

KERNELS YIELD IN MAIZE EARS - COMPARATIVE STUDY

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Abstract. The kernels yield on maize ears was analyzed in the study. Maize hybrids created within ARDS Suceava were cultivated within ARDS Lovrin, under conditions specific to the Western Plain of Romania. 20 maize hybrids (SV1 to SV20) were tested. The comparative crops was placed on a land with chernozem soil, medium fertility, non-irrigated crop conditions. Samples were taken and processed after culture harvest. The kernel yield per ear (YE, %) was determined. Values between $YE = 70.60 \pm 0.85\%$ (SV19) and $YE = 86.00 \pm 0.85\%$ (SV2) were recorded. Normal distribution of the data series was recorded, with $r = 0.959$. Anova Test (Alpha = 0.05) confirmed the presence of variance and data safety ($p = 0.000662$). The calculated mean value of the yield at the experiment level was $YE_m = 80.27 \pm 0.85\%$. Compared to the calculated mean value, nine hybrids presented values below the mean of the experiment, and eleven hybrids presented values above the mean. Positive differences, compared to the mean of the experiment, were recorded in the case of hybrids SV2, SV3, SV5 at the level of $p < 0.001$ (***), in the case of hybrids SV13 and SV20 at the level of $p < 0.05$ (**), and respectively in the case of SV8 and SV10 hybrids at the level of $p < 0.05\%$ (*). Negative differences, compared to the mean of the experiment, were recorded in the case of the SV4, SV7 and SV19 hybrids at the level of $p < 0.001$ (ooo), and in the case of the SV12 and SV16 hybrids at the level of $p < 0.01$ (oo). In the case of the other hybrids, the recorded differences did not show statistical certainty.

Keywords: cluster, comparative analysis, ears, kernel yield, maize

INTRODUCTION

Productivity elements were studied in relation to the growth of maize cobs and influencing factors, such as genetic factors, environmental and technological factors, as well as their influences (Otegui et al., 1998). Correlations of kernel yield with the number of kernels in maize ears was recorded (Otegui et al., 1998).

Maize grain yield was analyzed in relation to the potential of different genotypes (Almeida et al., 2005). Based on the recorded results, the authors of the study identified the varieties with high production potential. Maize grain yield was studied in relation to the way ears are formed, in relation to some possible anomalies and influencing factors (Ortez et al., 2022). Based on extensive documentation, the authors communicated the influence of genetic, environmental and technological factors, as well as their interactions in relation to the formation of ears and certain recorded anomalies.

Increasing the maize yield is a priority objective in breeding programs (Dong et al., 2023). The structural elements of the ear are important elements in defining the yield. Genetic and molecular studies have brought important information and elucidated aspects regarding the quantitative traits of the ear. Morphological elements of the ear were studied in relation to the defining molecular basis (Ning et al., 2021). The authors communicated the influence of ethylene, as a "key signal" in the development of the ear and the definition of the productivity elements at the level of the maize ear.

Maize seed yield was studied in relation to different genotypes, experimental locations and nitrogen fertilization rates (DeBruin et al., 2024). Productivity elements in maize were studied in relation to the efficiency of nitrogen use, through different levels of doses and moments of application (Gheith et al., 2022). The authors recorded correlations of the physiological parameters of plants and ears with the levels of nitrogen applied, associated with the moments of application. Ear differentiation in maize can influence yield (Ma et al., 2022). The authors of the study analyzed the differentiation of the ear in relation to different doses of nitrogen. The maize yield was analyzed in relation to the allocation of fertilizers, in order to increase the rate of nitrogen utilization and to optimize some economic indicators (Boldea and Sala, 2010; Sala et al., 2016, 2019; Jiang et al., 2024).

The importance of the genetic basis supporting the expression of phenotypic plasticity of ear traits in maize was analyzed (Liu et al., 2023). For the operability of the studies, automatic platforms were developed to facilitate the analysis of large databases of genotypes.

The aim of the study was to evaluate the grain yield of maize ears, in the case of 20 hybrids created by ARDS Suceava, and cultivated within ARDS Lovrin.

MATERIAL AND METHODS

According to the purpose of the study, twenty maize hybrids were cultivated in comparative crops in specific soil and climate conditions within ARDS Lovrin. The maize hybrids, named SV1 to SV20, were created within ARDS Suceava.

The crop was placed in a plot with chernozem soil, medium fertility. The crop technology ensured the adequate preparation of the land (plough, disc, combiner). Fertilization ensured 300 kg ha⁻¹ complex, and 200 kg ha⁻¹ ammonium nitrate, commercial product. Weed control was done by pre-emergent weeding and mechanical works, supplemented by manual works (in turn, as the case may be) in the vegetation. The sowing was done in the first decade of April, 2024 (4th of April). The experiment was set up manually, in three repetitions, and the experimental plot had a size of 6.7 m². The row length was 4.8 m, and the seeding density was 55,000 germinating grains/ m². The climatic conditions are presented in table 1, according to the data recorded at the ARDS Lovrin station.

Table 1. Climatic conditions during the experimental period

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Climatic parameters	Period												2023-2024
	2023				2024								
	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	
	Rainfall regime												Amount
Monthly amount	79.0	23.2	63.8	49.4	38.0	7.4	35.0	23.0	15.4	24.4	33.8	25.0	417.4
Multiannual mean	42.4	40.5	48.0	39.7	32.7	29.6	32.3	42.7	57.3	68.1	55.8	32.3	521.4
Deviation	36.6	-17.3	15.8	9.7	5.3	-22.2	2.7	-19.7	-41.9	-43.7	-22.0	-7.3	-104.0
	Thermal regime												Mean
Monthly mean	21.3	15.3	6.7	3.4	1.6	7.9	9.6	13.8	18.1	23.6	26.8	26.9	14.6
Multiannual mean	16.8	11.1	5.5	1.1	-1.1	0.9	5.3	10.7	16.3	19.8	22.2	21.7	10.9
Deviation	4.5	4.2	1.2	2.3	2.7	7.0	4.3	3.1	1.8	3.8	4.6	5.2	3.7

Samples of ears were taken randomly within each variant (hybrid) and repetition at the maturity of the plants (Meier, 2001). In relation to the purpose of the study, the samples of ears and grains were weighed on each experimental sample. Weighing the samples was done with a laboratory balance, precision ± 0.002 g.

The analysis and processing of experimental data was done in relation to the purpose of the study, through appropriate methods in EXCEL and dedicated applications (Hammer et al., 2001).

RESULTS AND DISCUSSIONS

The kernel yield of maize ears (YE) recorded mean values between $YE = 70.60 \pm 0.85\%$ (SV19) and $YE = 86.00 \pm 0.85\%$ (SV2). The series of data, average values, presented a normal distribution, with $r = 0.959$, figure 1. The Anova test ($\alpha = 0.05$) confirmed the reliability of the experimental data, and the presence of variance in the data set, table 2.

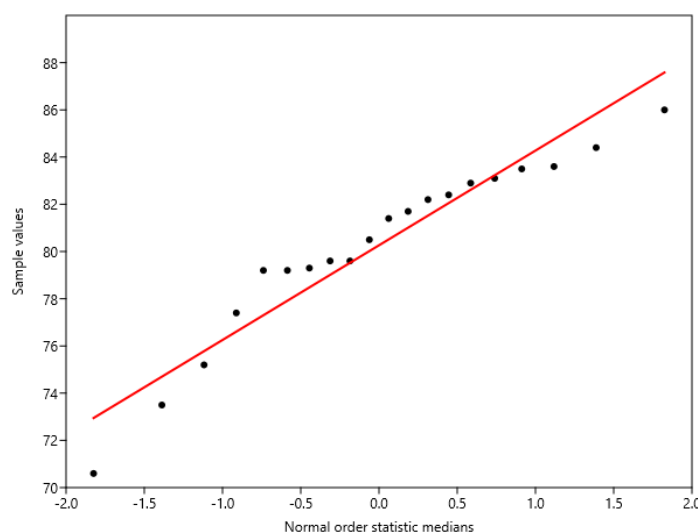


Figure 1. Normal probability plot, YE data series for the maize hybrids studied

Table 2. Anova Test results

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	826.1617	19	43.4822	3.33367	0.000662	1.852892
Within Groups	521.7337	40	13.04334			
Total	1347.895	59				

The mean values of kernel yield per ear (YE) were analyzed compared to the mean value at the experiment level ($YE_m = 80.27 \pm 0.85\%$). The results are the values presented in table 3. The graphic representation of the differences in kernel yield per ear, compared to the mean value at the experiment level, is presented in figure 2.

Of the twenty maize hybrids analyzed, nine hybrids presented values below the mean of the experiment, and eleven hybrids presented values above the mean.

Positive differences compared to the mean, with statistical significance, were recorded in the case of SV2, SV3, SV5 hybrids at the level of $p < 0.001$ (***), in the case of SV13 and SV20 hybrids at the level of $p < 0.05$ (**), and respectively at the level of SV8 and SV10 hybrids at the level of $p < 0.05\%$ (*).

Negative differences compared to the mean were recorded in the case of the SV4, SV7 and SV19 hybrids at the level of $p < 0.001$ (ooo), and in the case of the SV12 and SV16 hybrids at the level of $p < 0.01$ (oo). In the case of the other hybrids, the recorded differences did not show statistical certainty.

Table 3. The differences and the significance of the kernel yield values per ear compared to the mean value of the experiment

Maize hybrid	Given mean (YE, %)	Difference (%)	Statistical parameters			
			95% conf. interval:	t	p (same mean)	Significance
SV1	79.60	-0.665	(-1.1168 2.4468)	0.7812	0.4443	ns
SV2	86.00	5.735	(3.9532 7.5168)	-6.7368	1.95E-06	***
SV3	84.40	4.135	(2.3532 5.9168)	-4.8573	0.0001	***
SV4	73.50	-6.765	(4.9832 8.5468)	7.9467	1.85E-07	ooo
SV5	83.60	3.335	(1.5532 5.1168)	-3.9176	0.0009	***
SV6	79.60	-0.665	(-1.1168 2.4468)	0.7812	0.4443	ns
SV7	75.20	-5.065	(3.2832 6.8468)	5.9498	9.99E-06	ooo
SV8	82.40	2.135	(0.35322 3.9168)	-2.5080	0.0214	*
SV9	81.70	1.435	(-0.34678 3.2168)	-1.6857	0.1082	ns
SV10	82.20	1.935	(0.15322 3.7168)	-2.2730	0.0348	*
SV11	81.40	1.135	(-0.64678 2.9168)	-1.3333	0.1982	ns
SV12	83.50	3.235	(1.4532 5.0168)	-3.8001	0.0012	oo
SV13	82.90	2.635	(0.85322 4.4168)	-3.0953	0.0060	**
SV14	79.30	-0.965	(-0.81678 2.7468)	1.1336	0.2711	ns
SV15	80.50	0.235	(-1.5468 2.0168)	-0.2761	0.7855	ns
SV16	77.40	-2.865	(1.0832 4.6468)	3.3655	0.0032	oo
SV17	79.20	-1.065	(-0.71678 2.8468)	1.2510	0.2261	ns
SV18	79.20	-1.065	(-0.71678 2.8468)	1.2510	0.2261	ns
SV19	70.60	-9.665	(7.8832 11.447)	11.3530	6.56E-10	ooo
SV20	83.10	2.835	(1.0532 4.6168)	-3.3302	0.0035	**

The cluster analysis led to the diagram in figure 3 (Coph.corr = 0.841). The maize hybrids were associated on the basis of similarity, in relation to the recorded kernel yield values.

Two distinct clusters resulted. Cluster C1 grouped the hybrids with the lowest yield of kernels in ears (SV4, SV7 and SV19). In the C2 cluster, two subclusters were formed, each with several hybrids.

Subcluster C2-A, with a central position in the diagram, included hybrids with higher grain yield values.

A separate position was occupied by the hybrid SV2, with the highest kernel yield per ear. A series of nine hybrids were associated on the basis of similarity in two subclusters ((SV8,SV10), SV9,SV11)), respectively (SV3(SV5,SV12),(SV13,SV20)). The other maize hybrids were positioned in the C2-B subcluster,

with the association of hybrids based on similarity.

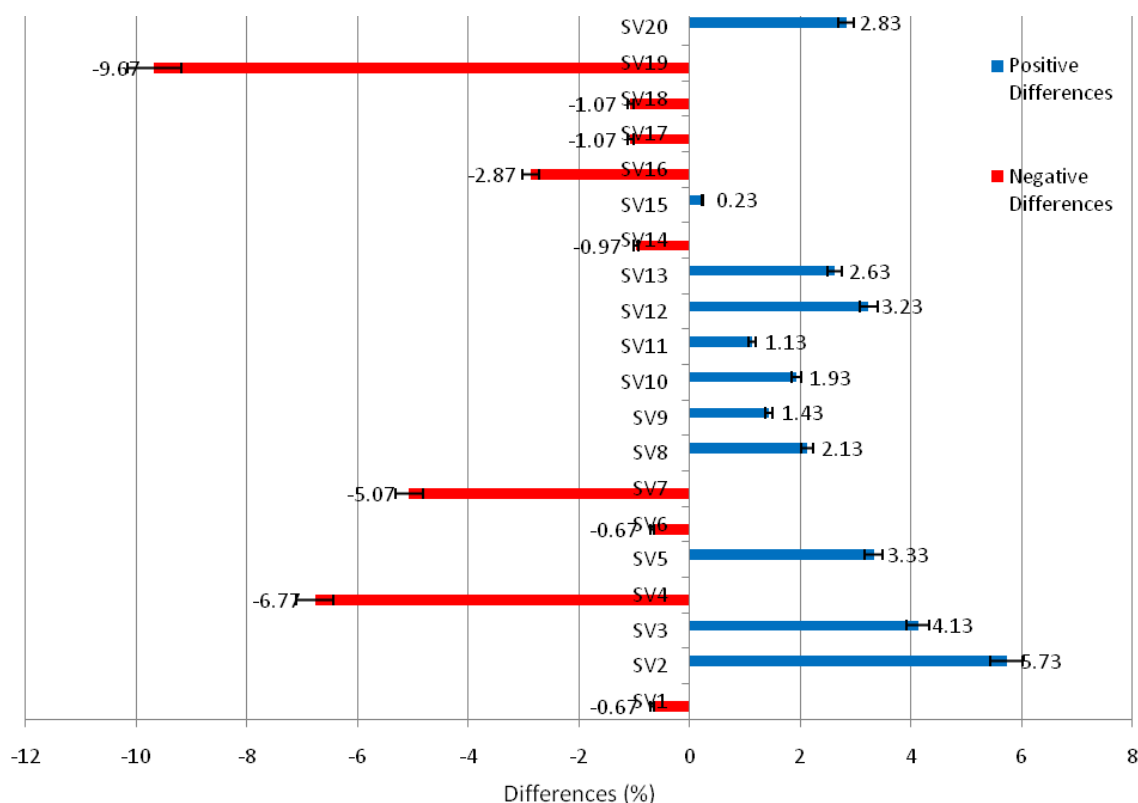


Figure 2. Graphical distribution of the YE parameter differences for the maize hybrids studied

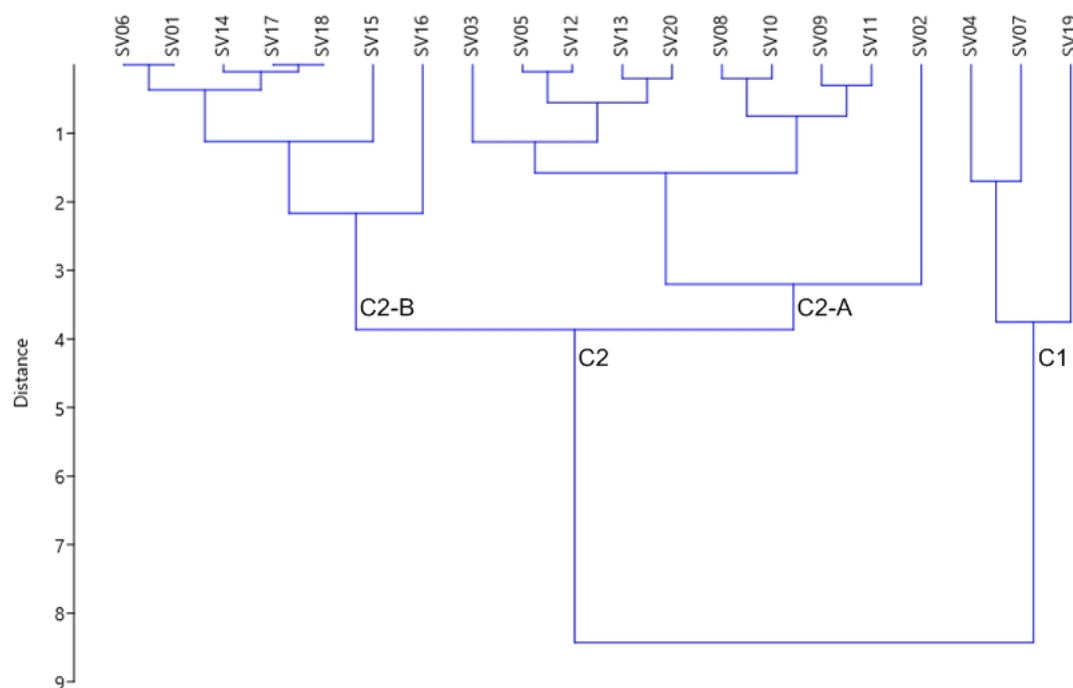


Figure 3. Dendrogram of maize hybrids based on Euclidean distances

Maize crop is important due to the production of grains and the content of starch, protein, oil and other

useful substances from the seeds (Maqbool et al., 2021; Lu et al., 2022; Agapie et al., 2024; Agapie and Sala, 2024).

Biometric parameters in maize ears were analyzed in relation to genetic factors, technological factors or environmental factors, with specific influences on plant status (Ortez et al., 2022; Konia et al., 2023; Rossini et al., 2023). Agapie et al. (2024) reported the variation of biometric parameters in maize ears in the study of a collection that included 80 genotypes, under similar crop conditions.

Many studies have analyzed the variation of the weight of the grains on the ear in relation to nutrients, especially in relation to nitrogen, as an important element in the quantitative determination of harvests (Fernandez and Ciampitti, 2021; Gheith et al., 2022; Ma et al., 2022).

The results recorded in the present study quantified the yield of grains at the level of maize cobs, and through the comparative analysis it differentiated the hybrids in relation to the average value at the level of the experiment.

CONCLUSIONS

The values recorded for the YE parameter (kernel yield in maize ears) reflected the genetic potential of the hybrids under the study conditions.

Nine hybrids recorded values lower than the mean at the experiment level (YE_m), and 11 hybrids recorded values higher than the mean. In the case of seven hybrids, the positive differences compared to the mean showed statistical certainty at the $p < 0.001$ level (SV2, SV3, SV5), at the $p < 0.01$ level (SV13 and SV20), at the $p < 0.05$ level (SV8 and SV10). The negative differences showed statistical certainty in conditions $p < 0.01$ (SV4, SV7 and SV19), $p < 0.01$ (SV12 and SV16).

The cluster analysis facilitated the grouping of ear hybrids based on Euclidean distances, in relation to the recorded YE parameter values, and highlighted the hybrids by group categories, associated with the formed clusters.

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