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Predicting of Combining Ability for Length,Width and Area of Flag Leaf and Grain Yield per Plant in Bread Wheat with Respect to Diallel Analysis

Şahin DERE [1] **Metin Birkan YILDIRIM**[2]

Özet

Ekmeklik Buğdaylarda Bayrak Yaprak Uzunluğu, Genişliği, Alanı ve Bitki Başına Tane Verimi Özelliklerinin Diallel Analiz Yöntemi ile Kombinasyon Yeteneklerinin Tahmini

Ekmeklik buğdaylarda sekiz ebeveynde diallel melezleme yoluyla bayrak yaprak uzunluğu, genişliği, alanı ve bitki başına tane verimi özellikleri için kombinasyon yetenekleri incelenmiştir.Genel kombinasyon etkileri bitki başına dane verimi dışında diğer özellikler için istatistiksel olarak önemli bulunurken, özel kombinasyon etkileri incelenen tüm özellikler için önemli bulunmuştur ($P<0.01$). Bayrak yaprak uzunluğu ve bayrak yaprak alanında genel kombinasyon etkileri özel kombinasyon etkilerinden büyük olmuştur. Elde edilen veriler Griffing analiz metoduna göre teste tabi tutulmuşlardır.

Bu sonuçlara göre genotiplerin genel ve özel kombinasyon yetenekleri varyansları bitki başına dane verimi dışında diğer özellikler için önemli bulunmuştur. Bayrak yaprak uzunluğu ve alanı özelliklerinin eklemeli gen etkileri altında, bayrak yaprak genişliği ve bitki başına tane veriminin ise eklemeli olmayan gen etkisi altında oldukları tespit edilmiştir. En yüksek gca etkileri bitki başına tane verimi için Ziyabey genotipinde, bayrak yaprağı genişliği, uzunluğu ve alanı için ise Yüreğir genotiplerinde belirlenmiştir. Özel kombinasyon etkileri bakımından ele alındığında ise Yüregir x Seri-82 melezi bitki başına tane verimi yönünden, Kasifbey x Marmara melezi bayrak genişliği için, Cumhuriyet x Kasifbey melezi bayrak yaprak alanı ve bitki başına tane verimi için en yüksek değerlere sahip olmuşlardır.

Anahtar sözcükler: Uyum yetenekleri, diallel, Griffing analiz, bayrak yaprak, tane verimi

[1] Dr; University of Ordu, Faculty of Agriculture, Department of Field Crops, ORDU
e-mail: sahin_dere@yahoo.com Tel: 452-324 70 98 Fax:452-324 44 00
[2] Prof. Dr; University of Ege, Faculty of Agriculture, Department of Field Crops, İZMİR

Introduction

Wheat is a major crop in Turkey where bread wheat production constitutes about 80 % of total cereal production (Anonymous, 2004; Anonymous, 2005). The crop has been grown at ratio 73 % about all of field crops areas and obtained 19 milyon ton production from growing area of 9,4 milyon hectare (Anonymous, 2004). The leaves, being the site of photosynthetic activity, appear to have an obvious relation to the plant's grain yield ability (Sharma et al. 2003a). Flag leaf makes a major contribution towards the grain weight (41–43 %) and is the major photosynhetic site during the grain filling period (Ibrahim and Elenein, 1977). Monyo ve Whittington (1973) have shown that leaf area is an indicator of potential grain yield in wheat and since the flag leaf plays a predominant role, it's size is likely to be important. Diallel analysis of self- and cross populations is used to study the genetic control of quantitative traits (Jinks and Hayman,1953; Hayman,1954,1958) to asses general and specific combining abilities (Griffing 1956) and perform heterosis analysis (Gardner and Eberhart,1966; Gardner,1967). It allows to select superior pure lines for crossing and in cross-pollinating species, to screen populations for use in a intra-and inter population breeding programs. Regarding cross-pollinating species, the general combining ability (gca) effect is an indicator of relative value of the population in terms of frequency of favourable genes and of its divergence, as compared to the other parents in the diallel. Thus, analysis of gca effects allows identification of superior parents, to be used intra population breeding programs. The specific combining ability (sca) efffect of two populations express the differences of gene frequences between them and their divergence, as compared to the diallel parents. Therefore, the gca and sca effects should be considered in the selection of populations for hybrid production and reciprocal recurrent selection programmes in addition to being indicators of the divergence of each population compared to the diallel parents, sca effects of a population with itself allow assesment of the predominant direction of the deviations due to dominance (Cruz and Vencovsky, 1989; Viana, 2000).

The purpose of this study was to select of the most promising genotypes and hybrid combinations to be used as breeding materials by using the Griffing type diallel analysis to a population of the F_1 progenies derived from crosses amongst some commercial wheat

genotypes grown in western of Turkey. The eight cultivars represent very important cultivars for Eagean Region of Turkey.

Materials and Method

The parents used in the crosses were Cumhuriyet (1), Kasifbey (2), Ziyabey (3), Marmara (4), Basribey (5), Malabadi (6),Yüregir (7) and Seri-82 (8). The parents are being sown widely in the wheat production area in the west of Turkey. The genotypes were crossed by hand without reciprocal in field conditions in 2000-2001 growing season. The eight parents and twenty eight F_1 progenies were grown at Bornova of Izmir province in Turkey. The experiment was a randomized complete block design with three replicates.The seed of each entry was sown in a plot which consists of a single 1-meter row spaced 30 cm apart with an intra row spacing 10 cm between plants. Standard agronomic and plant protection treatments were used for the duration of the experiment. At maturity, five plants were randomly selected from each plot. The length and maximum width of the flag leaf of the main steme of the each sampled plant was measured in centimeters and area was calculated following Simpson's (1968) formula as: Flag leaf area = (flag leaf length x flag leaf width) x 0.79. Grain yield per plant means was obtained with weighting of seeds from each plants. For each of the characters, the plot means were subjected to statistical analysis (Steel and Torrie, 1985). The combining ability analysis according to using Method II, Model I including the parents was applied directly crosses as well (Griffing, 1956). Analysis of the diallel crosses was performed through a microcomputer packet programme developed by Brow and Coors (1994). Data were recorded on grain yield per plant, width, length and area of flag leaf.

We considered the experimental assesment of n populations, their n(n-1) / 2 hybrids, obtained from the crossing of those populations in a diallel system (Kempthorne and Curnow,1961).

Results and Discussion

Preliminary analysis of variance indicated that crosses were different from each other for all the traits measured in the study at ($P<0.05$). Mean penotypic values on grain yield per plant, flag leag length,and flag leaf width, flag leaf area of eight wheat bread genotypes used in diallel analysis has been shown in Table 1. Mean squares and combining ability values obtained from variance analysis and diallel analysis has been given in Table 2. It was seen in Table 2

that flag leaf width and grain yield per plant have under non-additive gene effects while flag leaf length and flag leaf area traits have additive gene effects.

Flag Leaf Width

According to the results, it was understood that general combining abilities were significant and positive values. for the parents, Cumhuriyet-75 (0,03) and Yuregir (0,09), Malabadi (0,03);positive and insignificant for the parent Ziyabey (0,007); negative and insignificant for the parent Kasifbey (-0,01); negative and significant for the parents Marmara (-0,06) ve Basribey (-0,04) and Seri-82 (-0,04) as to flag leaf width (Table 3). It has been shown in Table 3 that the highest gca (0,09) effects has been obtained from Yuregir genotype while the lowest gca effects (-0,06) has been obtained from Marmara genotype. The genotype Yuregir which is the highest gca effects had also the highest mean of flag leaf width (2,24 cm). Basribey, Kasifbey, Seri-82 and Marmara genotypes had the lowest gca effects have existed also the lowest values of flag leaf width (1,92-1,93 cm) (Table 1). Yuregir has the first rank value among genotypes as to flag leaf width and the highest gca effects, indicating the best parent as to flag leaf width.

Examining specific combining abilities values, 1x2, 1x4, 1x8, 2x3, 2x4, 3x5, 3x6, 3x7, 6x8, 7x8 crosses has been shown positively statically significant while other crosses have not been determined any significance level ($P<0.05$). Cumhurıyet-75 x Kasifbey cross (1x2) has the highest sca (0,20) effects (Table 4). Looking at values of the combinations, Cumhuriyet-75 genotype has been the third rank in the highest values (2,03 cm), while Kasifbey genotype has been the last rank with 1,92 cm (Table 1). Kasifbey x Seri-82 which has the lowest sca value (-0,07) has shown flag leaf width with 2,14 cm as a average. Same results were obtained from Marmara x Seri-82 cross as well. The greatest flag leaf widths were obtained from cross combinations, 3x7 (2,49 cm), 1x2 (2,49cm), 3x6 (2,49cm). However, the cross combinations has been in same group, 7x8, 6x7, 2x7, 1x7, 6x8, 1x8, 2x4, 2x3, 3x5, 1x4, 5x6, 1x5, 1x6 4x6, 4x7, 1x3, 5x7, 2x6, 2x5, 3x4. The lowest flag leaf width (2,13 cm) has been found cross combination, 4x8 in Table 1.

Table 1. Mean values of genotypes and crosses on some agricultural characteristics of eight wheat bread genotypes used in diallel analyses

Genotype	Flag Leaf Length (cm)	Flag Leaf Width (cm)	GrainYield Per Plant (g)	Flag leaf area (cm^2)
Parents				
1)Cumhuriyet	25,40 ijkl	2,03 def	6,90 defgh	41.29 fgh
2)Kaşifbey	24,33 kl	1,92 f	4,40 gh	37.51 gh
3)Ziyabey	24,90 jkl	1,96 ef	7,30 defgh	38.89 gh
4)Marmara	24,60 kl	1,93 ef	3,83 j	37.73 gh
5)Basribey	22,46 il	1,95 ef	4,63 fgh	34.75 gh
6)Malabadi	25,40 defghıi	2,04 def	1,10 cdefgh	41.10 fgh
7)Yüreğir	29,05 kl	2,24 bcd	3,73 j	51.53 gh
8)Seri-82	23,86 kl	1,96 ef	5,43 efgh	37.08 h
Mean	25,40 ijkl	2,03 def	6,90 defgh	40.07fgh
Crosses				
1x2	34,00 a	2,49 a	8,03 cdefgh	67.11 a
1x3	30,73 abcdefg	2,32 abc	13,36 abcdefgh	60.60 abc
1x4	31,26 abcde	2,34 abc	15,30 abcd	54.24 abcd
1x5	32,73 abcd	2,33 abc	10,70 bcdefgh	60.85 abc
1x6	29,33 defgh	2,32 abc	7,53 defgh	54.12 cde
1x7	33,85 ab	2,43 ab	10,20 bcdefgh	66.02 a
1x8	31,86 abcde	2,42 ab	9,80 bcdefgh	61.18 abc
2x3	28,60 efghıij	2,38 ab	17,33 abc	53.93 cde
2x4	30,60 abcdefg	2,39 ab	8,30 cdefgh	58.30 abc
2x5	29,60 cdefghı	2,29 abc	14,26 abcdef	53.63 cde
2x6	28,73 efghıi	2,31 abc	6,90 defgh	52.65 cde
2x7	31,55 abcde	2,44 ab	12,16 abcdefgh	61.56 abc
2x8	27,43 fghıijk	2,14 cdef	7,66 cdefgh	46.47 defg
3x4	29,33 defghı	2,28 abc	11,50 bcdefgh	52.88 cde
3x5	27,13 ghıijk	2,38 ab	19,20 ab	51.14 cdef
3x6	30,10 bcdefgh	2,49 a	15,16 abcd	59.40 abc
3x7	33,20 abc	2,49 a	16,33 abcd	65.52 ab
3x8	28,71 efghıi	2,24 bcd	9,03 abcdefgh	50.90 cdef
4x5	26,13 ıijkl	2,14 cde	12,63 abcdefgh	44.38 efgh
4x6	29,78 cdefghı	2,32 abc	14,86 abcde	54.81 bcde
4x7	31,33 abcde	2,32 abc	14,03 abcdefg	57.61 abcd
4x8	26,60 hıijk	2,13 cdef	12,40 abcdefgh	44.75 efgh
5x6	29,43 defghı	2,33 abc	14,03 abcdefg	54.33 cde
5x7	30,60 abcdefg	2,32 abc	12,20 abcdefgh	56.36 abcd
5x8	29,80 cdefghı	2,26 bcd	14,80 abcde	53.26 cde
6x7	29,46 cdefghı	2,45 ab	11,10 bcdefgh	57.12 abcd
6x8	29,73 cdefghı	2,43 ab	9,63bcdefgh	57.23 abcd
7x8	31,00 abcdef	2,46 ab	21,73 a	60.50 abc
Mean	**30,10**	**2,35**	**12,50**	**50.64**
CV (0.05)	**7,52**	**5,8**	**47,6**	**13.5**
LSD (%)	**3,76**	**0,224**	**9,71**	**11.19**
Heterosis(%)	**0.30**	**5.09**	**7.73**	**16.22**

There are no difference between values showed with similar letter at % 5 level

Flag Leaf Length

According to the results, it was understood that general combining ability was positively significant for the parents, Cumhuriyet (1,39) , Yuregir (1,84); negative and non-significant for the parent, Kasifbey (-0,14), Ziyabey (-0,30), negative and significant for the parents, Basribey (-1,02), Seri-82 (-0,77), Marmara (-0,65) Malabadi (-0,32); (Table 3).

The highest gca effects revealed the genotype Yuregir (1,84) while the lowest estimates gca effect effects were obtained from the genotypes Basribey (-1,02).Yuregir which has the highest gca effect has shown the highest value (29,05 cm). Basribey which has the lowest gca effect has mean shown the lowest value (22,46 cm) in Table 1. The genotype, Yuregir, which has the longest flag leaf length and high gca effect can be used as valuable parent for increasing of flag leaf length.

Examining specific combining abilities values, 1x2, 1x4, 1x5, 1x7, 1x8, 2x4, 2x5, 3x4, 3x6, 3x7, 4x6, 5x6, 5x8, 6x8, the crosses has been shown to be positively and significant while other the crosses have not been determined at any significance (Table 4).

The highest sca effects (3,79) has been found from Cumhuriyet x Kasifbey cross and the fenotypic value belonged at the combination was determined as the highest mean that is 34,00 cm. Based on the lowest sca effect (-1,14) was obtained from Marmara x Basribey, (4x5) cross and flag leaf length which has the combination has had the lowest flag leaf length value (26,13). In order to improve flag leaf length, Kasifbey x Cumhuriyet cross combination can be taken into consideration as the most promising cross with 34,00 cm. However, the cross combination has been in same group with some combinations, 1x7, 3x7, 1x5, 1x8, 2x7, 4x7, 1x4, 7x8, 1x3, 2x4, 5x7. Sharma et al. (2003)indicated that non-fixable (non-additive) gene effects had a greater role than the additive gene effects (fixable) in controlling the inheritance of this trait. Other studies (Bariga, 1980; Menon and Sharma 1995) also substantiate this point.

Grain Yield Per Plant

According to the results obtained from the experiment, it was understood that general combining ability was significant positively for the parent, Ziyabey (1,94); but not significant for the parents, Yuregir (0,81) and Basribey (0,99); negative and negative and significant for the parents, Kasifbey (-1,36) and Malabadi (-1,39) non-significant for

the parents, Cumhuriyet (-0,83), Seri-82 (-0,11) and Marmara (-0,04); (Table 3).

Table 2: The results of variance analysis of flag leaf length, flag leaf width, flag leaf area and grain yield per plant traits of eight bread wheats used in diallel analysis

Variation Sources	Degrees of Freedom	Flag Leaf Width	Flag Leaf Length	Grain Yield Per Plant	Flag leaf Area
Block	2	0,329	72,692	231,261	792.478
Crosses	35	0,092	25,273	64,508	233.988
General Combining ability	7	0,086**	32,755**	42,697ns	282.768**
Specific Combining ability	28	0,094**	23,402**	69,961**	221.793**
gca/sca		0,91	1,39	0,61	1,27
Error	70	0,019	5,322	32,591	48.834

*,** - significant at the 5 % and 1 % level, respectively

The highest gca effect (1,94) have been obtained from Ziyabey genotype while the lowest gca effects (-1,39) has been obtained from Malabadi genotype (Table 3). The genotypes Ziyabey which is the highest gca effects has had also the highest value (7,30 g). The genotypes Malabadi which is the lowest gca effects has showed the lowest value (1,10 g) (Table 1). The genotypess Ziyabey which had the highest gca effects showed that it has been the parent for increasing of grain yield per plant point of view hopefully.

Considering specific combining abilities values, the crosses, 1x4, 2x3, 2x5, 3x5, 3x6, 4x6, 5x6, 5x8, 7x8 has been shown positively significant while the cross 3x8 has a negative and significant sca value (Table 4). The highest sca effect (10,24) has been obtained from Yuregir x Seri-82 crossing and also the cross combination has given the highest phenotpic mean (21,73 g).

The crosses Ziyabey x Seri-82 showed the lowest sca effects (-3,58) has been among crosses with lowest values as to grain yield per plant with 9,03 g value. In order to develop grain yield per plant, Yuregir x Seri-82 combination has been taken into consideration the best cross combination with 21,73 g value.

The greatest grain yield per plant was obtained from cross combinations, 7x8 (21,733 g). However, the cross combinations has been in same group 3x5, 2x3, 3x7, 1x4, 3x6, 4x6, 5x8, 2x5, 4x7, 5x6, 1x3, 4x5, 4x8 3x8, 5x7, 2x7. The lowest grain yield per plant has been found cross combination, 2x6 (6,90 g). It can be concluded from above

findings that as a consequence of the higher sca more than gca a non-additive gene effects involved in controlling the heritance of this trait in the present study (Table 2). The similar results obtained the experiment have been also reported in wheat for grain yield per plant by Brown et al., (1966); Whitehouse et al.(1958); Li et al. (1991). However, Yıldırım (1977) resulted that the trait had additive gene effects.

Table 3: The effects of general combining abilities on flag leaf length, flag leaf width, grain yield per plant and flag leaf area traits of bread wheat used in diallel analysis

Genotypes	Grain Yield Per Plant	Flag Leaf Width	Flag Leaf Length	Flag Leaf Area
Cumhuriyet	-0,83	0,03*	1,39**	3.62**
Kaşifbey	-1,36*	-0,01	-0,14	-0.47**
Ziyabey	1,94**	0,007	-0,30	-0.12
Marmara	-0,04	-0,06**	-0,65*	-2.80*
Basribey	0,99	-0,04**	-1,02**	-2.99**
Malabadi	-1,39*	0,03*	-0,32	-0.15
Yüreğir	0,81	0,09**	1,84**	5.43**
Seri-82	-0,11	-0,04**	-0,77*	-2.49*
Se (gi)s	**0,97**	**0,02**	**0,39**	**1.19**

*,** significant at the 5 % and 1 % level, respectively

Flag Leaf Area

The parents, Cumhuriyet-75 (3.62) and Yuregir (5.43) has positive and significant gca effects while the parents Kasifbey (-0.47), Marmara (-2.80), Basribey (-2.99), Seri-82 (-2.49) had negative and significant gca effects for flag leaf area (Table 3). It has been shown in Table 3 that the highest gca (5.43) effects has been obtained from Yuregir genotype while the lowest gca (-2,99) effects has been obtained from Basribey genotype. Yuregir had the highest gca effect and also the highest mean value (51.53 cm^2). Marmara, Basribey and Seri-82 genotypes which had the lowest gca effects had also lower mean values (37.73, 34.75 and 37,08 cm^2) (Table 1). Yuregir has the first rank value between genotypes as to flag leaf area and the highest gca effects, indicating the best parent as to flag leaf area.

Examining specific combining abilities values, 1x2, 1x3, 1x5, 1x7, 1x8, 2x4, 2x5, 3x6, 3x7, 4x6,5x6, 5x8, 6x8 and 7x8 crosses has been shown positively and significant statistically while in the other crosses have not been determined any significance level. Cumhuriyet x Kasifbey cross (1x2) has been the highest sca (11.35) effects (Table 4). Looking at fenotpyic values of the crosses, the cosses has had the first

rank as to the highest values (67.11 cm^2). Kasifbey x Seri-82 cross shown the lowest sca value (-3.15) has been among the lowest fenotipic means with 46.47 cm^2. It was understood that Cumhuriyet x Kasifbey cross combination can be examined carefully because of the highest phenotypic value of at the crossing research as it seen in Table 1.

It can be concluded from above findings that as a consequence of the higher gca more than sca had an additive gene effects involved in controlling the heritance of this trait in the study (Table 2). The findings obtained from the experiment have been also reported in wheat for flag leaf area by Sharma et al.(2003), Kashif and Khaliq (2004).

Table 4. The effects of specific combining ability on flag leaf length, flag leaf width, flag leaf area and grain yield per plant traits of bread wheat used in diallel analyses

Cross Combinations	Grain Yield Per Plant	Flag Leaf Width	Flag Leaf Length	Flag Leaf Area
1x2	-0,55	0,20**	3,79**	11.35**
1x3	1,47	0,006	0,68	4.49*
1x4	5,38**	0,10**	1,56*	3.80
1x5	-0,25	0,07	3,40**	7.61**
1x6	-1,02	-0,01	-0,69	-1.94
1x7	-0,56	0,03	1,65*	4.35*
1x8	-0,03	0,16**	2,28**	7.45**
2x3	5,96**	0,12*	0,09	1.92
2x4	-1,08	0,19**	2,44**	8.97**
2x5	3,84*	0,08	1,81*	4.50*
2x6	-1,12	0,02	0,24	0.68
2x7	1,92	0,09	0,89	4.00
2x8	-1,64	-0,07	-0,61	-3.15
3x4	-1,19	0,06	1,33*	3.20
3x5	5,46**	0,15**	-0,49	1.66
3x6	3,83*	0,18**	1,77*	7.08**
3x7	2,78	0,11*	2,69**	7.61**
3x8	-3,58*	0,002	0,83	0.91
4x5	0,88	-0,01	-1,14	-2.42
4x6	5,51**	0,08	1,80*	5.16*
4x7	2,47	0,02	1,18	2.37
4x8	1,76	-0,03	-0,93	-2.55
5x6	3,64**	0,07	1,82*	4.87*
5x7	-0,40	-0,002	0,82	1.32
5x8	3,12**	0,07	2,63**	6.15*
6x7	0,89	0,05	-1,01	-0.76
6x8	0,358	0,17**	1,87*	7.28**
7x8	10,24**	0,13**	0,96	4.95*
Sh(sij)	**2.98**	**0,07**	**1.20**	**3.65**

*,**-significant at the 5 % and 1 % level, respectively

Conclusion

In the research was determined effects of sca, gca and their percentage values, gca/ sca ratios, values of cross combinations for the traits examined. Considering gca values as, it was found that there were enough variation for all the traits except for grain yield per plant ($p<0.05$). At the end of the analyses performed have determined findings at following; Cumhuriyet-75, Yuregir genotypes have had positive and significant effects for flag leaf width and grain yield per plant. The genotypes can be taken into consideration for using of the traits at breeding programmes. Kasifbey and Malabadi genotypes have had negatif and significant effects for flag leaf length. Marmara, Basribey and Seri-82 genotypes have had negatif and significant effects for flag leaf width and grain yield per plant. Ziyabey genotype has had positive and significant effect for flag leaf length; This study suggested that additive gene effects for flag leaf length and area were considerably more prevalent than non-additive effects while flag leaf width and grain yield per plant have been controlled by non-additive gene effects. It can be concluded from above findings as a consequence of the cross combinations, particularly, Cumhuriyet x Kasifbey cross combination (1x2) for flag leaf length, flag leaf width, flag leaf area and Yüregir x Seri-82 cross combination (7x8) for grain yield per plant had the greatest means.

Summary

Combining ability for width, length and area of flag leaf and grain yield per plant components was studied in an eight-parent diallel cross in bread wheat. Data were examined by Griffing diallel analyses method.The effects of general combining ability (gca) were significant for all the traits except grain yield per plant, while the specific combining ability (sca) effects were significant for all the traits ($P<0.01$). General combining ability value were greater than specific combaning ability on flag leaf length and flag leaf area.

According to the results, the variance of general and specific combining ability of genotypes were significant for all the traits except for gca of grain yield per plant ($P<0.05$). The highest gca effects were determined in the genotype Ziyabey for grain yield per plant, Yuregir in flag leaf width, flag leaf length and flag leaf area. As a result of examinig specific combining ability, Yüregir x Seri-82 cross combination for grain yield per plant, Kasifbey x Marmara cross combination for flag leaf width, Cumhuriyet x Kaşifbey cross combinations for flag leaf length and flag leaf area had the highest specific combining abilities.

Key words: Combining ability, diallel, Griffing, flag leaf, grain yield

References

Anonymous. 2004. Republic of Turkey, Prime Ministry State Institute of Statistics. http://www.die.gov.tr/yillik/yillik_2004_eng.pdf. Acces: January 2006.

Anonymous, 2005. Production Estimates and Crop Assessment Division Foreign Agricultural Service. http://www.fas.usda.gov/pecad/highlights/2005/07/durum2005/durum%20tables .html Acces: February 2006.

Bariga, P.1980. Inheritance of photosynthetic areas above the flag leaf node in spring wheat. Plant Breeding Abstracts 50, 2712.

Brow, M. D and J. G. Coors. 1994. Diallel: A Microcomputer program for the simulation and analysis of diallel crosses. Agron.J.,86 (1): 154-159.

Brown, C.N. and R.O. Weibel, R.D. Seif. 1996. Heterosis and combining ability in common winter wheat, Crop. Sci. 6:392-383.

Cruz, C.D. and -Vencovsky,R.1989. Compparocao de algunsmetodos de analise dialelica. Rev. Bras Genet 12:425-438.

Gardner,C.O., S.A. Eberhart. 1966. Analysis and interpretation of the variety Cross Diallel and related populations. Biometrics 22: 439-452.

Gardner,C.O.1967. Simplified methods for estimating constants and computing sums of squares for a diallel cross analysis. Fitotec Latinoam 4:1-12.

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

Hayman, B.I. 1954 a. The theory and analysis of diallel crosses,Genetics, 39:789-809.

Hayman, B.I. 1958.The theory and analysis of diallel croses.II.Genetics 43:63-65.

Ibrahim, H.A. and R.A. Elenein. 1977. The relative contribution of different wheat leaves and awns to the grain yield and its protein content. Z. Ack. Pflanz 144: 1-7.

Jinks, J.L., B.I. Hayman. 1953. The Analysis of diallel crosses. Maize Crop Newslett 27:48-54.

Kashif, M., Khaliq. 2004. Manifestation of Heterosis for Some Metric Characters in Intraspecific crosses of T*riticum aestivum* L. International Journal of Agriculture and Biology. Vol.6, No.1p.132-137.

Kempthorne, O., R.N. Curnow. 1961. The Partial diallel cross. Biometrics. P.229-250.

Kılınç, M., 2001. The determination of combining ability of some agricultural characters at wheat breads. Mustafa Kemal University, The journal of Faculty of Agriculture 6 (1-2) :51-60. Hatay.

Li, L.Z., D.B. Lu.,D and Q. Cui. 1991. Study on the combining ability for yield and quality characters in winter wheat. Plant Breding Abst.(1994), 3:1.

Lupton, F.G.H. 1973. Selection criteria determining yield in semi dwarf wheat varieties. Ann. Appl.Biol. 72: 47-50. In: Sharma, SN., R.S. Sain and R.K. Sharma. 2003a. The genetic control of the flag leaf length in normal and late sown durum wheat. Journal of Agricultural Science 141:323-331.

Menon, U and S.N. Sharma,1995. Inheritance studies for yield and yield component traits in bread wheat over envinronments.Wheat Information Service 80, 1-5.

Monyo, J.H and W.J. Whittington. 1973. Genotypic differences in flag leaf area and their contribution to grain yield in wheat. Euphytica 22: 600-606.

Sharma, S.N., R.S. Sain and R.K. Sharma. 2003. Genetic analysis of flag leaf area in durum wheat over environments. Wheat Inf.Serv. India :96: 5-10.

Sharma, SN., R.S. Sain and R.K. Sharma. 2003a. The genetic control of the flag leaf length in normal and late sown durum wheat. Journal of Agricultural Science 141:323-331.

Simpson., G.M. 1968. Association between grain yield per plant and photosynthetic area above the flag leaf node in wheat. Canadian J.Pl. Science 48:117-183.

Steel, R.G.D., and J.H.Torrie. 1985. Principles and procedures of statistics. Second Edition. Mc. Graw- Hill Book Company Inc., New- York.

Viana, J.M.S. 2000. The parametric restrictions of the Griffing diallel analysis model: Combining ability analysis. Genet Mol Biol 23:877-881.

Yıldırım, M.B, 1977. Diallel analysis of four Agronomic traits in common wheat. In: Muhammed., A., Aksel R. and Borstel, R:C, 1977. Genetic diversity in plants. Plenium Pres. New York and London..

Whitehouse, R.N.H.,J.B. Thompson, M.A.M. Vale Riberio. 1958. Studies on the breeding of self- pollinating cereals. 2. The Use of diallel cross analysis in yield production. Euphytica 7:147-178.