Variability studies in chickpea (*Cicer arietunum* L.) varieties grown in Isparta, Turkey

Estudios de variabilidad en variedades de garbanzo (*Cicer arietunum* L.) cultivadas en Isparta, Turquía

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ABSTRACT

Chickpea is an important field crop for less quality fields and enduring to drought. In Isparta ecology, province of Turkey, as a sowing duty covers large area. This study aimed to investigate the variability of chickpea varieties grown under the ecological conditions of Isparta. Eleven varieties grown in Turkey were used in this two year long study (between the years 1996 and 1997) which has been sowed in a randomize block experimental design with four replications. Data were analyzed by multivariate statistical methods. According to the two-year results, the differences among varieties were found to be important in all components observed. Differences between years were proved to be significant in all components, except the number of pod per plant and the height of the first pod from soil. In both years, anthracnose (*Ascochyta rabiei*. [Pass.] Lab.) was not found in all varieties in natural conditions. It was found one principal component (PC_1) by factorial analyses. But, eleven examined varieties were separated in two main groups and three subclusters by cluster analyses.

Key words: Chickpea varieties, factor analysis, cluster analysis

RESUMEN

El garbanzo es un cultivo de importancia para suelos de baja fertilidad y es resistente a la sequía. En Isparta, provincia de Turquía cubre una gran área de siembra. Esta investigación se realizó para determinar la variabilidad de las variedades de garbanzo cultivadas bajo las condiciones ecológicas de Isparta, Turkey. Se emplearon once variedades cultivadas en Turquía en este estudio de dos años (entre 1996 y 1997) los cuales se sembraron en un diseño de bloques al azar con cuatro repeticiones. Los datos se analizaron mediante métodos estadísticos multivariados. De acuerdo a los resultados de dos años, las diferencias entre variedades fueron marcadas para todos los caracteres observados. Las diferencias entre años fueron significativas en todos los caracteres, excepto para el número de vainas por planta y la altura de la primera vaina. En ambos años, no se encontró antracnosis (*Ascochyta rabiei*. [Pass.] Lab.) atacando las variedades bajo condiciones naturales. Se determinó un componente principal (PC_1) utilizando el análisis de factores. Pero, las once variedades evaluadas se separaron en dos grupos principales y tres subgrupos mediante el análisis de conglomerados.

Palabras clave: Variedades de garbanzo, análisis de factores, análisis de conglomerados

INTRODUCTION

In today's world, paralleling to population growth, nutrition problem is growing increasingly. Especially production of high-range protein foods has been important for the solving nutrition problem. For this reason, it is necessary growing the most productive and high-quality varieties to the regions.

Growing of chickpea on the less quality fields and enduring to drought, makes important to this products. Chickpea, which has large market and entered to sowing duty with wheat pillar, is a demanded plant for dry and salty areas (Şehirali, 1988). When processed in the food industry, consumed as a roasted chickpea, if we look at to roasted chickpea export, it is a necessary product (Anonymous, 1995).

In the Isparta, Turkey ecology, when chickpea duty in the drought fields, cereal-chickpea, cereal-common vetch, cereal-lentil, cereal-fallow land implementing as a sowing duty, covers an important area (Anonymous 1996). Some researchers had carried out studies on the agronomical characteristics of some Chickpea varieties (Doğangüzel, 1998; Karasu 1993; Engin, 1989; Samal and Jagadey 1989 and Khargade *et al*. 1985).

Factor analysis with principal component and cluster analysis were used to determine the suitability of some features to characterize the variation of the observations and to determine natural groups from the varieties studied (Adam and Hwang 1999). In the first phase, factor analysis has been used for identification of the number of principal component analysis (PCA). In the second phase, cluster method has been used to determine disparities and similarities. PCA is concerned with explaining the variance-covariance structure through a few linear combinations of the original variables. Its general objectives are (1) data reduction and (2) interpretation. PCA method provides to form free new sets which are different from the beginning set. Reflecting of the variables at 'R' is one of advantages of the method. The usual objective of the analysis is to see if the first few components account for most of the variation in the original data (Adam and Hwang, 1999).

In this research, multivariate statistical methods were used to obtain more results than those from variance analysis. Rudimentary, exploratory procedures are often quite helpful in understanding the complex nature of multivariate relationships. Analysis of principal components is more of a means to an end rather than an end in them because they frequently serve as intermediate steps in much larger investigations. For example, principal components may be inputs to a multiple regression or cluster analysis. Moreover, principal components are one 'factoring' of the covariance matrix for the factor analysis model (Johnson and Wicherin, 1992).

Cluster analysis when searching the data for a structure of 'natural' groupings is an important exploratory technique. Grouping can provide an informal means for assessing dimensionality, identifying-outliers and suggesting interesting hypotheses concerning relationships (Johnson and Wicherin, 1992). The term of cluster analysis encompasses a large number of techniques developed to identify groups of observations with similar characteristics. It is based on the minimizing of the variance in the group and maximizing of the variance among groups (Johnson and Wicherin, 1992). The distance between two variants in which data have been standardized, can be stated as the monotonic transformation of the correlation between the two variables. This research has been done to investigate the variability of chickpea varieties grown under the ecological conditions of Isparta province in Turkey.

MATERIALS AND METHODS

This research has been carried out in the 1996-1997 years, so as to determining suitable chickpea varieties for Isparta ecological conditions. In the research, assured from different agricultural institutions; Eser 87 (V1), Akçin 91 (V2), Canıtez 87 (V3), Diyar 95 (V4), ILC-482 (V5), AK-7112 (V6), ICC-5566 (V7), Red roasted chickpea (ecotype) (V8), 4N-495/2 (V9), Spanish Chickpea (ecotype growing in the region) (V10) and Aziziye (V11), varieties have been used as a material.

While Atabey test area, which this research had been carried out in 1996, is axle-clay, silt, not salty, a little bit alkaline with much limely, average in phosphorus and medium level in organic matter, Çünür Kampus area which this research had been carried out in 1997 is silt, slight alkaline, not salty, mostly limely, average phosphorus and poor in organic material (Anonymous, 1997a). The average precipitation of the years 1996-1997 was realized different from average long years (Anonymous, 1997b).

Study have been set up every twice year, as randomize block experimental design with four replications. Every twice year, sowing have been done in the middle of March. Data about productive elements have been proved from counting and measurements from ten plants which are taken from every plot before harvest. Seed yield has been found from whole test field (6 m^2) with added ten plant production.

Principal component analysis (PCA) is concerned with explaining the variance-covariance structure through a few linear combinations of the original variables. Its general objectives are (1) data reduction, and (2) interpretation. PCA method provides to form free new sets which are different from the beginning set. Reflecting of the variables at 'R' is one of advantages of the method. The usual objective of the analysis is to see if the first few components account for most of the variation in the original data (Adam and Hwang, 1999).

Clustering (or grouping) is distinct from the classification methods. Cluster analysis is a more primitive technique in that no assumptions are made concerning the number of groups on the group structure. Grouping is done on the basis of similarities or distances (dissimilarities). The theory behind

clustering is an expected positive relationship between the variables Euclidean distance and the similarity of the observations (Johnson and Wicherin, 1992). As a result, cluster analysis is driven by the trade-off between minimizing the Euclidean distance of observations within a cluster, and maximizing the Euclidean distance between clusters. Clustering can be conducted directly on the data set or as a two-step procedure in combination with other statistical methods like factor analysis and principal component analysis. The number of clusters is not a *priori* given, to decide which number of clusters to choose. It's bared on the aim of cluster analysis, which is maximizing the difference between the clusters. There are a large number of different available how to conduct cluster analysis.

The eleven evaluated traits were: 1. Length of plant (cm), 2. Height from ground of first pod (cm), 3. Number of main brunch, 4. Number of side brunch, 5. Pod number per plant, 6. Seed number per plant, 7. 1000 seed weight (g), 8. Seed yield per plant (g), 9. Harvest index (%), 10. Seed yield (kg/da, 1 da = 1000 m^2), 11. Protein ratio (%) only in 1997.

So as to find the natural grouped between varieties and examining the changes in the data, principal component factor analysis and cluster analysis as multivariate statistical analysis methods have been used (Johnson and Wicherin, 1992; Adam and Hwangs, 1999).

RESULTS AND DISCUSSION

According to the two years analysis results obtained from chickpea varieties, it is proved that in the whole examined features, varieties differences are important (Table 1). Except the high of first pod from soil and the number of pod per plant, it has been proved that there are differences between years on the other features (data are not shown). Except for thousand seed weight and unit field seed yield, year and variety interaction have been important as statistically (data are not shown).

When Akçin-91 variety (26.68 cm) has been found the most length of plant, Kırmızı Nohut (22.05 cm) has the smallest length of plant (Table 1). Tosun and Eser (1975) determined the length of plant changed between 12.47 and 26.87 cm. Also, Singh and Tuwafe (1981) obtained similar results (15-50 cm). Accounted values of height from soil of first pod were changed between 14.8 and 19.14 cm (Table 1). Eser *et al*. (1987) found these values as 13.0-33.6 cm.

Table 1. Average values of quantitative characteristics of 11 chickpea (*Cicer arietinum* L.) varieties grown in two localities of Isparta, Turkey in 1996 (Atabey area) and 1997 (Çünür Kampus area).

	Quantitative characteristics †										
Varieties	1	2	3	4	5	6	7	8	9	10	11
Eser87	24.38	16.93	2.99	2.92	9.70	10.52	311.6	3.07	0.52	115.3	20.98
Akçin91	26.68	17.35	2.60	3.11	7.43	7.93	419.8	3.12	0.49	123.2	21.80
Canıtez87	23.87	15.52	2.79	3.31	7.22	7.60	516.4	3.59	0.49	110.9	19.08
Diyar95	25.38	17.80	2.84	3.30	5.53	5.95	449.6	2.67	0.49	114.6	19.63
ILC482	22.12	15.59	3.15	3.37	10.00	10.63	320.0	3.06	0.51	107.8	20.57
Ak7112	23.88	15.47	2.78	2.83	6.81	7.35	368.4	2.76	0.47	111.5	19.41
ICC5566	26.63	19.14	2.60	2.52	8.96	9.58	320.0	2.87	0.44	110.9	20.69
Kır.Nohut	22.05	14.80	2.70	3.44	6.93	7.25	522.6	3.56	0.51	111.3	19.36
4N-495/2	25.39	16.95	2.90	3.43	6.94	7.34	510.8	3.36	0.50	104.6	18.64
İspany.No	26.19	17.54	2.85	3.07	7.34	7.68	504.8	3.56	0.47	125.6	21.09
Aziziye	24.73	16.69	2.73	2.73	6.38	6.74	415.5	2.98	0.48	105.1	23.25
Average	24.66	16.70	2.81	3.08	7.56	8.04	423.6	3.14	0.49	112.8	20.41
LSD(%5)	0.543	0.4491	0.2169	0.3473	0.8838	0.88	6.173	1.090	1.852	6.89	0.49

† 1. Length of plant (cm), 2. Height from ground of first pod (cm), 3. Number of main brunch, 4. Number of side brunch, 5. Pod number per plant, 6. Seed number per plant, 7. 1000 seed weight (g), 8. Seed yield per plant (g), 9. Harvest index (%), 10. Seed yield (kg/da, 1 da = 1000 m^2), 11. Protein ratio (%) only in 1997.

For number of side brunch, Kırmızı Nohut (3.44) has the most, ICC 5566 (2.52) has the least value (Table 1). Similar results were reported by Singh & Tuwafe (1981) who found values between 0.3 and 22.7 and for Eser *et al.* (1987) between 1.4 and 6.4.

ILC482 has the most (10.00) and Diyar95 has the least (5.53) values of pod number per plant (Table 1). These results are near to researches of Singh & Tuwafe (1981) who reported a range of 4-100, Eser *et al.* (1987) with 3-12, Samal and Jagadey (1989) with 8.5-21.8), but they are small than results of Dumbre and Deshmuch (1984) who reported values between 14.4 - 67,0 and Khargade *et al.* (1985) with 53.5.

Mostly number of main brunch in the plant from ILC-483 variety and the less one is obtained from ICC-5566 and Akçin-91 (Table 1). Results have showed paralleling to the findings of Tosun and Eser (1975), Singh & Tuwafe (1981), Karasu (1993) and Eser *et al.* (1987).

When seed numbers is analyzed, ILC-482 has the most; Diyar 95 has the least values (Table 1). These results are near to the Singh and Tuwafe (1981), Eser *et al.* (1987) and Samal & Jagadey (1989), but far from Dumbre and Deshmuch (1984) and Khargade *et al.* (1985).

It was obtained that Kırmızı Nohut has high value (522.6 g); Eser 87 has small value (311.6 g) for 1000 seed weight (Table 1). Singh and Tuwafe (1981) obtained values between 87 and 791 g, and Engin (1989) obtained between 240 and 360 g for this characteristic.

Canıtez 87 variety has the most seed yield value (3.59 g); Diyar 95 has the least value (2.67 g) (Table 1). These values are near to values of Dumbre and Deshmuch (1984) who reported a range of 3.5 and 15.1 g and Eser *et al.* (1987) with range of 0.4 and 5.8 g, but they are small than values of Tosun and Eser (1975) who reported a range of 5.58 and 21.67 g. In both years, anthracnose (*Ascochyta rabiei*. [Pass.] Lab.) was not found in all varieties in natural conditions.

When giving importance to seed yield, it has been noticed that with Spanish chickpea (125.6 kg/da, 1 da = 1000 m^2) which is grown from producer and passed from natural selection and Akçin 91 (123.2 kg/da, 1 da = 1000 m^2) varieties are suitable for Isparta conditions (Table 1). While, Eser *et al.* (1987) who reported values from 200 to 208 kg, Poma *et al.* (1988) informed 150-237 kg of seed have been obtained, Engin (1989) have informed the most 277 kg. of seed has been obtained in 1989. Also, these varieties have advantage for suitable consumer wishes with high thousand seed weight (Karasu *et al.* 1999).

Protein ratios of varieties were obtained for year 1997. Aziziye variety has the most value (23.25 %); 4N-495/2 variety has the least value (18.64 %) (Table 1). Similar values for this range had been reported for Karasu (1993) who informed a value of 16.44 % and Doğangüzel (1998) who reported values between 19.95 and 24.3 %.

According to the principal component factor analysis results, one principal component (PC_1) have been obtained (it explained 99.45% of the total variance) (Table 2). For this reason, ignorant information lost is low degree in research (% 0.55). Communality values showed that, examined varieties have important degree of similarity genetic feature, and data are reliable. When done ordering, the varieties as their important degree (how can be act the

Table 2. Principal components and communalities rates for 11 variables† of 11 chickpea (*Cicer arietinum* L.) varieties grown in two localities of Isparta, Turkey in 1996 (Atabey area) and 1997 (Çünür Kampus area).

Varieties	Principal Component 1	Communalities (h_i^2)	Variance matrix (ε_i, Ψ)
Eser87	0.9945	0.9890	0.0110
Akçin91	0.9998	0.9995	0.0005
Canıtez87	0.9967	0.9934	0.0066
Diyar95	0.9998	0.9996	0.0004
ILC482	0.9963	0.9926	0.0074
Ak7112	0.9986	0.9973	0.0027
ICC5566	0.9938	0.9876	0.0124
Kır.Nohut	0.9958	0.9917	0.0083
4N-495/2	0.9962	0.9923	0.0077
İspany.No	0.9986	0.9971	0.0029
Aziziye	0.9996	0.9991	0.0009

† 1. Length of plant (cm), 2. Height from ground of first pod (cm), 3. Number of main brunch, 4. Number of side brunch, 5. Pod number per plant, 6. Seed number per plant, 7. 1000 seed weight (g), 8. Seed yield per plant (g), 9. Harvest index (%), 10. Seed yield (kg/da, 1 da = 1000 m^2), 11. Protein ratio (%) only in 1997.

group) they are enumerated as; Akçin 91, Diyar 95, Aziziye, AK-7112 and Spanish Chickpea which are more important varieties, and the least important variety is ICC-5566 which has the smallest principal component coefficient (Table 2).

In this study, multivariate statistical methods were used to classify a group of chickpea varieties on the basis of their agronomic characteristics. Classifying of investigated varieties into two basic groups which consist of eight groups has been suggested according to the cluster analysis (Figure 1). When making of the principal component values rotation, the most important varieties of the whole group are in sequence, Diyar 95, Akçin 91 and Aziziye. While Eser 87 and Red roasted chickpea have the farthest and the most different features (Euclidean distance 301), the nearest two varieties are Canıtez 87 and Red roasted chickpea (Euclidean distance 14) (Figure 1). It shows that, similar varieties have easily used for the others. When adaptation applications are done between varieties which are farthest from one another, so different and new varieties will be obtained.

According to the dendogram results produced by cluster analysis, varieties are separated to two main and three little groups (Figure 1). Beside, there are more different three main groups (3 sub clusters) by cluster analysis. Eser 87, ILC-482, ICC-5566 and AK-7112 varieties have formed the first population different from the others and high similarities second main group which is formed by the other separates to two little groups. The most similar ones among varieties are Red roasted chickpea and Canıtez 87, Aziziye and Akçin 91 and ILC-482 and Eser 87. It has been noticed that, examined varieties are divided thirdly groups. Similar varieties have importance for preference richness of producer. While the representation variety of first group is Diyar 95 (and Akçin 91), the most important of the second group is AK-7112 (Figure 1).

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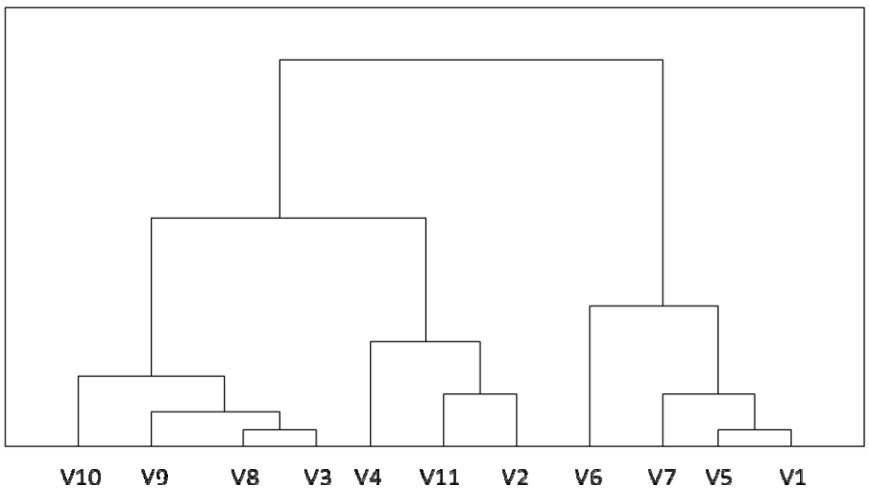

Varieties: Eser 87 (V1), Akçin 91 (V2), Canıtez 87 (V3), Diyar 95 (V4), ILC-482 (V5), AK-7112 (V6), ICC-5566 (V7), Red roasted chickpea (V8), 4N-495/2 (V9), Spanish Chickpea (V10) and Aziziye (V11)

Figure 1. Dendogram based on 11 evaluated traits (see Materials and Methods section) of 11 chickpea (*Cicer arietinum* L.) varieties grown in two localities of Isparta, Turkey in 1996 (Atabey area) and 1997 (Çünür Kampus area).

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