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ORIGINAL ARTICLE

Evaluation of Durum wheat varieties for yield and yield related traits in highland areas of Southern Ethiopia

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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 tested genotypes average productivity was evaluated at two locations (Alicho and Analimo Weredas) using a 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 a significant ($P<0.05$) difference among tested genotypes on the collected parameter indicating the presence of adequate variability. The highest average grain yield recorded was 44.46 qt/ha from the Hitosa variety while the lowest obtained was 36.34 qt/ha from the Denbi variety. Grain yield had strong positive correlations ($P<0.01$) with plant height, the number of seed per spikes and biomass.
Keywords: Durum wheat; Genetic variability; Grain yield; Variety.

Introduction

Durum wheat is the second most cultivated wheat next to bread wheat (FAO, 2011). Durum wheat is Indigenous to Ethiopia and it has been cultivated since ancient times. Accurate statistics on the area and production of durum wheat in the country are difficult to obtain since they are lumped together with bread wheat (Efrem, et al., 2000). It was one of the primary domesticated food crops and for 8000 years. It has been the primary staple food of the principal civilizations of Europe, west Asia and North Africa. Today, the crop is grown on a vast land area than any other commercial crop and remains to be the most important food grain source for humans. Its production became before all crops, including rice, maize and potatoes (Curtis, et al, 2002).Most of the tetraploid wheat varieties, grown in Ethiopia are landraces consisting of many 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).

Durum wheat is consumed as ordinary bread, macaroni, spaghetti, biscuits, pastries and various indigenous food preparation (FAO,2011). Despite 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 average domestic 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).The productivity of durum wheat in the country is very low compared to world average due to lack of improved variety, common cultural practices,moisture stresses andother biotic and abiotic factors. The highest food production regions have been those with favorable climatic conditions, relatively fertile soils and an adequate water supply, among others (Getachew, 2004). The primary breeding objective in durum wheat is to create new improved genotypes with features that contribute to more yield potential, increased yield stability and improved product quality (Poehlman and Sleper, 1995). There are different varieties of improved durum wheat varieties with desirable traits released from national agricultural research center in Ethiopia at different times. However, the varieties were not multiplied and distributed all over the region for farmers. The study objective was to select the most adaptable durum wheat varieties for highland areas and to select the varieties that have excellent agronomic performance in the area.

Materials and methods

Experimental Design and Methods

Seven durum wheat varieties were evaluated at two locations Siliti Zone (Alicho Wereda) Latitude: 7° 54' 59.99" N; Longitude: 38° 19' 60.00" E and Hadiya Zone (Analimo Wereda) Latitude: 7° 39' 59.99" N; Longitude: 37° 44' 59.99" E (Fig. 1). The varieties were released from 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 for two years. The size of experimental plot is 1.2 m x 2.5 m (3 m^2), with six rows which are 20cm apart each other. Recommended seed rate (125 kg/ha) and fertilizer rate (100 kg/ha urea and 100kg 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.

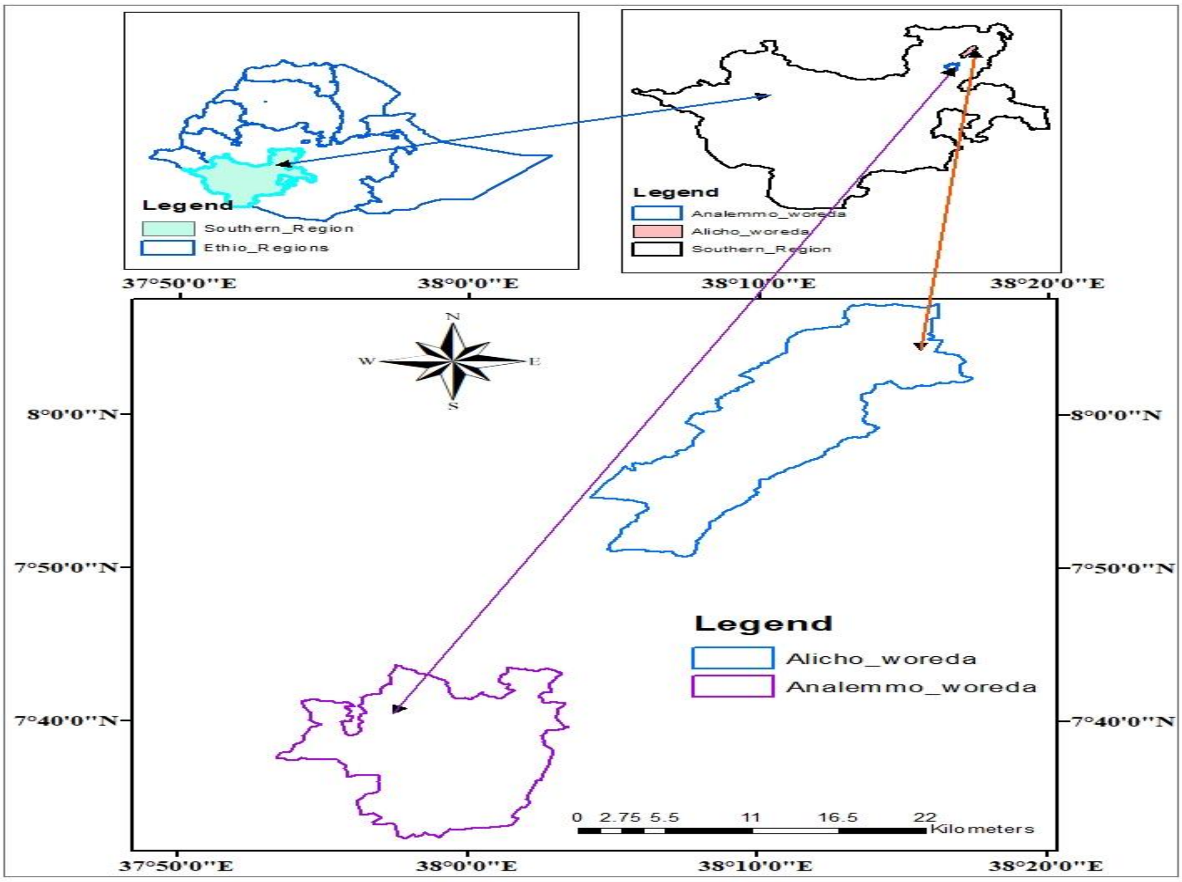

Fig. 1. Location map of Alicho and Analimo Woredas.

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 discussion

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 cm. The highest average plant height was recorded from Asassa variety (94 cm) while the smallest plant height was recorded from Mangudo (74.8 cm). 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 5300 to 10050 kg/ha. The maximum above ground biomass recorded from Ude variety (10050 kg/ha) while the smallest were recorded from Yerer variety (5300 kg/ha). The average grain yield recorded ranged from 3634.8 to 4446.3 kg/ha. The maximum grain yield recorded from Hitosa variety (4446.3 kg/ha) while the smallest were recorded from Denbi variety (3634.8 kg/ha).

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 well performed at Alicho as compared to Analimo site. At Alicho Ude, Hitosa and Mangudo ranked 1st, 2nd and 3rd with grain yield of 47.95, 44.72 and 42.89 qt/ha respectively while at Analimo Hitosa, Makiya and Asassa ranked 1st, 2nd and 3rd with grain yield of 44.19, 42.24 and 39.45 qt/ha respectively.

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

Varieties	PH	SL	TPP	BM	GY	HI
Asassa	94.0A	4.6B	2.5A	9350A	3809.3AB	0.5B
Denbi	78.5BC	5.0B	2.6A	5900BC	3634.8B	0.9A
Hitosa	76.8CD	4.7B	2.6A	7750ABC	4446.3A	0.7AB
Makiya	81.4B	4.9B	2.5A	8500AB	4112.6AB	0.5B
Mangudo	74.8D	4.5B	2.6A	8150ABC	3705.9B	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
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 (cm), SL= Spike length (cm), TPP= Tillers per plant, BM= biomass (kg/ha), GY= Grain yield (kg/ha), HI= Harvest index, LSD=least significant difference, And CV= coefficient of variation

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 Alicho. These varieties can be used for wheat production and seed system program at both locations.

Author Contributions

Conceptualization, Solomon shibeshi; methodology Solomon shibeshi ; formal Analysis, Solomon shibeshi ; investigation Solomon Shibeshi, Daniel kassa; data curation, Solomon shibeshi ; writing—original draft preparation, Solomon shibeshi ; writing and editing, Solomon shibeshi.

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Conflicts of Interest

The Authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, Analysis, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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