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THE COB MORPHOLOGY, BIOCHEMISTRY, AND PRODUCTIVITY OF SOME CORN (*ZEA MAYS* L.) GENOTYPES IN THE PEDOCLIMATIC CONDITIONS OF THE ARAD PLAIN (WEST ROMANIA)

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Abstract: This study follows the behavior of some corn (*Zea mays* L.) hybrids recommended by the experts in the field, in Arad area, with the purpose of finding the best solutions to improve these crops. The monofactorial trials included 6 corn hybrids, and was done in 4 replications, and respected appropriate culture technologies. Experimental variants used are: V1 – Dekalb (DKC) 4351; V2 – Dekalb (DKC) 4541; V3 – Dekalb (DKC) 4943; V4 - Kamparis (KWS); V5 - Kashmir (KWS), and V6 – Karpatis (KWS). The check variant is represented by the average values of the 6 studied hybrids. Evaluated criteria are plant size, weight of 1000 grains, number of grain rows on one cob, number of grains on a cob, seed production, grain's content of proteins, fats, and starch, in percentage. Crișurilor Plains can be recommended for the successful cultivation of the Kashmir and Karpatis hybrinds, that showed the best results, with high yields and economic efficiency, followed by Delkalb (DKC) 4943, Delkab (DKC) 4541, Kamparis and Dekalb (DKC) 4351. Dekalb (DKC) 4943 and Kashmir variants also showed high starch content, making them valuable prime materials for the industrial sector.

Keywords: Zea mays, corn hybrids, cob morphology, yield, Arad area.

INTRODUCTION

Zea mays L. is a species originating from Central America, currently cultivated in various regions around the globe as a food crop, industrial and fodder crop, and together with wheat (*Triticum aestivum* L.), comprises 80% of the cereal production (Jităreanu, 2020).

Studies on the biochemical composition of *Zea mays* L., show that 100 g of grains contain: 10 g fibers, 9 g proteins, 4 g fat, 1,5 g minerals, the rest being completed by carbohydrates. Essential minerals found in corn include: Potassium (295 mg), Phosphorus (215 mg), Magnesium (90 mg), Calcium (8 mg), Sodium (6 mg), Zinc (1,7 mg), Iron (1,5 mg), Mangan (415 mg) (Voet & Voet, 2004). The grains are also rich in Copper and Selenium. Other health benefits of corn consumption are given by its high content of vitamins (A, B1, B2, B3, B5, B6, E) and folic acid, essential amino acids like leucine, valine, fenilalanine, isoleucine and threonine. A significant advantage of corn, compared to other cereals, is the lack of gluten (David et al., 2011; Muntean et al., 2001, FAO, 1992).

Considering the surface area cultivated at global level, cereals represent the most important plant group. The optimal production value is considered 500-700 kg of cereals/citizen/year, yet most countries produce under 200 kg of cereals/citizen/year. In this light, there is a restless necessity to rise the cereal productions and improve the quality of crops (Axinte, 2006; Ion, 2010; Ungureanu et al., 2019).

Practically, all groups of plants that are cultivated at a large scale, need to raise their yield through a continuous crop technologies improvement, improving the crop's quality at the same time (David et al., 2011; Muntean et al., 2001). Compared to 1950, when the global population was of cca. 2,5 billion people, in 2010 the number raised 2,7 times, reaching cca. 6,8 billion people, and the prognosis for 2050 us of over 9,5 billion people (Axinte, 2006; Ion, 2010; Starodub, 2008).

At a global level, the chart for the usage of corn production is: 21% in alimentation, 72% as fodder, 4,7% in the industry, and 2,3% for seed (Ion, 2010; Starodub, 2008).

Corn was 2nd place in top 5 crops produced in 2017 worldwide, with 1 134 747 thousand tonnes, followed by wheat, rice and potatoes. Sugar cane was top crop by production quantity also due to its use as a biofuel. USA was the top corn producing country per capita in 2017 (~ 1250 kg/capita), followed by Argentina (~ 1125 kg/capita), Paraquay (~ 750 kg/capita) and Romania (~ 700 kg/capita). In terms of yields, America was the leader in 2017, with 80.000 kg/ha, followed by Oceania (70 000 kg/ha), Europe (a bit over 50 000 lg/ha), and Africa (20 000 kg/ha). There has been noticed an increase in corn production, between 2007-17, as a response to increased demand from the livestock sector.

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While the area harvested is the main factor determining crop productions, the adoption of high-yielding varieties, improved availability and agricultural imputs, lead to increased production from increased yields (FAO, 2019). In Romania, in 2018, 2371 thousand ha were cultivated with corn, and had a total production of 18353 thousand tonnes (INS, 2019). Romania's largest corn cultivation zones, with cca. 8 tonnes/ha, are: Great Brăila Island, Bărăgan Southern Plain, Banat Western Plain (Axinte, 2006; Ion, 2010; Muntean et al., 2001).

MATERIALS AND METHODS

A monofactorial experiment was performed, with 6 *Zea mays* L. hybrids, in 4 replications, with technological conditions reccomended by Jităreanu (2009) Săndoiu (2012), Săulescu et al., (1967).

Materials used:

- Surface plots of 45 m^2 (10 m x 4,5 m); protection space width = 3 m; space between repetitions = 2 m; rows between variants = 0,5 m;
- grains from the following hybrids: Dekalb (DKC) 4351, Dekalb (DKC) 4541, Dekalb (DKC) 4943, Kamparis (KWS), Kashmir (KWS) și Karpatis (KWS) (istis catalog, 2019).

Soil works consisted in:

- Autumn plowing at 25-28 cm depth, with aggregate plow with star harrow;
- Before sowing, a disc harrow was applied and the germination bed was prepared with a combine at 4-5 cm depth;
- Sowing was done in the second half of April, at 4-5 cm depth, and with a 75 cm between rows;
- Plant density was of 70.000 plants/ha;
- For the entire vegetation period, the plots were kept free of weeds by specific care works.

Fertilization was done with a complex NPK fertilizer: N = 120 kg/ha, P = 70 kg/ha and K = 60 kg/ha.

Experimental variants with corn hybrids: **V1** - Dekalb (DKC) 4351; **V2** - Dekalb (DKC) 4541; **V3** – Dekalb (DKC) 4943; **V4** – Kamparis (KWS); **V5** - Kashmir (KWS); **V6** – Karpatis (KWS).

Check is reprezented by the average value of the 6 hybrids taken into study.

All hybrids from the current study are recommended for cultivation in crop zones specific for *Zea mays* species, with podzol soils that have a low fertility, in sub-Carpathic hilly areas of Transylvania, North-West Romania, North of Muntenia and Oltenia, Banat Plain, Moldavia, and fertil soils of plains from the south and west parts of Romania.

The results obtained through measurements and laboratory analysis, were processed to determin the average values (Jităreanu, 2009; Jităreanu, 2020; Săndoiu, 2012; Săulescu et al., 1967). The economic calculus was done based on current methodology, using specific formulas (Alecu, 2006).

RESULTS AND DISCUSSIONS

Climatic conditions from 2019

The temperature, precipitations, nebulosity and relative humidity conditions didn't registered significant differences compared to the multiannual averages.

The temperatures during the cultivation period for *Zea mays*, April to September, were slightly over the normal ones, but did not have significant influence over the plant's growth.

Precipitations were, in general, sufficient for the vegetation period, with a little deficit during March-April, and an increase at the end of April and May.

Analysing the climatic conditions of year 2019, they were favorable for cultivation of corn in optimal conditions (Figure 1).

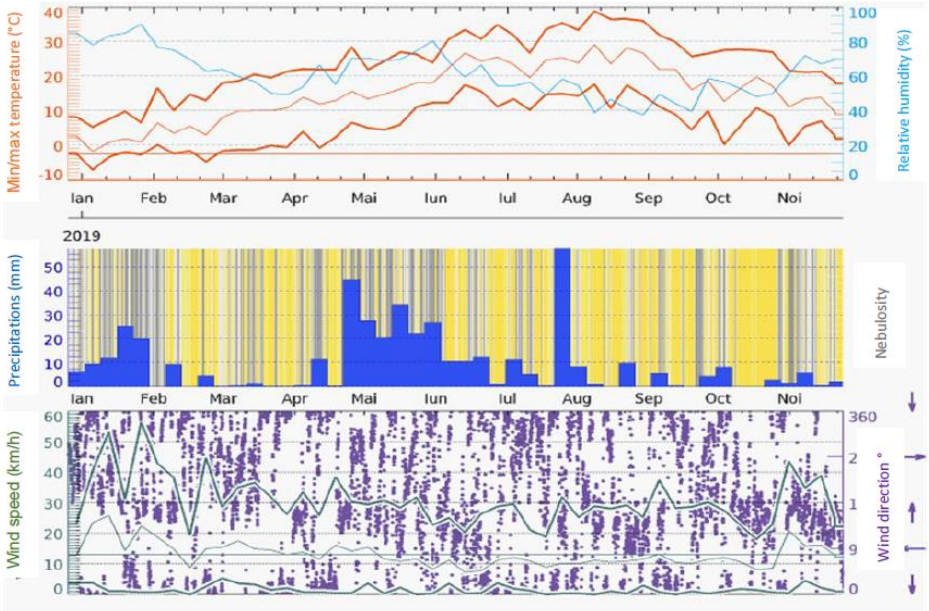

Fig. 1. Average values for temperature and precipitation, between January - December 2019 in Arad area (https://www.meteoblue.com- Arhiva meteo Arad).
Red – min/max temperature (°C), Light blue – relative humidity (%), Dark blue – precipitations (mm), Vertical grey stripes – nebulosity, Green – wind speed (km/h).

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Results

The plant size represents the result of the interaction between the growth potential of the hybrid, and the environmental conditions, along with the genotype's capacity to valorify the phytotechnical factors applied. For the studied hybrids, the plant size was between 230 cm (DKC 4351) and 256 cm (Karpatis), with an average value of 243 cm (check value). Highlighted were the hybrids DKC 4943 with 254 cm, and Kashmir, for which the plants had an average hight of 244 cm. With only 230 cm hight, Kamparis hybrid had the smallest size of all the experimental variants (Table 1).

Table 1

The influence of pedo-climatic conditions over the plant size

No.	Genotype / Hybrid	Plant size (cm)	Difference to mean (cm)
1	Dekalb (DKC) 4351	231	-12
2	Dekalb (DKC) 4541	242	-1
3	Dekalb (DKC) 4943	254	11
4	Kamparis (KWS)	230	-13
5	Kashmir (KWS)	244	1
6	Karpatis (KWS)	256	13
7	Check (mean)	243	-

The studied corn hybrids had over 16 rows of caryopses on one cob, reaching a maximum for the Karpatis type, with 19 rows, on average, for each cob. The smallest number of caryopses rows on a cob were registered for hybrids DKC 4541 and Kamparis, with 16 rows.

Overall, the average value for number of caryosis rows/cob was 17,3 (Table 2).

Table 2

The influence of pedo-climatic conditions over the number of rows with caryopses/cob

No.	Genotype / Hybrid	No. of rows/cob	Difference to mean (piece)
1	Dekalb (DKC) 4351	17	-0,3
2	Dekalb (DKC) 4541	16	-1,3
3	Dekalb (DKC) 4943	18	0,7
4	Kamparis (KWS)	16	-1,3
5	Kashmir (KWS)	18	0,7
6	Karpatis (KWS)	19	1,7
7	Check (mean)	17,3	-

The average number of caryopses on a cob for these corn genotypes was 36,7. Best results were registered for Karpatis and DKC 4943 hybrids, with 38 caryopses/cob, followed by Kashmir type with 37 caryopses/cob.

The smallest number was recorded for DKC 4351, with an average value of 35 caryopses/cob (Table 3).

Table 3

The influence of pedo-climatic conditions over the number of caryopses / cob

No.	Genotype / Hybrid	No. of caryopses/cob	Difference to mean (piece)
1	Dekalb (DKC) 4351	35	-1,7
2	Dekalb (DKC) 4541	36	-0,7
3	Dekalb (DKC) 4943	38	1,3
4	Kamparis (KWS)	36	-0,7
5	Kashmir (KWS)	37	0,3
6	Karpatis (KWS)	38	1,3
7	Check (mean)	36,7	-

The weight of 1000 grains (caryopses) (MMB) was influenced by the genotype's characteristics, as well as by the pedo-climatic and technological conditions, fluctuating between 299 g (DKC 4943 hybrid) and 328 g (Kashmir hybrid).

Large caryorpsis were obtained for hybrids DKC 4541 and Kamparis, where MMB 320 g and 312 g, respectively.

Overall, the caryopses of the analyzed hybrids were well developed, the weight of 1000 grains (MMB) being on average 311,7 g (Table 4).

Table 4

The influence of pedo-climatic conditions over the 1000 kernel wheight (TKW) for *Zea mays* L.

No.	Genotype / hybrid	TKW (g)	Difference to mean (g)
1	Dekalb (DKC) 4351	302	-9,7
2	Dekalb (DKC) 4541	320	8,3
3	Dekalb (DKC) 4943	299	-12,7
4	Kamparis (KWS)	312	0,3
5	Kashmir (KWS)	328	16,3
6	Karpatis (KWS)	309	-2,7
7	Check (mean)	311,7	-

The growth and development of the Zea mays plants was good, which led to a big production of caryopses reported to unit surface, with an average value of 11333 kg/ha.

To be noted that hybrids DKC 4351 and Kamparis registered the lowest grain productions, of only 10503 kg/ha and 10979 kg/ha, respectively.

Hybrids that best adapted to the crop conditions were Kashmir and Karpatis, for which the productions were of 12001 kg/ha and 11798 kg/ha, respectively.

At a closer analysis of the grain production for the experimental variants, it can be noted that all variants obtained good results, an aspect that would recommend their expansion in agricultural crops (Table 5).

Average percentages of proteins in caryopses taken into study were between 10,4% for Kashmir hybrid, and 11,7% for Kamparis. Worth mentioning are also the hybrids DKC 4351 and Karpatis, for with the caryopses registered 11,3% proteins. Average value for experimental variants was 11,1% proteins in their grains (Table 6).

Table 5

The influence of pedo-climatic conditions over the production of kernel for *Zea mays* L.

No.	Genotype	Yield (kg/ha)	Difference to mean (kg/ha)
1	Dekalb (DKC) 4351	10503	-830
2	Dekalb (DKC) 4541	11107	-226
3	Dekalb (DKC) 4943	11612	279
4	Kamparis (KWS)	10979	-345
5	Kashmir (KWS)	12001	668
6	Karpatis (KWS)	11798	465
7	Check (mean)	11333	-

Table 6

The influence of pedo-climatic conditions over the protein content (%) in *Zea mays* L. kernels

No.	Genotype	Protein contents (%)	Difference (%)
1	Dekalb (DKC) 4351	11,3	0,2
2	Dekalb (DKC) 4541	11,1	0,0
3	Dekalb (DKC) 4943	10,8	-0,3
4	Kamparis (KWS)	11,7	0,6
5	Kashmir (KWS)	10,4	-0,7
6	Karpatis (KWS)	11,3	0,2
7	Check (mean)	11,1	-

The content of fats in caryopses for the analyzed hybrids was between 4,52% (DKC 4351), and 4,98%(DKC 4943), with an average value of 4,78%. Good results, that exceeded the witness lot, were obtained for Kashmir (4,96%), Karpatis (4,83%), and Kamparis (4,79%) (Table 7).

Experimental variants registered a close starch content in grains, between 60,1% for Kashmir, and 58,9% for DKC 4351. Significant values were noticed for DKC 4943 and Karpatis, with a starch content that exceeded the one of the witness lot, being 59,9%, and 59,6%, respectively (Table 8).

The economic analysis of the experimental variants showed that they are efficient, the profits were between 1020 euros/ha (DKC 4351) and 2178 euros/ha (Kashmir).

Good results were obtained for the Kashmir crops, with a profit of 1236 euro/ha, and DKC 4943, with 1218 euros/ha.

The results were significant for all experimental variants, the average profit was of 1167 euros/ha, which sustains the adaptation of these hybrids to the given conditions (Table 9).

Table 7

The influence of pedo-climatic conditions over the fat content (%) in *Zea mays* L. caryopses

No.	Genotype / Hybrid	Fat contents (%)	Difference to means (%)
1	Dekalb (DKC) 4351	4,52	-0,26
2	Dekalb (DKC) 4541	4,61	-0,17
3	Dekalb (DKC) 4943	4,98	0,20
4	Kamparis (KWS)	4,79	0,01
5	Kashmir (KWS)	4,96	0,18
6	Karpatis (KWS)	4,83	0,05
7	Check (mean)	4,78	-

Table 8

The influence of pedo-climatic conditions over the starch content (%) in *Zea mays* L. caryopses

No.	Genotype / Hybrid	Starch (%)	Difference to mean (%)
1	Dekalb (DKC) 4351	58,9	-0,4
2	Dekalb (DKC) 4541	59,4	-0,1
3	Dekalb (DKC) 4943	59,9	0,4
4	Kamparis (KWS)	59,3	-0,2
5	Kashmir (KWS)	60,1	0,6
6	Karpatis (KWS)	59,6	0,1
7	Check (mean)	59.5	-

Table 9

The influence of pedo-climatic conditions over the economic efficiency of corn (*Zea mays* L.)

Genotype / Hybrid	Yield (kg/ha)	Value of grain production (euro/ha)	Profit (euro/ha)	Difference to mean (euro/ha)
Dekalb (DKC) 4351	10500	1890	1020	-147
Dekalb (DKC) 4541	11100	1998	1128	-39
Dekalb (DKC) 4943	11600	2088	1218	51
Kamparis (KWS)	10900	1962	1092	-75
Kashmir (KWS)	12100	2178	1308	141
Karpatis (KWS)	11700	2106	1236	69
Check	11317	2037	1167	-

1 kg corn grains = 0,18 euros; Production cost/ha = 870 euros; Profit = production value – production cost.

CONCLUSION

The cultivation of the 6 Zea mays L. hybrids in the soil and climate conditios of Arad area, led to some valuable morpho-physiological characters of all experimental variants.

High yield were obtained for all studied genotypes, especially Kashmir (KWS), for which the quantity of grains reported at surface unit was of 12,001 kg/ha. In the given environmental conditions of Arad area, with productions of over 11600 kg/ha, hybrids Dekalb (DKC) 4943 and Karpatis (KWS) proved to be a viable variant for cultivation in Crișurilor Plains area.

Protein content had small variantions between variants, highest content registered in Kamparis hybrid (11,7%) and lowest in Kashmir (10,4%). Dekalb (DKC) 4943 had the highest fat content (4,98%) and Dekalb (DKC) 4351 had the lowest fat content (4,52%), without significant differences between variants.

The high content of starch obtained from hybrids Dekalb (DKC) 4943 (59,9%), and Kashmir (KWS) (60,1%), makes them a valuable prime material for industry.

From and economic perspective, the best results were obtained for genotype Kashmir (KWS), which for an income of 2178 euros/ha brought a profit of 1308 euros/ha. Following, the genotype Karpatis (KWS), that for an income of 2106 euros/ha, brought a profit of 1236 euros/ha. The least efficient variants, with a profit of 1020 euros/ha, and 1092 euros/ha, respectively, were hybrids Dekalb (DKC) 4351, and Kamparis (KWS).

AUTHORS CONTRIBUTIONS

Conceptualization, U. O. and T. V.; methodology, U. O., U.E..; data collection U. O..; data validation, U.O., T.V. and S.I.; data processing U. O.; writing—original draft preparation, U. O., B. V.; writing—review and editing, B. V.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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