COMPARATIVE ANALYSIS OF SOME MAIZE GENOTYPES - PRODUCTION POTENTIAL AND QUALITY INDICES

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Abstract

The study comparatively analyzed 15 maize genotypes, under the aspect of production potential and some quality indices. The experiment was organized within the ARSD Lovrin. Eight maize genotypes from Lovrin (L experimental code; L1 to L8) and seven genotypes represented by commercial hybrids (CH experimental code; CH9 to CH15) were considered. The production of maize ears, Y(ears), varied between 6,236.00±570.14 kg ha^{-1} in hybrid L4 and 12,839.33±570.14 kg ha^{-1} in hybrid CH15. The physical grains production, Y(pgp) varied between 5,371.00±524.39 kg ha^{-1} in hybrid L4 and 11,640.00±524.39 kg ha^{-1} in hybrid CH15. The recalculated production (STAS, 14% moisture), Y(STAS) varied between 5,371.00±507.36 kg ha^{-1} for hybrid L4 and 11,579.33±507.36 kg ha^{-1} for hybrid CH15. The protein content (Pro, %) varied between 7.20±0.33% in the CH14 hybrid and 10.60±0.33% in the L3 hybrid. The oil content (Oil, %) varied between 5.20±0.09% in the CH15 hybrid and 6.40±0.09% in the L1 and L2 hybrids. According to PCA (95% confidence), the hybrids from group L were placed associated with the content of protein (Pro) and oil (Oil) as biplot. Hybrids from the CH group were placed associated with the Y(STAS) parameter. PC1 explained 72.693% of variance and PC2 explained 17.704% of variance. For the selection process of genotypes in breeding programs, the genotypes from the CH group (commercial hybrids) are of interest for the production potential, and the genotypes from the L group (Lovrin) are of interest for the quality indices (Pro, Oil)

Key words**:** *agricultural practices, breeding program, comparative analysis, maize, quality indices, yield*

INTRODUCTION

Maize is a crop plant of high importance, with multiple ecological valences and multifunctionality through its use in human food, as fodder but also in industrialization [9, 13, 17].
Maize production has increased constantly in the last decades, through more productive genotypes (more adapted to environmental conditions), through high-performance technologies (irrigation, fertilization, mechanization, plant protection, etc.), as well as through the expansion of cultivated areas [4, 9, 26, 28].
The breeding programs for maize genotypes are increasingly based on the concept and modern techniques of plant breeding [6, 22], biotechnologies [25, 29], informatics [3, 23], machine vision, deep learning, mathematical modeling [11, 27].
The evaluation of different maize genetic resources, their behavior in various climate and soil conditions, culture technologies, nutritional relationships, stress factors, etc. represented a basic concern for the identification of valuable genotypes for crops but also for breeding programs. [1, 7, 10, 24].
In order to obtain new, better performing corn hybrids, it is necessary that genotypes, potential lines in the improvement process, are always tested as well as behavior in climate and soil conditions specific to the area for which the new hybrids will be intended [8].
Maize production and quality indices are closely related to the genotype, but they can also be significantly influenced by agricultural practices, crop management, the level of technology, and various studies have quantified these aspects [4, 5].
The purpose of this study was to comparatively analyze the behavior of some maize genotypes in terms of production and some quality indices, with implications for agricultural practice, but also for the selection

process of some parents in the improvement process.

MATERIALS AND METHODS

The study evaluated the variation in production and some quality indices in 15 maize genotypes, in order to characterize them for production but also as genetic resources for the breeding process.

The study and field experiments were organized within ARSD Lovrin. Eight genotypes from the ARSD Lovrin collection (L1 to L8) and seven commercial hybrids (CH9 to CH15) were studied.

Genotypes L1, L2 are part of the PAO 320 group, genotypes L3, L4 and L5 are part of the FAO 340 group, and genotypes L6, L7 and L8 are part of the FAO 400 group. All eight genotypes are single hybrid type, with dented grain.

Within the commercial hybrid genotypes, CH9 is part of the FAO 300-320 group, the CH10 genotype is part of the FAO 300 group, the genotype is part of the FAO 320 group, the CH12 genotype is part of the FAO 400 group, the CH13 genotype is part of the FAO 380 group, the CH14 genotype is part of the FAO 420 group, and the CH15 genotype is part of the FAO 350 group.

All the maize genotypes considered in the study were cultivated under identical soil and technology conditions, respectively on a chernozem type soil, weakly glazed, epicalcare, medium clay loam.

The preparation of the land was done classically (plough, disc, combiner), and sowing was done on April 2, 2022.

Fertilization was done with complex (15:15:15) in a dose of 250 kg ha^{-1} and ammonium nitrate 200 kg ha^{-1}. Weed control was done by weeding (Radial, 0.7 l ha^{-1}, Dicoton 0.6 l ha^{-1}). The culture technology was in non-irrigated system. The harvest took place on September 24, 2022. The climatic conditions during the study period are presented in Figure 1.

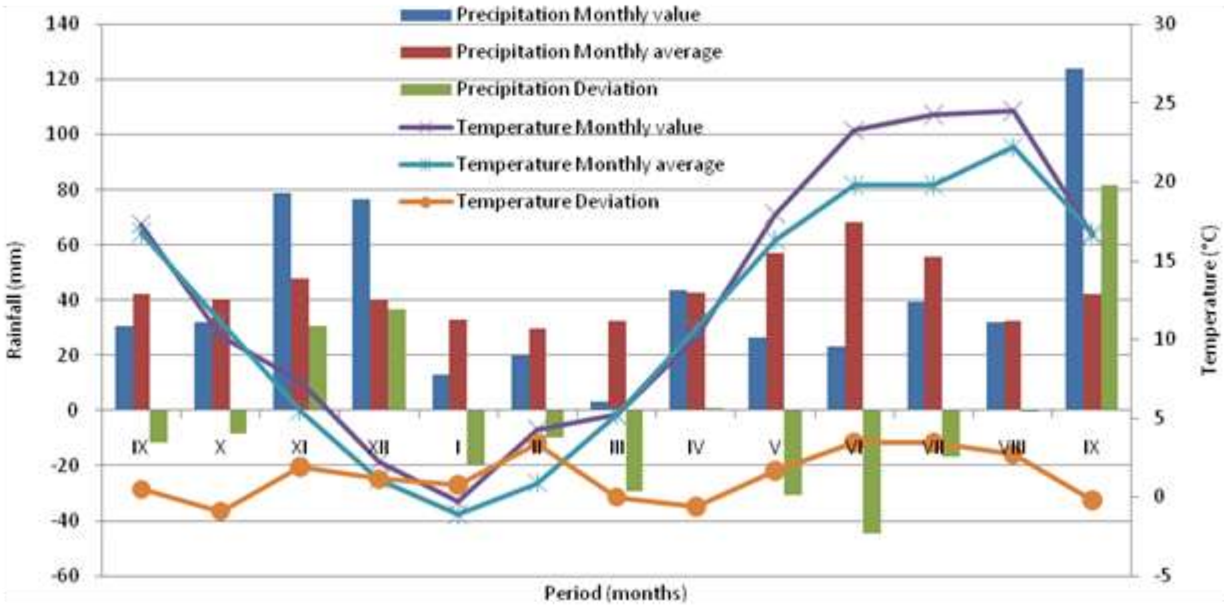

Fig. 1. Climatic conditions during the study period
Source: Original data, ARSD Lovrin Weather Station.

For the comparative analysis of the corn genotypes considered in the study, the production of maize ears Y(ears), the physical production of grains Y(pgp), the production of STAS, Y(STAS), the yield G(Y), the moisture (Mstr), the protein content (Pro) and the oil content (Oil) were determined.

The production parameters were expressed in kg ha^{-1}, and the quality parameters were expressed in %.

The recorded experimental data were analyzed to reveal the differences between the two groups of genotypes (L, and CH), and for this, appropriate mathematical and statistical tools were used [14, 15].

RESULTS AND DISCUSSIONS

The production of maize ears, Y(ears), varied between 6,236.00±570.14 kg ha^{-1} in hybrid L4 and 12,839.33±570.14 kg ha^{-1} in hybrid CH15. The physical production of grains varied between 5,371.00±524.39 kg ha^{-1} in hybrid L4 and 11,640.00±524.39 kg ha^{-1} in hybrid CH15. The recalculated production (STAS, 14% moisture), Y(STAS) varied between 5,371.00±507.36 kg ha^{-1} for hybrid L4 and 11,579.33±507.36 kg ha^{-1} for hybrid CH15. The yield (GY) varied between 83.20±0.51% for the L2 genotype and 90.70±0.51% for the CH15 genotype. The protein content (Pro, %) varied between 7.20±0.33% in the CH14 hybrid and 10.60±0.33% in the L3 hybrid. The oil content (Oil, %) varied between 5.20±0.09% in the CH15 hybrid and 6.40±0.09% in the L1 and L2 hybrids. The complete set of recorded data is presented in Table 1.

Table 1. Production data and quality indices for the maize genotypes studied

Myze genotype code	Y (ears)	Y (pgp)	Y (STAS)	GY	Mstr	Pro	Oil
	(kg ha^{-1})			(%)	(%)	(%)	(%)
L1	9,238.00	7,817.67	7,881.00	84.60	13.53	10.10	6.40
L2	7,057.33	5,873.67	5,936.00	83.20	13.03	10.20	6.40
L3	6,835.00	5,981.67	6,003.00	87.50	13.63	10.60	6.10
L4	6,236.00	5,278.67	5,371.00	84.70	12.47	9.30	6.30
L5	8,715.67	7,432.33	7,316.67	85.30	15.23	10.00	5.90
L6	6,338.67	5,448.33	5,611.33	86.00	11.33	10.40	5.90
L7	8,000.00	7,008.00	7,015.00	87.60	13.93	9.60	6.30
L8	10,352.67	8,856.33	8,910.33	85.50	13.50	10.30	5.90
CH9	11,222.33	9,888.00	10,027.67	88.10	12.80	7.90	6.20
CH10	11,949.33	10,377.00	9,793.33	86.80	18.87	7.80	6.20
CH11	12,694.67	11,059.67	11,026.00	87.10	14.30	8.80	6.00
CH12	9,867.33	8,783.67	8,727.33	89.00	14.57	7.30	5.50
CH13	9,596.67	8,484.33	8,599.67	88.40	12.80	7.80	5.50
CH14	10,231.33	9,035.00	9,141.33	88.30	12.93	7.20	5.80
CH15	12,839.33	11,640.00	11,579.33	90.70	14.47	7.30	5.20
SE	±570.14	±524.38	±507.36	±0.51	±0.44	±0.33	±0.09

Source: original data, recorded from the experiment

The Anova test confirmed the safety of the recorded experimental data, as well as the presence of variance in the data set (Alpha=0.001; F>Fcrit, p>0.001).

Table 2. Anova test

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1.9E+09	6	3.17E+08	172.768	8.15E-50	4.1149
Within Groups	1.8E+08	98	1837381			
Total	2.08E+09	104				

Source: original data, resulted from the calculation.

The values of the Anova test are presented in Table 2.

The correlation analysis led to the values in Table 3. Very strong, positive correlations were recorded between Y(pgp) and Y (ears), r=0.997***, between Y(STAS) and Y(ears), r=0.992*** and between Y(STAS) and Y(pgp), r=0.996***. Moderate correlations were recorded between Pro and Y(pgp), r=-0.702**, between Pro and Y(STAS), r=-0.703, between Pro and GY, r=-0.742 and between Oil and GY, r=-0.741. Correlations with weak intensity were also recorded, under statistical safety conditions (* $p < 0.05$; ** $p < 0.001$; *** $p < 0.001$), Table 3.

According to PCA (95% confidence), the diagram in Figure 2 resulted, in which the two groups of maize hybrids studied (L, CH) were differentiated. The hybrids from group L were placed associated with the content of protein (Pro) and oil (Oil), as biplot. The hybrids from the CH group were placed associated with the Y(STAS) parameter. PC1 explained 72.693% of variance, and PC2 explained 17.704% of variance.

Table 3. Correlation table

	Y(ears)	Y(pgp)	Y(STAS)	GY	Mstr	Pro	Oil
Y(ears)							
Y(pgp)	0.997***						
Y(STAS)	0.992***	0.996***					
GY	0.559*	0.620*	0.634*				
Mstr	0.515*	0.497	0.424	0.140			
Pro	-0.668**	-0.702**	-0.703**	-0.742**	-0.291		
Oil	-0.427	-0.476	-0.494	-0.741	-0.009	0.568*	

Source: Original data.

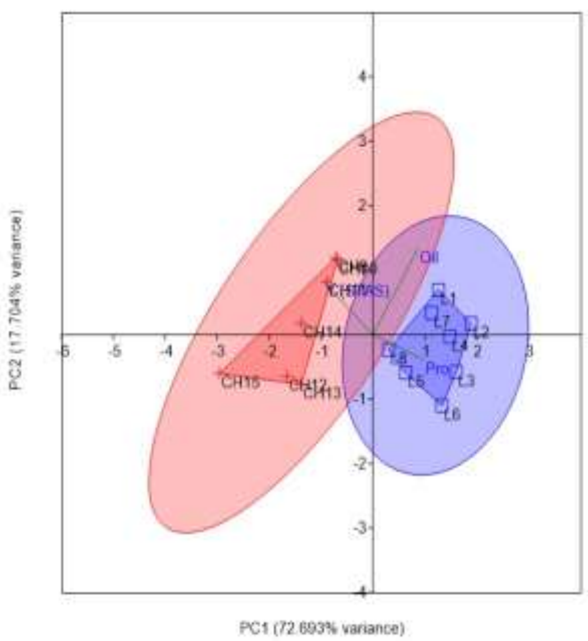

Fig. 2. PCA diagram regarding the distribution of the maize hybrids studied; blue color – ARSD Lovrin hybrids; red color – commercial hybrids
Source: Original figure.

In the framework of the Cluster analysis, based on the production parameters Y (STAS), and quality (Pro, Oil), the dendrogram from Figure 3 resulted, in conditions of Coph corr. =0.740.

The grouping of the analyzed hybrids in two distinct clusters was found. A C1 cluster included hybrids from the CH group (commercial hybrids) and a hybrid from the L group (L8 hybrid) with high yields and lower protein and oil content.

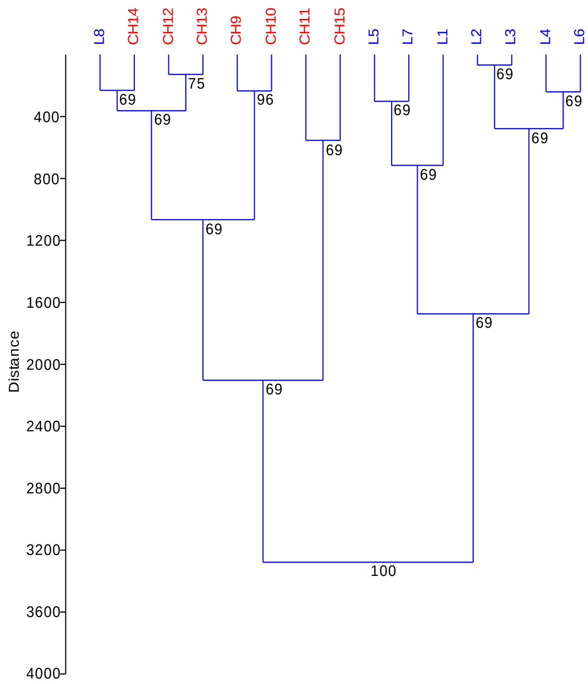

Fig. 3. Dendrogram of the maize hybrids studied, in relation to production and quality indices (Pro, Oil)
Source: Original figure.

Hybrids from group L (Lovrin hybrids), except L8, were associated in cluster C2. In cluster C2 there are hybrids with high protein and oil content.

In cluster C1 a high level of similarity was recorded between CH12 and CH13

(SDI=127.66), and in cluster C2 a high level of similarity was recorded between hybrids L2 and L3 (SDI=67.002), which was the highest level of similarity at the level of the experiment.

The differences in protein and oil content were calculated, in relation to the average of the experiment.

In the case of the protein content (Pro, %), the average value was Pro=8.97%, and in relation to the calculated average value, certain hybrids (commercial hybrids, CH) had a lower content, and other hybrids (hybrids from group L, Lovrin) a higher protein content. The graphic representation is given in Figure 4.

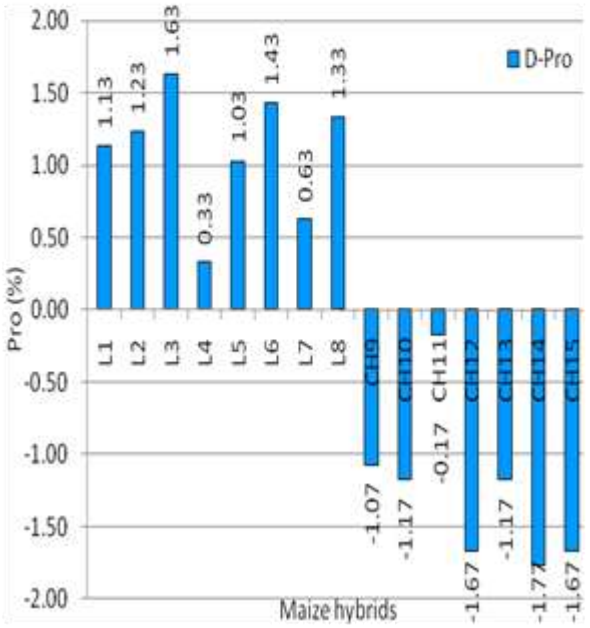

Fig. 4. The distribution of the differences regarding the protein content in the maize hybrids, in relation to the average of the experiment
Source: Original figure.

In the case of the oil content (Oil, %), the average value calculated at the experimental level was Oil=5.97%, and in relation to the average value calculated, it was found that certain hybrids had a lower oil content, and other hybrids a higher oil content. The graphic representation is given in Figure 5.

Hybrids from experimental group L (Lovrin) were highlighted by quality indices with higher values (Pro, Oil).

In relation to the production, the commercial hybrids (CH9 to CH15) presented higher values compared to the group of genotypes from Lovrin (L1 to L8). However, genotype L8 ensured production at the level of three of the commercial genotypes (Table 1), respectively at the level of genotypes CH12, Ch13 and CH14. This level of production was recorded both in the case of Y(ears), as well as in T(pgp) and Y(STAS), respectively.

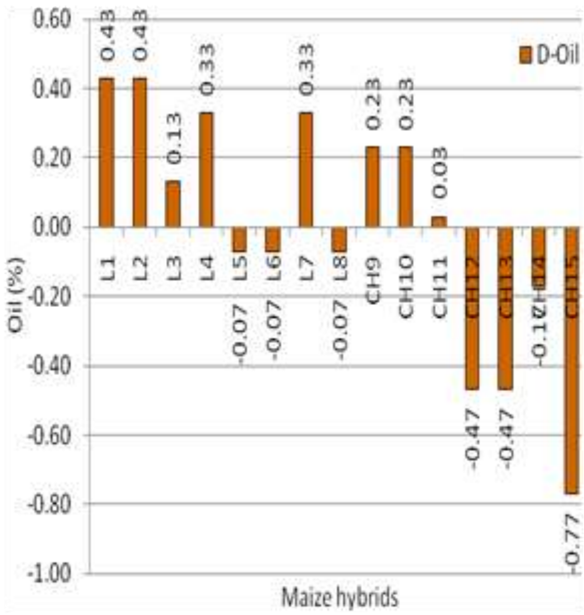

Fig. 5. The distribution of the differences regarding the oil content of the maize hybrids, in relation to the average of the experiment
Source: Original figure.

At the level of the L (Lovrin) hybrids group, the average production value was Y(ears)=7,846.67±526.26 kg ha^{-1}, Y(pgp)= 6,712.08±449.50 kg ha^{-1}, Y(STAS)= 6,755.54±438.26 kg ha^{-1}.

At the level of the group of commercial hybrids (CH), the average production value was Y(ears)=11,200.14±506.35 kg ha^{-1}, Y(pgp)=9,895.38±452.47 kg ha^{-1}, Y(STAS)=9,842.10±429.11 kg ha^{-1}.

In relation to the studied quality indices (Pro, Oil), the group of genotypes L (Lovrin) showed higher values than the group of genotypes CH (commercial hybrid).

In the case of the protein content (Pro), at the level of the L hybrids group (Lovrin), the calculated average value was Pro= 10.06±0.15%. Genotypes L1, L2, L3, L6 and L8 had values above the average.

At the level of the commercial hybrids group

(CH), the calculated average value of the protein content was Pro=7.73±0.21%. The CH9, CH10, CH11 and CH13 genotypes were above average.

In the case of the oil content (Oil), at the level of the hybrid group L (Lovrin), the calculated average value was Oil=6.15±0.08%. Genotypes L1, L2, L4 and L7 had values above the average.

At the level of the commercial hybrids group (CH), the calculated average value of the oil content was Oil=5.77±0.15%. The CH9, CH10, CH11 and CH14 genotypes were above average.

Katsenios et al. (2021) [16] used PCA to evaluate the relationship between production and quality indices (e.g. protein, fiber) in certain maize genotypes in relation to soil properties. Amegbor et al. (2022b) [2] studied the protein content of different maize lines in order to improve the nutritional value of maize genotypes in the context of Southern Africa conditions.

Langyan et al. (2022) [18] studied the nutritional diversity and quality indices in native germplasm identified and collected from different ecosystems in India, in order to identify valuable genetic sources adapted to environmental conditions.

An extensive and complex study on corn quality indices (protein quality) was conducted by Maqbool et al. (2021) [21] for the purpose of genetic characterization and establishment of breeding strategies.

Appropriate genetic methods were used by Lu et al. (2022) [19] to explain the protein content of maize grains in relation to the genetic basis.

Similar studies have been carried out to explain the variation of oil content in corn kernels (especially high values of oil content), especially in relation to the genetic basis, but also to influencing factors [12, 20].

Depending on the interest in the productive level or the quality indices, the appropriate maize genotypes can be chosen, in relation to the intended purpose. For production, Y(STAS), hybrids from the CH group (commercial hybrids) are of high interest, and for quality indices the genotypes from the L group (Lovrin) are of greater interest.

For the selection process of genotypes in breeding programs, the genotypes from the CH group (commercial hybrids) are of interest for the production potential, and the genotypes from the L group (Lovrin) are of interest for the quality indices (Pro, Oil).

CONCLUSIONS

The two groups of maize genotypes (L, CH) behaved differently in the study conditions, in relation to the production potential and considered quality indices (Pro, Oil).

The genotypes represented by commercial hybrids (CH) showed higher production potential, manifested by high production values, with a higher average production value compared to hybrids from group L (Lovrin).

The genotypes from Lovrin (L) presented better values for quality indices (Pro, Oil) with higher average values for both quality indices compared to the other group of hybrids (CH).

For high levels of production and yield, tested commercial hybrids (CH) present an advantage for crop, as well as as a genetic source for breeding programs, in terms of productive potential.

For quality indices, protein and oil (Pro, Oil), the genotypes from Lovrin (L) present an advantage for breeding programs, in terms of quality indices.

In order to obtain maize hybrids with high production potential and to improve the values of the quality indices (Pro, Oil), the base of genotypes studied in the present study and parental forms used for the transfer of valuable traits can be considered.

For production, for practical crop management purposes, the more balanced genotypes from the two tested groups can be taken into account, which ensure more balanced high productions but also quality indices at a good level.

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