

Evaluation of Bread Wheat (*Triticum aestivum* L.) Genotypes for Drought Tolerance Using Canopy Temperature and Chlorophyll Content

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Abstract: Bread wheat is important strategic crop used as staple crops worldwide including Ethiopia. Drought is the main limiting factor where bread wheat is commonly grown specially areas receiving low annual rainfall. Evaluation of genotypes for drought tolerance using different mechanism is the most pillars to make the area productive. Therefore, the present study was conducted at Werer Agricultural Research Center during 2019/20 to evaluate different genotypes for drought tolerance using canopy temperature and chlorophyll content as the main selection criteria. The experiment was conducted under normal and stress condition. The stress environment was imposed by withholding irrigation water at flowering stage and the optimum one irrigated at ten days interval up to physiological maturity. The analysis of variance showed the tested genotypes showed significant variation for grain yield under both conditions. The range of variation for grain yield ranged from 2.30-6.0 t ha⁻¹ and 1.01-4.36 t ha⁻¹ under optimum and stress condition respectively. High and moderate PCV and GCV values were recorded for grain yield under stress condition; whereas low PCV and GCV values were recorded for canopy temperature and chlorophyll content. Grain yield and chlorophyll content showed moderate heritability value whereas canopy temperature showed high heritability value. Correlation analysis revealed that chlorophyll content had positive significant correlation with grain yield; while canopy temperature showed significant negative correlation with grain yield. Generally, there is wide range of variation among the tested genotypes for traits considered which clearly indicate greater opportunity for yield improvement through selection.

Keywords: Bread Wheat, Drought, Heritability, Physiological Traits

1. Introduction

Bread wheat (*Triticum aestivum* L.) is a staple food for more than 35% of the world's population (Statista 2021). Globally, China, India and Russia are the largest wheat producers, while South Africa and Ethiopia are the largest wheat producers in sub-Saharan Africa (SSA) [27].

Wheat is one of the strategic crops in Ethiopia, because of its role for food security, import Substitution and supply of raw material for agro-processing industry. Ethiopia is the third largest wheat producing country in Africa. Ethiopia's annual production is about 5.8 million tons with mean productivity of 3 tons per hectare (t ha⁻¹) [8], which is relatively lower than the attainable yield of the crop, reaching

up to 5 t ha⁻¹ [28]. Wheat accounts for about 17% of total grain production in Ethiopia making it the third most important cereal crop after teff and maize [8]. However, drought stress which associated with heat stress at the end of growing session (during anthesis and grain filling stages) is the main limiting factor which caused major losses cereals productivity of arid and semi-arid regions. These limiting factors led to lower average wheat yield in Ethiopia (3 t ha⁻¹).

Drought tolerance is complex quantitative trait and use of physiological traits as selection criteria is helpful. Canopy temperature is one of physiological traits used to select stress tolerant crops. The genetic basis and association of canopy temperature with yield was reported by [20]. It has also been used as a screening tool in different crops in previous studies

[3, 18, 1]. In addition to canopy temperature, Chlorophyll content is the other physiological trait which can be either rapidly phenotyped or informative about how adaptation to drought can arise. Traits such as these that are rapid and integrative in nature are increasingly recognized not only as useful selection tools in breeding [3], but also as valuable screens for high throughput phenotyping of populations [15, 18]. Therefore, the present study was designed to evaluate different bread wheat genotypes for drought tolerance using canopy temperature and chlorophyll content as screening mechanisms.

2. Materials and Methods

2.1. Description of the Study AREA

The study was conducted during the off season (November to February) during 2019/20 at Werer Agricultural Research Center (WARC) experimental field. Werer is located 9°27' N and 40°15' E in Northeastern part of Ethiopia which is 280 km from Addis Ababa, Ethiopia. The altitude of Werer is 740 m.a.s.l. The average maximum and minimum temperature of the area is 34°C and 19°C, respectively, and the annual total rainfall in the area is about 571 mm annually. The soil type in

the experimental site is Vertisol with the porosity and bulk density (0-25 cm depth) of 49.06% and 1.35 g/cm³, respectively [27].

2.2. Experimental Materials

Sixty two different diverse bread wheat genotypes from elite spring bread wheat yield trial (ESBWYT) obtained from International Center of Agricultural Research for Dry Areas (ICARDA) and two released check varieties from national wheat breeding program (Table 1).

2.3. Experimental Design and Procedures

The experiment was laid out in 8*8 simple lattice design consisted of 64 bread wheat genotypes. The plot size was 4.5 m² (1.8 m x 3 m) and it consisted of six rows at 0.3 m interval on 0.6m ridge having two rows each. Seeds were sown on rows with manual drilling at a rate of 100 kg ha⁻¹ basis. Water stressed treatment was imposed by withholding three irrigation from 50% flowering up to physiological maturity. In the non-stressed water regime, plants were watered at every 10 days interval using furrow irrigation method. The experiment was done separately to avoid water leakage between the optimum and stress plot.

Table 1. List of bread wheat genotypes used in the experiment.

Code	Genotypes/pedigree	Seed source
G1	THELIN/WAXWING//ATTILA*2/PASTOR/3/INQALAB91*2/TUKURU 9Y-0B	ICARDA
G2	PASTOR//HXL7573/2*BAU/2/SOKOLL/WBLL1/4/SAFI-1//NS732/HER/3/SAADA	ICARDA
G3	PASTOR//HXL7573/2*BAU/3/SOKOLL/WBLL1/4/SAFI-1//NS732/HER/3/SAADA	ICARDA
G4	PASTOR//HXL7573/2*BAU/4/SOKOLL/WBLL1/4/SAFI-1//NS732/HER/3/SAADA	ICARDA
G5	SERI.1B//KAUZ/HEVO/3/AMAD/4/ESWYT99#18/ARRIHANE/5/SITTA/BUCHIN//CHIL/BOMB	ICARDA
G6	PFAU/MILAN//FUNG MAI 24/3/ATTILA*2/CROW	ICARDA
G7	FLORKWA-2/85 Z 1284//ETBW 4920/3/LOULOU-18	ICARDA
G8	SHARP/3/PRL/SARA//TSI/VEE#5/5/VEE/LIRA//BOW/3/BCN/4/KAUZ/6/HUBARA-5	ICARDA
G9	CHEN/AEGILOPS SQUARROSA (TAUS)//BCN/3/VEE#7/BOW/4/PASTOR/5/HUBARA-1	ICARDA
G10	KAUZ/FCT//ETBW 4920/3/MILAN/PASTOR	ICARDA
G11	FLORKWA-2/85 Z-1284//ETBW 4920/3/LOULOU-18	ICARDA
G12	REBWAH-11/QIMMA-12	ICARDA
G13	TEVEE-1/STAR'S//ETBW 4920/3/TEPOCA+LR34/2*BORL95	ICARDA
G14	MILAN/SHA7/3/THB/CEP7780//SHA4/LIRA/4/SHA4/CHIL/5/FARIS-6	ICARDA
G15	HUBARA-5/PASTOR-2//AREEJ	ICARDA
G16	MEXIPAK/FLORKWA-2//KRASNOVODOPADSKAYA25/GRU-47	ICARDA
G17	KAUZ/PASTOR/3/ALTAR 84/AEGILOPS SQUARROSA (TAUS)//OPATA/4/WARDA	ICARDA
G18	HUBARA-5/PASTOR-2//WARDA	ICARDA
G19	HUBARA5/PASTOR2/6/88ZHONG218//CTK/VEE/3/KVZ/GV//PR/4/KRASNOVODOPADSKAYA25/5/KS82117/MLT	ICARDA
G20	KAUZ/PASTOR/3/ALTAR 84/AEGILOPS SQUARROSA (TAUS)//OPATA/4/WARDA	ICARDA
G21	KAUZ/PASTOR/3/ALTAR 84/AEGILOPS SQUARROSA (TAUS)//OPATA/3/WARDA	ICARDA
G22	NESSER/SERI//TEVEE-1/SHUHA-6/3/JOUDI	ICARDA
G23	HUBARA-3*2/SHUHA-4//MURAJ	ICARDA
G24	LAKTA-1/QAFZAH-21//KABEER	ICARDA
G25	LALOUB1/5/PBWMUNIA//CHEN/ALTAR84/3/CHEN/AEGILOPSSQUARROSA(TAUS)//BCN/4/MARCHOUGH-83	ICARDA
G26	LALOUB-1 /3/91-142 a 139//TAM200/KAUZ	ICARDA
G27	FLORKWA2/6/SAKER'S/5/RBS/ANZA/3/KVZ/HYS//YMH/TOB/4/BOW'S/7/DAJAJ6/8/MUNIA//CHEN/ALTAR84/3/CH EN/AEGILOPSSQUARROSA (TAUS)//BCN/4/MARCHOUGH-8	ICARDA
G28	FLORKWA2/6/SAKER'S/5/RBS/ANZA/3/KVZ/HYS//YMH/TOB/4/BOW'S/7/DAJAJ6/8/MUNIA//CHEN/ALTAR84/3/CH EN/AEGILOPSSQUARROSA (TAUS)//BCN/4/MARCHOUGH-9	ICARDA
G29	HUBARA-3*2/SHUHA-4//NARC 2011	ICARDA
G30	DAJAJ-5/4/CMH82A.1294/2*KAUZ//MUNIA/CHTO/3/MILAN/5/QAFZAH 18/6/HAMAM-4	ICARDA

Code	Genotypes/pedigree	Seed source
G27	FLORKWA2/6/SAKER'S/5/RBS/ANZA/3/KVZ/HYS/YMH/TOB/4/BOW'S/7/DAJAJ6/8/MUNIA//CHEN/ALTAR84/3/CHEN/AEGILOPSSQUARROSA(TAUS)/BCN/4/MARCHOUGH-8	ICARDA
G28	FLORKWA2/6/SAKER'S/5/RBS/ANZA/3/KVZ/HYS/YMH/TOB/4/BOW'S/7/DAJAJ6/8/MUNIA//CHEN/ALTAR84/3/CHEN/AEGILOPSSQUARROSA(TAUS)/BCN/4/MARCHOUGH-9	ICARDA
G29	HUBARA-3*2/SHUHA-4//NARC 2011	ICARDA
G30	DAJAJ-5/4/CMH82A.1294/2*KAUZ//MUNIA/CHTO/3/MILAN/5/QAFZAH 18/6/HAMAM-4	ICARDA
G31	FENTALLE-2 (CHECK)	EIAR/WARC
G32	HUBARA-8/3/MUNIA/ALTAR 84//MILAN/4/ANGI-2/5/AFIF	ICARDA
G33	HUBARA-8/3/MUNIA/ALTAR84//MILAN/4/ANGI-2/5/CROW'S/BOW'S-3-1994/95//TEVEE'S/TADINIA	ICARDA
G34	HUBARA-8/3/MUNIA/ALTAR84//MILAN/4/ANGI-2/6/CROW'S/BOW'S-3-1994/95//TEVEE'S/TADINIA	ICARDA
G35	HUBARA-8/3/MUNIA/ALTAR84//MILAN/4/ANGI 2/5/CROW'S/BOW'S31994/95//TEVEE'S/TADINIA	ICARDA
G36	HUBARA-8/3/MUNIA/ALTAR 84//MILAN/4/ANGI-2/5/YAMAMA/SD 8036	ICARDA
G37	HUBARA-8/3/MUNIA/ALTAR 84//MILAN/4/ANGI-2/5/TENUR	ICARDA
G38	HUBARA-8/3/MUNIA/ALTAR 84//MILAN/4/ANGI-2/6/TENUR	ICARDA
G39	HUBARA-1/3/MUNIA/CHTO//MILAN/4/GOUMRIA-8/5/AFIF	ICARDA
G40	HUBARA-1/3/MUNIA/CHTO//MILAN/3/GOUMRIA-8/5/AFIF	ICARDA
G41	DAJAJ-5/4/CMH82A.1294/2*KAUZ//MUNIA/CHTO/3/MILAN/5/QAFZAH-18/6/HAAAL-44	ICARDA
G42	Pirsabak 2008/AZIZ	ICARDA
G43	Punjab 2011/ORFAN	ICARDA
G44	Punjab 2012/ORFAN	ICARDA
G45	BABAGA-3/4/KAUZ//TRAP#1/BOW/3/QAFZAH-21-1	ICARDA
G46	KARAWAN-1/TALLO 3//REGRAG-1/3/OUASSOU-11	ICARDA
G47	HAMAM2/DEEK2/5/ACHTAR*3//KANZ/KS8584/3/KATILA17/4/MON'S/ALD'S//ALDAN'S/IAS58/6/HUBARA-3*2/SHUHA-4	ICARDA
G48	BOW #1/FENGKANG 15//NESMA*2/261-9/3/DUCULA/4/SIDS-1/5/Line-12	ICARDA
G49	MOUKA-4/RAYON//SIDS 12/5/SERI.1B//KAUZ/HEVO/3/AMAD/4/KAUZ/FLORKWA	ICARDA
G50	GIRWILL-13/2*PASTOR-2//KAUZ'S/PREW	ICARDA
G51	SHUHA-4/FLORKWA-4//HUBARA-3/3/MURAJ	ICARDA
G52	HUBARA-15/ZEMAMRA-8//MASSIRA/4/FRAME//MILAN/KAUZ/3/PASTOR	ICARDA
G53	KING BIRD (CHECK)	EIAR/KARC
G54	REYNA-13/MASSIRA//SOONOT-10	ICARDA
G55	SAEED-1/BEZOSTAYA/4/MILAN/KAUZ//PASTOR/3/PASTOR	ICARDA
G56	UTIQUE 96/FLAG-1//BETHLEHEM/3/SAAMID-2	ICARDA
G57	SERI.1B*2/3/KAUZ*2/BOW//KAUZ/4/ATTILA/HEILO/5/TAN//TEMPORALRAM 87/AGR/3/NG8319//SHA4/LIRA	ICARDA
G58	CHAM-10/3/TNMU//MILAN/TUI/4/SANDALL-5	ICARDA
G59	KHIDER-1/5/PRL/SARA//TSI/VEE#5/4/TILHI/4/ATTILA/2*PASTOR/6/FAISAL-1	ICARDA
G60	KHIDER-1/5/PRL/SARA//TSI/VEE#5/3/TILHI/4/ATTILA/2*PASTOR/6/FAISAL-1	ICARDA
G61	SHARP/3/PRL/SARA//TSI/VEE#5/5/VEE/LIRA//BOW/3/BCN/4/KAUZ/6/MILAN/PASTOR/7/SUDAN#3/SHUHA-6	ICARDA
G62	MILAN/KAUZ/6/TOB/ERA//TOB/CNO67/3/PLO/4/VEE#5/5/KAUZ/7/MILAN/PASTOR/8/SANDALL-5	ICARDA
G63	MILAN/KAUZ//HD29/2*WEAVER/3/MILAN/PASTOR/4/REYNA-4	ICARDA
G64	SHAMISS-5//HEILO/MIRIAM 41/3/ICARDA-SRRL-5	ICARDA

2.4. Data Collection

- 1) Chlorophyll content: Soil plant analysis development (SPAD): It was recorded on five flag leaf from random samples of each plot during grain filling period under both optimum and stressed plots using a chlorophyll meter (SPAD 502, Konica Minolta, Osaka, Japan) during morning and late afternoon when there is no dew on the leaf and expressed as average.
- 2) Canopy temperature (°C): Canopy temperature of each genotype was taken two measurements per plot at grain filling period during sunny days 11:00-2:30 am with 7 days interval between each measurement from optimum and stress plot using a hand-held infrared thermometer and expressed as average.

3. Results and Discussion

The separate analyses of variance showed under optimum condition the tested genotypes showed significant variation for grain yield; but non-significant variation for chlorophyll content and canopy temperature (Table 2). Non-significant variation for canopy temperature in bread wheat under normal condition was reported by [19]. In contrast to the present result [21], reported highly significant variation for chlorophyll content and canopy temperature under normal condition. Under stress condition the tested genotypes showed highly significant variation for grain yield, canopy temperature and chlorophyll content. In line with the present result [19, 21], highly significant variation for chlorophyll content and canopy temperature among the tested genotypes under stress condition in bread wheat genotypes.

Table 2. Mean squares from analysis of variance for sixty four bread wheat genotypes evaluated at Werer Agricultural Research Center during 2019/20 under optimum and stress condition.

Traits	Replications (d.f=1)	Block Within replication (Adj.) (d.f=14)	Treatments (d.f=63) (Unadj.) (Adj.)		Intra block Error (d.f=49)	CV (%)
Under optimum condition						
Grain yield (t/ha)	0.34 ^{ns}	0.04 ^{ns}	1.52	1.44**	0.11	8.32
Chlorophyll content (SPAD)	33.83*	3.76 ^{ns}	8.84	7.29 ^{ns}	7.20	5.25
Canopy temperature (°C)	14.85 ^{ns}	0.47 ^{ns}	0.92	0.68 ^{ns}	0.87	3.51
Under stress condition						
Grain yield (t ha ⁻¹)	0.52*	0.16 ^{ns}	0.66	0.48**	0.124	13.27
Chlorophyll content (SPAD)	193.31**	4.73 ^{ns}	11.22	10.00**	5.18	4.65
Canopy temperature (°C)	1.11*	0.14 ^{ns}	1.67	1.54**	0.23	1.66

**,*=highly significant and significant at $p \leq 0.001$ and $p \leq 0.05$, ns= non-significant

3.1. The Mean Performance of Genotypes for Grain Yield, Chlorophyll Content and Canopy Temperature

The mean performance of grain yield under optimum condition ranged from 2.3 to 6.0 t ha⁻¹; with mean value of 4.05 t ha⁻¹. The highest grain yield was recorded for G10 (6.0 t ha⁻¹), followed by G64 (5.89 t ha⁻¹), G3 (5.56 t ha⁻¹), G44 (5.4 t ha⁻¹), G39 (5.31 t ha⁻¹), G24 (5.3 t ha⁻¹), G1 (5.13 t ha⁻¹), G26 (5.06 t ha⁻¹) and G14 (5.05 t ha⁻¹), while lowest grain yield was recorded for G38 (2.3 t ha⁻¹) followed by G12 (2.6 t ha⁻¹), G63 (2.63 t ha⁻¹), G7 (2.63 t ha⁻¹), G2 (2.63 t ha⁻¹) and G56 (2.72 t ha⁻¹). Depending on the mean performance twelve genotypes had mean value of greater than best performing check (Fentalle-2= 4.84 t ha⁻¹) for grain yield. Nine genotypes had mean values lower than standard check (Kingbird=3.22 t ha⁻¹) for grain yield. Similarly, several authors reported a wide range of variation in bread wheat for grain yield [2, 4, 9, 23].

Under stress condition, the mean performance for grain yield ranged from 1.01 to 4.36 t ha⁻¹ with mean value of 2.65 t ha⁻¹ respectively. Fourteen genotypes showed superior to standard check (Kingbird=3.18 t ha⁻¹) for grain yield. The highest grain yield was recorded for G28 (4.36 t ha⁻¹) followed by G40 (3.56 t ha⁻¹), G24 (3.56 t ha⁻¹), G48 (3.48 t ha⁻¹) and G8 (3.40 t ha⁻¹), while the lowest grain yield was recorded for G42 (1.01 t ha⁻¹) followed by G35 (1.57 t ha⁻¹), G52 (1.67 t ha⁻¹), G12 (1.7 t ha⁻¹) and G17 (1.82 t ha⁻¹). A similar range of variation was reported for grain yield under drought conditions [5]. Among 64 genotypes 21.87% showed superior to standard check (Kingbird) for grain yield. Drought significantly reduced the grain yield by 34.5%.

The mean chlorophyll content of SPAD meter value ranged from 46.55 to 55.75 and 43 to 53.15 with mean values of 51.07 and 48.98 under optimum and stress condition respectively. The highest mean value was recorded for G63 (55.75) followed by G60 (55.0), G42 (54.95), G15 (54.8), G59 (54.7) and G47 (54.1), while the lowest values were recorded for G49 (46.55) followed by G8 (46.8) and G58 (48.0) under normal condition. Under stress condition the highest chlorophyll content SPAD unit was recorded for G59 (53.15) followed by G3 (53.1), G48 (52.1), G50 (52.0) and G52 (52.0) while the lowest chlorophyll content was

recorded for G12 (43.0). A similar range of variation for chlorophyll content in wheat under drought condition was previously reported by [13, 25]. Similar range and significant variation for chlorophyll content in bread wheat under heat stress was previously reported [24]. Under normal condition, similar range and mean value was reported for chlorophyll content in bread wheat [12]. Chlorophyll content was used as screening tool for drought tolerance in wheat. Decrease in chlorophyll content is faster in drought sensitive than in drought tolerant genotypes [10]. Drought tolerant genotypes had higher chlorophyll content than sensitive genotypes under drought [11].

The mean performance for canopy temperature ranged from 24.87°C to 28.27°C and 27.12°C to 31.63°C with mean values 26.12°C and 29.36°C under optimum and stress condition respectively. Under normal condition the highest mean values were recorded for G34 (28.27°C) followed by G63 (27.75°C), G62 (27.52°C), G46 (27.4°C) G17 (27.22°C) and G15 (27.07°C). The lowest canopy temperature was recorded for G16 (24.87°C) followed by G20 (24.87°C), G26 (25.0°C) and G30 (25.25°C). Under stress condition the highest canopy temperature was recorded for G35 (31.63°C) followed by G9 (31.15°C), G49 (30.87°C), G17 (30.58°C) and G52 (30.55°C), while the lowest canopy temperature was recorded for G24 (27.12°C) followed by G30 (27.55°C), G16 (27.6°C) and G4 (27.75°C). Drought significantly increased canopy temperature by 11%. The result was similar to the finding of [23]. Canopy temperature is a useful trait used for screening drought tolerant wheat genotypes, as it reveals different physiological responses [14]. Relatively lower canopy temperature in drought stressed crop plants indicates a relatively better capacity for taking up soil moisture [6]. Low canopy temperature under drought is associated with drought tolerance in wheat.

3.2. Estimates of Variance Components

Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are used to measure the variability that exists in a given population. The values of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were categorized as low (0-10), moderate (10-20) and high (>20) as described by [23].

Accordingly, high PCV were recorded for grain yield. The present finding is in agreement with the finding of [17] and [20] reported high PCV value, for grain yield ($t\ ha^{-1}$) under

stress condition in wheat. Low GCV and PCV values were noted for chlorophyll content and canopy temperature. Low GCV and PCV value reported canopy temperature [21].

Table 3. Estimates of variability components for bread wheat genotypes evaluated at middle Awash during 2019/20 under stress condition.

Traits	Range	Mean \pm SEM	δ^2g	δ^2p	GCV (%)	PCV (%)	H ² b (%)	GA	GAM (%)
GY	1.01-4.36	2.65 \pm 0.25	0.16	0.28	15.48	20.22	58.60	0.65	24.45
ChC	43.0-53.15	48.98 \pm 1.61	3.01	7.95	3.55	5.76	37.90	2.21	4.51
CT	27.13-31.63	29.36 \pm 0.34	0.73	0.94	2.91	3.32	77.00	1.55	5.27

GY=grain yield, ChC=chlorophyll content, CT= canopy temperature δ^2g =genotypic variance, δ^2p =Phenotypic variance, PCV=Phenotypic coefficient of variation, GCV=Genotypic coefficient of variation, H²b= Broad sense heritability GA=Genetic advance and GAM= Genetic advance as percentage of mean

3.3. Estimates of Broad Sense Heritability, Expected Genetic Advance and Genetic Advance as Percentage of Mean

Under stress condition, high heritability value was noticed canopy temperature. High heritability value for these traits indicated that the variation observed was mainly under genetic control and was less influenced by environment. So, these traits may be used as a selection criterion under stress. High heritability value was reported for canopy temperature by [21]. Moderate heritability value was observed for chlorophyll content and grain yield under stress condition. Moderate heritability value was reported for chlorophyll content by [7]. Grain yield is a polygenic trait that is highly influenced by the environment under stressed condition; thus moderate heritability estimate of was expected for this trait [16].

3.4. Association Among Grain Yield, Chlorophyll Content and Canopy Temperature

Under optimum condition chlorophyll content and canopy temperature has no significant correlation with grain yield. Under stress condition both canopy temperature and chlorophyll content showed negative and highly significant correlation with grain yield at genotypic and phenotypic level. It indicated that elevated canopy temperature accompanied yield reduction under water stress condition; because plants could not maintain adequate transpiration rates [26]. Thus the genotypes should be selected for low canopy temperature and greater chlorophyll content under drought condition.

Table 4. Estimates of genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients among chlorophyll content, canopy temperature and grain yield.

Traits	ChC (SPAD)	CT (°C)	GY ($t\ ha^{-1}$)
ChC (SPAD)	1	0.01	0.452**
CT (°C)	-0.05	1	-0.541**
GY ($t\ ha^{-1}$)	0.527**	-0.483**	1

GY=grain yield, ChC=chlorophyll content, CT= canopy temperature

4. Conclusions

Generally, the tested genotypes exhibited significant variation for traits considered under study which clearly indicate high probability of improvement through selection. Canopy temperature and chlorophyll content were used as selection tool

for drought stress. The genotypes with greater chlorophyll content and low canopy temperature will stay green and gives better yield than those having low chlorophyll content and high canopy temperature. Therefore selection should be done for genotypes with high chlorophyll content and low canopy temperature to improve yield under drought condition.

Conflict of Interest

All the authors do not have any possible conflicts of interest.

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References

- [1] Abdipur, M., Ramezani, H. R., Bavei, V. and Talaei, S. 2013. Effectiveness of Canopy Temperature and Chlorophyll Content Measurements at Different Plant Growth Stages for Screening of Drought Tolerant Wheat Genotypes. *American-Eurasian Journal of Agriculture and Environmental Sciences*, 13 (10): 1325-1338.
- [2] Alemu Dabi, Firew Mekbib and Tadesse Desalegn. 2019. Genetic variability studies on bread wheat (*Triticum aestivum* L.) genotypes. *Journal of Plant Breeding and Crop Sciences*, 11 (2): 41-54.
- [3] Araus, J. L., G. A. Slafer, C. Royo and M. D. Serret, 2008. Breeding for yield potential and stress. *Adaptation in cereals. Critical Reviews in Plant Sciences*, 27: 377-412.
- [4] Ashebir Baye, Baye Berihun, Muluken Bantayehu and Bitwoded Derebe. 2020. Genotypic and phenotypic correlation and path coefficient analysis for yield and yield-related traits in advanced bread wheat (*Triticum aestivum* L.) lines. *Cogent Food and Agriculture*, 6 (1): 1752603.
- [5] Bazzaz, M. M., Hossain, A., Khaliq, Q. A., Karim, M. A., Farooq, M. and Teixeira da Silva, J. A. 2019. Assessment of tolerance to drought stress of thirty-five bread wheat (*Triticum aestivum* L.) genotypes using boxplots and cluster analysis. *Agriculturae Conspectus Scientificus*, 84 (4): 333-345.
- [6] Blum, A., Shipiler, L., Golan, G. and Mayer, J. 1989. Yield stability and canopy temperature of wheat genotypes under drought stress. *Field Crops Research*, 22 (1): 289-296.

- [7] Chowdhury, A., Akter, A. and Rahman, M. H. J. 2018. Characters association analysis of morpho-physiological traits in spring wheat (*Triticum aestivum* L.) under drought stress. *Journal of Science and Technology*, 16 (1): 37-47.
- [8] CSA. 2021. Agricultural sample survey: Report on area and production of major crops (Private peasant holdings, Meher Season). Volume I Statistical Bulletins 590, Addis Ababa, Ethiopia.
- [9] Dargicho Dutamo, Sentayehu Alamerew, Firdisa Eticha and Gezahegn Fikre. 2015b. Genetic variability in bread wheat (*Triticum aestivum* L.) germplasm for yield and yield component traits. *Journal of Biology, Agriculture and Healthcare* 5 (17): 140-147.
- [10] El-Tayeb, M. A. 2006. Differential response of two *Vicia faba* cultivars to drought: growth, pigments, lipid peroxidation, organic solutes, catalase and peroxidase activity. *Acta Agronomica Hungarica*, 54 (1): 25-37.
- [11] Farshadfar E, Ghasemi M. and Rafii, F. 2014. Evaluation of physiological parameters as a screening technique for drought tolerance in bread wheat. *Journal of Biodiversity and Environmental Science*, 4 (1): 175-186.
- [12] Goyal, V. K., Pandey, S., Shukla, R. S. and Rani, A. 2019. Morphological characterization and genetic analysis in newly developed cytoplasmic lines of bread wheat. *International Journal of Chemical Studies*, 7 (1): 2262-2266.
- [13] Karimpour, M. 2019. Effect of drought stress on RWC and chlorophyll content on wheat (*Triticum durum* L.) genotypes. *World Essays Journal*, 7 (1): 52-56.
- [14] Mason, R. E. and Singh, R. P. 2014. Considerations when deploying canopy temperature to select high yielding wheat breeding lines under drought and heat stress. *Agronomy*, 4 (2): 11-20.
- [15] Montes, J. M., A. E. Melchinger and J. C. Reif, 2007. Novel throughput phenotyping platforms in plant genetic studies. *Trends Plant Science*, 12: 433-436.
- [16] Mwadzingeni, L. Shimelis, H. and Tsilo, T. J. 2017. Variance components and heritability of yield and yield components of wheat under drought stressed and non-stressed conditions. *Australian Journal of Crop Science*, 11 (11): 1425-1430.
- [17] Naseri, R., Soleymannifard, A. and Moradi, M. 2012. The study genetic variation and factor analysis for agronomic traits of Durum wheat genotypes using cluster analysis and path analysis under drought stress condition in western of Iran. *International Research Journal of Applied and Basic Sciences*, 3 (3): 479-485.
- [18] Olivares-Villegas, J. J., M. P. Reynolds, H. M. William, G. K. McDonald and J. M. Ribaut, 2008. Drought adaptation attributes and associated molecular markers via BSA in the Seri/Babax hexaploid wheat (*Triticum aestivum* L.) population. In: *Proceedings of the 11 international wheat genetics symposium*. th Brisbane, Australia, 24-29 Aug 2008. University Press, Sydney.
- [19] Pour-Aboughadareh, A., Mohammadi, R., Etmnan, A., Shooshtari, L., Maleki-Tabrizi, N. and Pocza, P. 2020. Effects of drought stress on some agronomic and morpho-physiological traits in durum wheat genotypes. *Sustainability*, 12: 5610; doi: 10.3390/su12145610.
- [20] Rehman, S. U., Abid, M. A., Bilal, M., Ashraf, J., Liaqat, Sh., Ahmed, R. I. and Qanmber, G. 2015. Genotype by trait analysis and estimates of heritability of wheat (*Triticum aestivum* L.) under drought and control conditions. *Basic Research Journal of Agricultural Science and Review*, 4 (4): 127-134.
- [21] Singh, S. P., Singh, A. K., Sharma, M. and Salgotra, S. K. 2014. Genetic divergence study in improved bread wheat varieties (*Triticum aestivum* L.). *African Journal of Agricultural Research*, 9 (4): 507-512.
- [22] Sivasubramanian, S. and Menon, M. 1973. Heterosis and inbreeding depression in rice. *Madras Agricultural Journal*, 60 (7): 1139-1140.
- [23] Sohail, M., Hussain, I., Qamar, M., Tanveer, S. K., Abbas, S. H., Ali, Z. and Imtiaz, M. 2019. Evaluation of spring wheat genotypes for climatic adaptability using canopy temperature as physiological indicator. *Pakistan Journal of Agricultural Research*, 33 (1): 89-96.
- [24] Tadiyos, Bayisa, Ermias Habte and Mhratu Amanuel. 2019. Evaluation of bread wheat (*Triticum aestivum* L.) Genotypes for yield potential and related traits under high temperature stress condition at middle awash, Ethiopia. *Advances in Crop Science and Technology*, 7: 410.
- [25] Talebi, R. 2011. Evaluation of chlorophyll content and canopy temperature as indicator for drought tolerance in durum wheat (*Triticum durum* Desf.). *Australian Journal of Basic and Applied Science*, 5 (11): 1457-1462.
- [26] USDA. 2019. USDA world markets and Trade Report. Accessed on December 15, 2019.
- [27] Wondimagegn Chekol and Abera Mnalku. 2012. Selected physical and chemical characteristics of soils of the middle awash irrigated farm lands, Ethiopia. *Ethiopian Journal of Agricultural Sciences* 22 (1): 127-142.
- [28] Zegeye F, Alamirew B, Tolossa D. 2020. Analysis of wheat yield gap and variability in Ethiopia. *International Journal of Agricultural Economy*, 5 (4): 89-98.