www.ziraat.selcuk.edu.tr/dergi

Selçuk Üniversitesi
Ziraat Fakültesi Dergisi 21 (41): (2007) 104-108

COMBINING ABILITY AND INHERITANCE OF SOME AGRONOMICAL TRAITS IN BREAD WHEAT (*Triticum aestivum* L.)

Süleyman SOYLU[1] Necdet AKGÜN[1]

[1] Department of Field Crops, Faculty of Agriculture, Selçuk University, Konya/Turkey

ABSTRACT

Crosses were made between six female and seven male (6x7=42 hybrid combinations) bread wheat (Triticum aestivum L.) cultivars by line x tester in 1999 – 2000 growing season at Konya, a representative part of Central Anatolia, in order to study combining ability and genetic parameters for yield and yield associated characteristics. Plant height, spike length, spikelets number per spike, fertile tiller number, kernel number per spike, kernel weight per spike, 1000 kernel weight and grain yield per plant were determined in all parents and their hybrid progenies.The analysis of combining ability indicated that a large portion of the total genetic variation was associated with non-additivegene actions. Narrow sense heritabilities ranged from 0.06 (fertile tiller number) to 0.30 (spike length). Broad sense heritabilities ranged from 0.68 (1000 kernel weight) to 0.94 (plant height). Magnitude of SCA variance was more pronounced than GCA variance for all the traits. Therefore in selection, it is thought to be true that non additive gen effects and SCA's of hybrids should be considered.

Keywords: *Combining ability, Triticum aestivum L., line x tester, yield components*

EKMEKLİK BUĞDAYDA (*Triticum aestivum* L.) BAZI AGRONOMİK ÖZELLİKLERİN KOMBİNASYON YETENEĞİ VE KALITIMI

ÖZET

Orta Anadolu şartlarında ekmeklik buğday melez ve anaçlarının verim ve verim unsurları için kombinasyon yetenekleri ve genetik parametrelerini belirlemek amacıyla 1999-2000 üretim yılında 6'sı hat 7'si tester olarak kullanılan ekmeklik buğday anaçları arasında melezlemeler (6x7=42 melez kombinasyon) yapılmıştır. F_1 bitkileri ve anaçlar üzerinde bitki boyu, başak uzunluğu, başakta başakçık sayısı, fertil kardeş sayısı, başakta tane sayısı, başakta tane ağırlığı, 1000 tane ağırlığı ve bitki tane verimi özellikleri belirlenmiştir. Genel ve özel kombinasyon yeteneği varyansları, toplam genetik varyasyonun büyük kısmının eklemeli olmayan gen etkisi altında oluştuğunu göstermiştir. Dar anlamda kalıtım dereceleri 0.06 (fertil kardeş sayısı) ile 0.30 (başak uzunluğu) arasında, geniş anlamda kalıtım derecesi 0.68 (1000 tane ağırlığı) ile 0.94 (bitki boyu) arasında değişim göstermiştir. İncelenen bütün özelliklerde özel kombinasyon yeteneği varyansının genel kombinasyon yeteneği varyansından daha büyük olduğu görülmüştür. Bu yüzden seleksiyonun melezlerin özel kombinasyon yetenekleri ve eklemeli olmayan gen etkisi göz önüne alınarak yapılması gerektiği sonucuna varılmıştır.

Anahtar Kelimeler: *Kombinasyon yeteneği, Triticum aestivum L, Çoklu dizi, Verim komponentleri*

INTRODUCTION

Wheat is the most important cereal grain crop of the world and being a staple food of the majority of the people of Turkey. Breeders frequently use the crossing methods to obtained variation to wheat populations in Turkey. But some hindering factors such as area, labor and so on don't give the opportunity to breeders to cross more. Therefore the right selection of parents makes it possible to reduce labor and income. Combining ability studies are frequently used by plant breeders to evaluate newly developed cultivars for their parental usefulness and to assess the gene action involved in various characters, so as to design an efficient breeding plan for further genetic upgrading of the existing material. More than 50 cultivars of bread wheat have been developed in recent 15 years in Turkey. But the research about combination ability of agricultural features in these cultivars which have been developed and to be used in the further wheat breeding programmes have been limited. Line x tester analysis, which is a simple extension and has been very commonly used combining ability analysis in plant breeding. Success in crossing programs depends upon the choice of suitable parental material which will combine well to generate superior progeny. A knowledge of general and specific combining abilities (GCA, SCA) influencing yield and its components has become increasingly important to plant breeders in the choice of suitable parents for developing potential hybrids in many crop plants (Kruvadi, 1991). Either in Turkey or in the world, many researchers have studied the combining ability and genetic structure of bread wheat hybrid populations by using line x tester and diallel analysis methods related on yield and yield components (Yıldırım, 1974; Ekmen and Demir, 1990; Larik et. al., 1995; Yagdı and Ekingen, 1995; Tosun et al., 1995; Kınacı, 1996)

The main aim of this research is to find out the combining abilities of bread wheat genotypes which has mostly been developed in recent years in Turkey and to get general information about the genetic structure of hybrid populations obtained from these genotypes. The information thus obtained would help to develop a suitable breeding programme to evolve new varieties.

MATERIALS AND METHODS

Experiment was carried out in the experimental site of Department of Field Crops, Faculty of Agriculture, Selçuk University, Konya during 1999-2000 and 2000-2001 growing season. The crosses line x tester between six female bread wheat cultivars (Ikizce-96, Türkmen, Uzunyayla, Mızrak, Kınacı-97 and Dagdaş-94) and seven males bread wheat (Kıraç-66, Bezostaja-1, Atay-85, Sultan-95, Gün-91, Gerek-79 and Bolal-2973) were made in 1999-2000 growing season under field conditions. These varieties represent a broad spectrum of genetic diversity eventhough they were all developed in Turkey.

The parents and 42 hybrids were grown during the 2000-2001 season according to a Randomized Complete Block Experimental Design with two replications. The plots were 20 cm apart and each one consisted of two rows 2 m long with an interplant spacing of 15 cm. Routine and uniform field management practices were employed and no disease–control treatments were performed.

The assayed yield components and morphological characters, which were determined for each of the ten randomly selected plants per replication, were plant height (PH), spike length (SL), spikelets number per spike (SN), fertile tiller number (FTN), kernel number per spike (KN), kernel weight per spike (KW), 1000 kernel weight (TKW) and grain yield per plant (GY).

The plot means of the characters were utilized to calculate the statistical analysis of variance and combining ability effects following Singh and Chaudhary (1979), Yıldırım and Çakır (1986). Broad and narrow sense heritabilities were calculated using the variance component method (Falconer, 1980).

RESULTS AND DISCUSSION

The analysis of variance of the parents and crosses is given Table 1. Mean squares of F_1 hybrids for all characters were statistically significant indicating the presence of sufficient genetic variability for genetic analysis. The differences among female parents were also highly significant for all traits while the differences among male were significant for SL, SN, KN and KW. Contribution of female x male interaction was highly significant for all characters (Table 1).

The analysis of variance for general combining (GCA) and specific combining (SCA) abilities, additive and dominance variances are given Table 2. The estimates of SCA variance were higher than those of GCA variance for all characters. GCA variance contains additive epistasis, while SCA variance contains dominance epistasis (Griffing, 1956). Experiment results shown that the non-additive gene action have more effects on all investigated traits, according to proportion of GCA/SCA rate. The values of $(H/D)^{1/2}$ were higher than 1 in all characters, it revealed over dominance effect on characters. The variances for SCA were larger than those of GCA for all the traits, which suggest that the major portion of genetic variability in the base population was non- additive in nature. Similar to our research results, previous researchers found as following non additive existence of gene effects in population of hybrid bread wheat; Tosun et al. (1995), Kınacı (1996) for PH, Yağdı and Ekingen (1995), Tosun et al., (1995), Larik et al., (1995), Kınacı (1996) for SL and SN, Ekmen and Demir (1990), Kınacı (1996) for FTN, Tosun et al. (1995), Ekmen and Demir (1990) for KW, Kınacı (1996) for TKW, Prakasa (1977), Thakre et al., (1996) for GY.

Table 1. Mean squares related to measured characteristics in line x tester analysis.

Source of Variation	PH	SL	SN	FTN	KN	KW	TKW	GY
Block	94.85*	1.96*	0.56	55.75**	11.42	0.13*	18.63	5.88
Hybrid	276.37**	3.81**	7.82**	61.16**	139.52**	0.20**	30.44**	13.46**
Line	1534.32**	18.16**	27.12**	159.14**	244.18*	0.83**	114.52*	42.32**
Tester	65.72	4.92**	14.07**	87.31	302.22*	0.23*	12.74	11.48
Linextester	108.84**	0.75*	2.92**	37.20**	91.47**	0.07*	16.57*	8.02**
Error	15.83	0.33	0.66	5.58	10.86	0.03	9.85	2.15

*,** *Significant at 5% and 1% level of probability, respectively.*

Note : PH=Plant height, SL=Spike length, SN=Spikelets number per spike, FTN=Fertile tiller number, KN=Kernel number per spike, KW=Kernel weight per spike, TKW=1000 kernel weight, GY=Grain yield per plant.

Estimates of GCA effects of the parents are shown in Table 3. It is evident that parent Kınacı-97 was good general combiner for GY and yield components. This parent had significant GCA for all yield components, morphological characters and GY. The parents Uzunyayla, Dağdaş-94, Atay-85, Kırac-66 and Mızrak had significant effects for tallness and were good general combiners for this trait. İkizce-96 and Türkmen showed the highest GCA effects for dwarfness and can be exploited for breeding dwarf genotypes.

For the plant height, some researcher (Ekmen and Demir, 1990; Larik et al., 1995) found out additive gene action effects, while Tosun et al. (1995) and

Kınacı (1996) estimated the higher SCA's effects. Parents Uzunyayla and Gün-91 were good combiner for SL and GY. It was observed that the significant GCA effects of the parent Kınacı-97 for GY was associated with the significant GCA effects for the yield components. Therefore there may be a good change of success for getting high yielding segregants and it equally may be possible of developing a hybrid involving the parents Kınacı-97, Uzunyayla, Gün-91. This suggests that assessment on GCA effects for yield components has considerable importance in selecting parents for yield improvement.

Table 2**.** Ratios and general and specific combining abilities related to measured characteristics

Characters	GCA/SCA	D	H	$(H/D)^{1/2}$	H^2	h^2
PH	0.09	8.74	46.51	2.31	0.94	0.14
SL	0.38	0.16	0.21	1.15	0.91	0.30
SN	0.12	0.26	1.12	2.08	0.92	0.15
FTN	0.04	1.26	15.81	3.54	0.91	0.06
KN	0.03	2.50	40.31	4.02	0.92	0.05
KW	0.15	0.006	0.02	1.83	0.82	0.12
TKW	0.11	0.72	3.36	4.67	0.68	0.08
GY	0.05	0.28	2.94	3.24	0.83	0.07

D : Additive variance H^2 : Broad sense heritability H : Dominanat variance h^2 : Narrow sense heritability

Table 3. General combining ability (GCA) values related to measured characteristics for lines and testers

	PH	SL	SN	FTN	KN	KW	TKW	GY
Lines								
İkizce-96 (1)	-17.02**	-1.67**	-2.05**	-3.70**	-4.70**	-0.38**	-2.94**	-2.68**
Türkmen (2)	-6.94**	-0.80**	-1.65**	-3.29**	-6.01**	-0.14**	-2.43**	-1.99**
Uzunyayla (3)	13.07**	1.60**	1.29**	2.13**	0.07	-0.06	-2.06*	1.18**
Mızrak (4)	2.95**	-0.06	0.16	4.74**	1.19	-0.06	-0.25	0.71
Kınacı-97 (5)	2.86*	0.47**	1.11**	2.92**	5.08**	0.28**	3.26**	2.19**
Dagdaş-94 (6)	5.08**	0.45**	1.33**	-2.81**	4.38**	0.33**	4.43**	0.56
S.E.	**1.06**	**0.15**	**0.22**	**0.63**	**0.88**	**0.04**	**0.84**	**0.39**
Testers								
Kıraç-66 (7)	2.97*	0.18	-0.94**	4.50**	-8.25**	-0.16**	0.47	1.25**
Bezostaja-1 (8)	-2.28	-0.59**	-0.45	-3.17**	-1.15	-0.07	-0.04	-0.84
Atay-85 (9)	3.53**	0.79**	1.67	-0.69	5.33**	0.11*	0.87	-0.43
Sultan-95 (10)	-0.60	-0.01	0.73	-0.74	3.12**	0.14**	-1.08	-0.61
Gün-91 (11)	-0.15	0.67**	0.65	-0.25	3.54**	0.10	1.22	1.28**
Gerek-79 (12)	-1.77	-0.56**	-0.85**	-1.37*	-2.55*	-0.15**	-1.28	-0.56
Bolal-2973 (13)	-1.68	-0.46**	-0.58*	1.69*	-0.03	-0.01	-0.16	-0.12
S.E.	**1.15**	**0.17**	**0.23**	**0.68**	**0.95**	**0.05**	**0.91**	**0.42**

, Significant at 5% and 1% level of probability, respectively. S.E. : Standart error*

Estimates of SCA effects of the crosses showed that there were several crosses having significant and positive SCA effects for single plant yield (3x12, 4x10, 6x7 and 6x8) (Table 4). They showed also significant and positive SCA effects for some of the yield components.

The other crosses with significant and positive SCA effects were 1x12 for SL; 3x9 for SL, SN and KN; 3x13 for PH, SL and FTN; 1x10 for PH and SL; 4x9 for FTN and KN; 5x8 for SL and FTN and 6x9 for PH. The crosses with significant SCA effects indicated presence of non-additive gene action in them. The crosses which have shown significant SCA effects for grain yield per plant may be used similarly in the development of new varieties. Another possibility of these crosses is that non additive genes of the development of the crosses would give wider transgressive segregation. Careful selection of the potential transgressive segregants through family selection would be worth while for yield improvement. The combining ability studies indicate the existence of both additive and non-additive gene action in the present material. Non-additive gene action was more prominent for both yield components and GY. Preponderance of non additive (dominance and overdominance) gene action for most of the characters would suggest that selection of desired types should be practiced in later generations. Broad sense heritabilities ranged from 0.68 (TKW) to 0.94 (PH). Narrow sense heritabilities ranged from 0.06 (FTN) to 0.30 (SL) (Table 2). The broad sense heritabilities for yield and yield components were considerably larger than the corresponding narrow sense heritability estimates. Lower narrow sense heritability estimates were obtained for FTN, KN, KW, TKW and GY. Broad sense heritability is described as the proportion of genetic variance to phenotip variance. Narrow sense heritability is described to be the proportion of additive variance to phenotip variance.

Heritability is a result of genotyp x environment interaction. According to our research results, low narrow sense heritability may be the result of environmental effects. The researcher (Ekmen and Demir, 1990; Tosun et al., 1995; Kınacı, 1996) had a similar results about ours that the highest broad sense heritability was found for PH. The other researchers (Yağdı and Ekingen, 1995) also found out as is done in this research that the highest narrow sense heritability for SL. The others (Ekmen and Demir, 1990) who have researched about this subject have put forward the similar results that the lowest narrow sense heritability is 0.08 for KN and Tosun et al., (1995) found 0.12 for KW. Narrow sense heritabilities are less likely to be biased upward by dominance and epistatic effects.

Table 4. Specific combining ability (SCA) effects related to measured characteristics for hybrids.

Hybrids	PH	SL	SN	FTN	KN	KW	TKW	GY
1x7	-1.31	-0.03	-1.10	-6.27**	-0.17	-0.02	3.38	-2.48*
1x8	-4.44	-0.03	0.46	-2.99	7.23**	0.15	-0.35	0.05
1x9	-8.92**	-1.02*	-0.94	-2.81	-5.75*	-0.07	5.61*	-0.45
1x10	6.55*	0.93*	1.34*	3.58*	1.13	-0.02	-1.72	0.37
1x11	-4.56	-0.28	-0.24	2.37	-7.61**	-0.12	-2.24	0.27
1x12	4.76	1.34**	0.96	3.79*	7.88**	0.13	-1.73	1.16
1x13	3.42	-0.60	-1.43*	2.33	-2.74	-0.06	-2.98	1.14
2x7	-5.19	0.42	0.57	-2.57	1.56	-0.34**	-2.07	0.57
2x8	-1.04	-0.60	-1.62**	-1.44	-2.30	-0.25*	-1.11	0.37
2x9	1.85	-0.39	-1.87**	1.91	-6.07*	0.31*	2.23	0.74
2x10	3.29	-0.05	1.00	-0.13	-1.15	0.33**	0.66	0.46
2x11	4.60	0.06	0.01	-0.14	4.02	0.15	0.38	-0.93
2x12	-0.05	0.58	0.21	2.71	-0.44	-0.08	-2.12	-1.07
2x13	-3.46	-0.02	1.45*	-0.33	4.37	-0.10	2.06	-0.12
3x7	-0.14	-0.52	0.41	3.13	2.75	-0.03	1.86	-0.05
3x8	0.80	-0.64	-0.60	1.93	-2.34	0.03	-3.26	-0.83
3x9	3.24	1.77**	3.12**	-2.76	7.31**	-0.20	0.05	-2.37*
3x10	-22.38**	-1.69**	-2.69**	-8.00**	-16.98**	-0.19	-2.24	-4.11**
3x11	2.75	0.05	-0.78	-3.23	3.87	0.03	-2.19	1.40
3x12	8.21**	-0.51	0.41	1.13	4.11	0.30*	4.07	4.80**
3x13	7.52*	1.50**	-0.10	7.82**	1.29	0.08	1.69	1.16
4x7	-3.98	0.40	-0.32	-1.90	-11.05**	-0.13	-0.95	-0.92
4x8	-1.08	0.17	0.87	-4.56**	-3.66	0.15	1.23	-1.51
4x9	1.88	-0.36	0.07	3.82*	6.28*	0.09	-4.15	1.13
4x10	6.86*	0.48	-0.56	8.17**	13.12**	0.06	0.10	2.72*
4x11	-2.62	-0.06	-0.28	-0.91	-1.90	-0.04	0.86	-0.08
4x12	0.36	-0.04	0.06	0.28	-0.47	-0.04	1.23	0.26
4x13	-1.29	-0.59	-0.08	-5.37**	-2.38	-0.05	1.72	-1.56
5x7	1.74	-0.25	-0.07	1.08	9.87**	0.18	-3.41	0.14
5x8	2.76	0.86*	0.31	4.78**	2.87	-0.12	-0.65	-1.48
5x9	-5.31	-0.51	0.06	-2.68	-4.23	0.06	-3.09	0.79
5x10	-3.05	0.02	0.31	-1.39	-0.02	-0.10	0.27	1.76
5x11	2.91	-0.37	0.31	2.12	0.48	-0.01	4.81*	0.48
5x12	3.38	0.41	-0.85	-1.66	-2.15	0.05	0.37	-2.36*
5x13	-2.42	-0.17	0.48	-3.07	-6.84**	-0.01	1.68	0.70
6x7	8.90**	0.00	0.32	6.52**	-2.97	0.35**	1.20	2.75*
6x8	3.00	0.57	0.41	2.27	-1.79	0.09	4.11	3.42**
6x9	7.29*	0.52	-0.40	2.53	2.42	0.16	-0.64	0.21
6x10	4.30	0.30	-0.63	-2.20	3.83	-0.06	2.91	-1.14
6x11	-3.07	0.62	1.00	-0.20	1.14	0.03	-1.63	-1.12
6x12	-16.64**	-1.88**	-0.95	-6.68**	-8.95**	0.35**	-1.80	-2.78*
6x13	-3.80	-0.15	0.26	-2.24	6.32**	0.15	-4.15	-1.28
S.E.	**2.81**	**0.41**	**0.57**	**1.67**	**2.33**	**0.12**	**2.22**	**1.04**

*, ** *Significant at 5% and 1% level of probability, respectively.*

Non-additive genetic effects were greater magnitude than additive genetic effects on bread wheat hybrid populations. Being poligenic, grain yield is a total sum of the genetic expression of all the yield components and is greatly influenced by environmental factors. The overall performance of a hybrid, therefore, may vary due to changes in environment.

The selection of population simply on the basis of yield may not be benefical and may lead to incorrect conclusions. In that case, breeding method including selection in the late generations should be designed to exploit non-additive gene action in the present material.

REFERENCES

Falconer, D.S.1980. Introduction to Quantitative Genetics. Oliver and Boyd Ltd. London.

Ekmen, G. and İ. Demir. 1990. Bazı buğday melezlerinde bazı verim komponentlerinin kalıtımı üzerinde araştırmalar. E.Ü. Fen Bilimleri Enst. Derg. 1(2): 153-158.

Griffing, J.B.1956. Concepts of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol Sci. 9 463-493.

Kınacı, G. 1996. Orta Anadolu için line x tester yöntemiyle süne zararından az etkilenen verimli ve kaliteli ekmeklik buğday çeşitleri ıslahı üzerine bir araştırma. S.Ü. Zir. Fak. Der. 9(11): 181-187.

Kruvadi, S. 1991. Diallel analysis and heterosis for yield and associated characters in durum wheat under upland conditions. Turrialba Publ. 41 (3): 335-338. Canada.

Larik AS,AR Mahar and H.M.I.Hafız.1995. Heterosis and combining ability estimates in diallel crosses of six cultivars of spring wheat Wheat Information Service, 34: 12-19.

Prakasa, R.V.S. 1977. Heterosis, combining ability and gene action for yield and its components in wheat. Div.Genet.İndian Agric.Res.Inst. New Delhi.

Singh. R.K. and B.D.Chaudhary, 1979. Line x tester analysis.Biometrical methods in quantitative genetic analysis. Kalyani Publishers, 205-214, New Delhi.

Thakre, J.M., D.G.Vitkare, A.K. Godbole and S.B. Atale.1996. Line x tester analysis in wheat for yield and it's traits. Annals of Plant Physiology, 10: 1, 99-102. India.

Tosun, M., İ.Demir, C.Sever and A. Gürel. 1995. Line x tester analysis in some wheat crosses. Anadolu J. of AARI 5 (2) : 52-63.

Yağdı, K. and H.R. Ekingen, 1995. Beş ekmeklik buğday çeşidinin diallel melez döllerinde bazı agronomik özelliklerin kalıtımı. Uludağ Üniv. Zir. Fak. Derg., 11 : 81-93.

Yıldırım, M.B.1974. Beş ekmeklik buğday çeşidinin diallel melez döllerinde bazı tarımsal karekterlerin populasyon analizleri. Doçentlik Tezi. Ege Üniv. Ziraat Fak. İzmir.

Yıldırım, M.B. and Ş.Çakır, 1986. Line x tester analizi.E.Ü. Bilgisayar Araştırma ve Uygulama Merkezi Dergisi, 9(1): 1-7.