ANALYSIS OF SOME BIOMETRIC PARAMETERS IN THE CHARACTERIZATION OF CORN EAR

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Abstract. The study analyzed the variation of some biometric parameters in corn ears, the ‘Oana’ hybrid. The experiment was carried out within ARDS Lovrin, under non-irrigated crop system conditions. The ear samples were harvested at physiological maturity. The analyzed parameters were represented by: ear length (EL), row number (RN), grains number on rows (GNR), ear weight (CW), grains weight (GW) and cob weight (CW). Ear length varied between EL = 18.00 – 20.75±0.41 cm; row number presented values between RN = 16.00 – 16.50±0.11; grains number on rows presented values between GNR = 43.75 – 49.25±0.76; ear weight presented the values EW = 0.86 – 1.04±0.03 kg; grains weight varied between GW = 0.73 – 0.87±0.03 kg; cob weight varied between CW = 0.13 – 0.17±0.01 kg. The Anova test confirmed the presence of variance and the statistical reliability of the recorded data (F calculated > F crit, p<0.001; Alpha = 0.001). High variability was recorded in the case of cob weight (CV=10.1184), and low variability in the case of row number (CV=1.5971). Intermediate values were recorded for the other analyzed parameters, respectively CV = 4.0799 for GNR, CV = 5.3064 for EL, CV = 7.6181 for GW, respectively CV = 7.9539 for EW. Correlation of varying intensity levels was recorded between analyzed parameters (e.g. r=0.991 between EL and GW; r=0.949 between EL and GNR; r=0.845 between EL and CW). The regression analysis facilitated the finding of equations and graphic models that described the variation of EW and GW in relation to EL and RN parameters, under statistical safety conditions (R²=0.982 in the case of EW; R²=0.974 in the case of GW). From the equations obtained (values of the coefficients) as well as from the graphic models, it was found that the EL parameter had a determining influence (compared to RN) in the variation of the EW and GW parameters.

Keywords: biometric parameters, corn ear, genetic resources, models, regression analysis

INTRODUCTION

Corn is one of the main crops, along with wheat and rice, and is cultivated in various conditions of climate, soil, agricultural technologies in order to ensure food resources, for feed, industrialization, but also for other purposes (Wang and Hu, 2021; Zou et al., 2021). Corn presents a very high and varied genetic diversity and ecological plasticity (Sachs, 2009; Teixeira and Guimarães, 2021). Corn genetic resources were divided into two major categories, genetic stocks and germplasm accessions (Sachs, 2009).

A good knowledge of the genetic basis that governs economic traits is important for corn breeding programs and processes (Chozin and Sudjatmiko, 2019). The authors studied different sweet corn genotypes, in tropical agroecological conditions, in order to obtain varieties for ecological production.

Soliman et al. (2021) used PCA analysis and cluster analysis to analyze and characterize genetic diversity in corn, especially regarding drought tolerance, and the authors of the study identified important and valuable genetic resources in this direction. Salami et al. (2016) communicated important results, based on an extensive study, regarding corn conservation, production improvement and genetic resource management for the study area.

For corn hybrid improvement, some studies have communicated the importance given to commercial hybrids, as the germplasm potential (Suwanatapate et al., 2020). The authors of the study analyzed 15 commercial hybrids, obtained cluster grouping and characterization of genetic diversity, with importance for corn breeding programs. Corn crop was studied in relation to fertilization, from the perspective of valorizing fertilizing, organic and mineral resources, with soil or foliar application (Fahrurrozi et al., 2016). Different studies have communicated the response of plants based on biometric parameters, productivity elements, production and quality, but also from the perspective of optimizing fertilization (Boldea and Sala, 2010; Ai and Jane, 2017; Sala et al., 2019; Amegbor et al., 2022).

Corn biofortification was analyzed in complex studies, with irrigation and foliar fertilization options, and the authors of the study communicated the combinations of experimental factors that favorably influenced biometric parameters and production quality indices (e.g. proline, protein content) (Kandil et al., 2023). The recorded results facilitated the authors to formulate conclusions and recommendations regarding the improvement of the yield and some quality indices of corn for the study conditions. The yield of corn crops varies in relation to biological, economic and environmental factors. Some studies have evaluated the relationship of maize plants, in response to biotic and abiotic factors, in order to identify valuable genetic resources.
resources of maize (Dossa et al., 2023).

Galic et al. (2023), based on extensive studies on a consistent gene bank, communicated results obtained regarding the genetic coding of some proteins or some genes involved in the stress response of plants as well as the genetic diversity of the studied germplasm/ genotypes.

Pratt et al. (2022) studied the behavior of corn in conditions of aridity and salinity of irrigation water, specific to the United States in the South-West area. The authors of the study communicated important results regarding the behavior of some local populations, and commercial hybrids, with importance for the agricultural practice specific to the study area. Ranganatha et al. (2021) studied the behavior of some maize genotypes in relation to different pathogens and identified parental forms valuable for the improvement process.

The purpose of this study was to analyze the variability of some biometric parameters in corn ears and how certain parameters influenced the ear weight and grains weight, important information in corn breeding programs and in agricultural practice.

**MATERIAL AND METHODS**

The experimental research was carried out within the Lovrin Agricultural Development Research Station. The experiments were organized under non-irrigated crop conditions, with a chernozem type soil.

The biological material was represented by the 'Oana' hybrid. The experiment was organized in four repetitions, agricultural years 2022 - 2023. Ear samples (five ears on each repetition; random samples) were harvested at physiological maturity.

For the characterization of corn ears, basic biometric elements were considered: ear length (EL), row number (RN), grains number on rows (GNR), ear weight (EW), grains weight (GW), and cob weight (CW). The determination of ear length (EL) was made by measurement, with a precision of ±0.5 mm. The determination of row number (RN), and grains number on rows (GNR) was done by counting within the consideration elements. The determination of ear weight (EW), grains weight (GW), and cob weight (CW) was done by weighing, with a precision of ±0.05g.

For each parameter, determinations were made on the collected ears samples, and average values were calculated. In relation to the purpose of the study, the variability of the biometric parameters, the level of correlation and interdependence between the parameters was analyzed. Data security was analyzed by Anova test. Regression analysis was used to describe the variation of some representative parameters. Established applications and statistical safety parameters were used in the analysis of the results (Hammer et al., 2001; Wolfram Alpha, 2020).

**RESULTS AND DISCUSSIONS**

Based on the biometric measurements of corn ears, 'Oana' hybrid, the values of the parameters considered in the study were obtained, table 1. Ear length varied between EL = 18.00 – 20.75±0.41 cm; row number presented values between RN = 16.00 – 16.50±0.11; grains number on rows presented values between GNR = 43.75 – 49.25±0.76; ear weight presented the values EW = 0.86 – 1.04±0.03 kg; grains weight varied between GW = 0.73 – 0.87±0.03 kg; cob weight varied between CW = 0.13 – 0.17±0.01 kg.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>EL</th>
<th>RN</th>
<th>GNR</th>
<th>EW</th>
<th>GW</th>
<th>CW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>18.00</td>
<td>16.00</td>
<td>43.75</td>
<td>0.86</td>
<td>0.73</td>
<td>0.13</td>
</tr>
<tr>
<td>Max</td>
<td>20.75</td>
<td>16.50</td>
<td>49.25</td>
<td>1.04</td>
<td>0.87</td>
<td>0.17</td>
</tr>
<tr>
<td>Sum</td>
<td>114.14</td>
<td>97.00</td>
<td>275.00</td>
<td>5.89</td>
<td>4.95</td>
<td>0.95</td>
</tr>
<tr>
<td>Mean</td>
<td>19.02</td>
<td>16.17</td>
<td>45.83</td>
<td>0.98</td>
<td>0.83</td>
<td>0.16</td>
</tr>
<tr>
<td>Std. error</td>
<td>0.41</td>
<td>0.11</td>
<td>0.76</td>
<td>0.03</td>
<td>0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>Variance</td>
<td>1.01899</td>
<td>0.06667</td>
<td>3.49167</td>
<td>0.00610</td>
<td>0.00395</td>
<td>0.00026</td>
</tr>
<tr>
<td>Stand. dev</td>
<td>1.009</td>
<td>0.258</td>
<td>1.869</td>
<td>0.078</td>
<td>0.063</td>
<td>0.016</td>
</tr>
<tr>
<td>Median</td>
<td>18.88</td>
<td>16.00</td>
<td>45.50</td>
<td>1.02</td>
<td>0.86</td>
<td>0.16</td>
</tr>
<tr>
<td>25 prcntil</td>
<td>18.09750</td>
<td>16.00000</td>
<td>44.68750</td>
<td>0.89750</td>
<td>0.75250</td>
<td>0.14500</td>
</tr>
<tr>
<td>75 prcntil</td>
<td>19.81250</td>
<td>16.50000</td>
<td>46.81250</td>
<td>1.04000</td>
<td>0.87000</td>
<td>0.17000</td>
</tr>
<tr>
<td>Skewness</td>
<td>1.01079</td>
<td>0.96825</td>
<td>1.36536</td>
<td>-0.98781</td>
<td>-1.04409</td>
<td>-1.35376</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>0.94636</td>
<td>-1.87500</td>
<td>2.71132</td>
<td>-0.97022</td>
<td>-1.29229</td>
<td>1.23967</td>
</tr>
<tr>
<td>Geom. mean</td>
<td>19.00150</td>
<td>16.16496</td>
<td>45.80232</td>
<td>0.97898</td>
<td>0.82293</td>
<td>0.15761</td>
</tr>
<tr>
<td>Coeff. var</td>
<td>5.3064</td>
<td>1.5971</td>
<td>4.0769</td>
<td>7.9539</td>
<td>7.6181</td>
<td>10.1184</td>
</tr>
</tbody>
</table>

The Anova test confirmed the presence of variance in the data series and the statistical reliability of the
recorded experimental data (F> F<sub>crit</sub>, p<0.001), table 2.

The variability of the analyzed biometric parameters was evaluated graphically, figure 1, and based on the coefficient of variation values calculated for each parameter.

### Table 2. Anova test results

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>P-value</th>
<th>F&lt;sub&gt;crit&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>9466.803</td>
<td>5</td>
<td>1893.361</td>
<td>2475.223</td>
<td>2.78E-38</td>
<td>5.533913</td>
</tr>
<tr>
<td>Within Groups</td>
<td>22.94776</td>
<td>30</td>
<td>0.764925</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>9489.751</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Figure 1. Diversity profile for corn ear parameters, 'Oana' corn hybrid](image)

Based on the values of the coefficient of variation (CV) registered in study conditions, high variability was found in the case of cob weight (CV=10.1184), and low variability in the case of row number (CV=1.5971). In the case of the other parameters, intermediate values were recorded, respectively CV = 4.0769 in the case of grains number on rows, CV = 5.3064 in the case of ear length, CV = 7.6181 in the case of grains weight, and respectively CV = 7.9539 in the case of ear weight.

The correlation analysis led to the values in table 3. A very strong correlation was found between EL and GNR parameters (r=0.949), and between EW and GW (r=0.991). Strong correlation was recorded between EW and CW parameters (r=0.845). Moderate correlation was recorded between GW and CW (r=0.765). Weak correlations were recorded between EL and GW (r=0.663), between EL and EW (r=0.581), between GNR and GW (r=0.500). Other correlations between certain parameters were recorded, but of lower intensity.

### Table 3. Correlation table between biometric parameters in corn ears, 'Oana' hybrid

<table>
<thead>
<tr>
<th></th>
<th>EL</th>
<th>RN</th>
<th>GNR</th>
<th>EW</th>
<th>GW</th>
<th>CW</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL</td>
<td>-0.399</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RN</td>
<td></td>
<td>-0.345</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GNR</td>
<td>0.949</td>
<td></td>
<td>0.401</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EW</td>
<td>0.581</td>
<td>-0.329</td>
<td>0.500</td>
<td>0.991</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GW</td>
<td>0.663</td>
<td>-0.289</td>
<td></td>
<td>0.845</td>
<td>0.765</td>
<td></td>
</tr>
<tr>
<td>CW</td>
<td>0.145</td>
<td>-0.419</td>
<td>-0.078</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The production of ears and grains is of high importance, both in agricultural practice and in the corn breeding process. As biometric parameters, the variation of ear weight (EW) and grain weight (GW) was analyzed in relation to the other biometric elements considered.

The variation of the EW parameter in relation to EL and RN was described by equation (1), under conditions of R<sup>2</sup>=0.982, with the graphic distribution in figure 2.

\[
EW = ax^2 + by^2 + cx + dy + exy + f
\]  

(1)
where: EW – ear weight (kg); x – ear length (EL, cm); y – row number (RN); a, b, c, d, e, f – coefficients of the equation (1); a= -0.046643; b= -0.142623; c= -2.119771; d= 0; e= 0.247288; f= 19.479473

The variation of GW according to EL and RN was described by equation (2), under conditions of \( R^2 = 0.974 \), with graphic representation in figure 3.

\[
GW = ax^2 + by^2 + cx + dy + exy + f
\]

where: GW – grains weight (kg); x – ear length (EL, cm); y – row number (RN); a, b, c, d, e, f – coefficients of the equation (2); a= -0.034086; b= -0.113694; c= -1.819332; d= 0; e= 0.198254; f= 16.566204

The comparative analysis of the coefficient of variation (CV) values for biometric parameters considered in the characterization of corn ears, showed that the most constant was the number of rows (RN), for which CV
1.5971. The number of rows is a genetically determined parameter.

Starting from these findings, in the regression analysis it was found both for the weight of the ear (EW) and for the weight of the grains (GW) that the ear length parameter (EL) was the factor with the major involvement in the variation of the values of the two parameters (EW, and GW). This was highlighted by the values of the coefficients of equation (1) in the case of the EW parameter, as well as in the case of equation (2) for the GW parameter (d = 0). Also, the resulting 3D models as a graphic representation show the importance of the EL parameter (x – axis) in the variation of the EW parameters, Figure 3 (a), and of the GW parameter, Figure 4 (a).

Therefore, this means that in the corn breeding process, ear length requires attention, it is an important parameter in the selection of valuable genotypes.

For agricultural practice, it is also an important result, because through crop technologies, especially through fertilization and irrigation, the length of the ear can be influenced, which will lead to higher productions of ears and grains.

CONCLUSIONS

Biometric parameters considered and methods of experimental data analysis facilitated the description and characterization of corn ears for ‘Oana’ hybrid.

High variability was recorded in the case of cob weight (CV=10.1184), and low variability in the case of row number (CV=1.5971).

Very strong correlation was registered between EL and GNR parameters (r=0.949), and between EW and GW (r=0.991). Strong correlation was recorded between EW and GW parameters (r=0.845).

The variation of the EW parameter and the GW parameter in relation to the EL and RN parameters was described by models in the form of an equation under statistical safety conditions (R²=0.982 for EW; R²=0.974 for GW). 3D graphic models and in isonquant format represented the variation of EW and GW according to EL and RN parameters. The ear length parameter (EL) was the factor with the major involvement in the variation of the values of the two parameters (EW and GW), in the study conditions.

ACKNOWLEDGMENTS

The authors thank SCDA Lovrin for facilitating this study.

REFERENCES