

Study of variability for yield components in some popcorn (*Zea mays*, var. *Everfa*) genotypes

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Abstract

The objective of this study was to evaluate genetic variability based on the ear traits of 5 genotype popcorn (*Zea mays* var. *everta*) to be used in breeding programs. The genotype with the largest ear diameter was Pc3 (34.07mm), and the smallest ear diameter was recorded at Pc4 (31.37mm). The genotype with the highest number of grains per ear was Pc4 (326.52). The weight of the ear was 75.54 (g) and three of the genotypes exceeded the average weight for this character (Pc1, Pc2, Pc4). The genotypes with the highest percentage of grains per cob were Pc4 and Pc5. Based on ear traits, genotypes Pc4 and Pc5 showed 90% similarity and were located in the same cluster as genotype Pc1, which showed 80% similarity with them.

Keywords: popcorn, ear traits

Introduction

Maize (*Zea mays* L.) is the 3rd most significant cereal crop after wheat and rice [15]. Popcorn (*Zea mays* L. *everta*) is an important plant with an increasing economic value because it is used in human nutrition, animal feed, and the food industry. Popcorn is the most well-known subtype of corn used for making snacks [1]. Consumers prefer popcorn with a high burst volume, a tasty product that is soft and has less crust residue [9;10]. The types of popcorn grown in different regions depend on the variety, ecological conditions, and preferences of the consumers [5]. It is grown mostly in hot and tropical climates. It matures at high temperatures. There are 3-5 cobs on the plant. The grain color can be yellow. Yellow and white are preferred. After grain maturation, water remains in the endosperm, causing an explosion when the water is exposed to high temperatures. Because of its vitamins and minerals, popcorn is a preferred food item in terms of nutrition. The popcorn plant can be used in animal nutrition as green, dry, and silage fodder. Popcorn has also been suggested as an alternative silage crops [7]. Popcorn, a specialty type of corn, is believed to be one of the oldest types of corn that belongs to the Maydeae tribe of the grass family Poaceae and has been referred to as the original cereal snack food because it is the finest form of flint available. The kernels of popcorn consist of hard starch grains embedded in colloidal material, which pop upon heating to produce large, puffed flakes. This character separates popcorn from other types of corn. The yield of popcorn, as in other crops, is a complex character that depends on several components. The popcorn quality was measured primarily by the expansion volume and the number of unropped kernels^{15s}. The success of plant breeding depends on the extent of genetic variability in the crop. Knowledge of the nature and magnitude of genetic variation governing the inheritance of quantitative characters like yield and its components is essential for genetic improvement. A successful selection program depends not only on the heritability of desirable characters but also on information about the association among various yield component characters and their association with grain yield [2;11]. Variability is defined as differences among individuals owing to genetic composition and growing environment [14]. The existence of variability plays the most important role in the success of any plant-breeding program, depending on the genetic variability and selection skill of the plant breeder [3]. Selection is only effective when the parent population exhibits significant variability. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) provide insights into the magnitude of variability in a population, and heritability shows the component of a character that is transmitted to future generations [6;8].

Material and Method

This study was conducted in 2024. The experimental field was located in the Lugoj area, where the climate in this year varied from arid to semi-arid. The biological material was represented by 5 popcorn genotypes. The characteristics of the ear were analyzed for the following genotypes: length, diameter, and number/ear, ear weight (g), cob weight (g), grains weight/ear (g), grains-ear ratio (%), TGW). The obtained results were statistically processed. An analysis-of-variance (One-Way ANOVA) was performed to evaluate statistical differences between results. The means of the data obtained from the research were compared using the Duncan test at $P \leq 0.05$ [4].

Results and Discussion

According to variance analysis it was found statistically significant differences ($P \leq 0.01$) among popcorn genotypes on ear length, Ear diameter, Grains number/ear, Ear weight, Cob weight, TGW.

Table 1. Analysis of variance for ear traits in popcorn (*Zea mays L. var. Everta*) genotypes

| Source of variation | DF | Ear length | | | Ear diameter | | |
|---------------------|----|-------------------|---------|---------|-------------------|--------|---------|
| | | SS | MS | F value | SS | MS | F value |
| Total | 14 | 1713.60 | | | 51.80 | | |
| Replications | 2 | 78.40 | 39.20 | 0.61 | 7.37 | 3.68 | 1.98 |
| Genotypes | 4 | 1118.93 | 279.73 | 4.33* | 29.58 | 7.40 | 3.98* |
| Error | 8 | 516.27 | 64.53 | | 14.85 | 1.86 | |
| Source of variation | DF | Grains number/ear | | | Ear weight | | |
| | | SS | MS | F value | SS | MS | F value |
| Total | 14 | 13049.30 | | | 1424.50 | | |
| Replications | 2 | 2385.70 | 1192.85 | 2.90 | 226.20 | 113.10 | 2.29 |
| Genotypes | 4 | 7872.70 | 1968.18 | 4.78* | 803.90 | 200.98 | 4.08* |
| Error | 8 | 3290.90 | 411.36 | | 394.40 | 49.30 | |
| Source of variation | DF | Cob weight | | | Grains weight/ear | | |
| | | SS | MS | F value | SS | MS | F value |
| Total | 14 | 604.15 | | | 1164.60 | | |
| Replications | 2 | 108.79 | 54.40 | 3.35 | 202.90 | 101.45 | 2.10 |
| Genotypes | 4 | 365.51 | 91.38 | 5.63* | 574.80 | 143.70 | 2.97 |
| Error | 8 | 129.85 | 16.23 | | 386.90 | 48.36 | |
| Source of variation | DF | Grains-ear ratio | | | TGW | | |
| | | SS | MS | F value | SS | MS | F value |
| Total | 14 | 762.77 | | | 2877.29 | | |
| Replications | 2 | 108.25 | 54.13 | 1.57 | 513.47 | 256.74 | 2.72 |
| Genotypes | 4 | 378.62 | 94.66 | 2.74 | 1609.19 | 402.30 | 4.26* |
| Error | 8 | 275.90 | 34.49 | | 754.63 | 94.33 | |

The ear length ranged from 126.5 mm at Pc3 to 152.5 mm at Pc1. The average character size was 139.4 mm (Table 2). Pc1 and Pc2 were superior. The average ear diameter was 32.61 mm. The genotype with the largest ear diameter was Pc3(34.07mm), and the smallest ear diameter was recorded at Pc4 (31.37mm). The genotype with the highest number of grains per ear was Pc4 (326.52), whereas genotype Pc3 recorded the lowest number of grains per ear (281.67). In the genotypes analyzed, the weight of the ear was 75.54 (g) at Pc3 and 89.37 (g) at Pc2.

The average value for this character was 81.14 (g), and three of the genotypes exceeded the average (Pc1, Pc2, Pc4). The weights of the cob were 16.58 g at Pc5 and 25.68 g at Pc2. The genotypes Pc1 and Pc2 were recorded above average.

The average grain-per-ear weight was 61.31 g was recorded, with values between 56.45 g at Pc3 and 63.69 g at Pc2. The genotypes with the highest percentage of grains per ear were Pc4 and Pc5.

From the dendrogram, it can be seen that the genotypes, based on the ear traits, were divided into 3 clusters, the first cluster includes the genotypes Pc4 and Pc5, which show a similarity of 90%, and the genotype Pc1, which shows a similarity to them of 80%. Cluster 2 included genotype Pc2, which was 65% similar to the genotypes in the first cluster. Genotype Pc3, which was located in the third cluster, exhibited a similarity of approximately 60% with the genotypes of the other 2 clusters.

Table 2. Values of ear traits in popcorn (*Zea mays L. var. Everta*) genotypes

| Genotypes | Ear length (mm) | Ear diameter (mm) | Grains number/ear | Ear weight (g) |
|--------------------------|-------------------|-----------------------|----------------------|--------------------|
| Pc1 | 152.5±4.9 a | 32.30±0.75 ab | 321.14±5.21 a | 81.13±9.61 ab |
| Pc2 | 144.1±8.5 ab | 33.13±2.50 ab | 300.67±25.83 ab | 89.37±8.33 a |
| Pc3 | 126.5±6.2 c | 34.07±1.24 a | 281.67±5.70 b | 75.54±3.03 b |
| Pc4 | 136.9±4.7 bc | 31.37±0.76 b | 326.52±13.64 a | 80.63±8.47 ab |
| Pc5 | 136.4±2.3 bc | 31.38±1.45 b | 301.61±24.78 ab | 79.06±8.12 ab |
| Mean | 139.4±3.1 | 32.61±0.66 | 306.33±7.88 | 81.14±3.21 |
| <i>LSD</i> _{5%} | 15.1 | 2.56 | 38.19 | 13.22 |
| Genotypes | Cob weight (g) | Grains weight/ear (g) | Grains-ear ratio (%) | TGW (g) |
| Pc1 | 20.13±1.19 ab | 61.07±7.81 a | 73.55±4.60 a | 188.55±10.58 b |
| Pc2 | 25.68±2.80 a | 63.69±2.07 a | 72.46±6.75 a | 215.26±17.37 a |
| Pc3 | 19.09±1.85 ab | 56.45±1.29 a | 74.98±3.01 a | 200.95±13.29ab |
| Pc4 | 17.69±1.40 b | 62.94±6.07 a | 78.74±6.19 a | 192.70±18.16 b |
| Pc5 | 16.58±1.70 b | 62.48±5.52 a | 78.91±2.67 a | 212.71±9.81 a |
| Mean | 19.84±2.03 | 61.31±2.57 | 75.73±1.94 | 202.04±7.59 |
| <i>LSD</i> _{5%} | 7.59 | 13.10 | 11.06 | 18.29 |

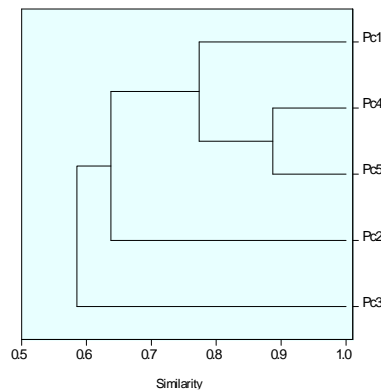


Figure 1. UPGMA clustering of popcorn (*Zea mays L. var. Everta*) genotypes based on ear traits

Based on the data from Table 3, it can be observed that the greatest contribution to the variability of ear traits to the diversity between pop corn (*Zea mays L. var. everta*) genotypes had the ear weight and the cob weight.

Table 3. Analysis of variance for the contribution of ear traits to the diversity between popcorn (*Zea mays L. var. Everta*) genotypes

| Trait | Between groups | | Within groups | | F Test |
|-------------------|----------------|----|---------------|----|--------|
| | SS | DF | SS | DF | |
| Ear length | 0.283 | 1 | 3.714 | 3 | 0.23 |
| Ear diameter | 0.160 | 1 | 3.841 | 3 | 0.13 |
| Grains number/ear | 0.124 | 1 | 3.878 | 3 | 0.10 |
| Ear weight | 3.262 | 1 | 0.738 | 3 | 13.25* |
| Cob weight | 3.425 | 1 | 0.583 | 3 | 17.62* |
| Grains weight | 0.844 | 1 | 3.153 | 3 | 0.80 |
| Grains ear ratio | 1.522 | 1 | 2.491 | 3 | 1.83 |
| TGW | 1.566 | 1 | 2.435 | 3 | 1.93 |

The multivariate analysis (Figure 2) based on the first two principal components expressed 70% of the variability of the 5 genotypes for ear traits in popcorn (*Zea mays L. var. everta*). Depending on the projection of each genotype on the vectors of ear traits (GWE, GnE, GER), the 'Pc5', 'Pc1' and 'Pc4' varieties showed a good contribution to these traits.

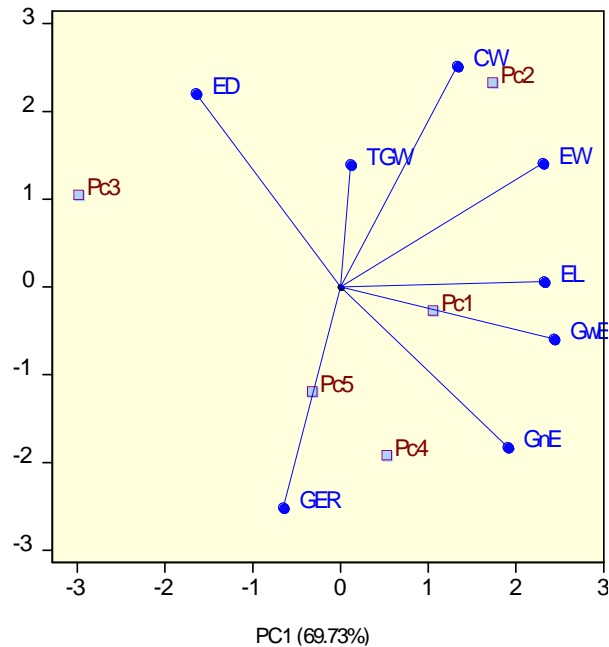


Figure 2. Biplot of first two principal components for ear traits in popcorn (*Zea mays L. var. Everta*) genotypes

Conclusions

The Pc3 genotype presented the largest ear diameter (34.07mm), and the smallest ear diameter was recorded at Pc4 (31.37mm).

The Pc4 genotype registered the highest number of grains per ear (326.52). The (Pc1, Pc2, Pc4) genotypes exceeded the average of weight of the ear 75.54 (g).

The Pc4 and Pc5 genotypes presented the highest percentage of grains per cob.

Based on ear traits, genotypes Pc4 and Pc5 showed 90% similarity and were in the same cluster as genotype Pc1, which showed 80% similarity with them.

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