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Cluster Analysis in Common Bean Genotypes (*Phaseolus vulgaris* L.)

[a]Ali KAHRAMAN*, [a]Mustafa ONDER, [a]Ercan CEYHAN
[a]Department of Field Crops, Faculty of Agriculture, University of Selcuk, Turkey
*Corresponding author: kahramanali@selcuk.edu.tr

Abstract

Phenotypic observations in the real farm conditions have importance for the plant breeding programs. Hierarchical cluster analysis is a useful guide to evaluation of different genotypes. In the present study, the common bean genotypes that are widely grown in Turkey were subjected to cluster analysis according to their phenotypic evaluations. Cluster analysis for the field performance of 35 promising common bean genotypes showed 3 main groups. Distance was ranged from 0.99 to 9.05 values. A dendrogram obtained which was based on the matrix of relationship between the genotypes. It can be concluded that cluster analyze can be useful to give information about selection of the promising genotypes for breeders.

Keywords: Breeding, dry bean, similarity, phenotypic classification, Turkey.

Kuru Fasulye Genotiplerinde Cluster Analizi

Özet

Tarla şartlarında yapılan fenotipik gözlemler, bitki ıslahı programlarında önemlidir. Hiyerarşik cluster analizi, farklı genotiplerin değerlendirilmesinde faydalı bir araçtır. Bu çalışmada, Türkiye'de yaygın olarak yetiştirilen kuru fasulye genotiplerinin fenotipik değerlendirmesine dayanarak cluster analizi yapılmıştır. Araştırmada kullanılan 35 farklı ümitvar kuru fasulye genotipinin tarla şartlarındaki performanslarına bağlı olarak yapılan cluster analizi neticesinde3 ana grup ortaya çıkmıştır. Hesaplanan mesafe 0.99 ile 9.05 değerleri arasında değişim göstermiştir. Araştırmada, genotiplerin benzerlik matrikslerine dayanan bir dendrogram oluşturulmuştur. Sonuç olarak, cluster analizinin ıslahçılar için ümitvar genotiplerin seleksiyonunda bilgi vermesi bakımından kullanışlı olduğu söylenebilir.

Anahtar Kelimeler: Islah, kuru fasulye, benzerlik, fenotipik sınıflandırma, Türkiye.

Introduction

Pulse crops have an importance between the plants with the consumption ratios of 22% protein and 7% carbohydrates in human nutrition while these ratios are 38% and 5% in animal feeding respectively (Wery and Grinac, 1983). Daily consumption of protein per person is 70.9g in the world, 85.0g in Turkey, 104.0g in developed countries and 61.0g in the developing countries (Anonymous, 2009).

Dry bean is the main pulse crop which is used to human nutrition over the world. Bean farming has a wide range of area especially on the warm regions and almost 94% of bean growing is in Asia, South America and developing countries (Anonymous, 2009). Dry bean faming is also important in Turkey as it seen over the world. Table 1 shows the statistics for dry bean production.

Researchers usually use the univariate statistics, which calculated from the mean values and the standard deviation of every single investigated variable, but, this method usually does not provide one to get general information about the analyzed data (Forina and Lanteri, 1984). Statistical analyses for multivariate are eligible to examination and analyzing a matrix of complicated values. Using of the hierarchical cluster analysis (HCA) is known as an easy method to grouping the investigated data through their similarities. The HCA includes mathematically applications to each data in terms of the multidimensional space characterized by the chosen variables (Bruns and Faigle, 1995; Moita Neto and Moita, 1998). Similarly, only one data which is essential for the

research aim could be used to make a cluster of samples or of variables. Possessing a matrix is possible by calculation of the distance from one point to the other points through the observations. The common way to figure out between two points is the Euclidean distance (Forina and Lanteri, 1984) calculating method. This method is related to a matrix of proximity between the samples which creates a similarity diagram known as dendrogram. Hierarchical clusters formed from a large number of mathematically grouping in multidimensional space. Grouping methods based on a specific algorithm that depends on the information of the proximity matrix to form a similarity dendrogram (Forina and Lanteri, 1984). Comment of a similarity dendrogram between data is made by using the closest two data which showed similar values for the investigated characteristics. Thus, the greater relationship between the calculations means that the greater similarity between the investigated characteristics. Dendrogram is useful, clear and easy phenomenon to determination of the similarity degrees between the investigated characteristics by a view of a twodimensional vision. If the created dendrogram is one of variables, the degree of similarity between two variables exposes a solid correlation between the data set of the study.

Table 1. Production quantities of dry bean

Place	Area (ha)	Production (ton)	Yield (kg ha^{-1})
World (Anon, 2013)	29.211.491	23250253	795.9
Turkey (Anon, 2013)	94.625	200.673	2120.0
Konya (Anon, 2011)	13.059	21.072	1613.0

Konya city has a wide range of dry bean diversity. The city also has the most production quantity in Turkey. Farmers in Konya get high yields from their local dry bean genotypes although they usually do not prefer the certified lines. There are many genotypes in the farmers. They usually called their dry bean population with a local name also the seeds are based on the same origin. There are some researches related to some agronomical and genetic characteristics of the common bean genotypes which grown in Turkey. Present study was made to put forth a similarity dendrogram by using cluster methods according to the field performance of the common bean genotypes.

Materials and Methods

Cluster analyze was based on the field performance of 35 dry bean genotypes (Table 2). All of the used common bean genotypes were collected depending on the following criteria: situation of preference, stability status over years, harvested in the last year, high market and cooling quality. Field observations which were performed according to the "Randomized Complete Block Design" with three replications during the year of 2008 were as fallowing: days to flowering, number of main branch per plant, number of leave per plant, plant height, pod/plant, seed/pod, first pod height, biologic yield, yield and harvest index.

The means of investigated characteristics in the field trials were used in a different study which is entitled as "Determination of Yield and some Yield Components of Common Bean (*Phaseolus vulgaris* L.) Genotypes that Grown in Konya Province" as an oral presentation in Hatay/Turkey (Kahraman and Önder, 2009a).

Hierarchical cluster analysis of 35 promising common bean genotypes was made with JUMP computerized program by view of their field performances.). Only the abstract part of the present study was presented as a poster presentation in a conference (Kahraman et al., 2013).

Results and Discussion

The values of distance between the genotypes were changed from 0.99 to 9.05 amounts (Table 3). According to the hierarchical cluster analysis of Figure 1, a total of 35 investigated common bean genotypes were grouped in 3 main groups. The farthest genotypes were the genotype 1 and genotype 3 while the genotype 10 and the genotype 29 were found as the most closest.

One of the main objectives in plant breeding is specify between a great number of genotypes through different environments. Behavior of genotypes differs within the same environment. Response of plants to environment depends on the relative performance and cause to GXE interaction (Byth et al, 1976).

Interactions of G X E make difficult to the selection of promising genotypes between. There are several biometrical methods to make easier the selection in the presence of G× E interaction (Horner and Frey, 1957; Plaisted and Peterson, 1959; Finlay and Wilkinson, 1963; Mungomery et al., 1974). Clustering is a method that provides the figuration of genotypes with relative response models through environments (Byth et al., 1976; DeLacy, 1981, 1989; Ghaderi et al., 1982; Hayward et al., 1982).

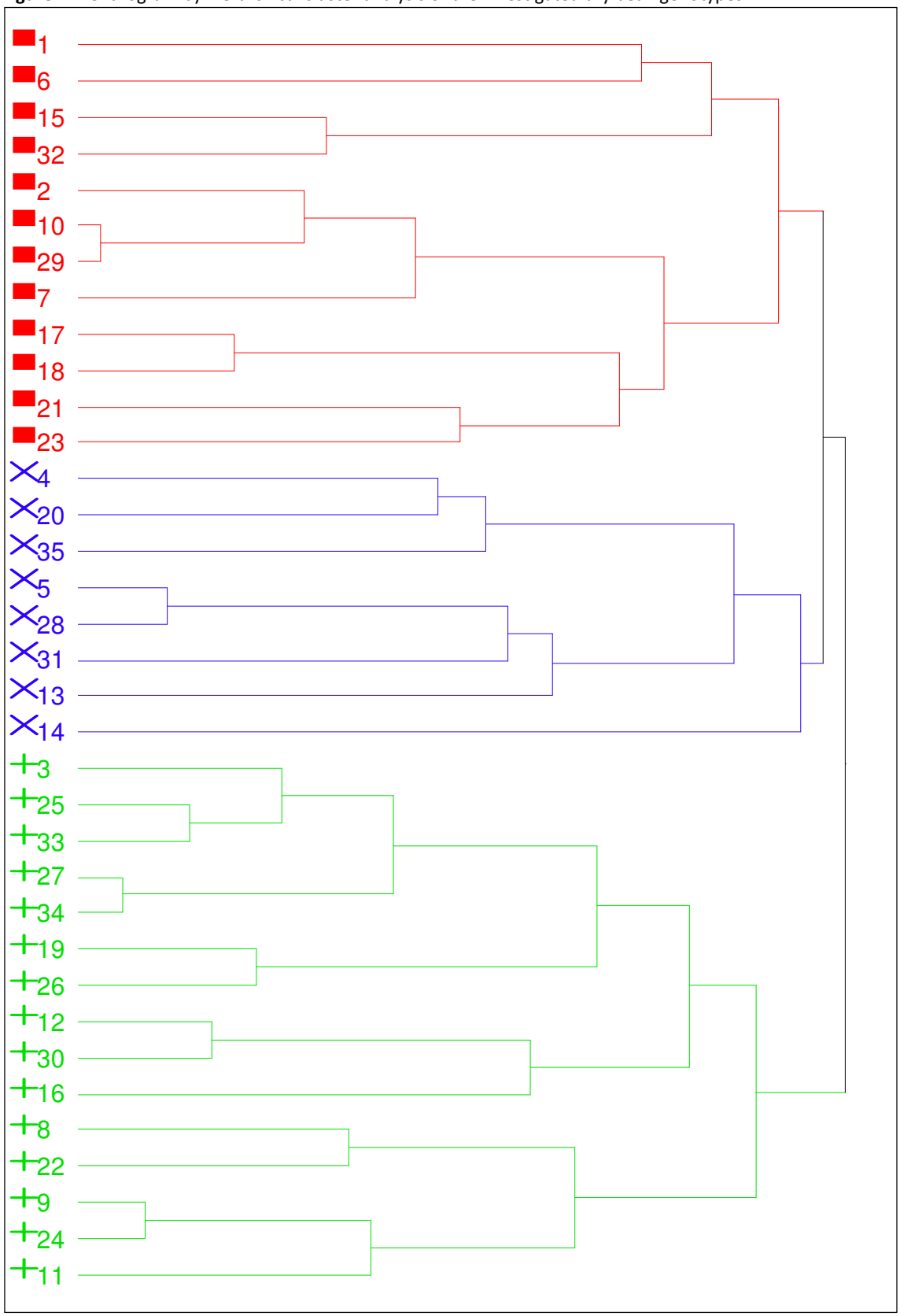
Table 2. Collection number (no), collection place (origin) and local names of the investigated dry bean genotypes

No	Origin	Local name	No	Origin	Local name
1	Başarakavak County	Horoz	**20**	Derbent (Center)	Amerikan (Beretta)
2	Başarakavak County	Sarıkız	**22**	Derbent (Center)	Şeker
3	Başarakavak County	Kanada	**23**	Beyşehir (Göçü Village)	Horoz
4	Çumra (Center)	Şeker (Bıyıklı)	**24**	Seydişehir (Center)	Sıra
5	Çumra (Center)	Kırgız Çalısı	**25**	Ilgın (Beykonak Village)	Beyaz Horoz
6	Çumra (Center)	Horoz	**27**	Sarayönü (Center)	Kanada
7	Çumra (Center)	Beyşehir Çalısı	**28**	Sarayönü (Center)	Amerikan Çalısı
8	Çumra (Center)	Bombay (Bomba)	**29**	Yunak (Center)	Üveynk (Veynk)
9	Çumra (Center)	Kanada	**30**	Yunak (Center)	Kanada
10	Altınekin (Center)	Amerikan Kollu	**31**	Çumra (Center)	Kırgız Yuvarlak (Kollu) Barbunya
11	Altınekin (Center)	Sarnıç	**32**	Derbent (Center)	Yuvarlak Barbunya
12	Altınekin (Mantar Village)	Amerikan Çalısı	**33**	Akşehir (Center)	Dermason
14	Konya (Center)	Gina	**34**	Akşehir (Sorkun Village)	Ayşe Kadın
15	Ereğli (Center)	Dermason	**35**	Akşehir (Center)	Horoz (Oturak)
16	Ereğli (Center)	Horoz	**36**	Akşehir (Center)	Dermason (Oturak)
17	Kadınhanı (Center)	Weihing	**37**	Kazım Karabekir	Kanada (Kara Yaprak)
18	Kadınhanı (Center)	Kanada	**38**	Kazım Karabekir	Dermason (Kırgız)
19 *	Kadınhanı (Center)	Akman – 98*	*Commercial line		

Table 3. The clustering history of the investigated dry bean genotypes

No. of Clusters	Distance	Leader	Joiner	No. of Clusters	Distance	Leader	Joiner
34	0,993265828	10	29	17	2,295316311	4	35
33	1,087381426	27	34	16	2,394814441	5	31
32	1,114412506	9	24	15	2,565121441	12	16
31	1,152484053	5	28	14	2,762167691	5	13
30	1,404887998	25	33	13	2,796268375	8	9
29	1,465354990	12	30	12	2,954308654	3	19
28	1,653607382	17	18	11	3,141656969	17	21
27	1,711490168	19	26	10	3,285295866	1	6
26	1,758384622	3	25	9	3,444005352	2	17
25	1,782969063	2	10	8	3,587191046	3	12
24	1,832654877	15	32	7	3,908414433	1	15
23	1,981428688	8	22	6	4,317940045	4	5
22	2,095026949	9	11	5	4,821362950	3	8
21	2,117922561	3	27	4	4,830995454	1	2
20	2,196575861	2	7	3	5,624046627	4	14
19	2,223465201	4	20	2	6,399442352	1	4
18	2,229972489	21	23	1	9,058971098	1	3

Figure 1. Dendrogram by hierarchical cluster analysis of the investigated dry bean genotypes



Examination of genotypic performance in plant breeding works is usually difficult to understand by using genotype × environment (G x E) interaction. Classification techniques can be used to simplify the determination of genotypic performance when G X E interaction is a main determinative factor to the variation (Bull et al., 1992). An issue in breeding programs is determination of changes in yield and yield components of promising varieties in different environmental conditions (Ceyhan et al., 2012).

Plant breeders can use the cluster analysis to determine patterns of genotypic performance and environmental productivity if the value of genotype x environment (G × E) interaction is confusing (Ivory et al., 1991). Köksal (2011) was also reported that solid correlations between the new indices and agronomic characteristics demonstrated their usefulness for the prediction of yield in dwarf green beans. Similarly, a previous research showed that quantitative analysis of fatty acids by using hierarchical clustering is applicable and reliable for rapid classification of microorganisms. The researchers reported that, this method does not depend on the availability of genome and proteome databases. The method has agricultural importance due to their visual role of lipid biosynthetic pathways in the design of targeted drugs or fungicides versus fungi in contrast to bacteria and animal (Li et al., 2011).

Farmers of Konya have too many dry bean genotypes. They usually use to different local names for the same genotypes. A recently research which was also used Konya dry bean genotypes was clustered the populations into 3 major groups (Kahraman and Önder, 2009b). In the temperate zone, Turkey is one of the most biologically diverse countries. More than one third of species found in Turkey are endemic, native to the region. So, Turkey is like a kind of small continent in terms of biodiversity (Kahraman et al., 2012). According to the previous research in Central Anatolian Region which includes Konya City, new dry bean genotypes should be developed which are adaptive to the region and has a superior quality characteristics. For this purpose, local populations are significant in breeding trials (Önder et al., 2012).

Investigation of the available species is essential to protection of the species and also to develop the desired characteristics. The present study was conducted to determine the variations of the local dry bean genotypes in Konya. Diversity between the used dry bean (*Phaseolus vulgaris* L.) genotypes was based on the hierarchical cluster analysis and it proposed that the investigated genotypes could be classified clearly.

Conclusion

Results of this study have provided a demonstration which implicated a definition and quantitative values of the dry bean genotypes. The method of hierarchical cluster analysis is a useful tool for many applications in terms of classification.

Knowledge about the variation of different genotypes is one of the principles in breeding programs. As it well known, determination of diversity between the genetic resources is also significant in breeding trials. Result of the present study could be used to evaluation of the dry bean genetic materials, background knowledge to use in future breeding programs.

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