EVALUATION OF GRAIN YIELD AND OF SOME YIELD TRAITS AT DIFFERENT FOREIGN CORN HYBRIDS CULTIVATED ÎN CENTRAL PART OF OLTENIA

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ABSTRACT

The field experiment was conducted during growing season of corn (2019) at the Agricultural Research and Development Station Şimnic - Craiova. This study emphasized on screening different foreign corn hybrids under agro-climatic conditions of Oltenia and to know the adaptability of these hybrids. Twelve foreign corn hybrids (6 of French and 6 of German origin) were evaluated. The yield traits and grain yield were recorded and statistically analysed for comparison amongst the hybrids. The study showed that the corn hybrids within the two sets of different origin (but not between the two sets) were significantly different for all traits analyzed, except for the length of the cob. The highest grain yields among hybrids of French origin were recorded by: ES INVENTIVE (60.74 q/ha) and ES FARADAY (60.02 q/ha) and the highest grain yields among hybrids of German origin were recorded by: KASHMIR (63.79 q/ha), KARPATIS (63.64 q/ha) and BELLAVISTA KXB 643 (63.04 q/ha).

INTRODUCTION

Corn (*Zea mays* L.) is the most important cereal crop in the world, occupying the second place, as cultivated area, after wheat. Globally, it is cultivated on an area of about 194 thousand hectares, the average production being 5.92 t/ha. In Romania, corn is grown annually on an area exceeding 2.4 million hectares, the average production reaching 7.54 t / ha (FAO, 2018).

Oltenia is an important agricultural area where corn is the main agricultural crop. This area is often affected by drought and heat, with only two out of ten years being favourable to crops. A decisive role in defining the corn production capacity in this area is played by the precipitations during the sowing-flowering period and the temperatures during the grain filling period (Bonea, 2020; Bonea and Urechean, 2020). Also,

water, the optimal fertilization and nutrition by macro and micro elements without insufficient or excess stages at the crop favour a normal dynamic of the accumulation of the nutritive elements and dry matter (Mocanu et al., 2012; Prioteasa et al., 2007; 2019).

On the Romanian market there is an extremely diverse offer of Romanian and foreign hybrids, which changes from one year to another, so it is absolutely necessary to know their main agro-productive characteristics, especially in drought conditions.

Corn hybrids can have very different production performances depending on the soil and climatic conditions in different areas.

However, farmers tend to use hybrids available on the market without knowing the adequacy/adaptability of the

hybrid to the location and resources available, which negatively affects the production and its profitability.

Saruhan et al. (2007) consider that genotypes of different origin can achieve higher grain yields than native ones.

The choice of the most appropriate corn hybrid along with other technological factors is the premise of increasing the production of this crop (Haş et al., 2014).

Therefore, this study was undertaken for the comparative evaluation of foreign maize hybrids of different origin, in terms of production potential and morpho-productive characteristics, in the central area of Oltenia.

MATERIAL AND METHODS

The present study was carried out in the climatic conditions of 2019, at the Agricultural Research-Development Station Şimnic, a station located in the central part of Oltenia.

The biological material included two sets of foreign hybrids of different origin, namely corn hybrids of French origin (belonging to the EURALIS Company) and German origin (belonging to the multinational Company KWS), which were obtained from the two companies. A total of 12 hybrids were tested.

The experiments were placed by the randomized block method, on a reddish preluvosol with a moderately acidic soil reaction (pH = 5.08-5.33), with a humus content of 2.23-2.68%, being characterized as poorly supplied with nitrogen (0.071-0.072 mg/kg), well supplied in extractable phosphorus (32.2-52.2 mg/kg) and medium supplied in exchangeable potassium (104-125 mg/kg) (Radu et al., 2019).

The sowing of all hybrids took place on April 10, 2019. Fertilization was performed with 250 kg/ha of complex fertilizers type 7-21-21, and herbicide was performed pre-emergently with DUAL GOLD - 1.5 l/ha.

Biometric determinations were performed on the plant (plant height, cob insertion height) and on the cob (length, number of rows, number of grains/row, total number of grains), thousand grain weight and grain yield was determined at harvest (q/ha).

The statistical processing of the results was done by analyzing the variance (ANOVA) with a single factor and the Duncan test for each set of hybrids, as well as by calculating the correlation coefficients (Săulescu et Săulescu, 1967).

RESULTS AND DISCUSSIONS

Meteorological data from the study year (Table 1) showed that corn hybrids were subjected to drought due to poor rainfall, both in the vegetative and reproductive periods.

The average monthly temperatures in the late grain filling period (August, September) exceeded the multiannual average by +2.6°C and +2.4°C, respectively.

During the reproductive period, maize is very sensitive to lack of water in the soil and to heat (temperatures ≥35 °C), as evidenced by the level of production obtained.

Plant height is an important agronomic feature that plays a significant role in plant fall resistance. Therefore, semi-dwarf plants are desirable, because such plants are more resistant to falling and make more effective use of applied fertilizers.

On the other hand, plant height reflects the behaviour of plants in relation to the availability of essential nutrients, nutritional space, water and

environmental conditions, in addition to genetic characteristics (Gazala et al., 2019).

Analysis of variance for plant height (Table 2) showed significant

differences (p ≤ 0.01) for this trait in all hybrids tested (but not between the two sets).

Table 1

Monthly meteorological data for the growing period at ARDS Simnic, 2019

Climatic elements / period		April	May	June	July	August	September
Precipitation (mm)	The first decade	4.0	10.0	74.0	20.0	9.0	0
	The second decade	25.0	16.0	25.0	12.0	0	0
	The third decade	13.0	6.0	37.0	27.0	0	0
	Total	42.0	32.0	136.0	59.0	9.0	0
	Multiannual average	53.1	71.7	73.6	82.2	47.0	61.8
	Deviation	**-11.1**	**-39.7**	**+ 62.4**	**- 23.2**	**-38.0**	**- 61.8**
Temperatures (°C)	Monthly average	11.9	16.2	22.7	22.9	25.1	20.2
	Multiannual average	12.2	17.5	21.5	23.8	22.5	17.8
	Deviation	**-0.3**	**-1.3**	**-1.2**	**-0.9**	**+2.6**	**+ 2.4**
Hot days (temperatures ≥ 35°C)			0	0	1	1	0
Tropical nights (temperatures ≥ 20°C)			0	0	2	9	0

Among the hybrids of French origin, the plants height varied from 225.0 cm to 325.5 cm with an average value of 286.92 cm. The highest plant height was recorded in the hybrids ES HORNET (325.5 cm), ES LAGOON (314.5 cm) and ES FARADAY (313.5 cm), and the smallest plant height in the hybrid ES GALERY (225.0 cm).

Similarly, in hybrids of German origin, the plants height varied from 243.0 cm to 310.5 cm, with an average value of 283.75 cm. The highest plant height was observed in the KASHMIR hybrid (310.5 cm), closely followed by the KAPITOLIS hybrid (305.5 cm), while the smallest plant height was observed in the KWS 4484 hybrid (243.0 cm).

The insertion height of the main cob is a very important agronomic feature. The larger it is, the more cobs can grow from the nodes below, but at the same time the weight of the cob can bend or even break the stem. Although a small insertion height of the cob is unfavourable for grain yield and makes harvesting difficult, it better protects the stem from excessive weight. Therefore,

the ideal height is an average height (Zsubori et al., 2002).

For the insertion height of the cob, the analysis of variance (Table 2) showed significant differences between tested hybrids (p ≤ 0.01) (but not between the two sets).

In hybrids of French origin, the values for this trait ranged from 88.5 cm to 118.0 cm, with an average value of 108.0 cm. The highest insertion height of the cob was recorded by the hybrids: ES HORNET (118.0 cm), ES INVENTIVE (115.0 cm), ES LAGOON (113.0 cm) and ES FARADAY (112.5 cm), while the lowest height of the insertion was registered by the KERALA hybrid (88.5 cm).

Among the hybrids of German origin, the insertion height of the cob varied from 101.5 cm to 123.5 cm, with an average value of 108.75 cm. The KAPITOLIS hybrid presented the highest value (123.5 cm), and the lowest value for the insertion height was presented by the KWS 4484 hybrid (101.5 cm).

Table 2

The morpho-productive traits of tested corn hybrids

Hybrids	The insertion height of the cob (cm)	Plant height (cm)
Hybrids of French origin		
ES INVENTIVE	115.0 a	272.5 b
ES GALERY	101.0 b	225.0 c
ES FARADAY	112.5 a	313.5 a
KERALA	88.5 c	270.5 b
ES LAGOON	113.0 a	314.5 a
ES HORNET	118.0 a	325.5 a
Average	108.00	286.92
Hybrids of German origin		
BELLAVISTA KXB 6432	102.5 cd	262.5 d
KARPATIS	104.0 cd	284.5 c
SMARAGD	109.5 bc	296.5 b
KASHMIR	111.5 b	310.5 a
KWS 4484	101.5 d	243.0 e
KAPITOLIS	123.5 a	305.5 ab
Average	108.75	283.75

Values followed by different letters are significantly different at $p \leq 0.05\%$

The production capacity is a complex polygenic trait, determined by intrinsic factors (components of production) and influencing factors (resistance to unfavourable action of external factors). Each element of production is in turn a complex quantitative trait, conditioned by both external and hereditary factors (Racz et al., 2014).

In our study, grain yield (Table 3) recorded significant differences between the tested hybrids ($p \leq 0.01$) within each set of hybrids with the same origin, but not between the two sets.

Within the hybrids of French origin, the yield varied from 40.34 q/ha to 60.74 q/ha, with a significant difference of 20.40 q/ha and an average value of 54.90 q/ha.

The hybrids ES INVENTIVE (60.74 q/ha) and ES FARADAY (60.02 q/ha) achieved the highest grain yields, while the hybrid ES GALERY (40.34 q/ha) achieved the lowest grain yield.

Within the hybrids of German origin, the grain yield varied from 49.01 q/ha to 63.64 q/ha, with a significant difference of 14.63 q/ha and an average value of 58.15 q/ha.

The hybrids KASHMIR (63.79 q/ha), KARPATIS (63.64 q/ha) and BELLAVISTA KXB 6432 (63.04 q/ha) recorded the highest yields, while the hybrid KAPITOLIS (49.01 q/ha) recorded the lowest yield.

Similar values for yield of hybrids of different origin cultivated at ARDS Caracal were reported by Mocanu et al., (2009). On the contrary, Bonea and Urechean (2019), reported the yields of 7.7 - 12.09 t/ha for several Romanian hybrids tested in 2019 at ARDS Simnic.

The negative effects of drought after pollination are slightly smaller: four days of permanent wilting at the early ripening stage reduced production by 40% (Petcu, 2008).

Extreme temperatures of 15°C and 35°C recorded during the grain filling period adversely affect the final weight of the grains. This effect was more severe when these temperatures were recorded during the early grain filling period than during the late grain filling period (Jones et al., 1984).

Table 3

Grain yield and yield traits of tested corn hybrids

Hybrids	Grain yield (q/ha)	The length of the cob (cm)	Number of grains on the cob	Thousand grain weight (g)
Hybrids of French origin				
ES INVENTIVE	60.74 a	22.3	602 c	250 b
ES GALERY	40.34 d	19.1	608 c	220 c
ES FARADAY	60.02 a	19.3	544 d	266 a
KERALA	53.10 c	19.0	504 e	270 a
ES LAGOON	58.08 b	21.1	720 a	240 b
ES HORNET	57.14 b	20.2	648 b	274 a
Average	54.90	20.17	604. 33	253.33
Hybrids of German origin				
BELLAVISTA KXB 6432	63.04 a	19.3	820 a	236 bcd
KARPATIS	63.64 a	19.4	672 c	240 bc
SMARAGD	52.93 c	19.0	756 b	226 cd
KASHMIR	63.79 a	19.3	528 e	280 a
KWS 4484	57.01 b	18.4	560 de	250 b
KAPITOLIS	49.01 d	16.2	576 d	220 d
Average	58.15	18.60	652.0	247.0

Values followed by different letters are significantly different at p≤0.05%.

Regarding the length of the cob, it did not register significant differences between the tested hybrids. The average value was 20.17 cm for hybrids of French origin and 18.6 cm for hybrids of German origin (Table 3).

For the total number of grains per cob, the analysis of variance (Table 3) showed significant differences (p≤0.01) in both sets of hybrids, but not between the two sets.

It ranged from 504 to 720, with a significant difference of 216 grains and an average value of 604.33 grains in hybrid of French origin. The ES LAGOON hybrid recorded the highest number of grains (720), while the lowest number of grains was recorded for the KERALA hybrid (504).

Similarly, in hybrids of German origin, the number of grains on cobs ranged from 528 to 820 with a significant difference of 292 grains and an average value of 652.0 grains. The highest number of grains was recorded for the BELLAVISTA KXB 6432 hybrid (820), and the lowest number of grains for the

KASHMIR hybrid (528) was closely followed by the KWS 4484 hybrid (560).

Also, the thousand grain weight showed significant differences among the hybrids tested but not between the two sets (Table 3).

Among the hybrids of French origin, it ranged from 220 g to 274 g, with an average value of 253.33 g. The highest thousand grain weight was recorded by the hybrids ES HORNET (274 g), KERALA (270 g) and ES FARADAY (266 g), while the smallest thousand grain weight was recorded by the hybrid ES GALERY (220 g).

Among the hybrids of German origin, the thousand grain weight ranged from 220 g to 280 g with an average value of 247.0 g. The highest value of the thousand grain weight was recorded by the KASHMIR hybrid (280 g), and the lowest value by the hybrid KAPITOLIS (220 g) followed closely by the hybrid SMARAGD (226 g).

The analysis of correlations (Table 4) showed that there was a positive and significant association between grain

yield and thousand grain weight (0.490**), as well as between grain yield and plant height (0.395*).

Other positive and significant correlations were observed between plant height and thousand grain weight (0.387*)

as well as between plant height and cob insertion height (0.645**).

A significant negative association was observed between thousand grain weight and the number of grains per cob (-0.443°°).

Table 4

Correlations between analyzed yield traits of corn hybrids

Traits	Grain yield	Length of the cob	Number of grains on the cob	Thousand grain weight	Plant height	Insertion height of the cob
Grain yield	1	0.291	0.168	0.490**	0.395*	0.109
Length of the cob		1	0.241	0.235	0.088	0.084
Number of grains on the cob			1	-0.443^{00}	0.039	0.115
Thousand grain weight				1	0.387*	0.018
Plant height					1	0.645**
Insertion height of the cob						1

*, ^{0} : significant for $p \leq 0.05$;   **, ^{oo} : significant for $p \leq 0.01$

CONCLUSIONS

The results of the present study indicated that the corn hybrids within the two sets of different origin (but not between the two sets) were significantly different for all traits analyzed, except for the length of the cob.

The comparative study of the level of grain yield between the two sets of hybrids of different origin showed that

most of them have a good adaptability to the dry conditions from the central part of Oltenia.

The most productive corn hybrids of French origin were the hybrids: ES INVENTIVE and ES FARADAY, and the most productive corn hybrids of German origin were the hybrids: KASHMIR, KARPATIS and BELLAVISTA KXB 6432.

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