Evaluation of Drought Tolerance in Durum Wheat Genotypes Using Drought Tolerance Indices

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Abstract

Drought has become challenging globally, particularly under rain-fed crop production systems of Ethiopia. It is one of the major causes for wheat yield reduction. One hundred forty-four durum wheat genotypes were evaluated at Debre-Zeit experiment station in 2017 dry season, under drought stressed and non-stressed environments, to identify drought tolerant genotypes and suitable drought screening indices. The trial was conducted during the off-season. Based on grain yield under stressed and non-stressed conditions, various drought tolerant indices including Abiotic tolerance indices (ATI), Geometric mean productivity (GMP), Stress tolerance indices (STI), Stress stability indices (SSI), Tolerance indices (TOL), Yield index (YI) and Drought resistance indices (DRI) were computed. The combined analysis of variance showed that moisture, genotypes and their interaction had a significant ($p \leq 0.01$) effect on grain yield. Principal component and Correlation analysis indicated that DRI, YI, YSI and REI, as important indices highly correlated with grain yield under stress suggesting their suitability to identify drought tolerant genotypes. Cluster analysis also grouped the genotypes into five different clusters having various characteristics. Overall, evaluation of durum wheat genotypes for drought stress using different analysis identified G-16, G-763, G-31, G-119, G-63 and G-30 as drought tolerant genotypes. DRI, YI and YSI could be regarded as good indices for the identification of drought tolerant lines. MP, GMP, and REI were the best indices to identify suitable genotypes to both drought and non-drought stressed environment.

Keywords: Cluster analysis, Durum wheat, Drought tolerance indices, Drought stress, Principal component analysis

Introduction

Wheat is the fourth most important cereal crop after maize, tef and sorghum in terms of area coverage and production in Ethiopia. In Ethiopia, both bread and durum wheat is grown extensively, although separate area coverage and production are not known. Both are cultivated over an area of 1.69 million hectares with an annual production of about 2.46 million tones with average productivity of 2.74 tones ha^{-1} (CSA, 2018) which is below the world average. There were several factors that can mention for low productivity of wheat in Ethiopia. Drought was one of the major causes of wheat yield reduction in the country. In Ethiopia, although durum wheat is traditionally grown in the highlands on vertisols with enough rainfall and extended growing season, the crop is usually grown late in the season due to the problem of water logging that exposed to terminal drought stress. Similarly, in lowland environments of Ethiopia, erratic rainfall with poor distribution as well as short growing seasons does not match with crop phenology resulting in terminal drought.

Several studies indicated the radical effect of drought stress on wheat. Exposure to terminal drought affects wheat grain by about 50% than drought at flowering **(**Chenu et. al., 2011), lower flag leaf and spike photosynthesis (Majid et.al. 2013), 1000 kernel weight and weight of kernels per spike by drought than heat (Plaut et. al. 2004) and crop phenology (McMaster, 1997**).** Thus, screening durum wheat for drought stress and identification of the right tolerant genotypes were among the important strategy to increase production and productivity. Breeding success and selection of genotypes under drought stress is often affected by low heritability of traits (Ceccarelli, 1994), high genotype by environment interaction (Hossain et. al., 1990) and lack of suitable screening techniques. The use of screening methods those are simple, cheap and repeatable are a pre-requisite and an alternative strategy to reduce factors that challenge the efforts of crop breeding for drought stress particularly when large numbers of genotypes are to be used for identifications of the right genotypes. Testing genotypes under stress and stress-free environmental conditions and the use of appropriate drought screening indices for associating the response of genotypes are suggested to be effective for identification of true field drought genotypes (Clark et.al. 1992; Trethowan et.al. 2002). The objective of this study was therefore to evaluate genotypes tested under drought stress and non- drought environments and identify tolerant ones using various drought tolerant and susceptible indices.

Materials and Methods

Description of experimental site

The field trial was conducted at Debre-Zeit Agricultural Research Center experimental station located in 8^0 41’36”latitude and 39^0 03’17” longitudes with an altitude of 1880 meter above sea level (masl). The station categorized as mid-highland that represents the major wheat growing areas of Ethiopia.

Experimental genotypes

One hundred forty four durum wheat genotypes were used in the study and the results for 90 of 144 genotypes were presented. Global wheat collections developed for dry environment ,landraces collected from different parts of the country and obtained from Ethiopian biodiversity institute,, local breeding lines and improved cultivars were included (Table 1).

Table 1.Source, number of genotypes and names of genotypes tested under drought stress and non-drought stress environment at Debre-Zeit sandy clay soil during 2017 dry season.

Sources	No of genotypes	Names
Released cultivars	21	Quamy, Assasa,Ginchi,Ude,Werer,Mangudo,Mukiye,Gerardo, Utuba,Kilinto,Bichena, Yerer , Denbi , Tob-66, Ejersa, Toletu, Flakit, Arendato, Boohai, Hitosa and Cocorit
Global wheat collections	57	ICA -381, ICA-45, ICA -47, ICA- 55, ICA-33, ICA -32, ICA-360, ICA - 77, ICA -378, ICA - 54, ICA-46, ICA-61, ICA-383, ICA-359, ICA- 59, ICA- 353, ICA-26, ICA -50, ICA -60, ICA -23, ICA- 56, ICA -13, ICA - 382, ICA -39, ICA-357, ICA- 346, ICA-358, ICA- 48, ICA - 29, ICA -58, ICA-32, ICA-34, ICA-24, ICA-355, ICA -65, ICA-74, ICA- 51, ICA -44, ICA -53, ICA -73, ICA-57, ICA-20, ICA-64, ICA-41, ICA -354, ICA - 25, ICA- 49, ICA-384, ICA-38, ICA-356, ICA -28, ICA -43, ICA -30, ICA -62 and ICA-37
Breeding lines from DZARC nurseries	**27**	Bl-1,Bl-2,Bl-3,Bl-4,Bl-5,Bl-6,Bl-7,Bl-8,Bl-9,Bl-10,Bl-11,Bl-12,Bl-13,Bl-14,Bl-15,Bl-16,Bl-17,Bl-18,Bl-19,Bl-20,Bl-21,Bl-22,Bl-23,Bl-24,Bl-25,Bl-26,and Bl-27
Landraces from EBI collections	**21**	EBI-1,EBI-2,EBI-3,EBI-4,EBI-5,EBI-6,EBI-7,EBI-8,EBI-9,EBI-10,EBI-11,EBI-12,EBI-13,EBI-14,EBI-15,EBI-16,EBI-17,EBI-18,EBI-19,EBI-20, and EBI21
Landraces from DZARC collections	**18**	GN-1,GN-2,GN-3,GN-4,GN-5,GN-6,GN-7,GN-8,GN-9,GN-10,GN-11,GN-12,GN-13,GN-14,GN-15,GN-16,GN-17 and GN-18
Total	**144**	

Experimental Design and Field Management

The plant materials were grown from January 14 to May 22, 2017 during the dry season when rainfall was not expected to affect the trial. The genotypes were arranged in 12 x12 simple lattice designs with two replications. Each genotype was grown in two rows of 2.0 m length and 0.20 meter width with a total plot area of 0.8m^2. Since drought stress is the only factor to be evaluated on genotypes expression, the cultural practices were the same in both conditions. The same amount of seeding rate and planting date were used for both experiments as per the recommendation. During planting, 50 kg/ha urea (46%N) as N sources and 100kg/ha DAP (46% %P_2O_5) as sources of phosphorus were applied. At the beginning of tillering, the remaining 50 Kg/ha urea (46%N) was applied by top dressing. To reduce the influence of biotic factors under both conditions, weeds were controlled manually as needed and tilt fungicides were sprayed twice to prevent the genotypes from stem and leaf rust infection.

In the drought stress treatment, genotypes were fully watered until 50 % of genotypes headed and then after irrigation stopped until time to maturity. The genotypes in non-drought conditions were irrigated when soil moisture was depleted throughout the growing period.

Data collection

Based on grain yield under stressed and non-stressed conditions, various drought tolerant indices were computed (Table 2).

Table 2. Drought tolerance indices

Drought Tolerance induces	Formula	References
Yield stability index (YSI)	Ysi /Ypi	Bouslama and Schapaugh (1984)
Relative efficiency index (REI)	RDI= (Ys/Yp)/ (S Y / P Y	Raman *et.al*. (2012)
Abiotic tolerance indices (ATI)	ATI =[(Yp-Ys) / (P Y / S Y)]× (Yp × Ys)0.5	Moosavi*et.al*. (2008)
Drought resistance indices (DRI)	(DI) = Ys × (Ys/Yp)/ S Y	Lan (1998)
Stress tolerance index (STI)	(Ypi x Ysi)/Yp2	Hossain *et.al*. (1990)
Geometric mean productivity (GMP)	$\sqrt{(\text{Ypi x Ysi})}$	Fernandez (1992)
Yield reduction percentages (YR)	$(\text{GYNS} - \text{GYMS})/GYNS$	(Fischer and Maurer 1978):
Tolerance index (TOL)	Ypi – Ysi	Rosielle and Hamblin (1981)
Mean productivity (MP)	(Ypi + Ysi)/2	Rosielle and Hamblin (1981)

Where, Ysi= Stress yield of a given genotype, Ypi=, none stress yield of a given genotype, PY=, Average of all genotypes under non-drought stress (Potential yield) SY=, Average yield of all genotypes under drought stress potential yield.

Data analyses

Analysis of variance was carried out using SAS version 9.0.Phenotypic and genotypic correlation coefficients were analyzed with Meta R statistical software. Principal component and cluster analysis were carried out using Minitab version16.

Results and Discussion

Analysis of variance

The combined analysis of variance for grain yield under stressed and non-stressed environments is given in Table 3. Moisture, genotypes and moisture levels by genotypes interaction were significant (P≤0.01). Moisture was the major source of variation on grain yield (56.7%) followed by genotypes (30.9%) and moisture by genotypes interactions (12.4%). This indicated that the intensity of drought stress was high enough to discriminate the genotypes and hence, the performance of genotypes on grain yield in each moisture environment varied in response to drought. This is in line with the finding of different authors with various durum wheat genotypes and environments (Habtamu et.al. 2016; Reza and Abdolvahab, 2017).

Table 3.Combined analysis on grain yield across 90 durum wheat genotypes tested under drought stress and non-drought stress environments.

Sources	DF	Mean squares	F-values
Moisture (M)	1	4184903.9	1771.3**
Genotypes (G)	89	22817.9	9.66**
Moisture x Genotype	89	10536.9	4.46**
Error	156	2362.7	

** Significant at 0.01

Reaction of durum wheat genotypes to drought

Drought stress reduced the yield of durum wheat genotypes and the genotypes respond differently to the effect of drought as revealed by drought indices (Appendix Table 1).According to TOL, genotypes 35, 29, 76, 77, 16, and 49 exhibited the most and 128, 8, 90, 74 and 50 were the least tolerance. For ATI the genotypes 35, 76, 77**,** 75 and 80, were the most and 58, 90, 128, 55, and 50 were the least tolerant genotypes. As per YSI, genotypes 76, 35, 77, 1 and 16were the most and 128,8,66,121 and 135 the least tolerant genotypes. Stress tolerance indices (STI) showed that genotypes 30, 55, 56, 58, 15 and 31 were the most, whereas genotypes 75, 64, 111, 22, and 35 the least tolerant genotypes. For Geometric mean productivity (GMP) genotypes 30, 55, 15, 58, 97, and 31 were the most and 75, 64, 111, 22, and 135 the least tolerant genotypes. Based on mean productivity (MP), genotypes 30, 15, 55, 58, 15, and 31 were found to be tolerant and the genotypes 75, 64,111, 22, and 35 were categorized as the least tolerant ones. Relative efficiency indices (REI) categorized the genotypes 75, 64,111, 22, and 135 as the most tolerant whereas genotypes 55,58,30,31 and 15 as the least tolerant ones. In Stress Susceptibility Index (SSI), the tolerant genotypes were genotypes 76, 35, 77, 1 and 16 whereas 128, 8, 66,121, and 35 were considered as the least tolerant genotypes.

Correlation analysis

Phenotypic and genotypic correlation coefficients of grain yield under drought stress, non-stress and drought tolerant indices are given in Table 4. The phenotypic and genotypic correlation coefficient of grain yield under drought stress in respective order were positive and strong with drought resistance indices (rp=0.92, rg= 0.94); relative efficiency indices (rp=0.90, rg=0.92); geometric mean productivity (rp=0.91, rg=0.94) and mean productivity (0.79, rg=0.85). The high correlation value of grain yield under drought with DRI, REI and GMP suggested that these indices could be used as drought tolerant selection traits and would able to discriminate drought tolerant genotypes. Hu et. al (2007) presented that high correlation of drought resistance indices with grain yield was an indication of drought tolerance. In contrast, grain yield under drought associated negatively with stress susceptibility indices (rp= -0.63, rg= -0.67) and tolerance (rp= -0.24, rg= -0.21). Similarly, yield under non drought stress was positive and strong with Abiotic tolerance indices (rp=0.94, rg=0.96); mean productivity (rp=0.91, rg=0.92); geometric mean productivity (rp=0.79, rg=0.81); and relative efficiency indices (rp=0.78, rg=0.82) but negatively correlated with yield stability indices (rp= -0.35, rg= -0.21). The existence of strong and positive association of grain yield under non-stress with abiotic tolerance indicates that these indices would be more suitable to identify genotypes that can be utilized to drought free environments than the other indices. This result was supported by Farshadfar et.al. (2012) and Tauqeer et al (2013) that ATI had the highest positive phenotypic and genotypic correlation coefficients with grain yield under non-drought stress. It was also noted that MP, GMP and REI had positive and strong association with grain yield of both drought stress and non-stress conditions.

Positive and strong correlations were observed among each pair of Tolerance and SSI with phenotypic and genotypic correlation coefficients of (0.86 and 0.84); Geometric mean productivity had positive and strong phenotypic and genotypic correlations coefficient values of (rp=0.97, rg=0.98 and rp=0.99, rg=0.99) with Mean productivity and relative efficiency indices respectively. In contrast, Geometric mean productivity and Tolerance were correlated negatively with stress susceptibility indices (rp= -0.26, rg= -0.37) and Mean relative performance (rp= -0.86, rg= -0.84) respectively (Table 4).

Principal Component Analysis

Two principal components (PCs) with eigenvalues of 6.03 and 8.8 explained a cumulative of about 98.7% of the total phenotypic variability observed among the durum wheat genotypes (Table 5). PC1 alone explained 58 % of the total variation with high loading due to grain yield in the stress (Ys), drought resistance index (DRI) yield index (YI), yield stability index (YSI) stress. The genotypes which have a high value of first component (PC1) are expected to have a high yield under drought stress condition. Assefa et. al. (2019) presented YI and YSI as principal indices to identify superior genotypes under drought using 256 bread wheat genotypes. The correlation matrix of this study also revealed that these indices were highly correlated with grain yield under stressed condition. This result was supported by Guilherme et. al (2021) and Ayad et. al. (2021) that DRI significantly correlated with grain

Table 4. Phenotypic (Rp= above Diagonal) and genotypic (Rg= below Diagonal) correlation coefficients for grain yield under drought stress, non-drought stress and drought tolerant indices for 90 durum wheat genotypes tested at Debre-Zeit sandy clay soil in 2017 dry season.

Traits	GYNS	GYST	TOL	MP	SSI	GMP	YSI	REI	YI	DRI	ATI	SSPI
Grain yield non-stress		0.47	0.75	0.91	0.35	0.79	-0.35	0.78	0.47	0.12	0.94	0.75
Grain yield stress	0.56		-0.24	0.79	-0.63	0.91	0.63	0.90	1.00	0.92	0.21	-0.24
Tolerance	0.69	-0.21		0.40	0.86	0.18	-0.86	0.18	-0.24	-0.56	0.88	1.00
Mean Productivity	0.92	0.85	0.34		-0.06	0.97	0.06	0.96	0.79	0.51	0.75	0.40
Stress susceptibility indices	0.21	-0.67	0.84	-0.18		-0.26	-1.00	-0.25	-0.63	-0.86	0.55	0.86
Geometric mean	0.81	0.94	0.14	0.98	-0.37		0.26	0.99	0.91	0.67	0.59	0.18
Yield stability indices	-0.21	0.67	-0.84	0.18	-1.00	0.37		0.25	0.63	0.86	-0.55	-0.86
Relative Efficiency Indices	0.82	0.92	0.15	0.97	-0.35	0.99	0.35		0.90	0.67	0.60	0.18
Yield indices	0.56	1.00	-0.21	0.85	-0.67	0.94	0.67	0.92		0.92	0.21	-0.24
Drought Resistance Indices	0.28	0.94	-0.50	0.63	-0.88	0.77	0.88	0.75	0.94		-0.16	-0.56
Abiotic Tolerance Indices	0.96	0.34	0.84	0.78	0.44	0.64	-0.44	0.67	0.34	0.03		0.88
Stress susceptibility percentage index	0.69	-0.21	1.00	0.34	0.84	0.14	-0.84	0.15	-0.21	-0.50	0.84	

yield under drought stress**.** Similarly, the proportion of the total phenotypic variance of the genotypes accounted for by the second PC was 40.2 percent. The major trait included in the second PC was grain yield under non-drought, mean productivity, SSPI, STI, GMP andATI (Table5). Principal component analysis showed the relationship of different indices with grain yield under two moisture conditions. When all drought tolerant indices and grain yield under both conditions were considered as variables, three groups were formed (Figure 1). In the first group, grain yield under non-stress including all drought indices were categorized in the second PC except tolerance and SSPI. The second group comprised of SSI, drought intensity, tolerance and SSPI. In the third group traits included were similar to that of the first principal component. Hence, the use of these indices would enable to identify suitable genotypes for the respective moisture environments

Table 5. Eigenvectors and eigenvalues of the two principal components for 15 traits of 90 durum wheat genotypes.

Traits	PC1	PC2
Grain yield non-stress	0.020	-0.412
Grain yield stress	0.344	-0.172
Tolerance	-0.237	-0.319
Mean productivity	0.178	-0.365
Stress susceptibility index	-0.342	-0.166
Geometric mean productivity	0.246	-0.313
Yield stability index	0.342	0.166
Relative Efficiency Indices	0.242	-0.312
Yield Index	0.344	-0.172
Drought Resistance Index	0.374	-0.024
SSPI	-0.237	-0.319
Reduction percentage	-0.345	-0.160
Abiotic Tolerance Index	-0.081	-0.396
Eigenvalue	6.9596	5.8274
Proportion	0.535	0.448
Cumulative	0.535	0.984

Cluster Analysis

The cluster analysis resulted in the clustering of 92 durum wheat genotypes into five major groups' comprising 2-29 genotypes (Table 6 and Figure 2). The numbers of genotypes categorized were 26, 29, 28, 7 and 2 in cluster 1, cluster 2, cluster 3, cluster 4 and 5 respectively. Cluster five included only G-58 and G-90 which are characterized by the highest grain yield under non-drought stress and above-average grain yield under low drought stress conditions with moderate yield stability and considered as both drought tolerant with high yield potential.

The cluster analysis using mean values of 92 durum wheat genotypes generated five cluster groups (Table 6). Tauqeer et al (2013) evaluated 46 bread wheat genotypes for drought tolerance and found only two clusters. The relatively large number of cluster could be due to the variability of genotypes in response to drought stress as well as different sources of origin while the genotypes found in the same group indicates the genetic affinity of the genotypes to respond to drought stress similarly than the genotypes in different group (Figure 2). The genotypes maintained under different groups had specific characters and it may give desirable genetic recombinants in developing drought tolerant varieties if they are used in hybridization.

The dendrogram presented in Figure .1 also showed similar result and trend with the correlation analysis and it classified the various indices in to three major categories such that YI, DRI and YSI were grouped with grain yield under stress. Similarly, grain yield under drought was also categorized with Abiotic tolerance indices indicating that the possibility of using alternative indices for identification of drought tolerant genotypes.

Table 6. Cluster numbers and lines grouped in each cluster for the 92 durum wheat genotypes tested at Debre-Zeit sandy clay soil in 2017 dry season.

Cluster no	No of genotypes	Genotypes	%
I	26	G-136, G-94,G-113,G-91,G-125,G-30,G-142,G-132, G-115, G-53,G-84,G-110,G-85,G-61,G-9,G-69,G-112,G-134,G-120,G-79,G-123,G-25,G-59,G-43,G-60 and G-37	28.3
II	29	G-121, G-26, G-127,G-63,G-137,G-97,G-89,G-104,G-98,G-135,G-133,G-103,G-105,G-18,G-39,G-31,G-66,G-33,G-144,G-32,G-102,G-17,G-140,G-13,G-3,G-36,G-4,G-138 and G-5	31.5
III	28	G-1,G-126,G-86,G-118,G-49,G-78,G-52,G-119,G-114,G-141,G-14,G-81,G-16,G-29,G-117,G-64,G-22,G-93,G-34,G-57,G-80,G-75,G-77, G-116,G-35,G-76,G-111, and G-71	30.43
IV	7	G-55,G-128,G-44,G-74,G-8,G-50 and G-15	7.6
V	2	G-58 and G-90	2.17
Total	92		

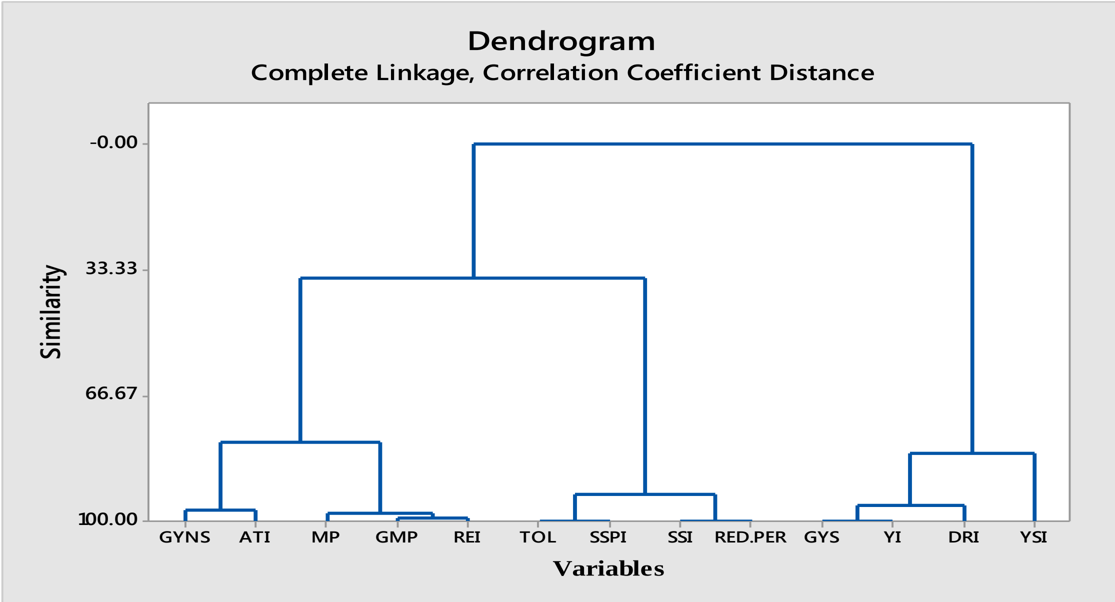

Figure . 1. Dendrogram of different drought screening indices on durum wheat

GYNS=Grain yield under no drought stress; GYS= Grain yield under low drought stress; ATI=Abiotic tolerance indices; MP=Mean productivity; GMP=Geometric mean productivity; REI=Relative efficiency index; TOL=Tolerance; SSPI=Stress susceptibility percentage index; SSI=Stress susceptibility index; RED.PER=Reduction percentage; YI=Yield index; DRI=Drought response index; YSI=Yield stability index

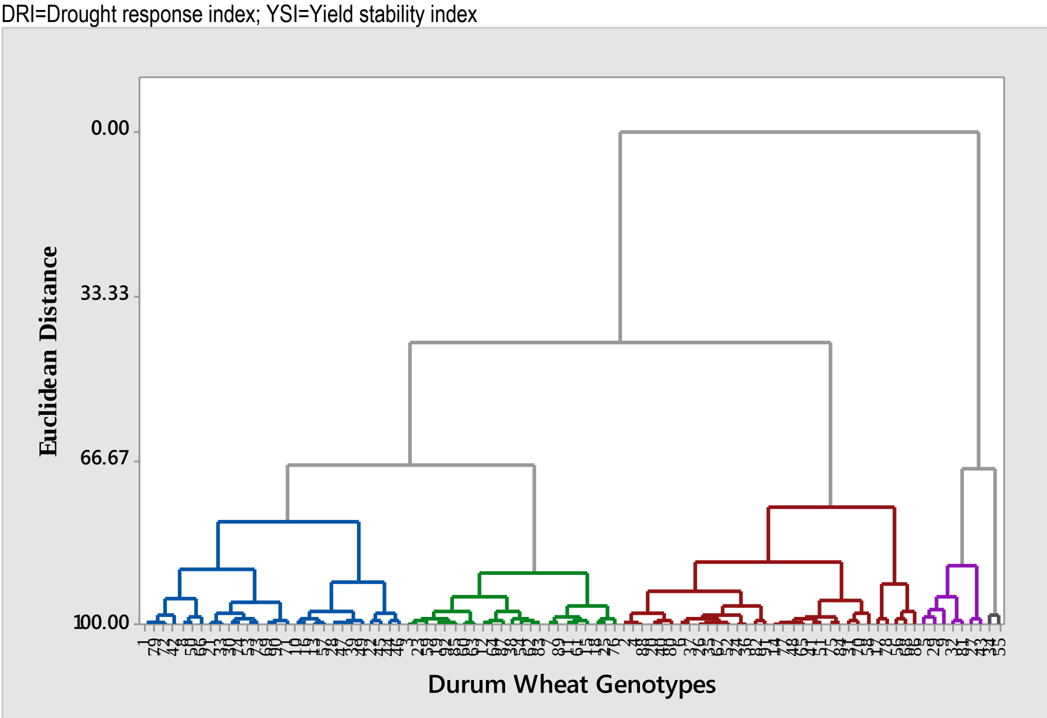

Figure . 2.Dendrogram categorizing durum wheat genotypes into five clusters

Conclusion

The results of the study based on the correlation matrices; cluster and principal analysis YI YSI and DRI were highly correlated to each other and to grain yield in stressed condition and could be used to identify drought tolerant genotypes. In contrast, ATI and MP had strong positive association with grain yield under non drought. MP, GMP, and REI associated with both grain yield under both drought and non-drought condition probably is the best indices for identification genotypes suitable for both environments. The durum breeding lines G-16, G-76, G-31, and G-119, G-63 and G-30 with better yield potential under drought stress with high drought resistant indices (DRI) and yield stability index could be used to identify drought tolerant genotypes.

Acknowledgments

The authors would like to thank the Ethiopian Institute of Agricultural Research (EIAR), Agricultural Growth Program II, (AGP II) and the International Center for Agricultural Research in the Dry Areas (ICARDA) for providing technical and financial supports for the execution of the field experiment. The authors also acknowledged the support provided by Wondo-Genet Research Center and Debre-Zeit Research Center. Research and technical staff members of the crop research process of Debre-Zeit Research Center are highly acknowledged for assisting us on field activities.

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Appendix 1.Drought tolerance indices for durum wheat genotypes

GEN	YNS	YST	SSI	RDI	TOL	MP	STI	GMP	YI	YSI	ATI	DRI	SSPI	DIN
1	444.35	278.50	0.68	1.40	165.85	361.43	0.71	351.78	1.49	0.63	26117.19	0.93	19.82	0.37
2	493.20	226.00	0.98	1.02	267.20	359.60	0.64	333.86	1.21	0.46	39933.55	0.55	31.93	0.54
3	449.25	226.00	0.90	1.12	223.25	337.63	0.58	318.64	1.21	0.50	31843.84	0.61	26.68	0.50
4	369.05	135.60	1.15	0.82	233.45	252.33	0.29	223.70	0.72	0.37	23377.71	0.27	27.90	0.63
5	425.00	167.00	1.10	0.88	258.00	296.00	0.41	266.41	0.89	0.39	30768.63	0.35	30.83	0.61
6	252.00	168.00	0.60	1.49	84.00	210.00	0.24	205.76	0.90	0.67	7736.95	0.60	10.04	0.33
7	404.60	132.00	1.22	0.73	272.60	268.30	0.31	231.10	0.70	0.33	28200.80	0.23	32.58	0.67
8	653.40	139.55	1.42	0.48	513.85	396.48	0.52	301.96	0.75	0.21	69458.69	0.16	61.41	0.79
9	483.15	149.85	1.25	0.69	333.30	316.50	0.41	269.07	0.80	0.31	40145.83	0.25	39.83	0.69
10	423.95	234.00	0.81	1.23	189.95	328.98	0.57	314.97	1.25	0.55	26781.83	0.69	22.70	0.45
11	301.25	144.50	0.94	1.07	156.75	222.88	0.25	208.64	0.77	0.48	14639.99	0.37	18.73	0.52
13	451.45	260.85	0.76	1.29	190.60	356.15	0.67	343.16	1.39	0.58	29279.18	0.80	22.78	0.42
14	320.95	196.00	0.70	1.36	124.95	258.48	0.36	250.81	1.05	0.61	14028.74	0.64	14.93	0.39
15	671.05	256.00	1.12	0.85	415.05	463.53	0.98	414.47	1.37	0.38	77007.60	0.52	49.60	0.62
16	374.40	305.50	0.33	1.82	68.90	339.95	0.65	338.20	1.63	0.82	10431.06	1.33	8.23	0.18
17	425.35	186.00	1.02	0.98	239.35	305.68	0.45	281.27	0.99	0.44	30136.92	0.43	28.60	0.56
18	472.85	254.50	0.84	1.20	218.35	363.68	0.69	346.90	1.36	0.54	33907.40	0.73	26.09	0.46
19	157.50	68.20	1.03	0.97	89.30	112.85	0.06	103.64	0.36	0.43	4143.04	0.16	10.67	0.57
20	235.25	42.00	1.49	0.40	193.25	138.63	0.06	99.40	0.22	0.18	8598.94	0.04	23.09	0.82
21	389.55	240.00	0.70	1.38	149.55	314.78	0.53	305.76	1.28	0.62	20469.60	0.79	17.87	0.38
22	276.65	153.50	0.81	1.24	123.15	215.08	0.24	206.07	0.82	0.55	11360.30	0.45	14.72	0.45
23	415.40	94.00	1.40	0.51	321.40	254.70	0.22	197.60	0.50	0.23	28430.12	0.11	38.41	0.77
24	220.30	96.00	1.02	0.97	124.30	158.15	0.12	145.43	0.51	0.44	8091.89	0.22	14.85	0.56
25	667.00	209.00	1.24	0.70	458.00	438.00	0.80	373.37	1.12	0.31	76548.60	0.35	54.73	0.69
26	477.75	294.50	0.69	1.38	183.25	386.13	0.80	375.10	1.57	0.62	30769.66	0.97	21.90	0.38
27	486.00	298.00	0.70	1.37	188.00	392.00	0.83	380.56	1.59	0.61	32027.26	0.98	22.47	0.39
28	112.95	65.00	0.77	1.29	47.95	88.98	0.04	85.68	0.35	0.58	1839.18	0.20	5.73	0.42
29	374.35	303.00	0.35	1.81	71.35	338.68	0.65	336.79	1.62	0.81	10756.97	1.31	8.53	0.19
30	670.60	384.50	0.77	1.28	286.10	527.55	1.47	507.79	2.05	0.57	65032.96	1.18	34.19	0.43
31	563.65	334.50	0.74	1.33	229.15	449.08	1.08	434.21	1.79	0.59	44540.84	1.06	27.38	0.41
32	454.15	263.00	0.76	1.29	191.15	358.58	0.68	345.60	1.40	0.58	29572.47	0.81	22.84	0.42

33	483.10	279.60	0.76	1.29	203.50	381.35	0.77	367.53	1.49	0.58	33480.14	0.86	24.32	0.42
34	382.95	240.00	0.68	1.40	142.95	311.48	0.52	303.16	1.28	0.63	19399.77	0.80	17.08	0.37
35	237.85	174.00	0.49	1.63	63.85	205.93	0.24	203.44	0.93	0.73	5814.64	0.68	7.63	0.27
36	373.10	122.00	1.22	0.73	251.10	247.55	0.26	213.35	0.65	0.33	23981.42	0.21	30.01	0.67
37	505.00	198.50	1.10	0.88	306.50	351.75	0.57	316.61	1.06	0.39	43440.23	0.42	36.63	0.61
38	418.50	223.50	0.84	1.19	195.00	321.00	0.53	305.83	1.19	0.53	26696.65	0.64	23.30	0.47
39	469.05	212.50	0.99	1.01	256.55	340.78	0.57	315.71	1.13	0.45	36257.41	0.51	30.66	0.55
40	581.50	66.00	1.60	0.25	515.50	323.75	0.22	195.91	0.35	0.11	45207.58	0.04	61.60	0.89
41	219.45	156.00	0.52	1.59	63.45	187.73	0.20	185.02	0.83	0.71	5255.30	0.59	7.58	0.29
42	559.00	105.00	1.47	0.42	454.00	332.00	0.34	242.27	0.56	0.19	49237.06	0.11	54.25	0.81
43	463.60	147.00	1.24	0.71	316.60	305.30	0.39	261.05	0.78	0.32	36997.89	0.25	37.83	0.68
44	526.35	269.65	0.88	1.14	256.70	398.00	0.81	376.74	1.44	0.51	43291.15	0.74	30.68	0.49
45	306.80	65.00	1.43	0.47	241.80	185.90	0.11	141.22	0.35	0.21	15285.38	0.07	28.90	0.79
46	465.50	79.00	1.50	0.38	386.50	272.25	0.21	191.77	0.42	0.17	33178.64	0.07	46.19	0.83
47	409.10	89.50	1.41	0.49	319.60	249.30	0.21	191.35	0.48	0.22	27375.92	0.10	38.19	0.78
48	264.65	173.25	0.63	1.46	91.40	218.95	0.26	214.13	0.92	0.65	8761.02	0.61	10.92	0.35
49	340.70	246.50	0.50	1.62	94.20	293.60	0.48	289.80	1.32	0.72	12220.28	0.95	11.26	0.28
50	497.40	205.55	1.06	0.92	291.85	351.48	0.58	319.75	1.10	0.41	41774.10	0.45	34.88	0.59
51	491.75	138.50	1.30	0.63	353.25	315.13	0.39	260.97	0.74	0.28	41268.15	0.21	42.21	0.72
52	377.60	244.00	0.64	1.44	133.60	310.80	0.53	303.54	1.30	0.65	18153.20	0.84	15.97	0.35
53	480.85	206.00	1.03	0.96	274.85	343.43	0.57	314.73	1.10	0.43	38723.08	0.47	32.84	0.57
54	236.15	76.00	1.23	0.72	160.15	156.08	0.10	133.97	0.41	0.32	9604.25	0.13	19.14	0.68
55	639.30	366.00	0.77	1.28	273.30	502.65	1.34	483.72	1.95	0.57	59179.09	1.12	32.66	0.43
56	699.35	291.50	1.06	0.93	407.85	495.43	1.16	451.51	1.56	0.42	82433.31	0.65	48.74	0.58
57	389.15	200.50	0.88	1.15	188.65	294.83	0.45	279.33	1.07	0.52	23588.93	0.55	22.54	0.48
58	638.90	316.00	0.91	1.10	322.90	477.45	1.15	449.32	1.69	0.49	64947.70	0.83	38.59	0.51
59	464.95	195.50	1.05	0.94	269.45	330.23	0.52	301.49	1.04	0.42	36365.57	0.44	32.20	0.58
60	502.80	195.50	1.11	0.87	307.30	349.15	0.56	313.52	1.04	0.39	43128.99	0.41	36.72	0.61
61	509.10	222.50	1.02	0.98	286.60	365.80	0.65	336.56	1.19	0.44	43179.58	0.52	34.25	0.56
62	233.60	86.50	1.14	0.83	147.10	160.05	0.12	142.15	0.46	0.37	9360.37	0.17	17.58	0.63
63	329.00	354.50	-0,14	2.41	-25.50	341.75	0.67	341.51	1.89	1.08	-3898.36	2.04	-3.05	-0.08
64	253.50	141.00	0.80	1.24	112.50	197.25	0.20	189.06	0.75	0.56	9521.09	0.42	13.44	0.44

65	245.75	126.00	0.88	1.15	119.75	185.88	0.18	175.97	0.67	0.51	9432.86	0.34	14.31	0.49
66	447.90	106.00	1.38	0.53	341.90	276.95	0.27	217.89	0.57	0.24	33348.65	0.13	40.86	0.76
67	311.10	31.50	1.63	0.23	279.60	171.30	0.06	98.99	0.17	0.10	12390.20	0.02	33.41	0.90
68	410.85	194.00	0.96	1.05	216.85	302.43	0.46	282.32	1.04	0.47	27405.50	0.49	25.91	0.53
69	483.75	186.00	1.11	0.86	297.75	334.88	0.51	299.96	0.99	0.38	39981.07	0.38	35.58	0.62
70	270.25	164.00	0.71	1.36	106.25	217.13	0.25	210.53	0.88	0.61	10013.12	0.53	12.70	0.39
71	327.00	201.00	0.70	1.37	126.00	264.00	0.38	256.37	1.07	0.61	14460.33	0.66	15.06	0.39
72	269.65	184.30	0.57	1.53	85.35	226.98	0.28	222.93	0.98	0.68	8517.30	0.67	10.20	0.32
73	371.45	158.50	1.04	0.95	212.95	264.98	0.34	242.64	0.85	0.43	23130.14	0.36	25.45	0.57
74	604.50	200.50	1.21	0.74	404.00	402.50	0.69	348.14	1.07	0.33	62961.12	0.36	48.28	0.67
75	206.65	129.95	0.67	1.40	76.70	168.30	0.15	163.87	0.69	0.63	5626.48	0.44	9.17	0.37
76	313.90	281.00	0.19	2.00	32.90	297.45	0.50	296.99	1.50	0.90	4374.02	1.34	3.93	0.10
77	283.25	240.50	0.27	1.90	42.75	261.88	0.39	261.00	1.28	0.85	4994.76	1.09	5.11	0.15
78	385.50	238.05	0.69	1.38	147.45	311.78	0.52	302.93	1.27	0.62	19995.25	0.78	17.62	0.38
79	427.05	222.50	0.87	1.16	204.55	324.78	0.54	308.25	1.19	0.52	28225.37	0.62	24.44	0.48
80	295.15	203.00	0.57	1.54	92.15	249.08	0.34	244.78	1.08	0.69	10097.19	0.75	11.01	0.31
81	326.65	231.00	0.53	1.58	95.65	278.83	0.43	274.69	1.23	0.71	11761.64	0.87	11.43	0.29
82	297.05	131.00	1.01	0.99	166.05	214.03	0.22	197.27	0.70	0.44	14663.07	0.31	19.84	0.56
83	420.50	190.50	0.99	1.01	230.00	305.50	0.46	283.03	1.02	0.45	29140.30	0.46	27.49	0.55
84	514.20	203.33	1.09	0.88	310.87	358.77	0.60	323.35	1.09	0.40	44996.65	0.43	37.15	0.60
85	401.50	171.00	1.04	0.95	230.50	286.25	0.39	262.02	0.91	0.43	27036.31	0.39	27.54	0.57
86	346.60	196.55	0.78	1.27	150.05	271.58	0.39	261.01	1.05	0.57	17531.64	0.60	17.93	0.43
87	440.05	306.00	0.55	1.55	134.05	373.03	0.77	366.95	1.63	0.70	22019.85	1.14	16.02	0.30
88	490.80	114.00	1.39	0.52	376.80	302.40	0.32	236.54	0.61	0.23	39898.02	0.14	45.03	0.77
89	387.05	167.50	1.03	0.97	219.55	277.28	0.37	254.62	0.89	0.43	25024.19	0.39	26.24	0.57

90	502.80	248.50	0.92	1.10	254.30	375.65	0.71	353.48	1.33	0.49	40238.60	0.66	30.39	0.51
91	572.85	332.50	0.76	1.30	240.35	452.68	1.09	436.43	1.78	0.58	46956.54	1.03	28.72	0.42
92	196.05	138.15	0.53	1.57	57.90	167.10	0.15	164.57	0.74	0.70	4265.53	0.52	6.92	0.30
93	232.70	214.50	0.14	2.06	18.20	223.60	0.29	223.41	1.15	0.92	1820.20	1.06	2.17	0.08
94	475.85	185.00	1.11	0.87	290.85	330.43	0.50	296.70	0.99	0.39	38630.09	0.38	34.76	0.61
95	431.20	130.80	1.26	0.68	300.40	281.00	0.32	237.49	0.70	0.30	31935.88	0.21	35.90	0.70
96	685.10	145.50	1.43	0.47	539.60	415.30	0.57	315.72	0.78	0.21	76263.40	0.16	64.48	0.79
97	505.10	278.00	0.81	1.23	227.10	391.55	0.80	374.72	1.48	0.55	38094.65	0.82	27.14	0.45
98	371.80	187.50	0.90	1.13	184.30	279.65	0.40	264.03	1.00	0.50	21782.93	0.50	22.02	0.50
99	374.35	90.50	1.37	0.54	283.85	232.43	0.19	184.06	0.48	0.24	23387.72	0.12	33.92	0.76
100	208.00	132.00	0.66	1.42	76.00	170.00	0.16	165.70	0.70	0.63	5637.26	0.45	9.08	0.37
101	323.15	71.50	1.41	0.49	251.65	197.33	0.13	152.00	0.38	0.22	17123.31	0.08	30.07	0.78
102	407.00	155.20	1.12	0.85	251.80	281.10	0.36	251.33	0.83	0.38	28329.21	0.32	30.09	0.62
103	369.60	199.00	0.84	1.20	170.60	284.30	0.42	271.20	1.06	0.54	20711.30	0.57	20.39	0.46
104	365.50	143.00	1.10	0.87	222.50	254.25	0.30	228.62	0.76	0.39	22770.76	0.30	26.59	0.61
105	395.80	119.00	1.27	0.67	276.80	257.40	0.27	217.03	0.64	0.30	26891.39	0.19	33.08	0.70
106	425.60	39.00	1.64	0.20	386.60	232.30	0.09	128.83	0.21	0.09	22296.19	0.02	46.20	0.91
107	317.45	131.00	1.06	0.92	186.45	224.23	0.24	203.93	0.70	0.41	17020.47	0.29	22.28	0.59
108	359.85	91.00	1.35	0.56	268.85	225.43	0.19	180.96	0.49	0.25	21778.46	0.12	32.13	0.75
109	401.75	61.00	1.54	0.34	340.75	231.38	0.14	156.55	0.33	0.15	23878.91	0.05	40.72	0.85
110	534.80	303.50	0.78	1.27	231.30	419.15	0.93	402.88	1.62	0.57	41714.44	0.92	27.64	0.43
111	278.50	132.50	0.95	1.06	146.00	205.50	0.21	192.10	0.71	0.48	12554.78	0.34	17.45	0.52
112	510.75	312.50	0.70	1.37	198.25	411.63	0.91	399.51	1.67	0.61	35455.05	1.02	23.69	0.39
113	528.85	164.00	1.25	0.69	364.85	346.43	0.50	294.50	0.88	0.31	48099.24	0.27	43.60	0.69
114	408.15	181.50	1.01	0.99	226.65	294.83	0.42	272.17	0.97	0.44	27614.66	0.43	27.08	0.56

115	516.80	265.00	0.88	1.15	251.80	390.90	0.78	370.07	1.41	0.51	41713.40	0.73	30.09	0.49
116	395.05	166.25	1.05	0.94	228.80	280.65	0.38	256.28	0.89	0.42	26248.14	0.37	27.34	0.58
117	324.00	160.50	0.91	1.11	163.50	242.25	0.30	228.04	0.86	0.50	16690.28	0.42	19.54	0.50
118	391.75	208.00	0.85	1.19	183.75	299.88	0.47	285.45	1.11	0.53	23480.06	0.59	21.96	0.47
119	472.70	374.00	0.38	1.77	98.70	423.35	1.01	420.46	2.00	0.79	18577.25	1.58	11.79	0.21
120	521.30	224.50	1.03	0.96	296.80	372.90	0.67	342.10	1.20	0.43	45451.86	0.52	35.47	0.57
121	405.30	118.50	1.28	0.65	286.80	261.90	0.27	219.15	0.63	0.29	28136.00	0.18	34.27	0.71
122	385.15	244.50	0.66	1.42	140.65	314.83	0.54	306.87	1.31	0.63	19321.01	0.83	16.81	0.37
123	527.40	223.00	1.04	0.94	304.40	375.20	0.67	342.94	1.19	0.42	46730.76	0.50	36.38	0.58
124	801.20	230.50	1.29	0.64	570.70	515.85	1.05	429.74	1.23	0.29	109786.65	0.35	68.20	0.71
125	561.10	210.50	1.13	0.84	350.60	385.80	0.67	343.67	1.12	0.38	53937.87	0.42	41.90	0.62
126	394.00	205.00	0.87	1.16	189.00	299.50	0.46	284.20	1.09	0.52	24044.88	0.57	22.59	0.48
127	456.90	207.50	0.99	1.01	249.40	332.20	0.54	307.91	1.11	0.45	34375.72	0.50	29.80	0.55
128	593.00	117.50	1.45	0.44	475.50	355.25	0.40	263.96	0.63	0.20	56186.57	0.12	56.82	0.80
129	294.65	118.00	1.09	0.89	176.65	206.33	0.20	186.46	0.63	0.40	14744.96	0.25	21.11	0.60
130	533.60	243.00	0.99	1.02	290.60	388.30	0.74	360.09	1.30	0.46	46842.75	0.59	34.73	0.54
131	515.95	148.50	1.29	0.64	367.45	332.23	0.44	276.80	0.79	0.29	45530.35	0.23	43.91	0.71
132	487.15	280.50	0.77	1.29	206.65	383.83	0.78	369.66	1.50	0.58	34195.50	0.86	24.69	0.42
133	310.00	162.50	0.86	1.17	147.50	236.25	0.29	224.44	0.87	0.52	14819.56	0.45	17.63	0.48
134	495.95	173.00	1.18	0.78	322.95	334.48	0.49	292.92	0.92	0.35	42346.06	0.32	38.59	0.65
135	376.90	112.50	1.27	0.67	264.40	244.70	0.24	205.92	0.60	0.30	24371.74	0.18	31.60	0.70
136	392.20	201.00	0.88	1.14	191.20	296.60	0.45	280.77	1.07	0.51	24031.20	0.55	22.85	0.49
137	487.30	282.85	0.76	1.30	204.45	385.08	0.79	371.26	1.51	0.58	33978.10	0.88	24.43	0.42
138	443.10	175.50	1.09	0.88	267.60	309.30	0.44	278.86	0.94	0.40	33404.98	0.37	31.98	0.60

139	433.30	42.50	1.63	0.22	390.80	237.90	0.11	135.70	0.23	0.10	23739.91	0.02	46.70	0.90
140	418.60	160.50	1.12	0.86	258.10	289.55	0.38	259.20	0.86	0.38	29947.52	0.33	30.84	0.62
141	359.65	144.00	1.09	0.89	215.65	251.83	0.30	227.57	0.77	0.40	21968.81	0.31	25.77	0.60
142	471.15	197.00	1.05	0.93	274.15	334.08	0.53	304.66	1.05	0.42	37388.38	0.44	32.76	0.58
143	506.45	82.00	1.52	0.36	424.45	294.23	0.24	203.79	0.44	0.16	38720.19	0.07	50.72	0.84
144	434.60	149.50	1.19	0.77	285.10	292.05	0.37	254.90	0.80	0.34	32531.07	0.27	34.07	0.66