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GENOTYPE DIVERSITY AND TRAIT RELATIONS IN COTTON LINES

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Abstract

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Principal component analysis, based on 6 agronomic and fiber traits was used to evaluate the genotype diversity among 14 lines and 3 cultivars of cotton, tested across 3 years. Among the studied genotypes the lines Nos. 409, 412, because of their longer fibers and bigger bolls, and No. 400, distinguished by a remarkable earliness, higher productivity and higher lint percentage were the most interesting for the cotton breeding. This analysis can provide additional useful information about the trait links and their changeability in different environments.

Key words: *cotton, G. hirsutum L., PC analysis, agronomic and fiber traits*

INTRODUCTION

Recently, in the plant breeding different multivariate methods particularly valuable for the genetic divergence evaluation have been applied. Methods, which have been successfully used in the breeding programs, are the cluster and the principle component analyses. In cotton few examples of applications of multivariate methods exist. Principal component and cluster analyses were used by Steven Brawn (1991), Kasly et al. (1995), Patil et al. (1999). In our country the PC analysis on cotton traits was used by Valkova and Dechev (2004, 2005).

The objective of our study was to evaluate the genotype diversity among 17 cotton genotypes (14 breed lines and 3 cultivars) by using the principle component analysis on the bases of the most important agronomic and fiber traits in terms of to find out the most suitable genotypes for the further breeding work.

MATERIAL AND METHODS

The study involved 14 lines and 3 cultivars of cotton. Lines Nos. 328, 330, 356, 363, 383 and cv. Avangard-264 were of interspecific hybrid origin (G. hirsutum L. x G. barbadense L.). Lines Nos. 322, 341, 408, 409, 412, 413 and 431 were obtained after the G. hirsutum hybridization with stabilized lines from the cross of G. hirsutum L. x G. barbadense L. species. Two lines (396 and 400) and the cultivars Chirpan-603 and Beli izvor were of intraspecific origin (G. hirsutum). The experiment was carried out at the experimental field of the Institute during the period 1996-1998. The lines and the cultivars were tested in four replications with a harvesting plot of 30 m^2 each in a block design. The following traits were analyzed: September yield (SY); total yield (TY); index of earliness (E); boll weight (BW); fiber length in mm (L) and lint percentage (R). Principal component analysis (PCA) corresponding to the three years of experimentation and to the three years average

was realized that allowed to establish the main components of the variance (PC1 and PC2) on all measured traits and genotypes. Statistica 6.0 (StatSoft, Tulsa, OK) was used. The interpretation of results is according to Yan and Rajcan (2002).

The climatic factors during the vegetation period in the separate years varied strongly: 1996 was moderately warm and very dry; 1997 was very cool especially during the second half of the vegetation period and moderately dry, very unfavorable; 1998 was warm and moderately dry to dry.

RESULTS AND DISCUSSION

The mean values of the studied traits are presented in Table 1. Significant differences among the genotypes for all traits can be seen. The lines differed slightly in their earliness and productivity between each other and from the standard cultivars in the result of preliminary selection by these traits. Line No. 400 only distinguished stronger from the others.

Table1. Mean trait values for 1996-1998

Genotypes	Total yield kg/da	September yield kg/da	Index of earliness %	Boll weight g	Lint percentage %	Fiber length mm
Chirpan-603	149.7	114.7	76.6	5.0	40.1	27.0
Beli izvor	148.5	114.6	77.2	5.0	39.1	26.0
Avangard-264	149.4	112.1	75.0	5.0	36.7	28.4
322	147.7	115.4	78.1	4.8	37.5	28.3
328	148.7	117.9	79.3	5.0	37.1	28.3
330	149.2	118.7	79.5	4.7	38.5	28.0
341	141.0	107.1	75.9	5.0	38.3	28.1
356	140.3	102.4	73.0	4.9	36.1	29.0
363	158.0	124.3	78.7	4.5	38.9	28.4
383	144.8	109.6	75.7	5.2	36.6	29.0
396	157.0	121.2	77.2	4.9	39.4	26.7
400	164.4	135.4	82.4	4.7	39.5	27.3
408	147.2	109.9	74.7	5.5	38.1	28.5
409	157.9	109.8	69.6	5.1	37.6	29.3
412	159.6	119.1	74.6	5.3	38.5	29.6
413	141.9	99.2	69.9	5.0	36.7	29.5
431	155.5	120.7	77.6	5.0	38.4	28.3
LSD(P = 0.05)	7.0	7.2		0.2	0.9	1.4

In the principal component analysis 75.08 % of the total variance of the two-dimensional matrix genotype x traits was accounted for by the first two PC axes. The contribution of the principal components was 74.15 % for 1996, 77.07 % for 1997 and 74.47 % for 1998. For this reason they could be used as a basis for grouping the genotypes by the assessed traits. The PC values obtained reveal middle complication of links between the studied traits (Yan and Rajcan, 2002).

The distribution of the traits and the genotypes, on the basis of the main components PC1 and PC2 is presented in figure 1a and 1b. Four quadrants were formed on the basis of the zero values of PC1 and PC2. The correlation vectors of the studied traits were laid on the same coordinate system. Part of the genotypes showed similarity in one or two,

and some of them in three traits. The genotypes individually apart from the others and distinguished significantly in one or two traits were of interest.

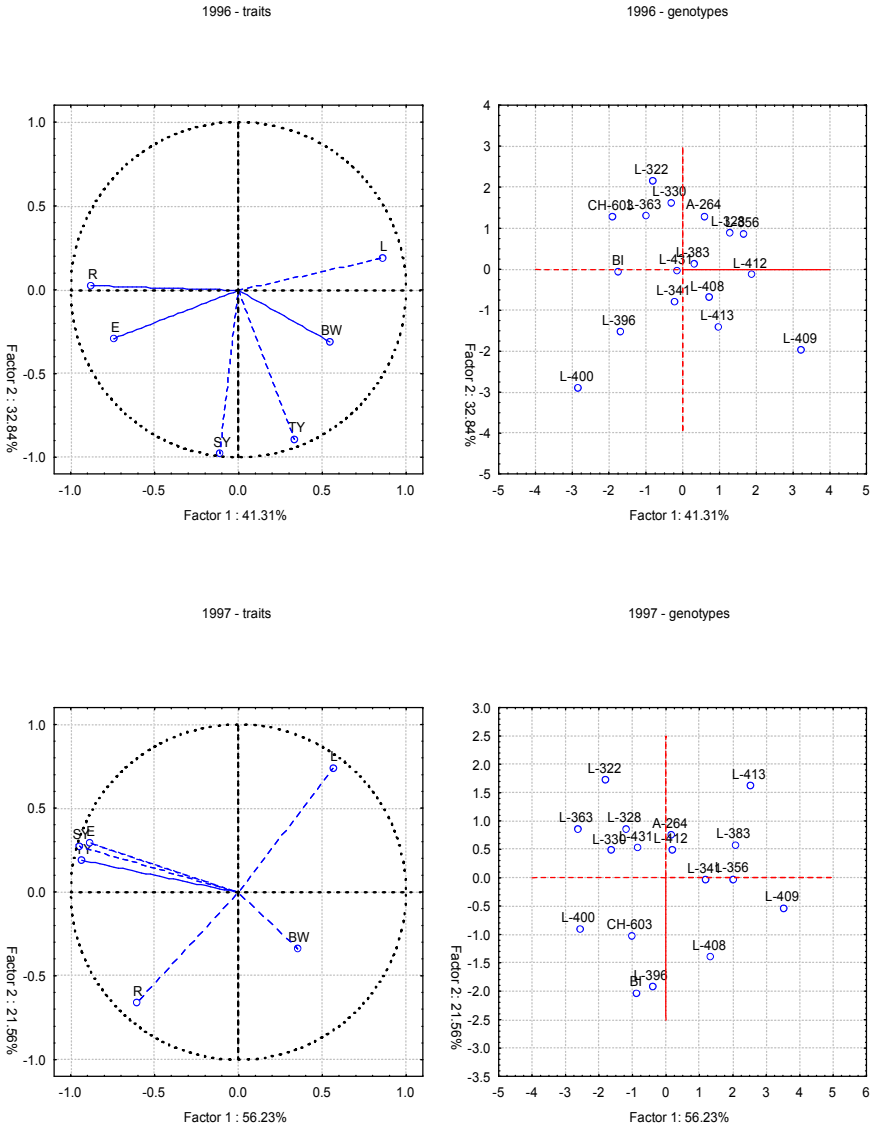

Fig. 1a. PC analysis of 17 cotton genotypes by 6 traits

In the first PCA, corresponding to the year 1996, in the upper right square (Fig. 1a) there are located the genotypes related to fiber length. The cv. Avangard-264 and line 412 that have shown high fiber length values refer to them. The genotypes situated on the left upper corner were associated with the fiber lint percentage. Included here are two standards Chirpan-603 that have shown the highest lint percentage and Beli izvor.

The lines No. 409 having the highest and positive value of PC1 and No. 400 having the highest negative PC1 and PC2 values are distinctly separated from the others. The

line No. 409 distinguished by the highest total yield during this year, and the line No. 400 – by the highest index of earliness.

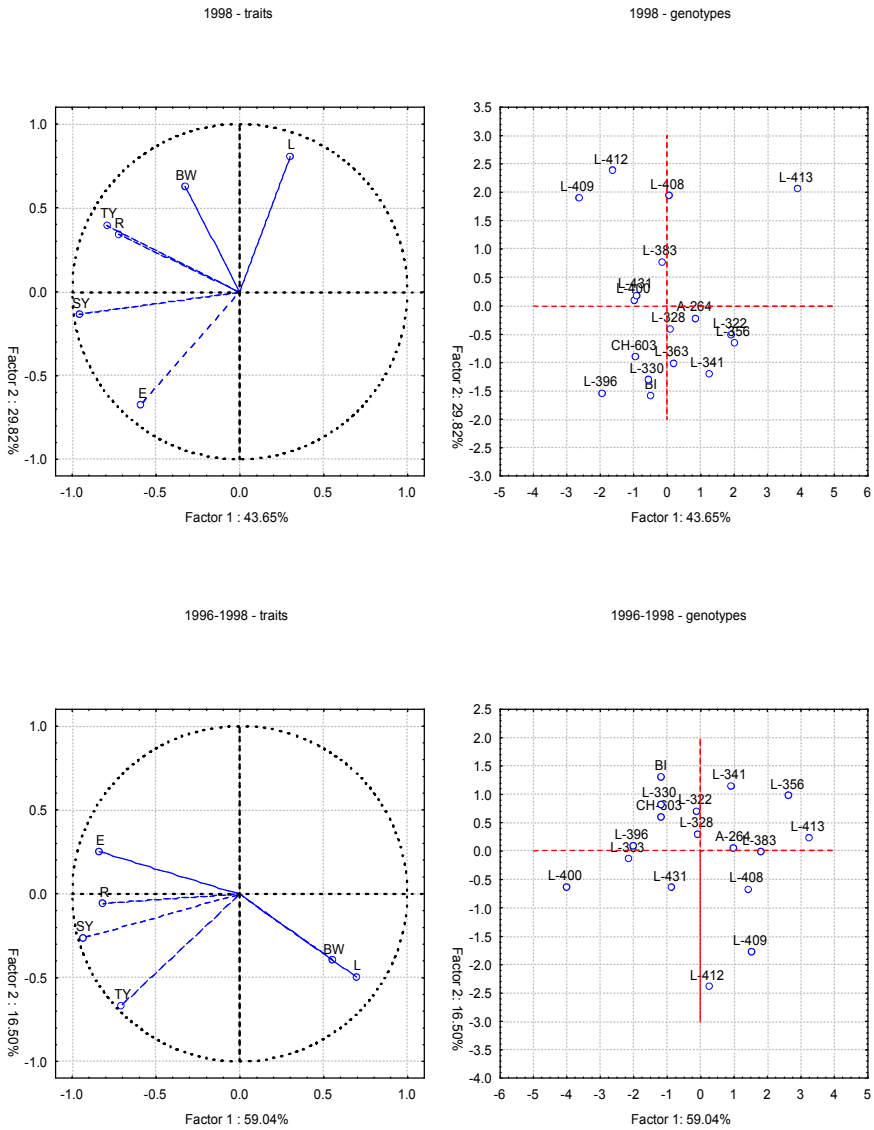

Fig. 1b. PC analysis of 17 cotton genotypes by 6 traits

In the second PCA, corresponding to the year 1997, the genotypes related with the fiber length are located on the same upper right corner. The genotypes located in the left upper corner were associated with the total and September yields and the index of earliness. In the lower right corner are situated the genotypes associated with the boll weight and in the lower left one – the genotypes accompanied by the lint percentage. In this year the genotypes Nos. 322, 413, 409, 408, 396, 400 and the cv. Beli izvor were further removed from the others. The line No. 409 showed the highest and positive PC1

value, was outermost because of the lowest index of earliness and the lowest September yield. The line No. 413 had the longest fiber in this year. Beli izvor and No. 396 had the shortest one. No. 408 was characterized by the biggest boll weight, No. 363 distinguished by the highest total and September yields, No. 400 had the highest lint percentage.

In the third PCA, corresponding to the year 1998, the genotypes related to the fiber length maintain the upper right quadrant. In the upper left quadrant there are situated the genotypes associated with the boll weight, the total yield and the lint percentage, and the lower left one – the genotypes associated with the September yield and the index of earliness. In this year the line No. 413 was the outermost from the group. It lays individually on the upper right quadrant and is distinguished by the highest positive PC1 value. This line distinguished by longer fiber, but was late in maturity and had the lowest September yield and the lowest index of earliness. The lines No. 409 showed the highest September and total yields in this year and No. 412 showed the highest value of lint percentage were distinctly separated from the others. Both lines had big bolls.

At the environmental changes the indices changed their situation in most of the cases, which could be explained by the effect of year conditions on their expression. It was found that the cotton lines and cultivars tested interacted significantly with environmental conditions as regards the total and September yields and fiber lint percentage. There were no significant genotype-environment interaction for the fiber length, boll weight and index of earliness (Stoilova, Dechev, 2002). The trait relations in some cases preserved their character, but in the other cases they changed. There was a close link between the September and the total yields across all three years of the study which is seen from the vectors situation of these two traits. September yield is the best criterion for assessing the earliness of genotypes. In our climatic conditions it is of prime importance cotton genotypes to realize their agronomic productivity.

In 1996 and 1998 there was a positive link between the total yield and the boll weight, their vectors were one-way, while in 1997 these ones were almost contrary. This could be explained by the year conditions. The heavy rainfall in the second year of study favoured the total productivity and the boll weight. Because of insufficient temperature supply part of retain bolls were not realized which reflected on the agronomic productivity. In comparison with the other two years index of earliness was much lower as a result of late maturity. Strong negative correlations can be seen between fiber lent and fiber lint percentage, and between fiber length and index of earliness.

In the PCA on the average results the genotypes No. 409, 412, associated with the fiber length and the boll weight, and No. 400, associated with the earliness and the lint percentage, were outermost from the outers. There existed very strong positive link between the fiber length and the boll weight, their vectors coincide. However, there were strong negative correlations between these two characters and the others, the most strongly expressed with the index of earliness and the lint percentage. Positive links can be seen between September yield and lint percentage, September and total yields. Further improvement of the lines can be achieved by increasing of their lint percentage and index of earliness.

CONCLISIONS

Among the studied genotypes the lines Nos. 409, 412, because of their longer fibers and bigger bolls, and No. 400, distinguished by a remarkable earliness, higher productivity and higher lint percentage were outermost and the most interested for the cotton breeding.

The employed component analysis allows for the revealing of the trait relations and their changeability in different environment conditions as well as the possibilities for further improvement of the cotton breeding process.

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