantial amount of variation among the varieties (Table 1). This is in agreement with the findings of [Getachew et al. \(1993\)](#), indicating that Ethiopian durum wheat germplasm exhibits tremendous genetic variability.

This suggested that the magnitude of differences in genotypes was sufficient to provide some scope for selecting genotypes to improve.

The varieties showed significant difference ($P < 0.05$) on plant height and spike length but they were not significantly different on number of productive tillers. The average plant height ranged from 74.8 cm to 94.0 cm. The highest average plant height was recorded from Asassa variety (94.0 cm) while the smallest plant height was recorded from Mangudo (74.8 cm) variety. The average spike length recorded among the genotype ranged from 4.5 cm to 6.7 cm. The maximum average spike length recorded from Ude variety (2.7 cm).

Beside plant height and spike length, the tested varieties were significant difference on above ground biomass and grain yield. The average above ground biomass recorded ranged from 5,300 to 10,050 kg ha⁻¹. The maximum above ground biomass recorded from Ude variety (10,050 kg ha⁻¹) while the minimum were recorded from Yerer variety (5,300 kg ha⁻¹). The average grain yield recorded ranged from 3634.8 to 4446.3 kg ha⁻¹. The maximum grain yield recorded from Hitosa variety (4446.3 kg ha⁻¹) while the minimum were recorded from Denbi variety (3634.8 kg ha⁻¹).

There was significant difference among genotype and location by genotype interaction on grain yield (Table 2). The yield difference across location may come from the adaptability of a particular genotype in specific area and difference in rainfall patterns and due to soil nature of the study area. The tested varieties were well performed at Alichio as compared to Analimo site. At Alichio Ude, Hitosa and Mangudo ranked 1st, 2nd and 3rd with grain yield of 4795.0, 4472.0 and 4289.0 kg ha⁻¹, respectively while at Analimo Hitosa, Makiya and Asassa ranked 1st, 2nd and 3rd with grain yield of 4419.0, 4224.0 and 3945.0 kg ha⁻¹, respectively.

Table 1. The Mean performance of tested genotype on collected traits for the two locations.

| Varieties | PH(cm) | SL(cm) | TPP | BM(kg ha ⁻¹) | GY(kg ha ⁻¹) | HI |
|-----------|---------|--------|------|--------------------------|--------------------------|-------|
| Makiya | 81.4b | 4.9b | 2.5a | 8500ab | 4112.6ab | 0.5b |
| Mangudo | 74.8d | 4.5b | 2.6a | 8150abc | 3705.9b | 0.5b |
| Asassa | 94.0a | 4.6b | 2.5a | 9350a | 3809.3ab | 0.5b |
| Ude | 77.5cd | 6.7a | 2.7a | 10050a | 4132.9ab | 0.5b |
| Yerer | 78.2bcd | 4.7b | 2.6a | 5300c | 3709.6b | 0.9a |
| Denbi | 78.5bc | 5.0b | 2.6a | 5900bc | 3634.8b | 0.9a |
| Hitosa | 76.8cd | 4.7b | 2.6a | 7750abc | 4446.3a | 0.7ab |
| LSD (5%) | 3.7 | 0.6 | 0.3 | 2993.2 | 671.2 | 0.2 |
| CV (%) | 4.8 | 8.2 | 10.1 | 16.8 | 14.9 | 18.3 |

Key: -PH= Plant height, SL= Spike length, TPP= Tillers per plant, BM= biomass, GY= Grain yield, HI= Harvest index, LSD=least significant difference, and CV= coefficient of variation
Mean value within the column with different letter are significantly different at $p < 0.05$.

Table 2. ANOVA for yield trait.

| Source of Variation | DF | SS | MS | F Value | P Value |
|---------------------|----|----------|---------|---------|---------|
| Replication | 3 | 1380603 | 460201 | | |
| Location | 1 | 1861319 | 1861319 | 5.38 | 0.0258 |
| Genotype | 6 | 4330848 | 721808 | 2.08 | 0.0172 |
| Location*Genotype | 6 | 5094454 | 849076 | 2.45 | 0.0115 |
| Error | 39 | 13500000 | 346263 | | |

Most of the collected agronomic characters showed positive correlation against grain yield. Spike plant⁻¹, biomass had strong correlation with grain yield with correlation coefficient value of 0.52 and 0.66 respectively (Table 3). Similar results were reported by Del Blanco *et al.* (2001)

and Ozturk and Aydin (2004), who showed significant positive correlations between spike plant⁻¹, biomass and grain yield in hexaploid wheat. There was negative correlation among plant height and number of tiller.

Table 3. Correlation among traits.

| | PH | SL | NT | BM | YLD | HI |
|-----|---------|---------|---------|----------|--------|----|
| PH | | | | | | |
| SL | 0.0207 | | | | | |
| NT | -0.0636 | 0.4778* | | | | |
| BM | 0.4112* | 0.4961* | 0.4019* | | | |
| YLD | 0.3311* | 0.523** | 0.4604* | 0.6578** | | |
| HI | 0.3223* | 0.3808* | 0.3362* | -0.3322* | 0.377* | |

* and ** Significant at the 5% and 1% levels of probability, respectively.

Conclusion

Shortage of improved varieties accessibility and limited studies in the study area was one of the main problems. This study generally indicated that there is an opportunity in selection of superior varieties on agronomic trait specially grain yield among tested durum wheat genotypes through direct selection at the study locations as short term strategy rather than a lengthy crossing program.

It was found that there is 22.34% boost of yield for using Hitosa variety (high yielder) as compared to Denbi variety (low yielder) at the study area. Variety Hitosa were well performed at both locations and Ude performed well at Alichio. These varieties can be used for wheat production and seed system program at both locations.

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