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Genetic Relationships of Turkish Bread Wheat Cultivars

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Abstract: Forty-two bread wheat cultivars released up to 1990 in Turkey have been investigated in order to understand their genetic relationships. Correlation, regression and principal component analyses have been applied to cultivar-to-cultivar parentage coefficients and similarity indices based on pedigree data. Correlation and regression analyses between cultivar-to-cultivar parentage coefficients and similarity indices have shown higher relationships implying that both estimates could be used interchangeably to predict genetic relationships in cultivars. Principal component analyses failed to group cultivars clearly, but some subgrouping were obtained.

Türkiye Ekmeklik Buğday Çeşitlerinin Genetik İlişkileri

Özet: Türkiye'de 1990 yılına kadar tescil ettirilmiş 42 ekmeklik buğday çeşidinin genetik ilişkileri, çeşitlerin soykütükleri yardımıyla elde edilen akrabalık ve benzerlik derecelerine korelasyon, regresyon ve ana bileşen analizi uygulanarak araştırıldı. Çeşitlerin akrabalık ve benzerlik derecelerine uygulanan korelasyon ve regresyon analizleri arasındaki yüksek ilişki; her iki yöntemin de çeşitler arasındaki benzerliklerin araştırılmasında kullanılabileceğini gösterdi. Ana bileşen analizi ile çeşitlerin kesin gruplandırılması yapılamadıysa da; bazı çeşitlerin küçük gruplar oluşturduğu saptandı.

Introduction

Variety improvement in which genitors with good combining ability utilized extensively and selection applied only for traits of interest has led to a decreased genetic variation in modern cultivars (1-7). The possibility selecting from a narrower genetic base has become smaller and risk encountered against yield limiting factors higher. The danger became evident when some epidemics occurred in various crops such as potato, maize, and wheat due to genetic uniformity of varieties (8-9). Serious yield losses in these crops have directed scientists to investigate genetic backgrounds of economically important crops. Genetic similarity or dissimilarity estimates of varieties within species may be based on morphological and biochemical genetic markers, quantitative traits, or pedigree analysis (10-13). Pedigree analysis could easily be applied in autogamouos crops when pedigrees are known. Parentage coefficents, ancestor-to-cultivar coefficents, and similarity indices based on pedigree data may be utilized to estimate genetic similarity/dissimilarity (14,15).

Although many studies on genetic background of wheat varieties have been carried out in some countries, few results are available in Turkey (6,7), where wheat genetic resources are abundant. Better understanding of genetic backgrounds of wheat cultivars will help to plan future crossing programs and reduce risk due to environmental factors. Therefore, this study aimed to 1) better understand genetic background of released Turkish varieties, 2) compare genetic similarity estimates based on pedigrees, and 3)group varieties with similar genetic backgrounds.

Materials and Methods

Forty-two bread cultivars released in Turkey were given by their growing zones i.e winter-facultative and releasing periods i.e. before 1970 and after 1970 in Table 1. Thirty-six of them were through selection from local populations.

Pedigrees of cultivars improved by crossing were first traced until it was reached to an ancestor/ population with no known relationship to any other one. Secondly, cultivar-to-cultivar parentage coefficients and similarity indices (14,15) between any two cultivars were computed based on pedigree data. At last,

correlation-regression (16) and principal component analysis (17) were applied to parentage coefficents and similarity indices.

Table 1. Bread wheat cultivars and their grouping into four separate gene pools.

Groups	
a.Winter wheat cultivars released before 1970	Pedigree
1.Cv.4-9	Mentana/Kızıldil//Akdil
2.Cv.4-11	Mentana/Kızıldil//Akdil
3.Ak702	Selection from local population
4.Akova B.2	Mutant
5.Ankara093-44	Mentana/Delfii 89-28
6.Bezostaja 1	Selection from Bezostaja 4
7.Bolal2973	Cheyenne//Kenya/Mentana
8.Kırac 66	Yayla305/Floransa71
9.Köse220-39	Selection from local population
10.Melez13	Mentana/Kizildil//Akdil
11.P8-6	Ak702/Sertak52//Yy305/Melez13
12.P 8-8	Ak702/Sertak52//Yy305Melez13
13.Porsuk 2800	N10B/3/27-15/Rio//Rex53/4/Burt
14.Sertak 52	Selection from local population
15.Sivas 111-33	Selection from local population
16.Surak 1593-51	Ankara093-44/Kose220-39
17.Wanser	Burt/Itana
18.Yayla305	Selection from local population
19.Yektay 406	Mentana/Aegilops ovata
b.Winter cultivars released between 1971-90	
20.Atay85	Hys/7C
21.Etoile de Choisy	Squarehead/Ardito
22.Gerek 79	Menk"S"/My48//4-14/3/Yy305
23.Haymana 79	Sut*5/Ag
24.Kırkpınar 79	63-112/66-2/7C
25.Karasu90	Lov11/BI2973//Mir264
26.Lancer	Turkey/Cheyenne/Hope/2*Cheyenne
27.Tosun 21	N10B/12231Murgul
28.Tosun 144	Bez1/54T72
c.Spring cultivars released before 1970	
29.Aköz	Mentana 1053/1181
30.Burt	27-15/Rio//Rex1944
31.Lerma Rojo 64	Y50/N10B//L52/3/Lr*2
32.Mentana	Rieti/Wilnelmina//Akagomughi
33.Nadadores 63	Frontana//K58/Newthatch//N10/B/3/2
34.Penjamo62	Frontana/Kenya58//Newthatch/3/N10/B
35.Pitic62	Yaktana54//Norin 10/Brevor
d.Spring cultivars released between 1971-90	
36.Ata81	Kvz/Cut75
37.Cukurova86	Bb/Kal
38.Cumhuriyet75	Son64*2/Tzpp/Y54/3/An64A/4/Fr*2//Y/Kt
39Genç 88	Cno"S'/Na//Cc/Inia/3/Bb/Nar59
40.Kaklic88	Kvz/Buho"S'//Kal/Bb
41.Marmara86	Bobwhite"S"
42.Sakarya75	Cno/Pi//Cno/7C

Results and Discussion

Cultivar-to-cultivar parentage coefficents (PC) and similarity indices (SI) based on pedigree data were given in Table 2. Higher PC's were obtained for the pairs of 'Sürak 1593-51-Ankara 093-44', 'Ata 81-Bezostaja 1', 'Melez 13-Cv.4-9', 'Melez 13-Cv.4-11', 'Aköz-Mentana', 'Mentana-Ankara 093-44', 'Mentana-Yektay 406', 'Atay 85-Kırkpınar 79', 'Cv.4-9-Cv. 4-11', 'Bolal 2973-Lancer', 'P8-8-P8-6', 'Lancer-Haymana79', and 'Mentana-Etoile de Choisy'. Except for the pairs of 'Ata 81-Bezostaja1' and 'Mentana-Etoile de Choisy', pairs were either from the same growing zone or period. Those two exception pairs were a result of very close utilization of common genitors. Higher SI's were acquired for the cultivar pairs of 'Kaklıç 88-Sakarya 75', 'Mentana-Etoilede Choisy', 'Wanser Burt', 'Kırkpınar 79-Atay 85', 'P8-6-P8-8', and 'Cv.4-9-Cv.4-11'. All cultivars were again either from the same growing zone or period. The 'Wanser-Burt' pair revealed higher SI was interesting since each of these cultivars was released for different growing zones.

Relationships between PC and SI measured by correlation coefficent were statistically significant.When all 861 pairs were included in the computations correlation coefficent was 0.58 ($P \geq 0.01$). This higher correlation coefficent might imply that PC and SI could be used interchangebly to estimate genetic similarity in Turkish cultivars. Furthermore, correlation coefficents were calculated for all cultivar pairs in winter-facultative and spring zones. They were 0.63 and 0.51, respectively. Regression equations, lines, and determination coefficients for all, winter-facultative, and spring cultivars were computed assigning similarity indices dependent, cultivar-to-cultivar parentage coefficients independent variable and ane given in Figure 1. winter-facultative cultivars have shown higher determination coifficient than that of spring cultivars. This might be resulted from lower number of an-

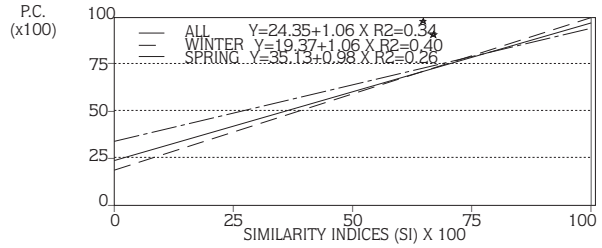

Figure 1. Regression equations, lines, and determination coefficients between cultivar-to-cultivar parentage coefficient and similarity indices of cultivars released in Turkey.

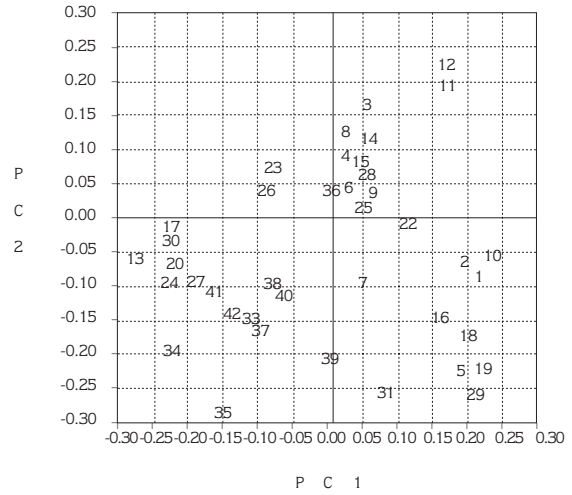

Figure 2. Associations among 42 Turkish bread wheat cultivars revealed by principal component analysis performed on cultivar-to-cultivar parentage coefficients. (PC1: 1st and PC2: 2nd principal components. Codes 1-19 winterfacultative cultivars before 1970;20-28 winter-facultative cultivars after 1971;29-35 spring cultivars released before 1970;36-42 spring cultivars released after 1971)

cestors involved in winter cultivars than those in spring cultivars. Determination coefficient for all cultivars was between those of winter-facultative and spring cultivers as expected.

Mean genetic similarity and parentage coefficients of cultivars were computed by era and growing zones (Table 3). Mean parentage coefficients were 8.73, 7.85, and 10.49 for all, winter-facultative, and spring cultivars, respectively, When winter-facultative cultivars

Table 2. Cultivar-to-cultivar parentage coefficients (below diagonal) and similarity indices (above diagonal) for cultivars up to 1990 in Turkey.

No.	CULTIVARS	1	2	3	4	5	6	7	8	9	10
1	4-9	-	100	0	0	73	47	67	0	0	100
2	4-11	56	-	0	0	73	47	67	0	0	100
3	AK 702	0	0	-	0	0	0	0	0	0	20
4	Akova B.2	0	0	0	0	0	0	0	0	0	0
5	Ankara 093-44	18	18	0	0	-	47	73	0	0	73
6	Bezostaya 1	2	2	0	0	0	4	-	47	27	0
7	Bolal 2973	10	10	0	0	20	3	-	0	67	
8	Kıraç 66	1	1	0	0	0	1	0	-	0	0
9	Köse 220-39	0	0	0	0	0	0	0	0	-	0
10	Melez13	75	75	0	0	18	2	10	0	0	-
11	P8-6	10	10	25	0	4	1	2	13	0	35
12	P8-8	0	10	25	0	4	1	2	13	0	35
13	Porsuk 2008	0	0	0	0	0	0	4	5	0	0
14	Sertak 52	0	0	0	0	0	0	0	0	0	0
15	Sivas 111-33	0	0	0	0	0	0	0	0	0	0
16	Surak 1593-51	9	9	0	0	80	2	10	0	50	9
17	Wanser	0	0	0	0	0	0	23	4	0	0
18	Yayla 305	0	0	0	0	0	0	0	0	0	0
19	Yektay 406	18	18	0	0	35	4	20	0	0	18
20	Atay 85	1	1	0	0	1	1	3	4	0	1
21	Etoile De Choisy	13	13	0	0	26	4	16	3	0	13
22	Gerek 79	10	10	0	0	9	1	5	25	0	10
23	Haymana 79	0	0	0	0	0	0	30	4	0	0
24	Kırkpınar 79	1	1	0	0	1	1	3	4	0	1
25	Karasu 90	2	2	0	0	5	7	40	0	0	2
26	Lancer	0	0	0	0	0	0	56	0	0	0
27	Tosun 21	0	0	0	0	0	1	5	0	0	0
28	Tosun 144	1	1	0	0	2	50	1	1	0	1
29	Aköz	18	18	0	0	35	4	20	0	0	18
30	Burt	0	0	0	0	0	0	2	3	0	0
31	Lerma Roj 64	10	0	0	19	2	13	0	0	10	
32	Mentana	35	35	0	0	70	9	4	0	0	35
33	Nadadores 63	1	1	0	0	1	1	2	2	0	1
34	Penjamo 62	2	2	0	0	5	1	6	5	0	2
35	Pitic 62	7	7	0	0	14	2	10	2	0	7
36	Ata 81	2	2	0	0	4	77	3	0	0	2
37	Çukurova 86	2	2	0	0	5	1	4	0	0	3
38	Cumhuriyet 75	3	3	0	0	7	1	5	0	0	3
39	Genç 88	5	5	0	0	10	1	7	0	5	1
40	kalkış 8	3	3	0	0	5	20	4	0	0	3
41	Marmara 86	1	1	0	0	2	1	3	0	0	1
42	Sakarya 75	2	2	0	0	3	1	4	0	0	2

Continue 2

No.	CULTIVARS	11	12	13	14	15	16	17	18	19	20
1	4-9	80	80	0	0	0	67	0	0	73	13
2	4-11	1	80	80	0	0	0	67	0	0	73
3	AK 702	13									
4	Akova B.2	20	20	0	0	0	0	0	0	0	0
5	Ankara 093-44	B.20	0	0	0	0	0	0	0	0	0
6	Bezostaya 1	57	57	0	0	0	91	0	0	80	8
7	Bolal 2973	40	40	25	0	0	47	22	0	50	31
8	Kıraç 66		53	53	13	0	0	67	18	0	80
9	Köse 220-39	17									
10	Melez13	0	0	61	3	3	3	67	17	0	47
12	P8-8	0	0	0	0	0	33	0	0	0	0
13	Porsuk 2008	80	80	0	0	0	0	67	0	0	47
14	Sertak 52	100	0	20	0	57	0	20	53	8	
15	Sivas 111-33	56	-	0	20	0	57	0	20	53	8
16	Surak 1593-51	0	0	-	0	0	0	98	0	0	87
17	Wanser										
18	Yayla 305	25	25	0	-	0	0	0	0	0	0
19	Yektay 406	0	0	0	0	-	0	0	0	0	0
20	Atay 85	2	2	0	0	0	-	0	0	73	8
21	Etoile De Choisy	0	0	50	0	0	0	-	0	0	74
22	Gerek 79	25	25	0	0	0	0	0	-	0	0
23	Haymana 79										
24	Kırkpınar 79	4	4	0	0	0	18	0	0	-	8
25	Karasu 90	0	0	34	0	0	1	24	0	1	-
26	Lancer	3	3	0	0	0	13	0	0	26	4
27	Tosun 21	15	15	0	0	0	5	0	50	9	0
28	Tosun 144		0	0	7	0	0	0	22	0	0
29	Aköz	4									
30	Burt	0	0	34	0	0	1	24	56		
31	Lerma Roj 64	0	0	0	0	0	2	7	0	5	1
32	Mentana	0	0	10	0	0	0	37	0	0	5
33	Nadadores 63	0	0	30	0	0	0	10	0	2	11
34	Penjamo 62	0	0	0	0	0	1	1	0	4	3
35	Pitic 62										
36	Ata 81	4	4	0	0	0	18	0	0	35	1
37	Çukurova 86	0	0	50	0	0	0	50	0	0	38
38	Cumhuriyet 75	2	2	6	0	0	10	4	14	4	
39	Genç 88	9	9	0	0	0	35	0	0	70	3
40	kalkış 8										
41	Marmara 86	0	0	8	0	0	1	3	0	7	13
42	Sakarya	0	0	30	0	0	2	10	0	7	32
		2	2	27	0	0	7	12	0	10	16
		1	1	8	0	0	2	9	0	4	3
			1	1	6	0	0	3	3	0	5
		26									
		1	1	16	0	0	3	18	0	6	6
		1	4	0	0	5	2	0	8	7	8
		1	1	5	0		0	3	2	0	5
		16									
		0	0	19	0		0	1	18	0	4
		19									
		0	0	14	0	0	2	5	0	4	11

Continue 3

No.	CULTIVARS	21	22	23	24	25	26	27	28	29	30
1	4-9	82	46	0	13	42	0	0	44	73	0
2	4-11	82	46	0	13	42	0	0	44	73	0
3	AK 702	0	0	0	0	0	0	0	0	0	0
4	Akova B.2	0	0	0	0	0	0	0	0	0	0
5	Ankara 093-44	90	46	0	8	44	0	0	47	80	0
6	Bezostaya 1	39	17	31	50	0	28	96	50	26	
7	Bolal 2973	82	54	20	17	83	33	11	44	73	18
8	Kıraç 66	23	51	47	25	24	73	26	0	72	
9	Köse 220-39	0	0	0	0	0	0	0	0	0	0
10	Melez13	0	23	51	47	25	24	73	26	0	72
12	P8-8	64	62	0	8	36	0	0	38	57	0
13	Porsuk 2008	64	62	0	8	36	0	0	38	57	0
14	Sertak 52	0	24	85	82	40	31	81	28	0	98
15	Sivas 111-33	0	0	0	0	0	0	0	0	0	0
16	Surak 1593-51	0	0	0	0	0	0	0	0	0	0
17	Wanser	82	46	0	8	42	0	0	44	73	0
18	Yayla 305	0	26	55	74	36	38	79	22	0	100
19	Yektay 406	0	10	0	0	0	0	0	0	0	0
20	Atay 85	90	48	0	8	12	0	0	47	80	0
21	Etoile De Choisy	8	38	60	100	40	30	79	7	8	79
22	Gerek 79	-	52	0	8	50	0	0	53	90	0
23	Haymana 79	7	-	39	38	45	46	23	28	44	29
24	Kırkpınar 79	0	2	-	60	40	57	51	0	0	67
25	Karasu 90	4	0	4	-	40	30	79	7	8	79
26	Lancer	4	1	9	1	-	26	28	48	44	15
27	Tosun 21	0	2	54	5	16	-	20	0	0	35
28	Tosun 144	2	0	7	11	2	9	-	27	0	81
29	Aköz	4	1	0	3	4	0	2	-	47	25
30	Burt	26	9	0	1	5	0	0	2	-	0
31	Lerma Roj 64	0	0	5	38	0	8	11	0	0	-
32	Mentana	14	9	5	4	3	5	6	1	19	4
33	Nadadores 63	52	18	0	3	9	0	0	5	70	0
34	Penjamo 62	7	4	4	13	1	4	12	0	1	3
35	Pitic 62	7	3	8	32	2	9	43	2	5	11
36	Ata 81	10	6	5	16	3	6	26	1	14	18
37	Çukurova 86	4	2	1	3	3	1	2	38	4	9
38	Cumhuriyet 75	5	0	5	26	1	4	10	1	5	2
39	Genç 88	6	3	3	6	1	2	3	0	7	19
40	kalkış 8	5	5	7	2	2	4	6	0	10	1
41	Marmara 86	5	25	4	16	2	4	8	10	5	2
42	Sakarya	4	2	4	19	1	3	9	1	2	19
		4	3	5	11	1	5	20	1	3	5

Continue 4

No.	CULTIVARS	31	32	33	34	35	36	37	38	39	40	41	42
1	4-9	23	80	11	16	25	28	16	32	24	15	17	16
2	4-11	23	80	11	16	25	28	16	32	24	15	17	16
3	AK 702	0	0	0	0	0	0	0	0	0	0	0	0
4	Akova B.2	0	0	0	0	0	0	0	0	0	0	0	0
5	Ankara 093-44	23	89	12	17	25	29	16	32	24	15	17	16
6	Bezostaya 1	37	53	31	35	39	45	35	39	40	34	35	33
7	Bolal 2973	36	80	23	28	34	36	26	40	34	22	26	26
8	Kıraç 66	47	0	56	57	47	39	45	32	39	42	45	47
9	Köse 220-39	0	0	0	0	0	0	0	0	0	0	0	0
10	Melez13	47	0	56	57	47	39	45	32	39	42	45	47
12	P8-8	22	62	11	15	24	28	16	31	17	15	24	15
13	Porsuk 2008	22	62	11	15	24	28	16	31	17	15	24	15
14	Sertak 52	76	0	81	90	77	58	68	65	60	61	65	67
15	Sivas 111-33	0	0	0	0	0	0	0	0	0	0	0	0
16	Surak 1593-51	0	0	0	0	0	0	0	0	0	0	0	0
17	Wanser	23	80	11	60	25	28	16	32	24	19	17	16
18	Yayla 305	67	0	73	82	69	42	62	61	54	57	60	60
19	Yektay 406	0	0	0	0	0	0	0	0	0	0	0	0
20	Atay 85	23	89	12	17	25	29	16	32	24	15	17	24
21	Etoile De Choisy	83	12	98	87	84	84	72	87	91	97	95	96
22	Gerek 79	25	100	13	19	27	29	16	33	24	15	17	16
23	Haymana 79	68	50	54	46	67	65	51	71	58	46	55	44
24	Kırkpınar 79	66	0	68	48	65	40	61	52	55	57	62	59
25	Karasu 90	83	12	98	87	84	84	72	87	91	97	97	95
26	Lancer	49	47	41	54	51	47	42	52	48	42	44	44
27	Tosun 21	40	0	36	39	38	31	33	36	30	28	34	30
28	Tosun 144	62	0	66	75	59	41	63	40	55	50	61	70
29	Aköz	37	50	30	35	38	40	34	39	35	34	40	32
30	Burt	23	89	12	17	25	29	16	32	24	15	17	16
31	Lerma Roj 64	56	0	73	79	68	48	61	49	53	56	60	60
32	Mentana	24	91	95	97	96	89	93	95	87	94	90	
33	Nadadores 63	39	-	12	17	25	29	16	32	17	15	17	16
34	Penjamo 62	14	2	-	94	94	89	98	93	99	87	98	98
35	Pitic 62	13	10	17	-	91	89	89	94	88	89	93	97
36	Ata 81	19	28	27	36	-	96	85	97	96	90	96	93
37	Çukurova 86	5	8	4	4	7	-	88	67	91	88	91	86
38	Cumhuriyet 75	7	10	31	33	36	2	-	89	99	99	99	98
39	Genç 88	9	13	7	7	13	9	4	-	92	87	92	89
40	kalkış 8	25	20	23	19	49	25	0	7	-	99	99	97
41	Marmara 86	17	11	23	24	34	17	0	4	0	-	99	100
42	Sakarya	13	4	15	24	31	10	0	19	0	0	-	98
		8	7	16	26	26	3	20	5	12	14	14	-

grouped into the ones before and after 1970, PC's were 7.67 and 8.21, respectively. When the same grouping applied to spring cultivars, PC's were 12.15 and 8.84, respectively. Higher PC mean in spring cultivars was due to more common progenitors. Mean similarity indices were 33.68, 27.76, and 45.50 for all, winter-facultative, and spring cultivers. Higher SI's were resulted from intensive use of common ancestors in spring wheat improvement programs. Mean PC and SI have increased in both zones with time indicating narrower genetic base in recent cultivars.

Associations among 42 Turkish bread wheat cultivars revealed by principal component analysis (PCA) performed on cultivar-to-cultivar parentage coefficents were given in Figure 2. The first (PC1) and the second (PC2) principal components accounted for 17.3 % and 11.9 % of the total variation in pedigree based cultivar-to-cultivar parentage coefficients, respectively. PC1 and PC2 have not seperated cultivars either to growing zones or releasing periods, but some small groupings occurred. Overlapping of cultivars from different zones and periods was due to closeness in genetic backgorund. Interesting groupings between winter-facultative and spring cultivars (Wanser-Burt; Tosun21-Marmara 86) might be an indicating of genetic closeness between two gene pools.

Associations among 42 Turkish wheat cultivars revelaed by principal component analysis (PCA) performed on similarity indices were given in Figure 3. The PC1 and PC2 principal components accounted for 49.5 % and 24.7 % of the total variation in pedigree based similarity indices. PC1 and PC2 failed to separate winter-facultative cultivars from spring and cultivars released before 1970 from those released after 1971.

It is clear to breeders that extreme environmental conditions necessitates cultivars based on a wide genetic background. On the other hand, breeding reduces genetic variation in cultivars to some desired extent. The same has been observed previously in Turkish bread and durum wheat cultivars (6-7) which was supported by present study as well.

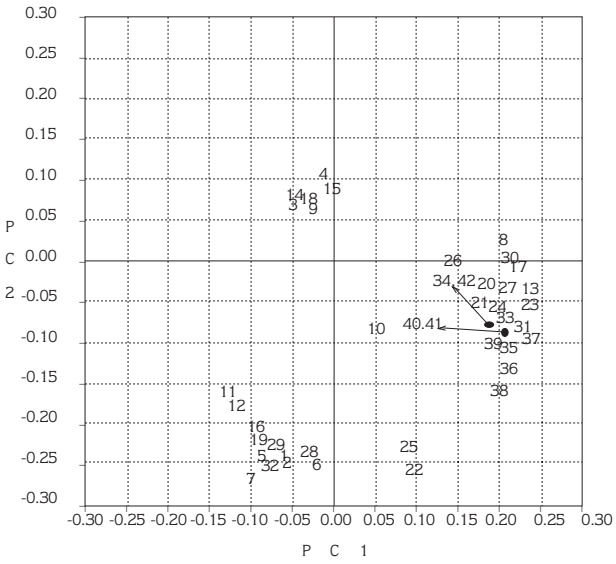

Figure 3. Associations among 42 Turkish wheat cultivars revealed by principal component analysis performed on similarity indices. (PC1: 1st and PC2:2nd principal components. Codes 1-19 winter-facultative cultivars before 1970; 20-28 winter-facultative cultivars after 1971; 29-35 spring cultivars released before 1970; 36-42 spring cultivars released after 1971)

Table 3. Mean cultivar-to-cultivar parentage coefficients and similarity indices for cultivars of all, winter-facultative, and spring growing zones grouped by relasing periods

Growing Zones	Releasing Periods	Parentage Coef.	Similarity Indices
All	Before and After 1970	8.73	33.68
Winter-Facultative	Before 1970	7.67	23.98
	After 1970	8.21	35.76
	Before and After 1970	7.85	27.76
Spring	Before 1970	12.15	42.92
	After 1970	8.84	48.09
	Before and After 1970	10.49	45.50

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