

Adult Genes Evaluation of Ethiopian Durum Accessions for Resistance to Stem Rust (Puccinia graminis f.sp. tritici)

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Abstract
The horizontal resistance is effective against broad range of pathogen races and even reduces the costs of fungicides for controlling.The objective of present study is based on the field assesment of adult resistance genes in Ethiopia durum wheat accessions for resistance to stem rust (Puccinia graminis f.sp. tritici). The 142 durum wheat accessions were obtained from the Ethiopian Biodiversity Institute and screening for stem rust in Debrezeit agricultural research experimental fields using alpha lattice design. The bulk of races (TTKSK (Ug99), TTTTF, TTRTF, JRCQC, TKTTF) inoculated during stem elongation stage. The disease assessment started the first symptom of seen in infector rows. In the field, durum accessions were examined utilizing for slow rust parameters. Accordingly, to that the 23 accessions were identified having low value of terminal rust resistance, low average coefficient of infection and low area under disease progress curve. The grain yield is negative and highly siginificant associated with slow rusting parameters. These accessions considered as having adult resistance genes with high partial resistance genes and important for further resistance breeding.
Keywords: Accessions, Area under disease progress curve, Average cofficient of infection, Puccinia graminis f.sp. tritici, Terminal rust resistance
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INTRODUCTION

Wheat is the most important cereal crops to guarantee food security program in the world population (Dhillon et al., 2020). Based on the level of production, many African countries are producing wheat for the purpose of both home consumption and marketing. The leading wheat producing countries in SSA are Ethiopia, South Africa, Sudan, Kenya, Tanzania, Nigeria, Zimbabwe, and Zambia in that order (Anteneh and Asrat, 2020). Ethiopia is one of the largest wheat producers in the Sub-Saharan Africa.however the production is limited both biotic and abiotic factors. From the side of production 3.4 t/ha were obtained, which is far less than the world average (CSA , 2021). The low productivity due to lack of resistant varieties to the prevalent wheat rusts namely the stem rust (*Puccinia graminis* f.sp. *tritici Eriks*. and *E. Henn*), leaf rust (*P. triticina Eriks*) and stripe rust (*P. striiformis Westend.* f. sp. *tritici Eriks*) are the major important diseases. Among the three rust diseases in wheat, stem rust can cause 100% yield loses when cultivars become susceptible plus favorable environmental conditions created (Admassu et al., 2012; Denbel et al., 2013, Huerta-Espino et al 2014).

Wheat producers in Ethiopia requires disease resistant varieties since they are environmentally safe, farmer friendly and economically feasible. Therefore, it is important to identify sources of resistance genes in order to develop disease resistant wheat cultivars. One of the rich sources of stress resistance germplasm are landraces, which are also known to be reservoirs of genetic resources like resistance genes for several plant diseases including wheat rusts (Burt et al. 2014; Randhawa et al., 2014; Bansal et al. 2015; Gessese, et al 2019). The Adult plant résistance is Race-nonspecific which were effective against multiple races of a pathogen species (effective against broad ranges of pathogens), quantitative, exhibiting partial or incomplete resistance typically triggered at later stages of development. The genes usually exhibit slower disease progress through an increased latency period, reduced infection points, lower levels of sporulation and increased rate of removal of infectious tissue (reducing the infectious period). The phenotypic effect of such genes is relatively minor to moderate, however, additive effects of multiple APR genes in combinations can result in very high levels of resistance (Singh et al., 2014). Therefore, the present study is based on evalution of the adult resistance genes of durum wheat accessions grown in Ethiopia for resistance to stem rust (*Puccinia graminis* f.sp. *tritici*).

MATERIALS AND METHODS

Description of Study Areas

Field study was conducted at the research facility farm of Debrezeit Agricultural Research Center (DZARC), during 2021 main cropping season. The center is located at geographic coordinates of 08° 46′ N and 39° 00′ E latitude and longitude respectively.The research farm is situated at an altitude of 1900 m.a.s.l (Bemnet et al., 2003). The area receives annual average rainfall of 851mm with 61.3% mean annual relative humidity. The annual average temperature ranges from 8.9 ^{o}C to 28.3 ^{o}C. The soil type is characterized by pellicvertisol (WRB, 2006).

Experimental Materials

One hundred fourty two durum wheat accessions were collected from the Ethiopian Biodiversity Institute and four additional cultivars namely, Boohai, Tob66, Arendato and Digalu were obtained from DZARC. Boohai and Tob66 were used as resistant control because they exhibit low severity percentage on field evaluation of stem rust pathogen races whereas, both Arendato and Digalu were equally mixed together and used as planting material for spreading the disease and bulk of stem rust races which are currently dominating the field infection were used for field evaluation; namely TTKSK (Ug99), TTTTF, TTRTF, JRCQC, TKTTF. These *Pgt* races were harvested from Debrezeit Agricultural Research experimental fields.

Experimental design and treatments

One hundred fourty two durum wheat accessions and two additional cultivars (Tob66 and the Boohai) were planted in alpha lattice design with two replications. The field trial was arranged in 12 blocks per replication and 12 plots per block (12 x 12 = 144 plots). Each plot has 50 cm row length and 20cm width. Distance between blocks and plots are 15 cm and 10 cm, respectively. Planting was carried out by drilling and inserting twenty seeds per plot with spacing of 2 cm X 30 cm. additionally, two susceptible cultivars namely, Digalu and Arendato were planted in mixture at equal ratio on borders and also at 50 cm intervals between two blocks of each replication as spreader row of Pgt (Das et al., 2006). Fertilizers were applied as side dress at rate of 41 kg/ ha N (applied in splits, the first half during planting time and remaining half a 30 days after planting) and 46 kg/ ha P_2O_5 during planting (MoARD, 2004). All other recommended agronomic practices such as cultivation, weeding, etc were adopted during the growing season.

Inocula preparation and inoculation

Urediniospores were collected from infected durum wheat and bread wheat nursery fields using cyclone collector and were stored in refrigerator at 4°C (Roelfs et al., 1992). Inoculum increase was carried out using universal susceptible cultivar Morocco in greenhouse and harvesting viable urediospore for field inoculation according to the protocol described by Roelfs et al., (1992). Inoculum was prepared with a mixture of 0.6mg urediospores of five stem rust races (JRCQC, TRTTF TKTTF, TTTTF, TTKSK) and suspending in distilled water plus one drop of Tween 20 per 0.5 liters of suspension (Stubbs et al., 1986).In the field stem rust epidemic was initiated by inoculating spreader rows with the inoculum mixtures of 0.6 mg Urediniospores (Stubbs et al., 1986). A total of three inoculations were carried out at weekly interval to ensure disease development. The first two inoculations were done through injection during stem elongation stage using 10 ml syringe and the last inoculation was carried out at booting growth stage using ultra low volume sprayer (Zadkos et al., 1974). Inoculation at field was done late in the evening when conditions were conducive for germination of spores and establish infection (Roelfs et al., 1992).

Data Collection

The data recording was started when first symptom of disease was oserved in the infector rows. This was continued afterwards until disease severity reached 100% in the infector rows and the data were collected at weekely interval during the course of disease progress. Disease severity was estimated as percentage of diseased plant parts (portion of stems, leaves) from twenty plants within each experimental plot using modified Cobb's scale (Peterson et al, 1948). This scale has a rate of score between 0 and 9. Where, 0%=immune and 100%=completely susceptible. Host plant response to infection was scored according to the description by Roelfs et al. (1992) Table1. The Coefficient of infection was calculated by taking the product of percent disease severity (modified Cobb scales) and a constant value of host response (Roelfs et al., 1992). Average Coefficient of Infection (ACI) was derived from the sum of CI values of each entry divided by the number of observation. Terminal Rust Severity (TRS): final record of stem rust severity when the susceptible check/spreader line displayed maximum disease severity (Ma and Singh 1996). The Grain yield in gram/plot at 12.5% moisture content (determined by high performance moisture analyzer) was recorded using sensitive balace and transformed into kg/ha.

Table 1. Host response and infection type descriptions used in field study of stem rust adult plant resistance

Field Response	Symbol	constant value	Infection type
Immune	0	0	No visible infection
Resistant	R	0.2	Necrotic areas with or without small pustules.
Moderately resistant	MR	0.4	Small pustules surrounded by necrotic areas
Intermediate or Moderate	M	0.6	Pustules of variable size, some necrosis or chlorosis.
Moderately Susceptible	MS	0.8	Medium sized pustules, no necrosis, but some chlorosis
Susceptible	S	1	Large pustules no necrosis or chlorosis.

According to published decription by Roelfs et al . (1992)

Data Analysis

The stem rust severity data were summarized to produce, avearge coefficient of infection (ACI), Area under Disease Progress Curve (AUDPC), disease progress rate (r) across different genotypes. The AUDPC values were produced by taking the weekly disease severity data using trapezoidal method in Microsoft Excel as decribed by Wilcoxson et al. (1975), using the following formula per accession lines per replication

$$\text{AUDPC} = \sum_{i=1}^{n-1} \frac{(x_{i+1} + x_i)}{2} (t_{i+1} - t_i)$$

Where, Xi is the cumulative disease severity expressed as a proportion at the ith observation; ti is the time (days after planting) at the ith observation and n is total number of observations. The apparent infection rate (r) of disease progress curve was estimated for each accession line per replication over successive disease severity recording periods using the lme4 R statistical packege (Bates et al., 2015). The rates of stem rust increase (r-value) as a function of time were estimated based on proportional measures of the extent of infection at different times by taking the coefficient of the slope of the regression line (Vanderplank, 1963; Harjit-Singh and Rao, 1989).

The residual (restricted) maximum likelihood estimation method to fit the alpha lattice design model with the different disease parametrs (indicated below) was carried using the agricolae package (De Mendiburu, 2019) as implement in R package (R Core Team, 2019). The estimation method produced the ANOVA table, the standardize and fitted value of the model, F- statstics, means and other relevant statistics to cheack model adequacy and the mean comparison using the least significance difference (LSD) method.

The model of alpha lattice design:

$y_{ijl} = \mu + \tau_i + \gamma_j + \rho_{l(j)} + \epsilon_{ijl}$,

Where, τ_i = treatment effect (wheat accessions), i = 1, 2, …t, γ_j = replication effect, j =1,2….r, $\rho_{l(j)}$ = block within replication effect, l= 1,2…s, ϵ_{ijl} = random error.The relationship between grain yield and slow rust parameters were computed using SAS version 9.0 (SAS Institute Inc, 2004).

RESULT AND DISCUSSION

Slow rusting genotypes were identified in the field considering their terminal rust severity (TRS), coefficient of infection (ACI), area under disease progress curve (AUDPC) and rate of stem rust progress. The analysis of variance showed highly significant variation among durum wheat lines for the stated disease parameters.

Table 2 Analysis of variance table for adult resistance parametrs

APR	Sum square		Mean square		CV (%)	F value	Pr(>F)
Parameters	Genotypes	residuals	Genotypes	residuals			
AUDPC	35,555,589.00	9,027,042.00	248640.0	68387.0	30	3.6	***
ACI	158,818.00	24235.0	1110.6	183.6	28	6.0	**
TRS	119921.00	23887.00	838.6	181.0	25	4.6	***
rate (r)	73.10	14.40	0.5	0.1	25	4.7	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Infection response and terminal disease severity

The distruibution of field responses to infection by the durum lines is indicated on Figure 1. The majority of the tested lines were in the category of susceptible and moderately susceptible with frequency of 59 and 75 respectively. Although, none of the lines examined have exhibited immune or resistance reaction, the two reference lines (Boohai and Tob66) showed a moderately resistance reponse. The remaining 23 lines were moderate in their reponse to field infection by *P. graminisis* f.sp. *tritici* at DZAR. According to Nzuve et al., (2012), the available resistance genes in the wheat landraces overcame the stem rust virulence in the field and led to statistically low disease severities despite the compatible host-pathogen reactions.

The terminal disease severity (TRS) ranges between 15% and 100% and most of the durum wheat accession lines investigated in this study produced variable results (Table 2). Accordingle, they were classified into three groups of slow rusting resistance based on the level of severity as having high, moderate and low partial resistance for genotypes showing 1-30 %, 31-50 % and >50 % TRS, respectively (Safavi, 2012). In the first case, a considerable number of wheat lines (25 in total) falls under a high partial resistance groups indicating presence of potentially diverse group of durum wheat lines confering some degree of resistance against the rust disease in Ethiopia as previously reported (Mitiku et al., 2018). Durum heat with a moderately partial resistance terminal disease severity constitutes 49 lines which may also be important for exploring stem rust resistance. The remaining lines were not promising to harbor resistance according to the level of disease severity observed.

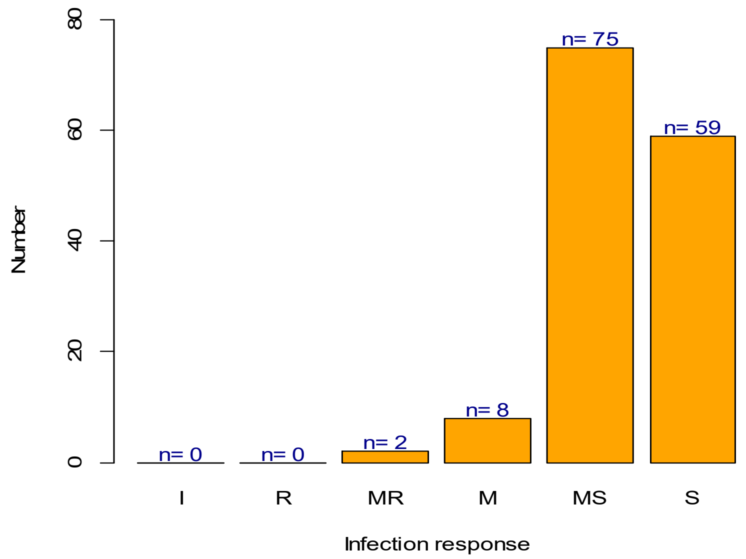

Figure 1. Frequency distribution of infection response by durum wheat accession lines from Ethiopia. I: immune; R: Resistance; MR: Moderately resistsnce; M: Medium; MS: Moderately susceptible; S: Susceptible

Coefficient of infection

The coefficient of infection values for wheat genotypes showed significance difference (p<.001) . The maximum value was recorded on accession 238127 and the lowest value was on the reference cultivars Bohai and Tob66 (Table 3). The values of coefficient of infection are regarded as indicative of the presence of stem resistance in adult plant study. According to Ali et al. (2009) wheat lines with coefficient of infection values of 0-20, 21 -40, and 41 -60 considered as possessing high, moderate, and low level of slow rusting resistance respectively. In this study a total 19 lines were found with CI values to satisfy the assumption of indicative resistance genes in the Ethiopian durum wheat lines. In addition, 44 lines were found to show a moderate level of slow rusting resistance according to the discription by Ali et al. (2009). These accessions might be low level of slowing stem rust development. The earlier findings reported that the slow rusting resistance in wheat stem rust were associated with low coefficient of infection indicating the presence of different partial resistance conferring genes as reported for the different durum wheat lines in this study (Patil et al., 2005; Pathan and Park, 2006; Draz et al. , 2015). The remaining lines were found to show low level of slow rusting resistance indicating their limitation for use in stem rust management (Draz et al., 2015; Hei , 2016).

Disease progress rate (infection rate)

Slow rusting resistance is characterized by a reduced rate of epidemic development despite a compatible host pathogen interaction (Parlevliet and J.E. 1988; Nzuve et al., 2012). The genotypes having lower disease progress rate are acceptable for practical purpose. As expected the accession lines analyzed in this study produced significantly variable infection rate (p<.0001). The maximum mean disease progress rate (2.52) was observed on accession number 238127 and lowest disease infection rate from Boohai (Table 3). The result also indicated that a conciderable number of accession lines (28%) having infection rate of less than one. In order to successful reduce the amount of disease, these genotypes can provide effective protection agiaint the spread of the pathogens. The genotypes assigned in first group using slow rusting parametrs of TRS and CI have generally low infection rate than the genotypes categorized in second group and third groups. However, mismatches were aslo observed for some genotypes between infection rate and the other slow rusting parmeters such as TRS, CI and AUDPC. A report of such cases was demonstrated in other studies where estimate of infection rate was not in line with results for TRS, CI, and AUDPC (Sandoval-Islas et al. 2007, Ali et al. 2008, Safavi 2013).

Area under disease progress curve

The area under the disease progress curve AUDPC) is a good indicator of partial resistance under field condition and directly related with yield loss (Subba et al., 1989; Wang et al., 2005). In the present study, significant (p<.001) variation was observed in the level of AUDPC across wheat genotypes. The range of the AUDPPC value recorded was 241.5 and 1788.5 for accession 214606 and 238127 (Table 2). In total, 13 significance groups of accession lines were detected based on the mean comparison results at alpha level of 5% (Table 2). The majority of the accession lines (68.75 %) were clustered in one significance groups (abcdefg) which was not significantly different from the reference cultivars (Tob66 and Bohai) which were grouped under diferent significance groups. The drum wheat accession line with the lowest AUDPC score formed its own significance groups and was significantly different from the majority of the genotypes tested. Different reports indicated that genotypes with low AUDPC values and moderately susceptible (MS) reponse carried genes for conferring durable resistance (Brown et al., 2001; Singh et al., 2005; Kaur et al.,2010).

Table 2. Infection reponse, terminal disease severirty, coefficient of infection, infection rate and AUDPC results of the field study with significance value for the AUDPC

Accesion	Response	TRS	CI	r	AUDPC	Significance group
238127	S	100	100	2.52	1788.5	a
226880	S	90	90	2.31	1757	ab
238115	S	85	85	2.16	1564.5	abc
214589	S	90	90	2.31	1512	abcd
5180	S	90	90	2.18	1477	abcde
204410	S	85	85	2.25	1473.5	abcdef
208201	S	85	85	2.21	1459.5	abcdef
238125	S	80	80	2.09	1403.5	abcdefg
208189	S	85	85	2.04	1386	abcdefg
222556	S	75	75	1.83	1386	abcdefg
222432	S	80	80	1.98	1372	abcdefg
222520	S	85	85	2.08	1354.5	abcdefg
222705	S	85	85	1.94	1330	abcdefg
204409	S	65	65	1.62	1319.5	abcdefg
226876	S	85	85	2.01	1319.5	abcdefg
208183	S	95	95	2.21	1319.5	abcdefg
222433	S	70	70	1.80	1302	abcdefg
5204	S	75	75	1.97	1298.5	abcdefg
204543	S	85	85	2.03	1284.5	abcdefg
222815	S	75	75	1.95	1284.5	abcdefg
208188	S	75	75	1.88	1284.5	abcdefg
204453	S	80	80	1.92	1284.5	abcdefg
226971	S	75	75	1.86	1281	abcdefg
222505	S	75	75	1.90	1263.5	abcdefg
214605	S	65	65	1.75	1249.5	abcdefg
236987	S	85	85	2.14	1246	abcdefg
212648	S	70	70	1.73	1228.5	abcdefg
222464	S	80	80	1.92	1214.5	abcdefg
214312	S	80	80	1.97	1214.5	abcdefg
204444	S	65	65	1.68	1211	abcdefg
204454	MS	80	72	1.93	1197	abcdefg
226889	S	75	75	1.88	1190	abcdefg
222582	S	80	80	1.83	1162	abcdefg
222435	S	75	75	1.80	1144.5	abcdefg
238121	S	70	70	1.76	1144.5	abcdefg
238114	S	75	75	1.88	1144.5	abcdefg
7974	S	55	55	1.47	1144.5	abcdefg
222474	S	80	80	1.77	1141	abcdefg
214527	S	70	70	1.79	1127	abcdefg
208128	S	70	70	1.65	1127	abcdefg
226869	S	65	65	1.55	1123.5	abcdefg
222428	S	65	65	1.82	1120	abcdefg
203968	S	65	65	1.55	1109.5	abcdefg
208200	S	65	65	1.69	1092	abcdefg
222469	S	50	50	1.39	1092	abcdefg
204586	S	85	85	1.98	1074.5	abcdefg
238120	S	65	65	1.62	1074.5	abcdefg
221740	S	65	65	1.58	1057	abcdefg
226882	S	60	60	1.47	1053.5	abcdefg
226859	MS	55	49.5	1.40	1036	abcdefg
238123	MS	55	49.5	1.41	1022	abcdefg
204560	S	60	60	1.44	1022	abcdefg

Accesion	Response	TRS	CI	r	AUDPC	Significance group
216069	MS	55	49.5	1.51	1018.5	abcdefg
204545	S	75	75	1.67	1004.5	abcdefg
222426	MS	55	44	1.44	1004.5	abcdefg
222560	S	75	75	1.84	962.5	abcdefg
213036	S	75	75	1.72	948.5	abcdefg
226973	MS	50	40	1.30	934.5	abcdefg
238129	MS	45	40.5	1.14	934.5	abcdefg
204506	S	50	50	1.30	934.5	abcdefg
238128	S	75	75	1.79	931	abcdefg
222482	MS	50	45	1.26	931	abcdefg
204363	S	55	55	1.46	917	abcdefg
226857	S	55	55	1.28	917	abcdefg
208197	MS	45	40.5	1.21	913.5	abcdefg
222388	MS	50	40	1.26	896	abcdefg
226886	S	55	55	1.45	896	abcdefg
206627	MS	55	44	1.42	896	abcdefg
216098	MS	55	44	1.41	882	abcdefg
208934	MS	55	49.5	1.38	847	abcdefg
204463	S	55	55	1.27	843.5	abcdefg
222488	MS	55	49.5	1.33	843.5	abcdefg
238132	MS	50	45	1.35	840	abcdefg
204428	MS	60	54	1.41	826	abcdefg
222439	MS	45	36	1.14	826	abcdefg
226867	MS	50	40	1.24	812	abcdefg
222494	MS	45	36	1.10	808.5	abcdefg
214495	S	55	55	1.28	808.5	abcdefg
222454	MS	45	36	1.24	794.5	abcdefg
208476	MS	50	40	1.25	794.5	abcdefg
204432	MS	55	44	1.28	791	abcdefg
222552	MS	50	45	1.23	791	abcdefg
238113	MS	60	54	1.39	791	abcdefg
238124	MS	55	49.5	1.30	777	abcdefg
226885	MS	40	32	1.02	759.5	abcdefg
208785	MS	45	36	1.20	759.5	abcdefg
222680	MS	45	36	1.12	756	abcdefg
222550	MS	45	36	1.03	740.25	abcdefg
204562	MS	45	36	1.13	738.5	abcdefg
204555	MS	40	32	1.06	717.5	abcdefg
226977	MS	50	45	1.21	707	abcdefg
238126	MS	40	32	1.03	686	abcdefg
5071	MS	40	32	1.05	686	abcdefg
204542	MS	50	40	1.19	682.5	abcdefg
204589	MS	45	36	1.05	672	abcdefg
208206	MS	50	40	1.07	654.5	abcdefg
214418	MS	45	36	1.05	637	abcdefg
222381	MS	40	32	1.02	633.5	abcdefg
214264	MS	35	28	0.91	619.5	abcdefg
222449	MS	30	24	0.82	619.5	abcdefg
211488	MS	35	31.5	0.84	602	abcdefg
222764	MS	45	36	1.03	598.5	abcdefg
226858	MS	35	28	0.91	598.5	abcdefg
8063	MS	45	36	1.00	598.5	abcdefg
222422	MS	35	28	0.95	584.5	abcdefg
222559	MS	35	28	0.86	581	abcdefg
204391	MS	35	28	0.89	563.5	bcdefg
222405	MS	35	28	0.85	563.5	bcdefg
226965	MS	35	28	0.85	563.5	bcdefg

Accesion	Response	TRS	CI	r	AUDPC	Significance group
204522	MS	40	32	0.85	546	bcdefg
208191	MS	35	28	0.90	532	cdefg
212650	MS	35	28	0.82	532	cdefg
214348	MS	35	28	0.85	528.5	cdefg
214608	M	35	21	0.87	518	cdefg
5250	MS	35	28	0.83	514.5	cdefg
238131	MS	35	28	0.84	507.5	cdefg
222553	MS	35	28	0.90	497	cdefg
204476	MS	35	28	0.84	493.5	cdefg
204521	MS	35	28	0.81	476	cdefg
213037	MS	25	20	0.68	462	cdefg
232119	MS	25	20	0.68	458.5	cdefg
226884	MS	35	28	0.79	458.5	cdefg
214467	M	25	15	0.69	444.5	cdefg
222437	M	25	15	0.69	444.5	cdefg
226898	MS	30	24	0.71	437.5	cdefg
204011	MS	30	24	0.71	430.5	cdefg
226883	MS	30	24	0.72	423.5	cdefg
226866	MS	25	20	0.64	420	cdefg
226860	MS	25	20	0.63	395.5	cdefg
222451	M	25	15	0.54	392	cdefg
222450	MS	25	20	0.68	392	cdefg
236988	MS	30	24	0.72	392	cdefg
222389	M	25	15	0.59	378	cdefg
204509	MS	25	20	0.62	374.5	cdefg
204566	MS	25	20	0.61	371	cdefg
226893	MS	30	24	0.70	371	cdefg
203992	MS	25	20	0.62	357	cdefg
226978	MS	25	20	0.58	353.5	cdefg
208331	MS	20	16	0.50	339.5	defg
236986	M	20	12	0.48	304.5	defg
226821	M	25	15	0.55	304.5	defg
Bohai	MR	15	6	0.40	273	efg
Tob66	MR	20	8	0.49	259	fg
214606	M	20	12	0.43	241.5	g

Color Code Key

Color	**Population**	Total
(red)	a	1
(light green)	ab	1
(blue)	abc	1
(yellow)	abcd	1
(magenta)	abcde	1
(cyan)	abcdef	2
(maroon)	abcdefg	99
(green)	bcdefg	4
(navy)	cdefg	28
(olive)	defg	3
(purple)	efg	1
(teal)	fg	1
(grey)	g	1

The Relationship between Disease Parameter and Grain yield

The disease parameters (TRS, CI, AUDPC) were negative and highly significant (P<0.001) associated with grain yield. This might be an indication that the amount of stem rust severity increased resulted in the highly significant reduction on the yield. The damage of stem rust disease was not only grain yield rather than several yield componenets. However, the sum of negative effect reside on final yield. Several previous studies showed that stem rust attacks or interferes with the normal physiological activities of the plant and results reduced number of tiller, small number of kernel per spike, reduced grain yield have the mechanism of limited transportation of water, inadequate nuitrent flow to the plant (Singh et al., 2006; Tadesse et al., 2010).

Table 3. Correlation between disease parameter and grain yield (GY)

Disease parametres	GY
TRS	-0.54**
CI	-0.57**
AUDPC	-0.53**

** Highly significant at P<0.001

CONCLUSSIONS

Stem rust is the most yield reducing in wheat over all epidemics in the world and devastating now. For this problem, 142 durum wheat accessions screening in the filed and evaluated using slow rusting parameters. The 23 durum genotypes selected based on TRS and CI < 30%, the AUDPC ranges 241.5-619.5. On the other hand, 49 Durum genotypes having TRS (31 % - 50 %), CI (21 -50) , AUDPC ranges 458.5-1092 were might be the moderately slow rusting resistance genotypes and the rest 70 genotypes were no slow rusting resistance .The Durum wheat genotypes having the slow rusting and moderately slow rusting from present study were assumed to be having genes for varying degree of slow rusting and this genes useful for further durum wheat resistance breeding program.

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Data availability statement

The basic important data related for this study is included If anything, additional is needed an available can provide it up on request.

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