

RELATIONSHIP AMONG BIOTIC STRESS FACTORS AND AGRONOMIC CHARACTERS IN BREAD WHEAT (*Triticum aestivum* L.) GENOTYPES UNDER VARIOUS ENVIRONMENTAL CONDITIONS

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Abstract

Infection of the biotic stress factors varies based on environment x genotypes interaction in Trakya region, Turkey. This research was carried out to investigate effect of the environmental condition on yield, quality parameters and some biotic stress based on location and correlation among these characters. The experiment was conducted in Trakya region at four locations during 2015-2016 growing cycle, with 25 advanced genotypes in RCBD with four replications. Grain yield, leaf rust, net blotch, plant height, days of heading, 1000-kernel weight, test weight, protein ratio, gluten, sedimentation, hardness and relationship among these parameters, based on location, were investigated. There were significant difference among genotypes and location. The mean yield of the experiment was 587.6 kg da⁻¹ and the highest yield was determined in Lüleburgaz location. Various level of epidemic occurred in leaf rust and net blotch across location. Aldane and three genotypes were tolerant to leaf rust and net blotch. The correlation coefficient was varied based on location and genotypes. Leaf rust was negatively correlated with protein ratio across location. Net blotch was negatively correlated with gluten index and sedimentation value in all location. There was highly significant correlation with net blotch and gluten index in three locations where disease infection was higher. Under all location sedimentation was negatively affected by net blotch. Also there was negatively relation between grain yield with protein ratio and gluten value in all locations, with leaf rust at three locations, with net blotch at two locations.

Key words: Bread wheat, biotic stress, environment, genotypes, agronomic characters

1. INTRODUCTION

Trakya region is located in the Northwestern part of Turkey. Mostly bread wheat cultivars are grown and average wheat yield is almost 5.0 tons/ha, production 3 million tons per year. Although, the average annual rainfall is 560 mm this precipitation ranges during the growing season. Distribution of rainfall is not regular. Due to this fluctuation of rainfall in some growing year causes decrease in grain yield and quality (Öztürk and Korkut, 2015). Success of a wheat breeding program depends on the regional adaptability of the cultivars improved and adaptability of cultivars in the target environments determined by its tolerance to biotic and abiotic stresses. The most important abiotic stress factor is the shortage of rainfall in the region (Altay, 2012). Almost all breeding programs in the world aim to improve varieties with stable yields. The yield stability is generally grouped as static or dynamic stability (Pfeiffer and Braun, 1989). Consistency in yield has always been a problem in crop production due to the strong influence of environmental effects during the various stages of crop growth. Many publications described the importance of G x E interactions and concluded that mean yields are not a satisfactory basis and emphasis should therefore be given on the evaluation of genotypes which could perform better irrespective of environmental fluctuations (Golmirzaie et al., 1990; Kinyua, 1992; Yan and Hunt, 2001; Viana and Cruz, 2002). Environmental factors play a main role in the expression of genotype characteristics (Peterson et al., 1998). In wheat, grain yield and baking quality are dependent on the environment, genetic factors and the interaction between them (Yan and Holland, 2010; Coventry et al., 2011). Protein content in the mature grain is largely determined by environmental and farm management factors, with genetics playing a minor role in being either low or high in protein content. By contrast, protein quality is determined by the genetic composition of the wheat variety and also how the environment influences genetic expression (Blakeney et al., 2009). Wheat yield potential in Trakya region changes across region due to various environmental conditions. Because of various infection of biotic stress factor such as leaf rust and *Septoria tritici* causes reduces yield and quality over location

(Öztürk et al., 2016). The objective of this research was to assess the yield and yield stabilities, biotics and agronomical traits and relation among investigated characters of the genotypes.

2. MATERIALS AND METHODS

The experiment was conducted at four locations in Trakya region, Turkey, in 2015-2016 growing seasons. Twenty five winter wheat genotypes, 5 of them were local check and 20 advanced lines, were examined under field condition with randomized complete block design with four replications. All plots were sown into 6 rows, and plot sizes were 6 m² at harvesting. In the experiment 500 seed m⁻² was used at planting. Grain yield, 1000-kernel weights and test weight, (Blakeney et al., 2009), protein ratio (% NIR AACC 39-10), grain hardness, gluten, gluten index, and sedimentation (Köksel ve ark., 2000; Perten H. 1990; Anonymous, 2002) were investigated. The quality analysis of Zeleny sedimentation test and wet gluten content were determined according to ICC standard methods No. 116/1 and 106/2, respectively (Anonymous, 1972; Anonymous, 1984). Modified Cobb scale (Prescott et al., 1986; Roelfs et al., 1992; Saari and Prescott, 1985; Peterson et al., 1948) was used for leaf diseases. Several methods have been developed to analyze genotype x environment interaction (Lin et al., 1986; Piepho, 1998). Finlay and Wilkinson's joint regression model (1963) and Eberhart and Russel's method (1966) were applied and the regression coefficient (b), determination coefficients of the regression equations (R²) were calculated (Finlay and Wilkinson, 1963; Eberhart and Russell, 1966 and 1969; Tai, 1971). Also, regression graphs are used to predict adaptability of genotypes. Data were analysed statistically for analysis of variance (ANOVA) following the method described by Gomez and Gomez (1984). The significance of differences among means was compared by using Least Significant Difference (L.S.D. at a %5) test.

3. RESULTS AND DISCUSSION

The results of variance analysis are presented in Table 1 and 2. It was showed that there was statistically difference among genotypes according to yield and other investigated characters. As a result, the highest grain yields were determined in TE6411-12 with 694.8 kg da⁻¹ and OCW01S304T-7 line with 683.0 kg da⁻¹. Lodging is one of the mainly problem in Trakya region. Plant height is important traits to evaluation genotypes especially for lodging resistance. Plant height ranged from 77.8 cm up to 114.8 cm and mean was 98.6 cm. The lowest plant height was obtained in Entry 22, 23, 9, 4 and 17 genotypes. Earliness is other important characters and there was significant difference among genotypes and earliness was determined in Aldane and Gelibolu cultivars with entry number 7, 8 and 16 genotypes.

The ranges of variation for 1000-kernel weight and test weight in all genotypes were evaluated at four locations. These are the characters a very important yield component in wheat and affected by environmental conditions, agronomic practice and genotypic traits. According to genotypes there was a wide variability both in thousand kernel weights and test weight. Thousand kernel weight ranged from 30.5 g to 48.2 g among genotypes and mean value was 40.0 g. The highest 1000-kernel weight was measured in TE6348-18 genotypes. There were significant differences among genotypes based on test weight. The test weight ranged in genotypes from 78.6 kg to 85.7 kg and the highest test weight scaled in Entry 7 and followed by Selimiye (84.9 kg), Pehlivan (84.2 kg) and Gelibolu (84.1 kg) cultivars, mean value of the test weight was 81.9 kg (Table 1).

Table 1. The mean value of the genotypes on agronomic, physiological, morphological and quality characters

Entry No	Genotypes	GY	PH	DH	TKW	TW
1	Aldane	569.0 e-h	98.5 d-g	106.3 ij	45.6 abc	83.3 b-e
2	TCI992280-2	633.2 bc	109.3 abc	111.8 def	33.2 jk	81.6 d-g
3	UR01062 -3	486.0 j	111.3 ab	118.5 a	34.9 j	83.6 a-d
4	ICWH99018-4	607.1 cd	87.5 ij	109.5 e-h	30.5 k	81.3 e-h
5	Selimiye	540.7 gh ₁	96.5 fg	109.3 fgh	40.2 fgh	84.9 ab
6	TE6411-6	668.9 ab	100.0 def	112.0 de	39.5 f- ₁	79.2 ₁
7	OCW01S304T-7	683.0 a	97.8 efg	105.8 j	35.7 ij	85.7 a
8	TCI011656-8	609.5 cd	95.8 fg	108.0 hij	36.8 hij	83.6 a-d
9	TE6627-9	525.4 ₁	84.0 jk	118.8 a	39.3 f- ₁	78.6 ₁
10	Bereket	534.6 h ₁	103.5 cde	109.0 gh	39.2 gh ₁	82.4 cde
11	TE6295-11	618.8 c	93.3 gh ₁	110.8 d-g	39.4 f- ₁	81.5 d-g
12	TE6411-12	694.8 a	97.8 efg	111.3 d-g	41.4 d-g	79.9 f- ₁
13	TE6411-13	574.3 d-g	97.8 efg	112.3 d	38.9 gh ₁	79.1 ₁
14	TCI032295-14	527.7 ₁	114.8 a	119.3 a	40.1 fgh	81.8 def
15	Pehlivan	551.0 f- ₁	108.8 abc	110.8 d-g	44.4 a-e	84.2 abc
16	TCI011656-16	629.1 c	94.5 fgh	107.0 hij	36.8 hij	83.7 a-d
17	TE6295-17	632.9 bc	89.5 hij	111.3 d-g	40.6 e-h	83.1 b-e
18	TE6348-18	554.8 f- ₁	108.5 bc	115.5 bc	48.2 a	83.6 a-d
19	TE6813-19	597.7 cde	104.3 cd	113.3 cd	46.7 ab	79.6 gh ₁
20	Gelibolu	617.8 c	96.5 fg	108.8 gh ₁	39.9 fgh	84.1 abc
21	TE6813-21	606.3 cd	98.3 d-g	113.0 cd	45.3 a-d	79.5 h ₁
22	TE6627-22	546.1 f- ₁	78.3 kl	119.3 a	39.2 gh ₁	79.0 ₁
23	TE6627-23	548.0 f- ₁	77.8 l	119.3 a	39.1 gh ₁	78.6 ₁
24	TE6627-24	555.7 f- ₁	112.0 ab	118.5 a	43.2 b-f	82.9 b-e
25	TE6627-25	578.5 def	111.7 ab	117.7 ab	41.8 c-g	82.9 b-e
Mean		587.6	98.6	112.6	40.0	81.9
CV (%)		8.8	4.4	1.7	7.1	1.8
LSD (0.05)		36.2	6.2	2.7	3.9	2.1
F		**	**	**	**	**

Note: Significance at **: P<0.01 and *: P<0.05; GY: Grain yield (kg da⁻¹), PH: Plant height (cm), DH: Days of heading, TKW: 1000-kernel weight (g), TW: Test weight (kg)

Protein quality and quantity have received more attention than other quality attributes, partly owing to the significant influence imparted by protein on end-use product quality of both common wheat and durum wheat. Environmental factors, such as nitrogen fertilization, water and temperature, influence protein content (Sissons et al., 2005). In contrast, protein quality is largely under genetic control (Lerner et al., 2006; Rogers et al., 2006). In this research, protein ratio has changed between 9.9% and 12.6% in the genotypes across location. The highest protein content was determined with 12.6% in Aldane and UR01062-3 line. Table 2 shows that mean and ranges of variation for protein ratio in all genotypes were evaluated across locations. Gluten ratio ranged from 25.0% to 38.6% among genotypes and mean gluten

was 31.6%. The highest gluten ratio was measured in Entry 14, TE6348-18 and followed by Entry 3 and Aldane cultivar. The highest gluten index was determined in Entry 7 and Aldane cultivar. Also, sedimentation in genotypes ranged from 18.8 ml to 58.5 ml and the highest sedimentation scaled in Aldane (58.5 ml), entry number 3 and 7 genotypes. The mean sedimentation value was 40.0 ml.

Table 2. The mean value of the genotypes on agronomic, physiological, morphological and quality characters

Entry No	Genotypes	PRT	GLT	IND	HARD	SED
1	Aldane	12.6 ab	35.8 ab	90.0 ab	46.3 hij	58.5 a
2	TCI992280-2	11.1 d-h	30.0 d-g	77.5 cde	48.3 e-i	43.8 c-f
3	UR01062 -3	12.6 ab	36.0 ab	86.8 abc	47.0 g-j	56.8 a
4	ICWH99018-4	10.3 hij	25.0 h	68.2 e	48.3 e-i	28.0 j
5	Selimiye	10.4 g-j	30.7 c-g	79.6 b-e	48.5 e-i	40.3 efg
6	TE6411-6	10.8 e-i	29.8 efg	82.1 abc	49.8 c-g	44.3 cde
7	OCW01S304T-7	11.1 d-g	29.6 efg	93.4 a	44.8 j	55.0 a
8	TCI011656-8	10.4 g-j	30.1 d-g	85.6 abc	46.3 hij	49.5 b
9	TE6627-9	11.3 cde	33.7 bc	52.0 f	50.8 b-e	37.3 ghi
10	Bereket	9.9 j	29.1 fg	81.5 bcd	46.5 hij	36.3 ghi
11	TE6295-11	10.5 f-j	29.5 fg	79.2 b-e	47.3 f-j	42.8 def
12	TE6411-12	10.5 f-j	29.8 efg	83.1 abc	49.5 c-g	42.8 def
13	TE6411-13	10.8 e-i	29.7 efg	86.6 abc	49.0 d-h	46.3 bcd
14	TCI032295-14	12.0 bc	38.6 a	44.6 fg	51.0 b-e	40.3 efg
15	Pehlivan	10.7 e-i	33.3 bcd	40.1 g	47.8 f-i	35.5 hi
16	TCI011656-16	10.3 ij	30.1 d-g	85.9 abc	47.8 f-i	47.5 bc
17	TE6295-17	10.7 e-i	30.6 c-g	84.7 abc	50.0 b-f	45.5 bcd
18	TE6348-18	12.9 a	38.1 a	56.2 f	54.0 a	40.0 efg
19	TE6813-19	11.0 d-i	33.8 bc	35.9 g	50.8 b-e	21.5 k
20	Gelibolu	9.9 j	27.7 gh	87.1 abc	50.8 b-e	39.8 fgh
21	TE6813-21	10.5 f-j	28.2 gh	13.9 h	46.0 ij	18.8 k
22	TE6627-22	11.2 def	31.8 c-f	52.1 f	51.8 a-d	35.0 i
23	TE6627-23	11.1 d-g	31.6 c-f	53.4 f	52.3 abc	36.0 ghi
24	TE6627-24	11.1 d-g	33.0 b-e	53.8 f	52.8 ab	37.8 ghi
25	TE6627-25	11.8 cd	35.9 ab	69.3 de	50.4 b-f	48.3 bc
Mean		11.0	31.6	68.8	49.1	40.9
CV (%)		4.8	7.5	12.0	4.2	7.6
LSD (0.05)		0.7	3.4	11.7	2.9	4.4
F		**	**	**	**	**

Note: Significance at **: P<0.01 and *: P<0.05; PRT: Protein ratio (%), GLT: Gluten, IND: Gluten index, HARD: Hardness, SED: Sedimentation (ml)

Correlation coefficients among the tested characters were done based on location and results of the Edirne location were given in Table 3. A strong negative and highly correlation was observed between grain yield and days of heading ($r=-0.537^{**}$), and leaf rust ($r=-0.431^{*}$). Leaf rust was negatively correlated with TKW ($r=-0.458^{*}$), protein ratio ($r=-0.423^{*}$). These result indicated that higher infection of leaf rust caused decreasing in grain yield, TKW and test weight based on disease infection level. Infection level of the septoria leaf disease depends on environment condition, such as humidity and temperature. It was determined that a negative correlation between *Septoria tritici* with gluten index ($r=-0.531^{**}$), hardness ($r=-0.539^{**}$), and sedimentation ($r=-0.550^{**}$). Also, days of heading was highly and positively correlated with grain hardness ($r=0.714^{**}$), and gluten value ($r=0.430^{*}$). Days of heading was negatively correlated with test weight ($r=-0.515^{**}$), and gluten index ($r=-0.584^{**}$).

Wheat leaf rust is the most destructive and widespread diseases in Trakya region and susceptible cultivars leading to serious yield losses. There were differences among location and genotypic reaction according to leaf rust (*Puccinia recondita*) infection. A high incidence and severity of wheat leaf rust and *Septoria tritici* was in Edirne location because of suitable environmental condition and disease severities on susceptible varieties reached 100% in leaf rust and *Septoria tritici* reached up to 89 based on Double digit scale. Aldane and entry 3, 7 and 18 lines was tolerant or resistant to leaf rust under field condition across locations. In three locations, diseases infection was generally a low or moderate.

Table 3. The correlation coefficients among tested characters in Edirne locations

Traits	GY	DH	PH	LR	SEPT	TKW	TW	PRT	GLT	IND	HARD
DH	-0.537**										
PH	0.353	-0.120									
LR	-0.431*	-0.094	-0.477*								
SEPT	-0.353	0.300	-0.195	0.149							
TKW	0.179	-0.030	0.440*	-0.458*	0.266						
TW	0.312	-0.515**	0.562**	-0.149	-0.266	0.265					
PRT	-0.304	0.377	0.257	-0.423*	-0.161	0.260	-0.015				
GLT	-0.403*	0.430*	0.310	-0.295	0.029	0.255	0.030	0.836**			
IND	0.377	-0.584**	-0.018	-0.147	-0.531**	-0.231	0.319	-0.175	-0.150		
HARD	-0.342	0.714**	-0.171	-0.105	0.539**	0.095	-0.449*	0.160	0.252	-0.621**	
SED	0.198	-0.313	0.169	-0.271	-0.550**	-0.169	0.298	0.297	0.309	0.806**	-0.579**

Note: Significance at **: $P<0.01$ and * : $P<0.05$; GY: Grain yield (kg da^{-1}), DH: Days of heading, PH: Plant height (cm), LR: Leaf rust, SEPT: *Septoria tritici*, TKW: Thousand kernel weight (g), TW: Test weight (kg), PRT: Protein ratio (%), GLT: Gluten (%), IND: Gluten index (%), HARD: Hardness, SED: Sedimentation (ml)

Table 4. The correlation coefficients among tested characters in Lüleburgaz locations

Traits	GY	DH	PH	LR	SEPT	TKW	TW	PRT	GLT	IND	HARD
DH	-0.636**										
PH	0.215	0.118									
LR	0.325	-0.318	-0.051								
SEPT	-0.442*	0.467*	0.074	-0.107							
TKW	0.062	0.191	0.031	-0.124	0.271						
TW	0.460*	-0.113	0.270	0.284	-0.305	0.077					
PRT	-0.236	0.138	0.245	-0.592**	-0.108	0.128	-0.029				
GLT	-0.311	0.318	0.375	-0.282	0.290	0.254	-0.074	0.756**			
IND	0.606**	-0.435*	0.115	0.141	-0.604**	-0.193	0.574*	0.000	-0.264		
HARD	0.078	0.509**	0.177	-0.236	0.004	0.536**	0.212	0.048	0.081	0.148	
SED	0.388	-0.362	0.252	0.019	-0.509**	-0.072	0.596**	0.406*	0.271	0.747**	0.042

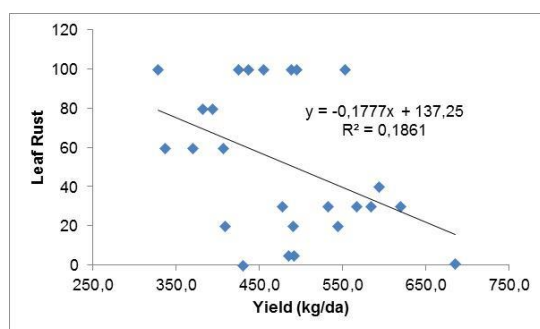
Table 5. The correlation coefficients among tested characters in Keşan locations

Traits	GY	DH	PH	LR	SEPT	TKW	TW	PRT	GLT	IND	HARD
DH	-0.337										
PH	-0.377	0.122									
LR	-0.062	-0.129	0.089								
SEPT	0.149	-0.291	-0.267	0.238							
TKW	-0.055	-0.040	-0.045	-0.511**	0.178						
TW	-0.073	-0.558**	0.115	-0.027	0.087	0.012					
PRT	-0.453*	0.494*	0.329	-0.523**	-0.539**	0.159	-0.030				
GLT	-0.504*	0.456*	0.385	-0.389	-0.412*	0.282	0.009	0.910**			
IND	0.232	-0.440*	-0.052	0.012	-0.114	-0.508**	0.398*	-0.128	-0.263		
HARD	0.106	0.117	-0.186	0.002	0.086	0.178	-0.284	0.041	0.098	-0.101	
SED	-0.115	0.031	0.097	-0.354	-0.391	-0.204	0.366	0.591**	0.485*	0.599**	-0.111

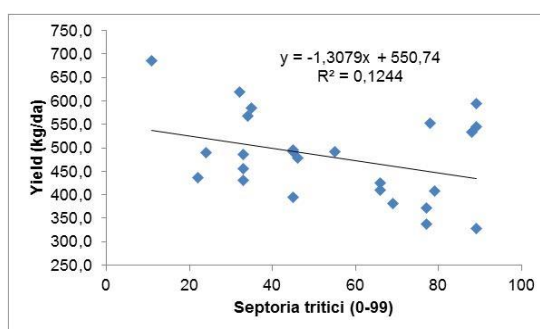
Grain yield and quality parameters were affected by environmental fluctuations across all locations. So, it was found various relations between yield, quality and diseases infection based on location interaction. In this research these characters were examined and assessed for relationship amongst them and increasing in diseases severity of the leaf rust and *Septoria tritici* was negatively affected and reduced yield and quality parameters. As it expected there was slightly negatively relation between leaf rust with grain yield ($R^2=0.186$), and protein ratio ($R^2=0.178$) in Edirne location where leaf rust infection occurred moderately or heavily level. Also, it was found close and negatively relation between leaf rust and 1000-kernel weight ($R^2=0.260$) in Keşan location. *Septoria tritici* in wheat negatively affected yield and quality traits. There was negative relation between *Septoria tritici* with grain yield ($R^2=0.124$), zel-sedimentation ($R^2=0.302$), and gluten index ($R^2=0.282$) (Figure 1).

Table 6. Correlation coefficients among tested characters of cultivars in Tekirdağ location

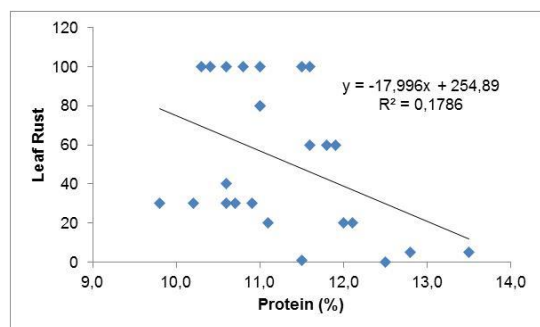
Traits	GY	DH	PH	LR	SEPT	TKW	TW	PRT	GLT	IND	HARD
DH	-0.072										
PH	-0.557*	0.036									
LR	-0.142	-0.037	0.282								
SEPT	0.292	0.077	-0.095	0.173							
TKW	-0.309	0.252	0.461*	0.126	0.148						
TW	-0.344	-0.549**	0.435	-0.043	-0.080	0.218					
PRT	-0.436	0.587**	0.232	-0.340	-0.249	0.294	-0.047				
GLT	-0.486	0.605**	0.487**	0.134	0.092	0.640**	-0.006	0.748**			
IND	0.020	-0.490*	-0.248	-0.067	-0.446*	-0.608**	0.129	-0.157	-0.500*		
HARD	-0.121	0.554**	0.153	-0.058	-0.018	0.080	-0.246	0.356*	0.482**	-0.259	
SED	-0.224	-0.333	0.021	-0.094	-0.490**	-0.324	0.239	0.229	-0.060	0.788**	-0.268



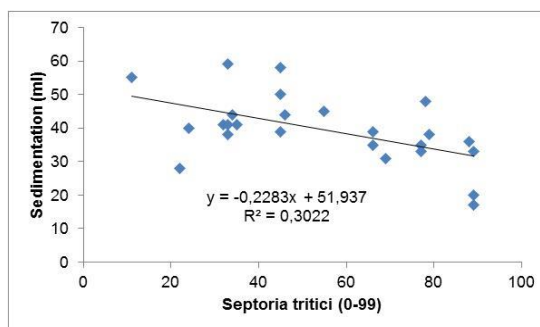
Leaf rust and yield (Edirne location)



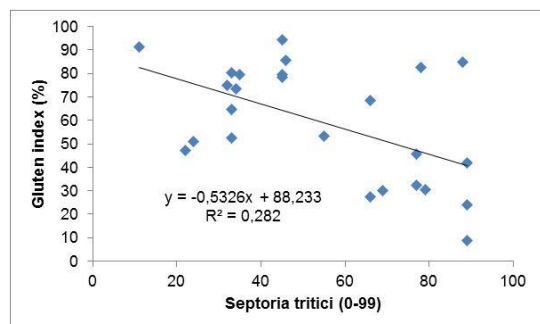
Yield and septoria tritici (Edirne location)



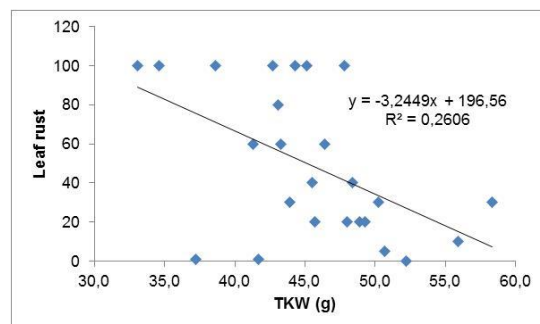
Leaf rust and protein ratio (Edirne location)



Septoria tritici and sedimentation (Edirne location)



Septoria tritici and gluten index (Edirne location)



Leaf rust and TKW (Kesan location)

Figure 1. Relation among biotic stress factor and yield and quality parameters

A genotype having high yield across the environment is very important for wheat breeders and growers. Genotype x environment interaction is a mainly issue to plant breeders in improving high-yielding, stable genotypes across variable environments. Several methods of measuring stability of genotypes tested across a range of environments have been proposed. Stability parameters of the genotypes are presented in Table 7. It was showed that all stability parameters were significantly different. Due to the highest determinations coefficient (R^2), entry number 2, 4, 8 and 19 line and Pehlivan, Selimiye and Bereket cultivars were very stable. It was shown that the regression coefficients (b) values ranged between -0.08 and 1.64 among genotypes. The variation in b value (Table 7) reflected a wide range of stability among genotypes. Gelibolu, Aldane cultivar and entry number TE6411-6, TE6627-23 and line 14 have optimum b value. It was determined the highest intercept values (a) in entry number 21, 7, 19, 12, 17 and 13 lines. This result showed that these genotypes were higher yield potential both under well and less fertile environment condition. According to all stability parameters it could be seen that TE6295-17, TE6411-12 and OCW01S304T-7 lines were very stable genotypes under unfertile environment condition. Gelibolu, TCI011656-16 and TE6411-6 genotypes were very suitable under all environments, TE6295-11 and TCI992280-2 was well adaptable to fertile environment conditions.

Table 7. The stability parameters of the genotypes based on grain yield

Entry No	Genotypes	X	R^2	S^2d	a	b
1	Aldane	568.98	0.74	13.69	-7.79	0.98
2	TCI992280-2	633.18	0.99	0.39	-122.00	1.29
3	UR01062 -3	486.05	0.73	8.11	45.13	0.75
4	ICWH99018-4	607.10	0.99	1.21	-249.14	1.46
5	Selimiye	540.70	0.93	5.74	-285.89	1.41
6	TE6411-6	668.93	0.61	26.05	79.71	1.00
7	OCW01S304T-7	682.95	0.25	9.47	515.76	0.28
8	TCI011656-8	609.50	0.96	2.30	-86.47	1.18
9	TE6627-9	525.35	0.60	35.98	-153.88	1.16
10	Bereket	534.63	0.92	5.30	-211.24	1.27
11	TE6295-11	618.85	0.85	10.05	-76.11	1.18
12	TE6411-12	694.80	0.62	15.19	229.24	0.79
13	TE6411-13	574.30	0.81	4.48	166.69	0.69
14	TCI032295-14	527.70	0.94	2.47	-52.02	0.99
15	Pehlivan	551.00	0.97	3.63	-411.35	1.64
16	TCI011656-16	629.15	0.80	8.28	100.28	0.90
17	TE6295-17	632.95	0.59	15.66	194.28	0.75
18	TE6348-18	554.78	0.66	29.49	-148.03	1.20
19	TE6813-19	597.70	0.94	1.00	243.39	0.60
20	Gelibolu	617.80	0.84	8.39	10.01	1.03
21	TE6813-21	606.25	0.04	6.86	654.50	-0.08
22	TE6627-22	546.08	0.54	46.97	-141.01	1.17
23	TE6627-23	548.03	0.62	27.28	-73.61	1.06
24	TE6627-24	555.70	0.85	13.51	-246.58	1.37
25	TE6627-25	578.45	0.42	48.33	26.11	0.94

Note: X: mean yield, R^2 : determinations coefficient, S^2d : Deviation from regression, a: intercept value, b: regression coefficient

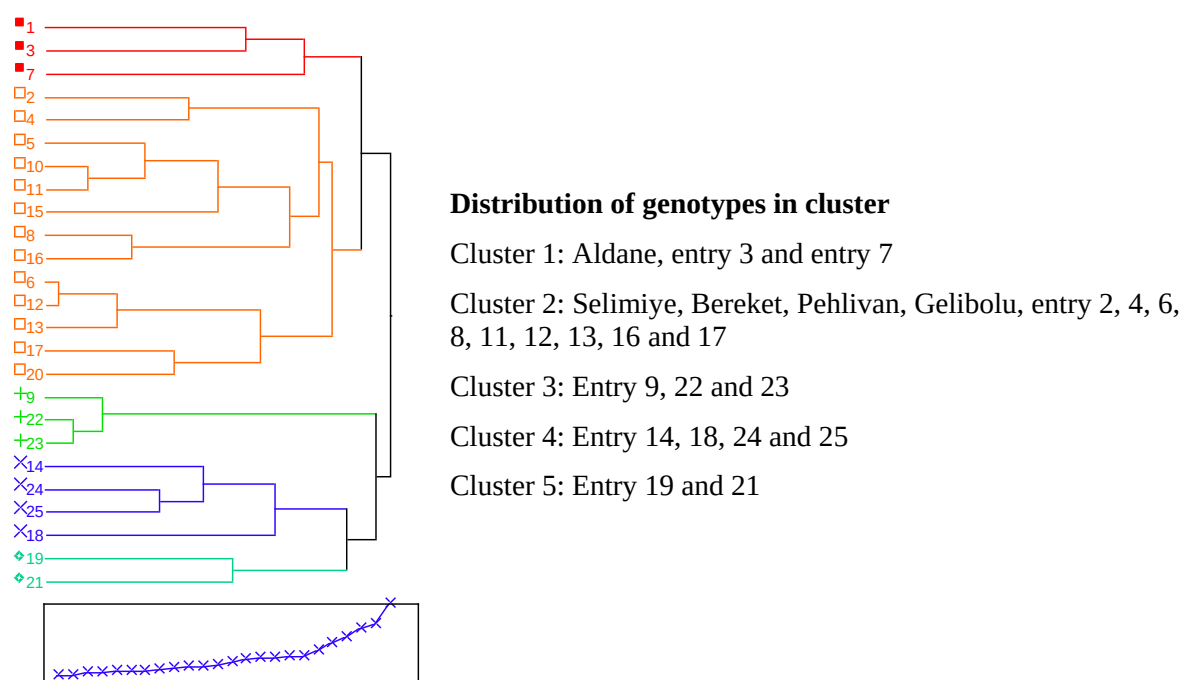


Figure 2. Cluster diagram of 25 genotypes based on morphoagronomic and disease traits

Totally 25 genotypes in each cluster were also analysed for basic statistics and divided into 5 clusters. The mean value of the characters in each cluster is presented in Figure 2. Cluster 1 consisted of 3 genotypes. This cluster was found to have a characteristic feature of low yielding, high gluten index and sedimentation value. Thirteen genotypes which include the standard check Selimiye, Bereket, Pehlivan and Gelibolu constitute cluster 2. This cluster can be characterized by having low level of protein and moderately low wet gluten contents. Cluster 3 had the lowest mean performance in grain yield, test weight, sedimentation value and gluten index. Also cluster 3 had short plant height and late maturing in the genotypes. Cluster 4 had four genotypes with a characteristics feature of long duration of maturity, the highest gluten value and plant height. According to cluster analyses there is significant genetic variability among tested genotypes that indicates the presence of opportunity to bring about improvement through wide hybridization by crossing genotypes in different clusters.

4. CONCLUSION

There were significant difference among genotypes and location because of varies environmental condition. Infection and level of the disease epidemic varied in leaf rust and *Septoria tritici* across location. Aldane and three genotypes (Entry 3, 7 and 18) were tolerant to leaf rust and *Septoria tritici* across all location under normal field condition. The correlation coefficient varied based on location, genotypes and their interaction. Leaf rust affected and reduced protein ratio so there was negatively correlated with protein ratio with protein in all location. *Septoria tritici* was negatively correlated with gluten index and sedimentation value across all location. There was highly negative significant correlation with *Septoria tritici* and gluten index at three locations where disease infection was higher. Under all location sedimentation was negatively affected by *Septoria* leaf disease. Also there was negatively relation between grain yield with protein ratio and gluten value in all locations, with leaf rust at three locations, with *Septoria tritici* at two locations. The overall results indicated that because of the various infections of the biotic stress factor negatively affected and causing various levels of investigation parameters. Also, days of heading was highly and positively correlated with grain hardness and gluten value. Days of heading was negatively correlated with test weight and gluten index. A strong negative and highly correlation was observed between grain yield and days of heading

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