Turkish Journal of Agriculture and Forestry

Volume 36 | Number 5 Article 2

1-1-2012

Use of discriminant analysis for selection of hybrid maize parent lines

AHMET ÖZ

Turk J Agric For
36 (2012) 533-542

doi:10.3906/tar-1201-35

Research Article

Use of discriminant analysis for selection of hybrid maize parent lines

Ahmet ÖZ
Department of Biology, Faculty of Science, Çankırı Karatekin University, Çankırı – TURKEY

Received: 19.01.2012 ● Accepted: 23.03.2012

Abstract: This study was conducted to investigate the opportunity to utilize discriminant analysis in the selection of parent lines in hybrid maize breeding. For this purpose, top crosses were obtained by top-crossing 31 inbred maize lines with the FRMo.17 line in 2003. These hybrids were subjected to preyield trials in 2004. The same lines were subjected to observation tests in 2003 and 2004, and yield and yield components were determined. The obtained data were analyzed using the discriminant analysis method. The distances between the lines were determined according to D2 and canonical values. The TK-108, TK-110, TK-13, TK-347, TK-175, TK-157, and TK-120 lines were selected as parental lines after the evaluation of the results of the top cross. The TK-120, TK-145, TK-413, TK-284, TK-169, TK-68, and TK-304 lines were selected as parents in line with the evaluations made as a result of discriminant analysis.

Key words: Combination ability, discriminant analysis, maize, top cross

Introduction

Identifying genetic differences between parent lines in order to get high heterosis in obtaining hybrid cultivars in open-pollinated plants like maize is very important. Because of this, breeders develop source populations from different heterotic groups and perform crossbreeding among these populations. Some researchers develop different models in order to obtain high heterosis (Radovic and Jelovac 1995; Sinobas and Monteagudo 1996; Gouesnard et al. 1996). Reid × Lancaster is a heterotic model in which commercial hybrids are mostly obtained (Soengas et al. 2003). After the inbred lines have been obtained, their combination ability is checked and hybrid combinations are formed.

Determination of combination ability is the most important criterion in selecting genotypes to form a source population and in obtaining inbred lines from the source population. Top-crossing is the most widely used method to determine combination ability. The purpose of forming the top cross is to create an opportunity for an inbred line, traits of which have been put under pressure via inbreeding, to be left to free pollination with a tester, thus completely revealing its yield potential by getting rid of this pressure. While determining the testers, certain genetic information must be known in order for the inbred lines to be correctly classified (Rawlings and Thompson 1962). Two of the most widely used testers are the Mo17 inbred line from the Lancaster heterotic group and the B73 inbred line from the Reid heterotic group (Uhr and Goodman 1995). Along with their high combination ability, high grain yield, and flowering features, these inbred lines are

* E-mail: ahmetoz01@hotmail.com

also important in terms of hybrid seed production. The yield of hybrids obtained from inbred lines that have high grain yield is high. Likewise, the yield of hybrids obtained from inbred lines that have low grain yield is low (Lonnquist and Lindsey 1964; Lamkey and Hallauer 1986). If the top crosses have shown high ability in a line, the "general combination ability" of that line is high (Sprague and Tatum 1942). In a study, Kara (2001) determined the general and special adaptabilities related to the yield and yield components of 6 parent lines. Three testers and 18 F_1 maize hybrids were analyzed in accordance with the line × tester analysis. According to the results of the analysis of variance, the variation between the F_1 hybrids and the parent lines was found to be significant in terms of all examined traits.

The fact that a great majority of the characters that have economic importance emerge as a result of polygenic inheritance and environmental effects increases variability (Poehlman and Sleper 1995). Typically, each character is studied individually in this type of analysis, which can cause erroneous interpretations and suggestions in many cases. Computers enable us to evaluate agricultural research in a more appropriate manner and interpret values more reliably. Multivariate analysis methods that were difficult to use in the past have become more easily implementable. Among these methods, factor, principal component, and discriminant analyses are used to supplement or replace univariate methods. Thus, more characters can be analyzed together (Tatsuoka 1971; Rencher 1995).

The distance between the inbred lines in discriminant analysis is determined using D^2 values and axes. $D^2 = (X_i - X_j)^2 \operatorname{cov}^{-1} (X_i - X_j)$ and the formalized distance is the square of the distance between 2 breeds. X_i and X_j values refer to the general average of i and j cultivars. Discriminant analysis has features that support univariate analysis of variance and regression analysis and reinforce their interpretations rather than being one of the techniques that can be used in place of these analyses (Tatsuoka 1971; Rencher 1995). Discriminant analysis not only describes numerically the general distance between the breeds with D^2, but also shows the characters that serve the purpose of distinguishing the cultivars among the studied criteria. It is possible to classify the studied cultivars and applications using these characters, which use coefficients from various canonical distributions. If a coefficient is higher than ±0.5, that character is defined as distinguishing. Figures are formed in accordance with the average values belonging to each breed (Tatsuoka 1971). Year and location are not taken into account, and replications are used in discriminant analysis. Ilarslan et al. (2002) evaluated 32 pop, flint, and dent maize lines collected from different regions of Turkey via discriminant analysis in accordance with morphological and agronomic traits, and their genetic transformations were researched. Canonical discriminant analysis of 25 morphological and agronomic traits revealed that 2 canonical discriminant variables explained 68% of the total variation among accessions. In a study conducted with 27 maize cultivars, Öz et al. (2003) stated that the cultivars exhibited wide distribution according to discriminant analysis, but there were also cultivars that showed high similarity to each other, and cultivars were listed in 4 groups according to cluster analysis. In a similar study that was carried out with 30 dent maize inbred lines in Samsun and Tokat conditions, Aydın et al. (2007b) evaluated the traits belonging to the lines using multivariate analyses (discriminant and cluster). They were attempting to determine the variation between the inbred lines and the top crosses obtained by crossbreeding these lines with the FRMo.17 line. Axes and D^2 values were utilized in the discriminant analysis. Aydın et al. (2007a) also tried to evaluate the combination abilities of 30 inbred maize lines via the top-crossing method in terms of grain yield and some other traits. According to the researchers, combination ability is an important selection criterion for studying hybrid breeding. The lines that exhibited positive combination ability at a significant level in terms of plant height, ear height, and 1000-grain weight were also best in terms of grain yield.

Developing pure lines, top crossing, and determining the combination ability of these lines are performed over a 10-year period in hybrid maize breeding. Examining the traits of the material and reducing the duration for appropriate parent selection in the early stages of obtaining inbred lines (S_4 or S_5) will be a significant gain. The aim of this study was to examine the employability of discriminant analysis, a type of multivariate analysis, in the selection of parents in hybrid maize breeding.

Materials and methods

This research was conducted with 31 inbred maize lines (Table 1) at the Black Sea Agricultural Research Institute in 2003 and 2004 in Samsun. Sixteen of these inbred lines were obtained from the International Maize and Wheat Improvement Center (CIMMYT), and the others were developed using the selfing method at the Black Sea Agricultural Research Institute (Table 1). The characteristics of the inbred lines are given in Table 2. The test, which was composed of the lines that were to be evaluated via discriminant analysis, was conducted with 3 replications according to randomized blocks design. The experimental plots had 4 rows, each 5 m long with spacing of 0.70 m between rows and 0.25 m within rows. Fertilizer of 200 kg N and 70 kg P_2O_5 ha^{-1} was applied. Sowing was performed in the beginning of May. Harvest was performed in the middle of September. Yield and yield components belonging to the lines were recorded. Following the analysis of these traits, parent lines were identified. Hybridization was performed among these parent lines in 2005.

The same lines (31 inbred lines) were subjected to top crossing with the FRMo.17 line. Line FRMo.17 is an inbred line used as a tester in hybrid maize studies (Aydın et al. 2007b). Top crossing was conducted in 2003 in an isolated area via free pollination by manually pulling the tassels of the female lines. These hybrids were subjected to a yield test in 2004. The inbred lines to be included in the new hybrid combinations were identified according to the results of the test. This identification was performed in accordance with the combination ability values that emerged after analyzing the grain yield of the hybrids per 0.1 ha and other obtained observation values (flowering duration, plant height, ear height, plant appearance, and ear appearance). In view of this evaluation, crossbreeding was conducted among the lines that were present on end points in 2005. Grain yield values were grouped via analysis of variance in accordance with Duncan's test. An analysis of combining ability was done with linear comparison using the MIXED procedure in SAS (1998). Combining ability was calculated by subtracting the average performance of the hybrids from the performance of the F1 hybrid. A canonical discriminant was computed using the DISCRIM procedure. Distances between inbred

Table 1. Inbred lines and pedigrees.

No.	Line	Pedigree	No.	Line	Pedigree	No.	Line	Pedigree
1	TK-2	A.251*	12	TK-289	Yıldız.13**	23	TK-347	KD.25**
2	TK-38	B.79*	13	TK-314	Yıldız.51**	24	TK-98	IDRN.Cornell*
3	TK-13	A.634*	14	TK-315	Yıldız.53**	25	TK-157	W.401*
4	TK-120	CM.174*	15	TK-110	504W*	26	TK-341	KD.19**
5	TK-145	Pa.866*	16	TK-390	KAR.14**	27	TK-227	ALKD.542*
6	TK-58	H.60*	17	TK-366	KD.53**	28	TK-413	KD.15-1**
7	TK-284	Akpınar.59**	18	TK-68	H.103*	29	TK-415	KD.16-2**
8	TK-304	Yıldız 40**	19	TK-175	496W*	30	TK-417	KD.18.1**
9	TK-49	FR.15*	20	TK-108	B.97*	31	TK-300	Yıldız.35**
10	TK-171	2202-2A*	21	TK-428	KD.33-1**			
11	TK-169	TANYU*	22	TK-442	KD.45-1**			

*Lines were obtained from CIMMYT.

**Lines were evaluated in the TMP-2 gene pool in Samsun.

Table 2. Means of the investigated characteristics of the inbred lines.

Line	Grain yield(**) (kg ha^{-1})	Flowering time (days)	Maturing time (days)	Plant height (cm)	Ear height (cm)	Leaf count	Ear row count	Grain count per row	Moisture (%)	Grain-to-ear ratio (%)	Cob diameter (mm)	Ear diameter (mm)	Ear length (cm)	1000-grain weight (g)	Grain count per ear
TK-227	12,500 a	65	135	275	125	13	18	48	27	81	29	51	22	346	724
TK-98	10,660 a	66	137	274	125	13	16	45	29	83	27	46	22	365	692
TK-442	8790 b	67	137	253	118	14	14	35	31	81	29	50	18	475	436
TK-347	8390 bc	66	136	238	93	13	17	36	29	81	27	48	20	323	632
TK-390	7420 bd	64	133	230	106	13	13	40	23	78	26	42	20	311	470
TK-68	7390 bd	70	140	253	126	14	15	42	29	82	23	41	20	298	537
TK-13	6620 ce	66	138	200	80	13	16	29	24	82	26	44	17	343	409
TK-108	6460 cf	70	139	199	79	13	13	26	25	80	25	45	16	355	323
TK-300	6300 df	68	139	206	94	13	14	34	28	78	28	43	19	318	444
TK-145	6250 df	68	138	193	75	13	13	37	27	81	23	46	22	355	437
TK-315	6240 df	64	133	206	89	14	19	42	30	82	27	44	19	299	681
TK-171	5500 dg	64	133	241	91	13	13	32	25	77	24	40	19	321	383
TK-175	5370 dh	68	139	195	68	13	13	27	26	80	24	42	17	316	355
TK-49	5160 eh	71	140	191	64	15	14	35	30	72	29	44	18	273	433
TK-58	5000 fi	65	134	198	85	12	17	33	24	82	26	41	16	235	594
TK-169	5000 fi	65	135	215	68	13	14	27	27	79	28	44	16	366	357
TK-110	4900 fi	70	139	213	85	13	12	28	23	79	26	42	18	349	333
TK-38	4870 fi	70	139	198	93	14	15	24	31	78	27	47	15	387	270
TK-2	4360 fj	63	133	198	69	13	15	34	21	83	24	44	15	262	406
TK-304	3600 gj	70	138	188	61	12	16	26	29	72	31	47	18	331	421
TK-366	3540 gj	69	138	204	83	12	13	38	32	80	23	39	17	256	534
TK-417	3410 gj	68	139	203	70	14	14	33	27	76	26	39	16	252	381
TK-415	3330 gj	70	139	178	86	13	14	30	27	84	23	38	15	233	377
TK-314	3330 gj	64	132	196	61	14	16	29	26	84	24	43	15	304	404
TK-413	3280 hj	71	140	168	94	11	14	34	30	80	24	41	16	276	429
TK-120	2960 ij	60	130	183	63	11	17	30	17	77	26	41	14	187	406
TK-157	2600 j	61	131	160	59	12	13	24	17	83	21	34	13	222	283
TK-289	2500 j	62	131	193	60	13	14	23	25	77	28	42	14	314	240
TK-341	2400 j	69	138	203	71	14	15	23	27	73	25	39	16	313	314
TK-428	2370 j	69	138	203	78	12	13	28	27	70	27	40	15	283	317
TK-284	2340 j	60	130	161	55	12	18	23	21	77	28	43	11	189	366
Mean	5250	67	136	207	83	13	15	32	26	79	26	43	17	305	432
CV (%)	18.9	2.31	0.71	7.70	11.46	9.79	7.67	11.1	6.72	1.86	4.97	5.46	6.87	10.41	14.14

**: Different letters in column indicate significance at 0.01. CV: coefficient of variation.

Table 3. D² values of the inbred lines.

	Line	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	TK-2	-																													
2	TK-38	201																													
3	TK-13	118	49																												
4	TK-120	127	442	275																											
5	TK-145	124	210	106	426																										
6	TK-58	49	171	115	151	156																									
7	TK-284	194	347	336	96	535	173																								
8	TK-304	274	199	214	339	337	261	380																							
9	TK-49	228	165	173	412	291	202	331	279																						
10	TK-171	69	165	81	230	83	64	286	226	258																					
11	TK-169	232	269	198	406	244	265	461	168	475	142																				
12	TK-289	110	262	225	96	313	132	123	204	374	116	159																			
13	TK-314	71	157	90	223	162	77	209	277	291	52	151	95																		
14	TK-315	134	182	135	252	237	46	190	339	195	122	362	214	100																	
15	TK-110	151	102	79	419	76	162	497	163	212	107	194	280	188	257																
16	TK-390	82	190	125	220	112	68	300	210	248	42	202	155	132	135	115															
17	TK-366	104	231	176	291	115	89	337	405	207	135	383	270	135	200	191	174														
18	TK-68	288	221	177	620	196	225	559	588	185	264	624	576	302	192	248	297	146													
19	TK-175	91	158	85	346	43	155	442	220	205	98	206	253	154	260	42	131	134	236												
20	TK-108	106	73	31	388	81	135	385	218	143	96	210	246	137	206	47	124	171	192	42											
21	TK-428	110	150	165	219	207	118	265	162	99	167	317	207	217	204	109	133	157	285	113	116										
22	TK-442	283	199	136	639	163	267	646	392	484	162	197	373	212	306	170	175	352	374	237	171	401									
23	TK-347	81	163	60	274	74	65	309	234	228	42	172	190	67	99	116	72	113	201	88	94	181	166								
24	TK-98	161	181	93	427	97	111	448	356	303	96	277	323	143	123	147	90	163	170	166	140	269	98	46							
25	TK-157	63	395	295	68	263	125	186	427	425	159	368	117	151	245	328	199	181	478	228	288	224	510	212	342						
26	TK-341	108	145	122	250	132	124	333	126	144	107	212	192	173	217	58	113	146	276	55	90	31	318	121	218	222					
27	TK-227	175	270	143	418	143	132	435	486	346	127	368	359	171	133	254	121	187	180	231	199	334	170	73	34	332	288				
28	TK-413	297	192	234	559	313	236	442	525	115	350	689	536	347	215	280	362	169	86	279	214	200	535	306	319	467	264	369			
29	TK-415	155	127	112	417	162	141	367	386	103	189	458	361	193	163	149	240	98	80	152	104	137	403	214	218	296	151	266	46		
30	TK-417	90	136	109	235	147	82	250	192	71	117	289	201	158	154	100	133	106	203	87	72	51	366	129	208	202	45	258	152	70	
31	TK-300	129	63	52	339	102	91	328	161	111	90	243	231	152	138	53	88	147	183	83	41	109	205	89	114	295	76	185	168	91	48

Table 4. Total-sample standardized canonical coefficients.

Variables	Canonicals				
	1	2	3	4	5
Grain yield	1.59	0.41	1.21	−0.36	0.12
Germination time	−0.34	−0.81	−3.03	−0.55	0.10
Flowering time	−0.34	−0.81	0.78	−0.22	−0.39
Plant height	−1.03	2.43	0.36	−0.56	−0.73
Ear height	1.38	−1.24	−0.05	1.19	1.21
1000-grain weight	−0.34	2.83	0.87	−1.01	−0.12
Leaf count	0.98	−1.43	0.31	0.83	−0.16
Grain moisture	1.03	-0.15	1.00	2.21	−1.58
Cob diameter	−1.48	0.38	−1.23	2.51	−0.09
Ear diameter	−0.03	0.98	−1.39	0.44	0.60
Total grain count per ear	0.11	−0.07	0.69	−1.38	1.56
Ear length	0.22	1.16	−1.27	−0.83	0.62

lines and hybrids were estimated using Mahalanobis distances computed as: $D^2 = (X_i - X_j)^2 \text{ cov}^{-1} (X_i - X_j)$. X_i and X_j are the general means of the i and j lines. Graphics were established based on the mean of each cultivar (Tatsuoka 1971).

Results

The findings obtained in the research were evaluated separately based on the discriminant analysis and top-crossing results. Grain yield and yield components were identified (Table 2) and subjected to discriminant analysis and, when possible, differences between the lines were identified. Grain yield values ranged from 2340 kg ha^{-1} to 12,500 kg ha^{-1}. The obtained data also exhibited a wide distribution in terms of other traits.

D^2 values obtained as a result of discriminant analysis are given in Table 3. When these values were examined, it was found that TK-413 and TK-169 were the lines with the highest value; that is, they were genetically the most distant lines from each other (D^2 = 689). As can also be seen in Table 3, it was found that TK-341 and TK-428, along with TK-108 and TK-13, were the lines closest to each other (D^2 = 31). Therefore, lines TK-341 and TK-428 probably come from same genetic source. The value of the agronomic characters of lines TK-413 and TK-169 are the most different among inbred lines. When the canonical coefficients were examined collectively, it was understood that plant height, ear height, grain yield, cob diameter, number of leaves, and ear diameter were effective in distinguishing the lines (Table 4).

Figures were created based on the average values belonging to each line. When the results were analyzed, it was found that plant height, number of leaves per plant, and ear height exhibited themselves as distinguishing characters in Canonical 1, whereas flowering time, grain yield, ear diameter, and grain moisture exhibited themselves as distinguishing characters in Canonical 2 (Figures 1–3). Selected inbred lines are at different points in the canonicals. The TK-120, TK-145, TK-413, TK-284, TK-169, TK-68, and TK-304 lines were selected as parents in line with the evaluations made as a result of discriminant analysis.

The inbred lines that were subjected to testing were crossbred with the FRMo.17 line under free pollination conditions in an isolated area in 2003. The obtained top crosses were subjected to a yield test. Their grain yield and some other traits were identified (Table 5). Grain yield of the top crosses ranged from 6170 kg ha^{-1} to 10,290 kg ha^{-1}, and the mean was 8200 kg ha^{-1}. The difference among the top crosses was found to be statistically significant ($P < 0.01$) as a result of the analysis conducted on the grain yield

Table 5. Results of the yield trial of top crosses and combination ability.

Top crosses	Grain yield(**) (kg ha^{-1})	Combination ability	Flowering time (days)	Plant height (cm)	Plant appearance (1–5)	Ear appearance(1–5)
TK-108 × FrMo.17	10,290 a	208.6	68.0	309	2.1	1.3
TK-110 × FrMo.17	9980 ab	178.1	67.5	305	2.3	1.0
TK-13 × FrMo.17	9820 ab	161.9	67.3	286	1.8	1.4
TK-347 × FrMo.17	9780 ab	158.1	67.3	270	2.1	1.9
TK-175 × FrMo.17	9520 ac	132.4	67.0	305	2.4	1.0
TK-171 × FrMo.17	9160 ad	96.1	66.8	300	2.1	1.9
TK-442 × FrMo.17	9140 ad	93.8	67.8	311	2.2	1.5
TK-38 × FrMo.17	9090 ae	88.6	67.8	285	1.7	1.0
TK-300 × FrMo.17	9060 ae	86.1	67.0	289	2.4	1.7
TK-390 × FrMo.17	8780 af	58.4	66.0	308	1.8	2.0
TK-417 × FrMo.17	8780 af	57.6	66.5	296	2.0	1.8
TK-413 × FrMo.17	8710 ag	51.4	67.0	291	1.9	1.8
TK-304 × FrMo.17	8700 ag	49.9	67.3	294	2.0	1.9
TK-49 × FrMo.17	8680 ag	48.4	68.5	281	2.1	1.6
TK-68 × FrMo.17	8440 bh	24.4	69.3	325	2.0	1.6
TK-227 × FrMo.17	8270 bi	7.4	66.3	295	2.2	1.5
TK-169 × FrMo.17	7940 cj	–26.1	65.3	283	2.6	1.8
TK-428 × FrMo.17	7750 cj	–44.6	67.3	305	2.6	2.1
TK-145 × FrMo.17	7690 dj	–50.6	67.5	269	2.2	1.8
TK-98 × FrMo.17	7650 dj	–54.6	66.8	305	2.3	1.8
TK-315 × FrMo.17	7600 dj	–59.1	66.0	273	2.1	2.1
TK-58 × FrMo.17	7600 dj	–60.0	66.8	272	2.4	2.1
TK-314 × FrMo.17	7300 ej	–88.1	65.5	284	2.7	2.1
TK-415 × FrMo.17	7150 fj	–104.9	67.0	273	2.5	2.3
TK-341 × FrMo.17	7100 fj	–109.6	66.8	289	2.3	1.7
TK-366 × FrMo.17	7050 fj	–114.9	67.3	296	2.5	2.3
TK-289 × FrMo.17	6920 gj	–127.9	64.8	276	2.5	2.3
TK-284 × FrMo.17	6820 hj	–137.8	64.3	274	2.6	2.6
TK-2 × FrMo.17	6710 hj	–148.9	65.2	290	2.5	2.6
TK-157 × FrMo.17	6480 ij	–171.1	64.3	259	2.8	2.6
TK-120 × FrMo.17	6170 j	–202.9	64.0	260	2.9	3.0
Mean	8200		66.6	289	2.3	1.9
CV (%)	9.93					

**: Different letters in column indicate significance at 0.01. CV: coefficient of variation.

values. Parent lines were identified for crossbreeding combinations by looking at the combination ability values that emerged after analyzing the grain yield per 0.1 ha of the hybrids and other obtained observation values (flowering time, plant height, ear height, plant appearance, and ear appearance). As for the top crosses, the TK-108 × FRMo.17 hybrid gave the highest yield and, accordingly, the highest combination ability. The TK-110 × FRMo.17 hybrid was the next best (Table 5). The TK-108, TK-110, TK-13, TK-347, TK-175, TK-157, and TK-120 lines were selected after evaluation of the results. The TK-157 and TK-120 lines had the lowest combination ability. The TK-157 and TK-120 lines are probably in different heterotic groups, so these lines were selected for hybridization with other selected lines (Table 5).

According to our evaluation of the results, the TK-108, TK-110, TK-13, TK-347, TK-175, TK-157, and TK-120 lines were selected as parental lines after evaluation of the results of top crossing. The TK-120, TK-145, TK-413, TK-284, TK-169, TK-68, and TK-304 lines were selected as parental lines based on the evaluations made as a result of discriminant analysis.

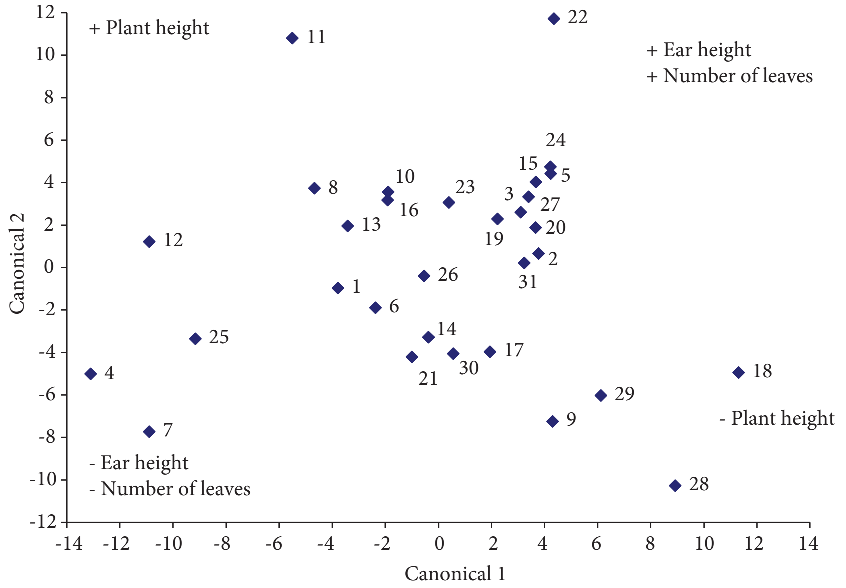

Figure 1. Scatter plot of first and second canonical variables.

Discussion

The TK-120, TK-145, TK-413, TK-284, TK-169, TK-68, and TK-304 lines were selected as parents based on the evaluations made as a result of discriminant analysis. The TK-108, TK-110, TK-13, TK-347, TK-175, TK-157, and TK-120 lines were selected after evaluation of the results. According to these results, only the TK-120 line was selected by both methods.

Top crossing is the most widely used method to determine combination ability (Sprague and Tatum 1942; Lamkey and Hallauer 1986; Aydın et al. 2007a; Kara 2011). Combination ability is an important selection criterion for the material studied (Aydın et al. 2007a). Some inbred lines, such as Mo17 and B73, are widely used for top crossing (Uhr and Goodman 1995).

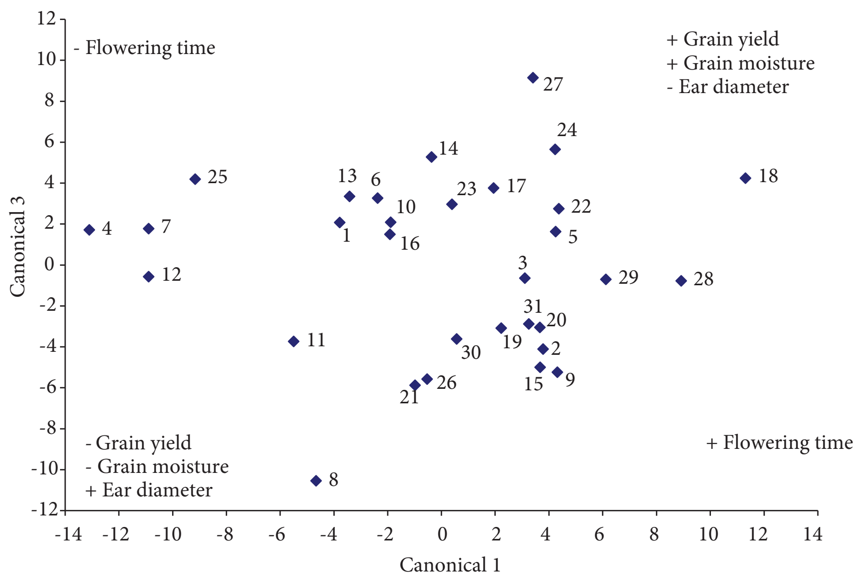

Figure 2. Scatter plot of first and third canonical variables.

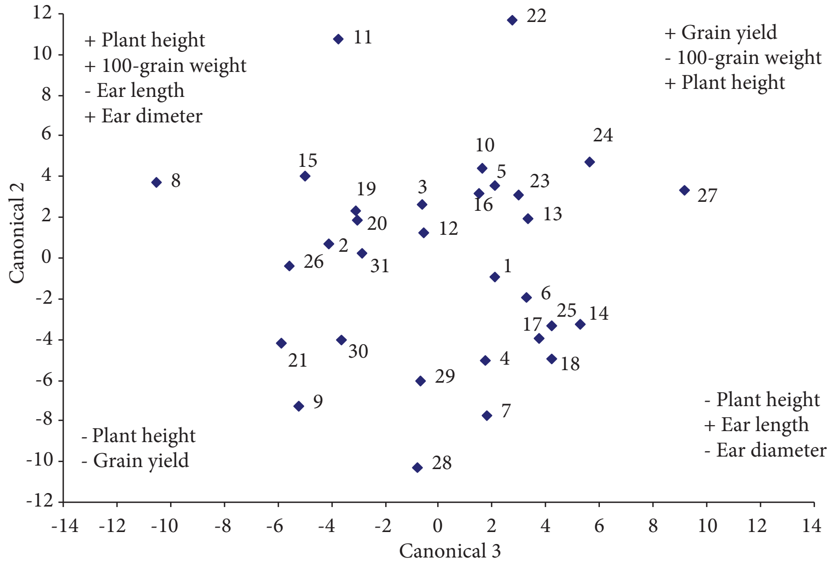

Figure 3. Scatter plot of second and third canonical variables.

Discriminant analysis can be used for classification and identification (Ilarslan et al. 2002; Öz et al. 2003). Various coefficients were formed based on the canonical as a result of the analysis that was conducted in order to classify the lines and applications that were studied by benefiting from the examined characters. When these coefficient values were higher than ±0.5, that character was defined as distinguishing (Tatsuoka 1971). In this study, when the canonical coefficients were collectively examined, it was shown that plant height, ear height, grain yield, cob diameter, number of leaves, and ear diameter were effective in distinguishing the lines (Table 4). According to Figures 1–3, plant height, number of leaves, and ear height were shown to be distinguishing characters in Canonical 1 whereas flowering duration, grain yield, ear diameter, and grain moisture were distinguishing characters in Canonical 2. A large part of the variation emerges in the first 3 canonicals in the discriminant analysis (Ilarslan et al. 2002). The distance between the lines in the graph, especially in the direction of the diagonals, shows the differences for those characters that are between those lines. The proximity of the lines increases as they get closer to the center point. The reason for showing the lines in 3 different figures is that a selection must be performed for the characters and selecting the breed that has traits required for this grouping is easy (Tatsuoka 1971; Rencher 1995; Aydın et al. 2007b).

In view of the performed evaluations, it was observed that the lines identified by the 2 methods were different lines, except for the TK-120 line.

References

Aydın N, Gökmen S, Yıldırım A (2007a) Kendilenmiş mısır hatlarının tane verimi ve diğer bazı özellikler bakımından kombinasyon yeteneklerinin yoklama melezlemesi yöntemiyle belirlenmesi. Ankara Üniversitesi Ziraat Fakültesi Tarım Bilimleri Dergisi 13: 120–127.

Aydın N, Gökmen S, Yıldırım A, Öz A, Figliuolo G, Budak H (2007b) Estimating genetic variation among dent corn inbred lines and topcrosses using multivariate analysis. J Appl Biol Sci 1: 63–70.

Gouesnard B, Panouille A, Dupin M, Boyat A (1996) Evaluation of three grain maize composites developed from broad-base synthetics by divergent selection on three complementary testers. Agronomie 16: 187–193.

Ilarslan R, Kaya Z, Kandemir I, Bretting PK (2002) Genetic variability among Turkish pop, flint and dent corn (*Zea mays* L. spp. *mays*) races: morphological and agronomic traits. Euphytica 128: 173–182.

Kara ŞM (2001) Mısır kendilenmiş hatlarında verim ve verim öğelerinin değerlendirilmesi I. heterosis ve uyum yeteneklerinin line × tester analizi. Turk J Agric For 25: 383–391.

Lamkey KR, Hallauer AR (1986) Performance of high × high, high × low, and low × low crosses of lines from the BSSS maize synthetic. Crop Sci 26: 1114–1118.

Lonnquist JH, Lindsey MF (1964) Topcross versus S_1 line performance in corn. Crop Sci 4: 580–584.

Öz A, Kapar H, Üstün A (2003) Türkiye'de üretimi yapılan bazı mısır çeşitlerinin discriminant ve cluster analizleri ile farklılıklarının belirlenmesi. Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi 20: 115–121.

Poehlman JM, Sleper DA (1995) Breeding Field Crops, 4th ed. Iowa State University Press, Ames, Iowa, USA.

Radovic G, Jelovac D (1995) Identification of the heterotic pattern in Yugoslav maize germplasm. Maydica 40: 223–227.

Rawlings JO, Thompson DL (1962) Performance level as criterion for the choice of maize testers. Crop Sci 2: 217–220.

Rencher AC (1995) Methods of Multivariate Analysis. John Wiley & Sons, New York, USA.

SAS Institute (1998) SAS/STAT User's Guide, Release 3.03. Cary, North Carolina, USA.

Sinobas J, Monteagudo I (1996) Heterotic patterns among U.S. corn belt and Spanish maize populations. Maydica 41: 143–148.

Soengas P, Ordas B, Malvar RA, Revilla P, Ordas A (2003) Heterotic patterns among flint maize populations. Crop Sci 43: 844–849.

Sprague GF, Tatum LA (1942) General vs. specific combining ability in single crosses of corn. J Amer Soc Agron 34: 923–932.

Tatsuoka MM (1971) Multivariate Analysis, 2nd ed. Macmillan, New York, USA.

Uhr DV, Goodman MM (1995) Temperate maize inbreds derived from tropical germplasm. I. Testcross yield trials. Crop Sci 35: 779–784.