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Estimation of broad-sense heritability for grain yield and some agronomic and quality traits of bread wheat (*Triticum aestivum* L.)

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Abstract

Twenty-five wheat genotypes (*Triticum aestivum* L.) were grown at three locations (Samsun, Amasya and Tokat) in the Middle Black Sea Region of Turkey in order to estimate the broad-sense heritability for grain yield and some agronomic and quality traits. Estimation of the heritability will help to identify selection parameters in our breeding programs for target environments. The heritability for grain yield, test weight, 1000-kernel weight, Zeleny sedimentation, protein content and plant height were 46.05%, 86.88%, 81.82%, 89.13%, 87.45% and 43.69%, respectively. It was found that Zeleny sedimentation was the least affected trait over environments and followed protein content, test weight and 1000-kernel weight. On the other hand, grain yield and plant height were the most affected traits across environmental conditions.

Key words: Bread wheat, heritability, grain yield, Zeleny sedimentation, protein content.

Introduction

Bread wheat (*Triticum aestivum* L.) is the most commonly planted and used crop in the world. It is also one of the most important crops in Turkey. Grain yield is affected by genotype, environment and genotype x environment interaction in wheat [1]. Some genotypes are more affected from one environment than another one due to environmental differences. To measure environmental interaction and to see interaction variance, different genotypes are reared or grown in a range of environments [2]. The breeders are faced with an array of environments in which their breeding program is to achieve results [3]. Thus, heritability estimate should be determined for optimum breeding program. Test weight, 1000-kernel weight, Zeleny sedimentation, and protein content are the important traits for wheat breeding programs and they do not require complicated equipment and effort to find out. Plant height is a crucial character affecting the lodging resistance for some environments. It is a big challenge to combine high grain yield and high protein content in a genotype for wheat breeders [4]. Many researchers reported that there is a negative correlation between grain yield and protein content [5-8]. Protein quality is more important than protein content to determine the acceptable end-use quality in wheat. Graybosch *et al.* [9] pointed out that the effects of genotypic components are more important than those of environmental components on gluten quality that closely related to Zeleny sedimentation [10]. The aim of this study was to measure the broad sense heritability of grain yield and 5 traits in order to determine selection criteria for our bread wheat breeding program.

Materials and Methods

Twenty-five bread wheat (*Triticum aestivum* L.) cultivars/advanced lines were used in the trials. The trials were conducted during 2004-2005 growing season in three different locations in Turkey. The locations were Samsun (41°21´N Lat., 36°15´E Long., 4 m above sea level), Tokat (40°19´N Lat., 36°43´E Long., 640 m above sea level) and Amasya (40°35´N Lat., 35°39´E Long., 450 m above sea level). Genotypes were sown in a randomized complete block design with four replications. Seeding rates were adjusted for density of 500 seeds m^{-1}. Plot size was 6 m^2 (6 rows, 20 cm apart). Mineral fertilizers were applied at the rate of N 120 and P_2O_5 60 kg ha^{-1} for the all locations. The following data were recorded: grain yield, test weight, 1000-kernel weight, Zeleny sedimentation rate[10], protein content and plant height. The soil was silty loam in Samsun, loam in Tokat and silty clay loam in Amasya. Average temperature, rainfall and relative humidity of the growing seasons are shown in Table 1.

Analysis of variance was performed on grain yields and agronomic components data using the SAS [11] program. Broad sense heritability (h^2) for mean values over locations was calculated following Türk *et al.* [12] and Çamaş and Esendal [13] from components of variance:

$$h^2 = \sigma_g^2/(\sigma_g^2 + \sigma_{gl}^2/l + \sigma_e^2/rl)$$

where l, g and r are number of location, genotype, and replication, respectively; σ_g^2 and σ_e^2 are components of variance for genotypes and error, respectively.

Results and Discussion

Average grain yield of the location was 5.55 t ha^{-1}. Grain yield ranged from 2.73 to 11.23 t ha^{-1}. The test weight was between 71.5 and 85.5 kg, whereas 1000-kernel weight was between 25.9 and

Table 1. Monthly precipitation, mean temperature and relative humidity at Samsun, Amasya and Tokat locations in Turkey.

2004-2005	Precipitation (mm)			Temperature (°C)			Humidity (%)		
Month	Samsun	Amasya	Tokat	Samsun	Amasya	Tokat	Samsun	Amasya	Tokat
October	59.5	7.1	18.9	16.9	15.4	14.7	75.9	56.1	61.4
November	174.2	105.4	90.4	12.2	8.6	7.4	68.5	57.5	67.2
December	84.4	29.0	23.3	8.9	3.5	2.6	65.8	64.1	67.5
January	62.8	22.3	38.4	9.0	5.2	4.5	71.7	60.1	65.7
February	43.1	32.2	38.8	7.5	5.5	4.3	69.1	52.9	61.7
March	141.6	112.6	108.7	7.2	7.4	7.1	78.2	56.8	62.4
April	87.8	89.7	50.6	11.4	13.9	13.1	79.0	49.4	56.1
May	34.7	41.9	101.3	15.8	17.8	16.2	82.5	51.3	65.1
June	51.1	46.4	12.1	20.2	20.9	19.2	75.8	43.8	56.6
July	5.9	19.5	26.4	24.2	25.5	23.7	76.9	44.7	56.6
Total	745	506	509	-	-	-	-	-	-
Mean	-	-		13.3	12.4	11.3	74.3	53.7	62.0

Table 2. Value of average, minimum, maximum and coefficient of variation of grain yield and agronomic traits for wheat genotypes.

	Grain yield (t ha^{-1})	Test weight (kg)	1000-kernel weight (g)	Zeleny sedimentation (ml)	Protein content (%)	Plant height (cm)
Mean	5.55	80.2	37.9	35.4	12.3	96
Min	2.73	71.5	25.9	15.0	9.1	70
Max	11.23	85.5	50.4	65.0	15.4	115
CV (%)	10.6	1.27	3.99	4.26	2.26	4.68
SE	0.21	0.29	0.46	0.42	0.079	0.26

CV: Coefficient of variation, SE: Standard error.

Table 3. Result of variance analysis and heritability for grain yield and agronomic traits of wheat genotypes.

Source of variation	Grain yield	Test weight	1000-kernel weight	Zeleny sedimentation rate	Protein content	Plant height
Location (L)	23452.22**	561.14**	2027.82**	8955.80**	283.37**	1752.07**
Genotype (G)	368.52**	38.34**	74.62**	644.567**	4.035**	164.98**
G x L	198.84**	4.99**	13.98**	70.056**	0.857**	92.89**
Error	36.74	1.048	2.21	2.2725	0.07697	20.31**
Heritability (%)	46.05	86.88	81.32	89.13	87.45	43.69

* Significant at P≤0.05; ** significant P≤0.01; ns: no significant.

50.4 g. The Zeleny sedimentation, protein content and plant height were between 15 and 65 ml, 9.1% and 15.4%, 70 and 115 cm, respectively (Table 2).

The results of combined variance analysis of traits in 25 bread wheat genotypes used in this study are presented in Table 3. There were statistically significant differences within the three locations and significant genotype x location interactions for all the characters studied. The analysis of variance revealed significant differences within the genotypes for all the components studied.

The highest heritability (h^2) was observed for the Zeleny sedimentation (89.13%) followed by protein content (87.45%), and test weight (86.88%). On the other hand, the lowest heritability was observed for the grain yield (46.05%) and plant height (43.69%) (Table 3).

Grain yield had the lowest heritability in our study. This is expected, because grain yield is a complex polygenic character in wheat and it is also affected by environment [1]. Adaption genes are very important to obtain the stable grain yield across the environments and wheat breeders want to fix some adaption genes into their genotypes [14]. Plant height had relatively low heritability compared to other characters studied. It means that breeders should pay more attention to select the genotypes with lodging resistance for the locations in which trials were conducted. On the contrary, Kashif and Khaliq [15] found that plant height had the highest heritability (92.08%) in their study. However, Aycicek and Yildirim [16] and Yagdi and Sozen [17] reported low heritability for plant height. Protein content, test weight and 1000-kernel weight had high heritability percentages in our study. These results indicate that we can use these quality traits as the selection parameters because of their high heritability. Our result confirms the findings of the studies for 1000-kernel weight [15-18] and test weight [17]. Zeleny sedimentation had the highest heritability in our study. This result supports that Zeleny sedimentation might be used to select the genotypes with high gluten quality in the target environments. Our results are consistent with Graybosch *et al.* [9]. They reported that effects of genotypic components are more important for gluten quality.

Conclusions

According to results obtained, Zeleny sedimentation rate was the least affected trait over environments and followed by protein content, test weight and 1000-kernel weight. Grain yield and plant height were the most affected traits across environmental conditions. In conclusion, Zeleny sedimentation can be used as a selection criterion to select genotypes with good quality traits in target environments. Our results confirmed that grain yield is one of the traits, most affected across environments.

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