Determination of Variability Between Grain Yield and Yield Components of Durum Wheat Varieties (*Triticum durum* Desf.) in Thrace Region

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Variability of grain yield and some yield components of 17 durum wheat varieties with native and exotic originated was investigated. This research was performed under rainfed conditions in three different environments (Tekirdağ, Lüleburgaz and Edirne) during two growing years (2001-2002 and 2002-2003). Significant differences among cultivars, locations and production years were determined. The highest variations among characters were found in grain weight/spike, grains/spike, spike length and grain yield. In the first experimental year, there was a high positive significant correlation between grain yield and grain weight/spike, test weight and 1000 grain weight. In the second experimental year, grain yield showed positive and significant correlations with 1000 grain weight, test weight and stem length. The biggest differences among investigated cultivar of durum wheat were found in stem length, grains/spike and 1000 grain weight. Grain yield of examined cultivars depended mainly on 1000 grain weight, test weight, grain weight/spike and agroecological conditions during the growing period. However, location, production year and genotypes were the most important determinant of potential yield of cultivars. Ç 1252, Fuatbey 2000, Epidur, Kızıltan95, Aydın 93 and Altın 97 were found more suitable cultivars that the others for durum wheat production in Thrace Region.

Keywords: Durum wheat, genotype, location, grain yield, yield components, variation.

Trakya Koşullarında Makarnalık Buğday Çeşitlerinin (*Triticum durum* Desf.) Tane Verimi ve Verim Komponentleri Arasındaki Değişimin Belirlenmesi

Çalışmada, yerli ve yabancı kökenli on yedi makarnalık buğday çeşitinde verim ve verim komponentlerinde değişim araştırılmıştır. Denemeler, üç farklı lokasyonda (Tekirdağ, Lüleburgaz and Edirne) iki yıl süresince yürütülmüştür. Yapılan varyans analizi sonuçlarına göre, çeşitler, lokasyonlar ve yıllar arasında istatistiki olarak önemli farklılıklar belirlenmiştir. İncelenen karakterlerden başakta dane sayısı, başakta tane ağırlığı, başak uzunluğu ve tane verimi arasında en yüksek varyasyon bulunmuştur. İlk deneme yılında tane verimi ile başakta tane ağırlığı, hektolitre ağırlığı ve 1000 tane ağırlığı arasında önemli olumlu ilişkiler belirlenmiştir. İkinci yıl ise, dane verimi 1000 tane ağırlığı, hektolitre ağırlığı ve sap uzunluğu ile önemli olumlu ilişkiler göstermiştir. Makarnalık buğday çeşitleri arasında en önemli varyasyon sap uzunluğu, başakta tane sayısı ve 1000 tane ağırlığında bulunmuştur. Makarnalık buğday çeşitlerinde tane veriminin ana olarak 1000 tane ağırlığı, hektolitre ağırlığı, başakta tane sayısı ve yetişme periodu süresince agro ekolojik koşullarla bağıntılı olduğu bulunmuştur. Bununla yanında, lokasyon, yetiştirme yılı ve genotiplerde çeşitlerin verim potansiyallerini belirleyen önemli belirleyiciler olmuşlardır. Trakya bölgesi için Ç 1252, Fuatbey 2000, Epidur, Kızıltan 95 , Aydın 93 ve Altın 97 en uygun makarnalık buğday çeşitleri olarak bulunmuştur.

Anahtar kelimeler: Makarnalık buğday, genotip, lokasyon, tane verimi, verim komponentleri, varyasyon.

Introduction

Thrace and Marmara Regions are suitable for durum wheat productionin respect to climatic conditions. Whereas the proportion of durum wheat was 60 % in 1960's, this rate in 1980's decreased to 5 % (Ada, 1993). Bacause new high yielding durum wheat varieties which cam complete with bread wheat varieties haven't been improved. It is necessary that not only new durum wheat breeding researches should be put forwarded but also well-adapted genotypes among presents should be selected in the region.

The successful process of durum wheat breeding based on the knowledge of characteristics of the genotypes as well as interaction genotype and locations. Understanding of the cause of genotype by environment interaction can be used to established breeding objectives, identify ideal test conditions, and formulate recommendations for areas of optimal cultivar adaptation (Weikai and Hunt, 2001).

The direct selection based on just yield can not be effective, but selection via yield and its components has more efficiency. Selection of a short stem, bigger spikelets/unit area and grains/spike (Hay, 1995), 1000 grain weight (Martincic et al., 1996), and higher grain weight/spike (Drezner, 1995) contributed most to a higher grain yield. Information on nature and extend of variability is of paramount importance in enhancing the efficiency of selection in target area. Especially, this information is very important for durum wheat in Thrace Region because of no enough study has been performed for durum wheat in the region. The objectives of this study were to evaluate the variability of grain yield and yield components of different durum wheat cultivars under Thrace Region Conditions and to contribute the accumulation of scientific knowledge.

Material and Methods

Plant material and site characteristics: Seventeen durum wheat varieties which are native and exotic originated were tested under rainfed conditions in three different environments (Tekirdağ, Lüleburgaz and Edirne) during two growing years (2001-2002 and 2002-2003). The experiment was carried out in a random block design with three replications. The plots were 6 m^2 (6 rows, 5 m long, spaced 20 cm apart). Standard cultural practices were followed for raising the crop.

The examined varieties are different in genetic background, origin and several characteristics. The chosen locations also differed, for instance, in the height above sea level, chemical composition of the soil and climate conditions. The height above sea level of Tekirdağ is H = 10 m which is a low-lying area, while Lüleburgaz's height above sea level is H = 41 m. The other location's altitude (Edirne) is H = 32 m. Differences among the locations chemical compositions of soil and climatic conditions are shown in Table 1. The plots were fertilized with 36 kg N ha^{-1} and 36 kg P_2O_5 ha^{-1} at sowing, 46 kg N ha^{-1} at tillering, 41 kg N ha^{-1} at stem elongation and 41 kg N ha^{-1} at anthesis (Sağlam, 1992).

Methods: Grain yield and its components, namely, stem length, spike length, spikelets /spike, grains/spike, grain weight/spike, 1000 grain weight and test weight were determined according to standard methods and the mean values are shown in Tables 3 and 4.

Influences of genetic and agro-ecological conditions of locations on the grain yield components were examined by variance analysis and tested by F-test. The significance of the differences between varieties and locations was determined by Duncan's Multiple Range Test (DMRT) ($P_{0.05}$*, $P_{0.01}$**) (Steel and Torrie, 1960). The interrelation of components of the grain yield was determined by correlation analysis according to Dewey and Lu (1959).

Results

The mean stem height of all durum wheat varieties was 95 cm in Tekirdağ, 84 cm in Edirne and 83 cm in Lüleburgaz in 2001/2002 (Table 3). Prior to harvest, plants were slightly higher in 2001/2002 than in 2002/2003 at three locations. The higher stem height of 2001/2002 and highly significant correlations with 1000 grain weight (0.331**) and spikelets/spike (0.130*). In the same year, stem height showed negative and insignificant correlation with grain yield and while correlation with spike length was negative and significant (- 0.123*) related to cultivar specificity and climate conditions

during the vegetation period (Table 5). Stem height correlated significantly with grain yield and 1000 grain weight 2002/2003 (Table 6). According to the variance analysis, influences of genotype and location were higher in 2001/2002 than in 2002/2003 (Table 2).

Table 1. Site localization and agronomic details

Locations	Tekirdağ		Lüleburgaz		Edirne	
Coordinates	40°59'N,27°34'E		41°22'N,27°16'E		41°38'N,26°35'E	
Altitude, m	10		41		32	
Soil characteristics						
Texture	Loamy clay		Fine loamy		Silty clay	
pH	7.15		7.70		5.82	
P, mg kg^{-1}	16.03		27.70		26.50	
K, mg kg^{-1}	36.94		69.25		40.24	
Organic matter, %	1.38		2.24		1.24	
Long-term weather data						
Seasonal rainfall, mm	466.0		446.5		451.9	
Rainfall during GFP	75.4		95.5		98.1	
Average temperatures°C (during GFP)						
Tmax	33.9		36.5		38.2	
Tmean	22.8		19.1		19.9	
Tmin	6.0		3.8		3.7	
	2002	2003	2002	2003	2002	2003
Seasonal rainfall, mm	513.4	422.3	486.2	450.7	380.4	486.2
Rainfall during GFP	49.4	15.4	55.5	46.3	42.1	85.0
Average temperatures°C (during GFP)						
Tmax	29.9	28.4	34.0	35.5	34.2	34.6
Tmean	19.7	20.5	19.4	20.5	20.9	22.5
Tmin	10.8	12.1	5.0	3.0	8.9	8.1
Agronomic practices (Fertilizer,kg ha^{-1})						
N (S, T, SE and A)	36-46-41-41		36-46-41-41		36-46-41-41	
P_2O_5	36		36		36	
Sowing time	16 Nov	25 Nov	18 Nov	29 Nov	19 Nov	1 Dec

GFP, grain filling period
Tmax, Tmean, Tmin are maximum, mean and minimum temperatures, and
S, T, SE and A are sowing, tillering, stem elongation and anthesis stages, respectively.

Table 2. Impact of location and genotype on grain yield components of examined varieties of durum wheat (*F*-test)

Yield components	2001/2002			2002/2003		
	Location (L)	Genotype (G)	Interaction (G x L)	Location (L)	Genotype (G)	Interaction (G x L)
Stem length (cm)	3208.764 **	562.851 **	121.172 **	812.413 **	750.829 **	61.168 **
Spike length (cm)	77.469 **	3.467 **	2.132 **	7.658**	4.490 **	0.752 **
Spikelets/spike (no)	40.031 **	15.832 **	7.503 **	23.698**	6.853 **	3.554 **
Grains/spike (no)	1993.480 **	171.657 **	115.387 **	597.458 **	148.592 **	111.407 **
Grain weight/spike (g)	0.802 **	0.488 **	0.327 **	1.250 **	0.472 **	0.432 **
1000 grain weight (g)	2819.693 **	82.271 **	20.374 **	659.853 **	60.947 **	19.719 **
Test weight (kg)	82.560 **	36.134 **	9.592 **	102.893 **	9.847 **	11.236 **
Grain yield (t*ha^{-1})	62.786 **	1.823 **	0.727 **	49.297 **	3.296 **	0.851 **

* and ** significant at P≤ 0.05 and 0.01, respectiveley.

According to locations means, the spike length mean of 2001/2002 was lower than 2002/2003. The higher influences of genotypes, locations and its interactions in 2001/2002 than in 2002/2003 indicates that variation of the spike lengths among varieties in the first year was higher than the second year (Table 2). In 2001/2002 according to correlation coefficients between spike length and other characters (Table 5), it was obvious that spike length increased as spikelets/spike, grains/spike and grain weight increased, but 1000 grain weight, test weight and grain yield decreased. Its positive and significant relations in the second year were similar to that of the first year. Highly significant negative correlation was observed between spike length and 1000 grain weight (Table 6).

The influence of genotype on spikeletes/spike in both growing seasons was substantial as well as the interaction of location and genotype and lower than location. As it seems, spikelets/spike in two years greatly depended on the location. The average values of the spikelets/spike of all genotypes did not vary significantly. This finding is verified by the variability coefficients which were computed in each location in both years.

The average grains/spike increased about 14 % in 2002/2003 more than in 2001/2002. The average grains/spike was higher in Edirne than in other two locations (Tables 3 and 4) and lower variability coefficients of 21.88 and 16.42 in both years. In both experimental years, the grains/spike depended more on location. In either year of experiments, a positive and significant correlation was observed between grain yield and grain weight per spike, thousand kernel weight and test weight. In the first year of experiment, a negative and significant correlation was observed between grain yield and spike length, spikilets per spike and number of grains per spike (Tables 5 and 6).

The variance and F-test showed the lowest significant influence of genotype, location and its interaction on grain weight/spike (Table 2). The mean values of the grain weight/spike and variability coefficients were nearly identical at three locations and in both years (Tables 3 and 4). In both years, grain weight showed highly significant correlations with grains/spike, spikelets/spike and spike length. Although the correlation coefficient between grain weight and grain yield was highly significant in the first year, this relation was observed as insignificant in the second year.

Table 5. Correlation coefficients between grain yield components and grain yield of examined varieties of durum wheat in 2001-2002 on three locations

	Spike length (cm)	Spikelets/ Spike (no)	Grains/spike (no)	Grain weight/ spike (g)	1000 grain weight (g)	Test weight (kg)	Grain yield ($t*ha^{-1}$)
Stem length (cm)	- 0.123 *	0.130 *	- 0.094	- 0.030	0.331 **	0.078	- 0.087
Spike length (cm)		0.564 **	0.617 **	0.269 **	- 0.521 **	- 0.341 **	- 0.264 **
Spikelets/spike (no)			0.576 **	0.413 **	- 0.219 *	- 0.165 **	- 0.139 **
Grains/spike (no)				0.592 **	- 0.398 **	- 0.103	- 0.114 *
Grain weight/spike (g)					- 0.068	0.065	0.289 **
1000 grain weight (g)						0.382 **	0.114 *
Test weight (kg)							0.249 **

* and ** significant at P≤ 0.05 and 0.01, respectiveley.

Table 3. Mean values of grain yield components of examined varieties of durum wheat in Tekirdağ (T), Lüleburgaz (L) and Edirne (E) in 2001/2002

Varieties	Stem length (cm)			Spike length (cm)			Spikelets/spike (no)			Grains/spike (no)			Grain weight/spike (g)			1000 grain weight (g)			Test weight (kg)			Grain yield ($t*ha^{-1}$)		
	T	L	E	T	L	E	T	L	E	T	L	E	T	L	E	T	L	E	T	L	E	T	L	E
Yavaros-79	95	78	80	6.78	7.92	8.15	17.33	19.67	21.00	30	33	39	1.433	2.033	1.410	53.2	45.1	34.0	79.00	79.23	75.71	6.339	6.958	4.619
Fırat-93	88	84	80	5.88	5.71	7.57	18.00	15.67	18.33	26	24	36	1.567	1.427	1.313	56.2	48.6	45.4	80.01	80.91	80.63	5.374	6.999	5.059
Zenit	83	78	75	5.42	5.83	8.57	18.67	17.67	19.67	20	26	30	1.167	1.600	1.253	47.7	42.6	35.9	79.00	79.35	78.87	5.148	5.433	4.735
Ç 1252	96	86	100	5.57	8.63	10.23	17.00	21.00	22.67	23	34	46	1.100	1.767	2.213	52.0	47.6	40.4	81.00	78.37	78.45	6.659	6.801	5.224
Selçuklu-97	94	83	80	7.36	8.28	9.13	20.67	22.33	23.00	35	36	45	1.583	1.817	1.740	44.0	35.1	32.1	78.00	74.16	72.07	6.064	6.048	4.083
Tunca-79	100	85	80	6.52	6.75	9.55	20.33	21.00	21.00	26	34	40	1.050	1.733	1.520	47.2	44.6	34.1	77.67	78.00	75.05	4.660	6.543	4.528
Fuatbey-2000	96	85	80	7.00	6.69	7.37	20.00	22.00	20.00	36	48	39	1.767	2.973	1.833	53.3	40.9	47.2	81.67	79.16	79.89	6.389	7.162	4.850
Sham-I	102	81	80	7.62	7.89	10.03	20.67	23.00	22.33	39	49	39	1.950	2.413	1.453	50.7	40.5	34.1	78.66	80.81	75.88	5.659	6.053	4.004
Ege-88	87	79	75	5.73	7.07	7.80	22.33	20.00	21.33	30	46	51	1.567	2.733	1.967	49.7	45.5	40.0	81.67	81.53	79.11	5.141	7.178	4.476
Kunduru-1149	128	118	110	5.33	6.87	8.47	21.33	20.00	21.33	28	31	39	1.367	1.310	1.893	51.3	40.4	40.1	81.00	75.76	76.87	6.333	4.404	3.692
Yılmaz-98	94	78	83	7.00	6.00	9.08	22.33	18.00	21.67	35	28	36	1.800	1.433	1.473	49.5	46.5	41.2	79.67	79.68	78.05	7.560	6.414	4.667
Diyarbakır-81	104	81	85	6.42	7.73	8.37	22.33	18.00	20.33	30	28	32	1.450	1.623	1.313	53.8	44.4	44.3	81.00	77.94	80.72	4.924	5.685	4.310
Harran-95	97	75	80	6.92	4.67	8.22	20.33	17.67	19.67	32	25	45	1.800	0.933	1.820	55.2	45.1	37.2	81.41	79.43	76.39	4.260	6.758	4.753
Sarıçanak-98	104	87	85	8.17	4.92	8.56	21.67	17.00	21.33	37	24	43	1.667	1.250	1.780	51.0	43.2	37.5	80.00	80.40	77.19	5.085	6.058	4.332
Akbaşak	105	118	80	8.18	8.53	9.05	22.33	21.00	20.33	53	36	34	1.817	2.193	1.273	51.5	40.0	37.6	81.22	78.48	80.00	7.075	5.693	3.436
Epidur	94	79	100	7.13	7.56	7.96	20.67	18.67	20.00	41	39	40	2.053	1.853	1.613	49.0	43.5	37.6	80.63	81.12	77.91	5.021	7.172	5.446
Aydın-93	102	87	90	4.86	5.65	7.55	19.00	17.67	19.67	32	31	39	1.600	1.520	1.413	47.2	37.1	34.4	81.33	80.03	79.56	5.934	6.431	4.699
Çakmak-79	87	88	85	4.80	5.76	8.95	16.67	15.00	21.67	24	21	40	1.117	0.853	1.453	48.7	37.5	33.6	75.00	75.99	74.35	5.738	5.874	4.211
Gediz-75	90	80	75	6.92	6.99	8.37	20.67	19.33	21.00	37	31	55	2.083	1.677	1.673	50.2	41.4	41.2	79.00	78.41	78.49	4.963	6.776	4.627
Kızıltan-95	97	77	85	5.58	8.02	8.49	20.33	22.00	22.67	31	32	52	1.733	1.727	2.160	51.7	39.7	36.4	77.00	74.69	73.63	5.617	5.941	4.943
Ankara-98	94	74	85	6.92	6.25	8.33	17.67	21.33	20.67	24	36	41	1.233	2.133	1.900	56.0	48.6	40.1	68.33	79.01	73.68	5.195	5.887	4.446
Svevo	88	86	80	7.95	7.92	7.30	20.00	18.33	17.33	44	33	40	1.980	1.833	1.460	46.2	42.7	41.0	80.05	79.18	79.04	4.907	7.019	4.202
Amanos-97	91	84	75	5.78	7.23	7.59	16.33	18.67	17.00	28	34	39	1.433	2.020	1.587	54.5	44.0	36.7	82.00	79.97	77.57	5.334	6.978	4.506
Altın-97	87	83	90	6.29	6.64	9.43	16.67	18.00	23.00	31	30	46	1.520	1.833	2.060	49.7	42.1	38.4	80.25	76.84	72.64	6.689	5.925	4.836
Mirzabey	94	91	85	6.67	7.35	9.26	20.67	19.67	21.33	29	35	44	1.583	1.647	1.893	50.3	47.1	34.5	77.00	74.83	75.13	5.090	6.149	4.815
Mean	*95*	*83*	*84*	*6.48*	*6.97*	*8.56*	*19.76*	*19.31*	*20.73*	*33*	*33*	*39*	*1.759*	*1.762*	*1.672*	*50.8*	*42.9*	*38.2*	*79.26*	*78.53*	*77.08*	*5.757*	*6.451*	*4.680*
CV	*12.17*	*13.93*	*13.76*	*20.43*	*18.99*	*15.46*	*11.22*	*11.48*	*10.69*	*25.83*	*25.83*	*21.88*	*25.41*	*25.37*	*26.73*	*12.43*	*14.72*	*16.53*	*3.40*	*3.43*	*3.49*	*17.82*	*15.90*	*21.92*

Table 4 . Mean values of grain yield components of examined varieties of durum wheat in Tekirdağ (T), Lüleburgaz (L) and Edirne (E) in 2002/2003

Varieties	Stem length (cm)			Spike length (cm)			Spikelets/spike (no)			Grains/spike (no)			Grain weight/spike (g)			1000 grain weight (g)			Test weight (kg)			Grain yield (t*ha^{-1})		
	T	L	E	T	L	E	T	L	E	T	L	E	T	L	E	T	L	E	T	L	E	T	L	E
Yavaros-79	83	74	79	8.87	8.67	9.33	21.00	21.00	21.33	50	39	37	2.627	1.957	1.990	46.4	50.5	44.2	81.49	80.97	79.70	4.773	3.917	3.767
Fırat-93	83	81	85	7.17	6.47	7.30	18.00	19.33	21.33	37	28	53	1.633	1.467	3.287	50.6	50.4	47.5	83.09	79.69	79.21	4.762	4.092	2.994
Zenit	71	62	73	8.57	8.20	7.90	21.00	21.00	21.00	45	37	47	2.210	1.700	2.300	46.4	46.9	43.5	82.43	78.22	81.96	4.023	2.847	3.893
Ç 1252	97	95	83	8.63	8.20	8.43	21.33	21.67	20.67	46	44	52	2.867	2.633	2.517	49.5	47.2	43.3	81.77	79.37	80.80	5.899	6.826	4.800
Selçuklu-97	90	84	83	7.53	6.77	7.90	20.33	19.00	21.67	47	41	55	2.133	1.887	2.363	40.3	46.5	35.1	78.52	78.99	78.67	5.557	4.927	4.440
Tunca-79	89	79	84	8.60	8.87	8.86	19.67	19.67	23.00	37	51	55	1.620	2.287	2.510	46.1	42.0	39.1	81.31	81.73	74.69	5.730	4.185	4.553
Fuatbey-2000	87	81	86	7.00	7.10	6.40	20.33	20.33	19.33	43	48	50	2.190	2.673	3.113	53.8	49.3	50.2	82.31	81.31	80.47	5.966	4.724	3.942
Sham-I	91	84	82	9.13	8.60	8.57	20.33	21.00	21.33	50	47	43	2.463	2.057	2.287	47.6	45.4	43.8	80.74	80.68	79.86	5.802	4.780	5.210
Ege-88	74	67	78	7.97	7.96	7.86	18.33	21.00	21.33	45	49	37	2.433	2.670	1.903	47.1	48.1	41.2	83.41	79.46	80.15	4.667	4.245	3.282
Kunduru-1149	114	108	120	6.50	6.93	7.43	17.67	19.00	20.67	36	37	41	1.920	2.033	2.180	52.2	49.1	42.8	82.38	79.34	78.38	5.061	5.329	3.660
Yılmaz-98	89	83	79	8.20	7.70	7.87	22.33	21.00	21.33	54	47	40	2.907	2.463	1.970	51.9	50.2	43.6	80.45	77.57	81.97	5.402	4.922	3.552
Diyarbakır-81	93	84	87	6.90	7.13	8.00	19.00	19.00	20.33	29	28	51	1.367	1.310	2.763	50.2	50.1	47.9	81.45	81.35	78.67	4.872	2.612	3.563
Harran-95	81	72	78	7.33	6.73	7.90	20.67	21.00	20.67	33	36	48	1.767	1.933	2.173	49.9	48.7	38.0	80.41	78.84	73.17	5.190	3.558	3.756
Sarıçanak-98	94	90	89	7.07	8.30	7.70	20.33	21.67	21.67	39	46	47	2.170	2.480	2.460	48.0	48.2	43.6	80.59	80.23	74.64	4.830	3.370	3.855
Akbaşak	110	83	113	9.17	8.73	8.90	22.33	21.00	20.33	51	49	48	2.090	2.383	2.620	54.9	40.5	45.2	80.30	79.81	75.81	6.013	3.953	5.243
Epidur	82	72	77	9.40	7.83	8.50	22.33	17.00	21.00	49	44	45	2.507	2.070	2.183	47.7	46.1	44.4	81.95	81.55	77.38	6.142	3.701	3.971
Aydın-93	92	84	89	6.17	5.73	8.17	19.00	19.00	20.67	44	32	51	2.137	1.563	2.607	45.3	40.8	41.9	82.11	82.21	76.69	5.159	4.327	3.944
Çakmak-79	85	83	88	6.70	7.23	8.07	19.00	19.67	21.67	36	44	36	1.903	2.157	1.577	44.1	47.9	40.2	78.04	79.49	78.70	5.104	5.011	4.832
Gediz-75	77	74	78	7.07	7.16	8.07	21.67	20.00	20.67	44	47	52	2.133	2.450	2.023	47.2	49.6	42.1	82.57	82.24	78.91	6.069	3.690	4.606
Kızıltan-95	92	94	86	6.70	6.93	7.57	19.67	19.00	20.67	35	38	40	1.880	2.173	2.000	45.3	43.1	38.7	77.68	80.00	78.94	5.235	5.393	3.920
Ankara-98	91	81	77	6.90	6.53	7.67	18.33	19.67	20.67	47	32	50	2.807	1.847	2.767	52.2	49.1	47.0	80.38	77.82	80.01	4.027	4.222	3.493
Svevo	81	74	81	7.97	6.96	8.30	21.00	18.33	22.00	46	39	53	2.507	2.043	2.640	47.8	47.0	38.1	81.22	80.54	75.47	5.973	3.443	3.156
Amanos-97	87	80	85	6.07	6.60	7.77	17.00	17.67	18.33	33	34	43	1.700	2.040	2.063	48.8	49.3	41.7	80.37	76.91	78.77	3.800	4.111	2.770
Altın-97	90	94	88	6.70	7.33	8.80	19.00	20.33	21.67	34	41	37	1.953	2.293	2.000	52.7	48.8	43.4	75.29	79.63	79.91	4.758	5.834	4.695
Mirzabey	87	84	87	7.13	7.17	7.77	19.67	20.33	20.00	37	41	50	1.863	2.133	2.347	45.5	51.0	42.6	79.37	78.69	80.16	4.945	5.321	3.873
Mean	*88*	*81*	*84*	*7.75*	*7.64*	*8.02*	*19.08*	*19.91*	*20.93*	*40*	*40*	*46*	*1.992*	*2.028*	*2.258*	*48.5*	*47.4*	*42.8*	*80.79*	*79.87*	*78.52*	*5.387*	*3.920*	*3.695*
CV	*11.55*	*12.55*	*12.10*	*12.22*	*12.39*	*11.81*	*9.21*	*8.83*	*8.40*	*18.88*	*18.88*	*16.42*	*25.71*	*25.26*	*22.68*	*8.89*	*9.10*	*10.08*	*3.10*	*3.13*	*3.19*	*19.77*	*27.16*	*39.64*

Table 6. Correlation coefficients between grain yield components and grain yield of examined varieties of durum wheat in 2002-2003 on three locations

	Spike length (cm)	Spikelets/ Spike (no)	Grains/spike (no)	Grain weight/ spike (g)	1000 grain weight (g)	Test weight (kg)	Grain yield (t*ha^{-1})
Stem length (cm)	- 0.070	- 0.045	- 0.036	0.045	0.190 **	- 0.076	0.204 **
Spike length (cm)		0.607 **	0.486 **	0.346 **	- 0.234 **	- 0.020	0.042
Spikelets/spike (no)			0.393 **	0.298 **	- 0.199 **	- 0.111	0.046
Grains/spike (no)				0.726 **	- 0.201 **	- 0.079	0.066
Grain weight/spike (g)					0.028	- 0.017	0.093
1000 grain weight (g)						0.262 **	0.227 **
Test weight (kg)							0.206 **

* and ** significant at P≤ 0.05 and 0.01, respectiveley.

In each year, location had a strong influence on the 1000 grain weight, while the impact of genotype was less expressed. The variability coefficients of 1000 grain weight were higher in 2001/2002 than in 2002/2003. It shows that variability in this character causes from the locations and years. There were statistically significant positive correlations between 1000 grain weight and stem length (0.331**, 0.190**), test weight (0.382**, 0.262**) and grain yield (0.114*, 0.227**) in 2001/2002 and 2002/2003, respectively. The expected relations between 1000 grain weight with spike length, spikelets/spike and grains/spike were found negatively significant.

The average test weights of investigated varieties in both years were not highly differences at each three location. It was obtained lower test weight at Edirne than at Lüleburgaz and Tekirdağ in the both year. Variance analysis and F-test showed a high influence of location on test weight in 2001/2002. The influence of location on test weight slightly increased in 2002/2003. The test weight showed positive and significant correlations with 1000 grain weight and grain yield in 2001/2002 and 2002/2003. In 2001/2002, correlation between test weight and spike length, spikelets/spike was negative and significant, but in 2002/2003 there was not negative and significant correlation between test weight and other characters.

According to mean performances of all characters among the examined cultivars, Fırat 93, Ç 1252, Fuatbey 2000, Ege 88, Epidur, Aydın 93 and Altın 97 were found as well-performanced cultivars in 2001-2002. In the second year, Ç 1252, Fuatbey 2000, Sham I, Epidur, Aydın 93, Ankara 98 and Altın 97 showed the best performance. Accornding to the results of evaluations depending on location and year, it can be say that Ç 1252, Fuatbey 2000, Epidur, Aydın 93 and Altın 97 are more suitable cultivars than the others durum wheat cultivars in Thrace Region.

Discussion

Variance analysis and F-test results of grain yield and yield components of investigated varieties showed a significant differences among varieties, locations and experimental years. Especially locations influence all of the examined characters was highly significant in the Thrace Region. Influenced by location and genotype, the total stem height varied significantly. Spike length and spikelets/spike are a marked cultivar specificity influenced strongly by location (Table 2).

Variability among varieties, locations and experimental years was specially established for 1000 grain weight. These variations could be explained by different locations and climate conditions of the crop. Hruby (1993) claimed that 1000 grain weight was strongly influenced by the production year. A high significant correlation of 1000 grain weight with grain yield implies that 1000 grain weight plays a very important role in the possible increase of the grain yield of new wheat genotypes in the Thrace Region. The higher grain yields were found in examined varieties with the higher 1000 grain weight .The high influence of location and genotype on grains/spike and correlation coefficient between grains/spike and

grain yield implied that there was a big fluctuation for grains/spike. This result is supported by Fisher (1975).

In both years, it was determined the lowest influence of location, genotype and their interaction on grain weight/spike. The impact of location was nearly identical to genotype and interaction. The positive correlations between grain weight and spike length, spikelets/spike, grains/spike and grain yield showed that these characters became more pronounced because of spike elongation.

The location and genotype influenced the test weight equally in 2001/2002. But in 2002/2003, effects of location and interaction on test weight were more than the genotype. The variance analysis results and it significantly related with 1000 grain weight implied that test weight depended on growing season and location like 1000 grain weight.

The grain yield of durum wheat cultivars was positive proportional to 1000 grain weight, test weight and grain weight/spike. In 2001/2002 the spike length, spikelets/spike, grains/spike and stem length were the directly limiting factors for the grain yield because of their negative correlation with grain yield. In 2002/2003, the examined genotypes had longer stems, more 1000 grain and test weight, which directly affected the grain yield. Because of the fact that test weight and 1000 grain weight depended on growing season and location, grain yield depended fundamentally on the grain weight/spike and agro-ecological conditions during the growing period. Significant correlations between grain weight and the spike length, spikelets/spike and grains/spike showew that these indirect effects of character via grain weight on grain yield were more expressive than the direct effects.

Conclusion

Significant differences among cultivars, locations and production years were fixed. The highest variations among characters were found in grain weight/spike, grains/spike, spike length and grain yield. In the first experimental year, there was a high positive significant correlation between grain yield and grain weight/spike, test weight and 1000 grain weight. In the second experimental year, grain yield showed positive and significant correlations with 1000 grain weight, test weight and stem length. The biggest differences among investigated cultivar of durum wheat were found in stem length, grains/spike and 1000 grain weight. Grain yield of examined cultivars depended mainly on 1000 grain weight, test weight, grain weight/spike and agroecological conditions during the growing period. However, location, production year and genotypes were the most important determinant of potential yield of cultivars. Ç 1252, Fuatbey 2000, Epidur, Aydın 93 and Altın 97 were found more suitable cultivars than the others for durum wheat cultivars in Thrace Region.

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