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A Quantitative Approach on the Evaluation of Agronomical Characteristics of Some Cowpea Varieties (*Vigna unguilata* L.) Grown in Turkey

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Abstract: This study aims to evaluate the yield and yield components of eleven cowpea varieties grown in different 9 areas in Turkey. The data used were obtained from an experiment carried out with randomizes block design with three replications in the production periods of 1996 and 1997. According two years combined results, significant differences were observed between the varieties as in the seed yield, biological yield and vegetation time etc. Factor analysis based on principal components (PCA) showed that two factors representing 99.13% of the total variation. PC_1 which is explaining 98.69% of the total variance is highly correlated with seed and pod size factors. PC_2 may be considered as vegetation time and yield per plant. Eleven examined cultivars were separated in two groups by factor and cluster analysis.

Key words: Cowpea · cultivar · factor analysis · cluster analysis

INTRODUCTION

The importance of plant genetic resources and the need for adaptation characteristics have been increasingly emphasized in the last years. Their vital significance for their maintenance of genetic improvement and biodiversity has been worldwide recognized [1]. Important initiations to document global genetic cowpea have been carried out in certain countries.

Adaptation characterization and evaluation is a priority task for successful breeding program. Cowpea as an animal feeding stuff is an important crop and subject to scientific studies especially in some developing and underdeveloped countries. For example there are some studies about breeding of cowpea [2-4], which have been generally focused on to develop quality and yield components of cowpea.

Multivariate statistical methods especially cluster analysis as a method to classification varieties with similar conditions with respect to set of variables has gained increasingly interest in recent years. Similar analysis has already been used in some studies such as [5-8].

This study aims to evaluate agrological characteristics of agronomical characteristics of some cowpea varieties and classification of these varieties according to the variation in those characteristics under investigation. In other words examination of the genetic differences among cultivars and to classify them into relatively homogenous groups has been aimed.

MATERIAL AND METHODS

The most important 11 local cowpea varieties grown in Turkey were studied in the 1996 to 1997 production years which were named for statistical analysis as Karagöz (V_1), Akkız (V_2), Burdur (V_3), Aydın (V_4), Bursa (V_5), Denizli (V_6), Antalya (V_7), Fethiye (V_8), Izmir (V_9), Isparta (V_{10}) and Balıkesir (V_{11}). Experiments have been carried out in Isparta province which is one of the most important regions for cowpea production in Turkey [9]. The average air temperature of the years 1996-1997 was between 12.5-13.4°C and average precipitation was 541.6 - 496.4 mm [10] in the studied region. The soil is clay-silt, insipid, more limely, average in phosphorus and average in organic matter [11]. A standard fertilization and spraying were applied for all varieties.

Factorial 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 cultivars studied [12-14].

Principal component (PCA) and cluster analysis have been used in the study to evaluate obtained data. The proposed procedure involves several analyses for

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dimension reduction of data that are conducted principal component analysis. In the first phase, factor analysis has been used for identification of the number of PCA's. In the second phase, cluster method has been used to determine disparities and similarities. The results have been presented by graphs and tables. Principal component analysis is based on the maximum variance linear combinations of beginning variables [12]. 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. Mathematical details of this method can be found in any book dealing with multivariate techniques [15, 16].

The approach used to group varieties is cluster analysis, which is a well-known method within the multivariate statistical approaches [15]. 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 [12]. 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. The theory behind clustering is an expected positive relationship between the variables Euclidean distance and the similarity of the observations [12]. 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 primary purpose of the cluster analysis was to provide delineation of what cropping system constitute them. Agronomic results in this way will be used for subsequent breeding studies.

According to the algorithm, the graphical displaying of grouping results of the acquired data is made with drawing the two dimensionally diagram. The presentation of graphic which is also called as Dendogram can be presented in many forms such as single or complete linkage. The analysis filters automatically determine the primary and dominant crops for cluster characterization. In this study the data related to the quantitative characteristics of eleven varieties in two years time period (1996-1997) has been analyzed. The panel data grouped in 15 characteristics of varieties has been evaluated by multivariate statistical methods. It has been determined internally homogenous groups of cowpea varieties on the basis of crop characteristics. For the classifying assessment, cluster analysis was carried out using a divisive hierarchical algorithm on the matrix of eleven cultivars.

RESULTS AND DISCUSSION

The cultivars were classified into 2 categories as follows on the basis of their vegetation period. Mean values for each cultivar over 2 years were used in the comparative assessment:

Categories	Vegetation	Harvest time of cultivars (days)
Early	97-109	End of august
Mid-early	110-120	September

Examined V_5 and V_{11} varieties are grown in North-west Anatolia region of Turkey while others are grown in West and/or South Anatolia region. A description of these eleven varieties used is presented in Table 1.

Factorial analysis indicated 2 principal components which eigenvalues <1 accounting for 99.13% of the overall variance. The first and most important principal component (PC_1), accounting for 98.69% of the total variance is characterized by seed and pod size factors. Then, seed and pod size factors which explains 98.69% of the total variance looks sufficient to show differences among the varieties. The seed and pod size parameters as the height of pod from the ground, seed number, 1000 seed weight, biological yield, bunch number, length of plant, weight of pod are highly contributed to this factor.

Table 1: Categories of varieties, quantitative characteristics of pods and seeds

Var	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
V_1	5.69	10.6	5.4	7.9	33.7	4.6	158	36.5	21.8	7.3	103	12.6	51.0	0.78	55.3
V_2	7.09	11.5	5.9	8.0	40.5	5.0	137	36.2	19.3	8.7	105	11.9	48.0	0.77	53.2
V_3	4.91	8.9	4.5	6.0	25.9	4.4	178	41.5	17.8	5.7	106	11.6	52.5	0.79	59.3
V_4	6.29	11.2	5.6	6.1	32.4	5.1	188	42.7	21.2	8.1	108	12.1	47.7	0.78	51.2
V_5	5.09	11.6	5.3	6.6	34.2	5.1	150	40.2	19.3	8.0	108	10.8	50.0	0.77	53.3
V_6	5.51	11.5	5.9	7.1	36.6	5.2	158	40.8	19.2	9.2	112	12.1	51.0	0.77	56.0
V_7	4.92	10.5	5.4	5.9	31.2	5.1	174	41.2	18.3	6.7	108	12.3	52.2	0.74	56.2
V_8	6.58	14.6	6.2	7.2	36.9	5.2	174	44.5	22.0	9.0	118	11.0	49.0	0.80	51.2
V_9	6.80	11.8	6.6	7.7	38.0	4.6	177	38.2	19.7	9.9	111	11.6	44.8	0.81	50.2
V_{10}	6.91	13.2	6.8	6.7	35.2	5.3	185	40.5	22.7	9.2	100	12.3	45.5	0.82	50.7
V_{11}	7.16	13.6	6.6	7.6	40.3	5.1	167	40.0	22.2	9.9	113	11.9	44.3	0.78	48.8

Note: *1*. Yield per plant (kg/ha), *2*. Biological yield (gr/plant), *3*. Seed yield per plant (gr), *4*. Pod number per plant, *5*. Seed number per plant, *6*. Seed number per pod, *7*. 1000 seed weight (gr), *8*. Length of plant (cm), 9. Height from ground of first pod (cm), *10*. Bunch number, *11*. Vegetation period (day), *12*. Length of pod (cm), *13*. Maturation of pod (day), *14*. Width of pod (cm), *15*. Flowering 50%.

Table 2: Accounted principal components and communalities rates for varieties

Varieties	1.Principal component	2.Principal component	Communalities (h_i^2)	Variance matrix (ε_i, Ψ)
V_1	0.997	- 0.121	0.994	0.006
V_2	0.989	0.103	0.977	0.023
V_3	0.994	- 0.723	0.987	0.013
V_4	0.996	0.026	0.992	0.008
V_5	0.990	- 0.970	0.979	0.021
V_6	0.997	- 0.063	0.993	0.007
V_7	0.996	- 0.059	0.991	0.009
V_8	0.995	0.016	0.990	0.010
V_9	0,994	0.021	0.998	0.012
V_{10}	0.992	0.116	0.985	0.015
V_{11}	0.989	0.004	0.979	0.021

Complete linkage distance

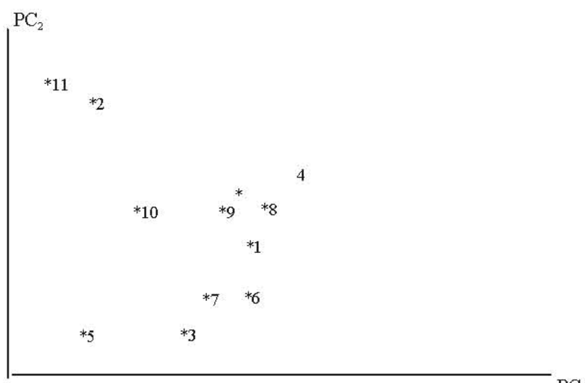

Fig. 1: Projection of varieties on PC_1 and PC_2

Communalities (h_i^2) are generally high level consequently indicating that the similarities among the ecotypes are high (Table 2). Plotting the cultivars over the 1st and 2nd principal components grouped the early and late maturity cultivars in separate areas (Fig. 1).

Two principal component shows that results could be explained in two dimensional spaces (R). The second principal component (PC_2) accounting for 0.44% of the total variance is characterized by the time of vegetation and seed yield per plant.

As a result of this analysis, the investigated 11 varieties can be classified into eight groups. Indeed, there is not any standard procedure to determine the final number of cluster exist [7]. Instead many criteria and guidelines have been developed. For that reason, the set of varieties is run for different numbers of clusters; two, three, four, five, six, seven and eight clusters. The dendogram produced by cluster analysis is also grouped the early and mid-early planted varieties in separate areas (Fig.2). Cultivars were grouped into 3 clusters. Especially, some ecotypes which have the highest crop yield were grouped in same cluster (2nd and 11th cultivars).

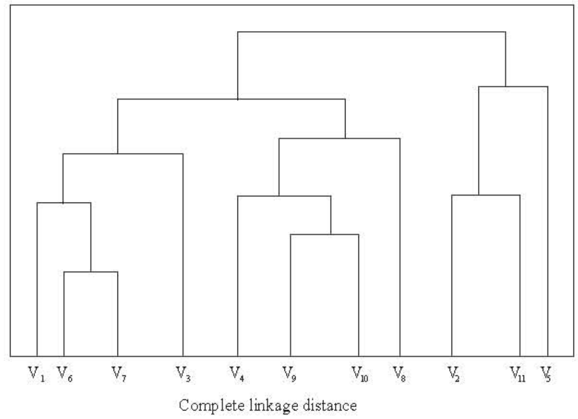

Fig. 2: Dendogram obtained by cluster analysis on the initial data

Nineth variety (V_{11}) had a somewhat intermediate position in the cluster analysis (Fig. 1). Also this variety has the most similarity across other cultivars. However, the most different variety is the fifth variety (V_5).

As the agronomical characteristics of included cultivars are recognized by a great variation in all varieties for these experiments seems promising.

CONCLUSIONS

In this study multivariate statistical methods were used to classify a group of cowpea varieties on the basis of their agronomic characteristics. Classifying of investigated varieties into three basic groups which consist of eight groups has been suggested according to the cluster analysis. Most of used variables mean values are increasing or decreasing (depends if indicator is positively or negatively correlated with crops data) from the first to the last group. The multivariate analysis methods showed substantial variation among cultivars.

The results clearly show that there is wide variation among the 11 accessions with regard to important characteristics which could be effectively used for vegetation time, seed and pod factors and crop yield. Differences within each of the eleven varieties were evident only at the generic level. Cultivars differed in many factors (yield, seed number, weight, length, etc.)

Cluster group showed a distinct separation between varieties. Included varieties in this study were separated into two basis group by factor and cluster analysis. Beside, there are more different three main groups (3 sub cluster) by cluster analysis.

Since 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. Based on the intensive study on the data and the correlation between them, the cluster analysis itself is run as a non-hierarchical analysis. Other methods like factor analysis and principal component analysis is have also been used, but the results were less fruitful.

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