Scientific Papers. Series A. Agronomy, Vol. LXII, No. 2, 2019
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

INVESTIGATION OF THE PRODUCTION POSSIBILITY OF EARLY MAIZE HYBRIDS, CULTIVATED FOR GRAIN UNDER NON-IRRIGATION IN NORTH-EAST BULGARIA

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Abstract

The field experiment was held in the experimental of the selected area in Tulenovo village in region Shabla (North-East Bulgaria) during the period 2015-2017. The test was performed by means of a block method with four repetitions; experimental field area - 25 m^2 after winter triticale predecessor. The following hybrids of Syngenta Company were tested; Ambishas, Cansas, Cobalt, Ulises and Iridium. The aim of the study was to establish the elements of productivity and the yield of early maize hybrids, cultivated for grain under non-irrigation in North-East Bulgaria. All the stages of the established technology for maize growing were followed. The grain yield is determined with standard grain moisture of 13%. The indices; length of the cob (cm), number of the row per cob, number of the grains per row, mass of the cob, mass of the grains per cob (g) thousand kernel weight (g), test weight (kg), and grain yield (kg/ha) were determined. The analysis of the results showed that the production possibility of hybrids maize is determined to a great degree by the meteorological conditions of the year mostly by the precipitation quantity. The highest values of elements of productivity were reported with the hybrid Iridium and the lowest - with the Cansas hybrid. On average during the period of the study (2015-2017), the highest grain yield was obtained from Iridium - 8007 kg/ha, followed by Ulises - 7690 kg/ha and the lowest - from hybrid Cansas - 6893 kg/ha. The highest weight of thousand kernel (grain) and test weight of maize grain was reported for Iridium hybrid (367 g and 76.9 kg). Out of the studied maize hybrids grown in the region of North-Eastern Bulgaria, it is recommended to cultivate hybrid Iridium, as it proved to be more productive than hybrids Ambishas, Cansas, Cobalt and Ulises in climatically different years.

Key words*: maize, hybrids, elements of productivity, yield of grain, thousand kernel (grain), test weight.*

INTRODUCTION

The need to diversify and enrich the genetic reserve in the selection practice requires a continuous study of new and world-wide maize hybrids (Chen et al., 2013; Dong et al.,2016; Ilchovska, 2017; Kandil, 2013; Liu, et al., 2012; Popova et al., 2015; Yankov et al., 2014).

This is the subject of thorough and purposeful research on which doesn't cease to work. On the basis of the studies in the proceedings new maize hybrids are included with high genetic potential.

Cultivated in different agro-environmental regions of the country, they are of great interest and have a definite significance of scientific and practical significance. (Delibaltova, 2014; Dimitrova et al., 2013; Niaz et al., 2014; Popova et al., 2012; Zivkov & Matev, 2005). Proper choice of hybrid selection is decisive for the yield value and quality of the harvest product.

This requires the continued introduction of better and stronger hybrids that are most appropriate and effective for individual micro-regions of the country.

A number of scientists (Delibaltova, 2018; Kirchev, 2016; Tsankova et al., 2006) are working on studying the productivity of maize hybrids, recommending the most suitable for growing in the different regions of the country.

The aim of the study was to establish the elements of productivity and the yield of early maize hybrids, cultivated for grain under non - irrigation in North-East Bulgaria.

MATERIALS AND METHODS

The field experiment was held in the experimental of the selected area in Tulenovo village in region Shabla (North-East Bulgaria) during the period 2015-2017. The test was performed by means of a block method with four repetitions; experimental field area - 25 m^2 after winter triticale predecessor. The following

hybrids of Syngenta Company were tested; Ambishas, Cansas, Cobalt, Ulises and Iridium.
The basic of soil treatment includes a reversal of stubble in August at a depth of 10-12 cm and a deeper plow at 28-30 cm in October. Annually, before sowing treatment include of double spring cultivation with harrowing in March and April. Autumn saving fertilization before deep plowing with 25 kg active substance phosphorus (50 kg triple super-phosphate) and before seeded 10.2 kg active substance nitrogen (30 kg ammonium nitrate).
Annually sowing is carried out in the second 10 days of April. The seeds were pre-treated against diseases by the manufacturer Syngenta. Immediately after sowing done rolling the crop. Pesticides were used to control the weeds, diseases and insects. During the vegetation of the corn, two inter-row treatments were carried out. The indices; length of the cob (cm), number of the row per cob, number of the grains per row, mass of the cob, mass of the grains per cob (g) thousand kernel weight (g), test weight (kg), and grain yield (kg/ha) were determined.
For the purpose of determining the quantity dependence between the studied indicators, the experimental data were processed according to the Anova Method of dispersion analysis, and the differences between the variants were determined by means of the Dunkan's Multiple Range Test.

RESULTS AND DISCUSSIONS

The main climatic factors determining growth and yield of maize are temperature and rainfall as it is combining and distributed during the vegetation period. The analysis of these factors shows that in the three years of the study (2015-2017), average monthly temperatures have similar values and meet fully the requirements the maize of heat from sowing to harvesting, while the amount and distribution of rainfall varies during in the different years.
In 2016, rainfall in the April-September period was 244.3 mm, i.e. values lower (by 42.6 mm) than the multi-year period (287.0 mm) and too unevenly distributed.
In the period April-June the amount of rainfall was significantly - 193.5 mm, which gave hopes for a year with high yields in maize - yields to offset favourable purchase prices. But at the end of June almost everywhere drought began, drought exceeded two months, as from June temperatures reached 28-29°C and in July even 40°C. During the growth phases, rainfall was almost lacking, and the temperature was over 35°C, which adversely affected the growth processes and yields of corn plants. In 2015, the amount of rainfall during the maize growing season was 337.7 mm at 319.6 mm for the multi-year period or 26 mm more than 2016. The last year of the survey (2017) is characterized by a higher sum of rainfall than the previous one - 368.7 mm.
Of the three years of study, the most favourable for maize in 2017, follows in 2015 and less favourable in 2016. The resulting averages for the structural elements of the extraction is presented in Table 1. The results show that these indicators change under the influence of meteorological factors during the survey years.
The highest values of the main structural elements of the yield were reported in 2017, followed in 2015, and the lowest in 2016. From the studied hybrids Iridium is distinguished from the others with longer cobs, with more rows and grains in the cob, as well as with a larger mass of cobs and grains.
The highest values of the main structural elements of the yield were reported in 2017, followed in 2015, and the lowest in 2016. From the studied hybrids Iridium is distinguished from the others with longer cobs, with more rows and grains in the cob, as well with a larger mass of cobs and grains. Average for the period of study length of the cob in hybrid Iridium is 18.0 cm and superior hybrids Ulises and Cobalt 5.3%, Ambishas with 14.6% and 20.0% in Cansas. In favourable for the growth and development of plants were recorded at 2017 - high values of number of grains in a row they range from 28.0 pcs. with hybrid Cansas up to 42.0 at - Iridium. Hybrid Ulises superior hybrids Cobalt and Ambishas by 11.8 and 26.7%, and hybrid Kansas 35.7% but inferior to Iridium 10.5%. In 2016, the maize hybrids tested produced a smaller number of grains in a row compared to the previous one. This indicator ranges from 24.0 to 32.0, i.e. from 16.7% to 31.2% lower. In the first year of the study maize hybrids formed from 26.0 to 38.0 grains per line and exceeded 8.3 to 18.7%

obtained in 2016 but declined from 10.5 to 16.5% of those in 2017. On average over the test period, a large number of grains in a row realized the Hybrid Iridium - 37.3 pcs followed by Ulises- 34.0 pcs and the lowest value was recorded in the Cansas hybrid - 26.0 pcs. The indicator table on the ear in the test hybrid is amended during the years, ranging from 160 g to 200 g in 2015, from 140 to 240 in 2016 and from 170 to 270 g in 2017 The values of this parameter are highest in hybrid Iridium, and the lowest at Cansas.

Table 1. Structural elements of the yield

		Length of the cob, cm	Number of the row per cob	Number of the grains per row	Mass of the cob	Mass of the grains per cob, g
Years (A)	2015	16.6^{b}	15.8^{b}	32.6^{b}	194.0^{b}	167.0^{b}
	2016	15.4^{a}	13.8^{a}	27.2^{a}	180.4^{a}	147.0^{a}
	2017	17.8^{c}	16.3^{c}	34.4^{c}	210.2^{c}	176.0^{c}
Hybrid (B)	Ambishas	15,7	14.5	28,7	173.0	140.0
	Canzas	15,0	13.4	26,0	157.0	128.0
	Cobalt	17,0	15.2	31,0	183.0	148.0
	Ulises	17,3	16.0	34,0	204.0	177.0
	Iriduun	18,0	17.3	37,3	257.0	225.0
2015	Ambishas	15,5^{a}	15,0^{ab}	30,0^{b}	170^{b}	140^{a}
	Canzas	15,0^{a}	14,0^{a}	26,0^{a}	160^{a}	135^{a}
	Cobalt	17,0^{b}	15,5^{b}	33,0^{c}	180^{c}	150^{b}
	Ulises	17,5^{bc}	16,5^{b}	36,0^{d}	200^{d}	180^{c}
	Iriduun	18,0^{c}	18,0^{c}	38,0^{d}	260^{e}	230^{d}
2016	Ambishas	14,5^{b}	13,0^{b}	26,0^{b}	160^{b}	130^{b}
	Canzas	14,0^{a}	12,0^{a}	24,0^{a}	140^{a}	110^{a}
	Cobalt	16,0^{c}	14,0^{c}	26,0^{b}	170^{c}	135^{b}
	Ulises	16,0^{c}	14,0^{c}	28,0^{c}	192^{d}	160^{c}
	Iriduun	16,5^{d}	16,0^{d}	32,0^{d}	240^{e}	200^{d}
2017	Ambishas	17,0^{b}	15,5^{a}	30,0^{b}	190^{b}	150^{b}
	Canzas	16,0^{a}	14,3^{ab}	28,0^{a}	170^{a}	140^{a}
	Cobalt	18,0^{c}	16,0^{ab}	34,0^{c}	200^{c}	160^{c}
	Ulises	18,5^{cd}	17,5^{bc}	38,0^{d}	220^{d}	190^{d}
	Iriduun	19,5^{d}	18,0^{c}	42,0^{e}	270^{e}	244^{e}
Anova	A	*	*	**	**	**
	B	*	*	**	**	**
	AB	n.s	n.s	*	n.s	n.s

*Means within columns followed by different lowercase letters are significantly different (P<0.05) according to the LSD test
* F-test significant at P<0.05; ** F-test significant at P<0.01;
ns - non-significant

On average, for the period 2014-2016, the mass of the cat in the hybrids studied ranges from 157 to 257 g. Hybrid Iridium exceed 48 g, 77 g, 85 g and 97 g in the values of this parameter hybrids Ulises, Cobalt, Ambishas and Cansas. Differences in climatic conditions during the years of the experiment are one of the reasons for the formation of grains of different mass. In the second year of study (2016), due to insufficient moisture in maize growing, the grain mass in the hull varies from 110 g in the Cansas hybrid to 200 g at Iridium. In the first experimental year, which is favourable for the growth and development of corn plants, this indicator ranges from 135 g to 230 g in the hybrids under study, or 15% to 23% more than in 2016. The third experimental year, the most corn-friendly corn, the grain mass in the cob ranges from 140 g in the Cansas hybrid to 244 g at - Iridium.

Intermediate for the experimental period, the Iridium hybrid formed with 48 g, 77 g, 85 g, and 97 g greater grain mass in the coke compared to Ulises, Cobalt, Ambishas and Cansas respectively.

The results obtained for the grain yield of the maize hybrids tested show that both the productivity components and the values of this indicator vary depending on the weather conditions during the experiment years (Table 2). Falling vegetation rainfall, their good distribution and combined with monthly average temperatures favour higher grain yields in 2017 compared to 2015 and 2016.

During the last experimental year, this indicator is 9.7% and 4.0% higher than the second and first business year.

In 2017, the highest yield was statistically proven from the Iridium hybrid - 8160 kg/ha, followed by Ulises (8040 kg/ha) and Cobalt (7990 kg/ha), and the lowest - from Cansas (7170 kg/ha).

Table 2. Grain yield, kg/ha

Hybrid	Years of study			Average for the period kg/ha
	2015 kg/ha	2016 kg/ha	2017 kg/ha	
Ambishas	7320^{b}	6750^{b}	7710^{b}	7260
Canzas	7010^{a}	6500^{a}	7170^{a}	6893
Cobalt	7460^{c}	7260^{c}	7990^{c}	7570
Ulises	7680^{d}	7350^{d}	8040^{d}	7690
Iriduun	8100^{e}	7760^{e}	8160^{e}	8007
Mean values for Years	7514	7124	7814	7484

* Means within columns followed by different lowercase letters are significantly different (P<0.05) according to the LSD test

The uneven distribution of rainfall during the 2016 vegetation and especially its shortage during the collapse and harvesting of corn are the reason for the reported lower grain yields

compared to the others included in the experiment. In test hybrids, they range from 6500 to 7760 kg/ha. This year's hybrid, Ulises, has proven to outperform Ambishas and Cobalt by 8.9 and 2.1%, but yields to Iridium by 5.6%. It is mathematically proven that the Iridium hybrid was obtained on average 11.4% higher than the others. The lowest grain yield was obtained from the Cansas hybrid.

In the first year of experience (2015), grain yields are in the range of 7010 to 8100 kg/ha, i.e. up to 390 kg/ha more than in 2016. The highest yield is realized by hybrid Iridium and proven superior to 420, 640, 780 and 1090 kg/ha hybrids Ulises, Cobalt, Ambishas and Cansas, respectively.

Average for the period of examination of the tested hybrids at - high yield is Iridium and realized grain yield to 8007 kg/ha he is superior to 4.1, 5.8 and about 10.3% hybrids Ulises, Cobalt and Ambishas, and the - or low-yield is Cansas (6893 kg/ha). This hybrid is statistically proven by the hybrids - Iridium with 16.2%, Ulises with 11.6%, Cobalt with 9.8 and Ambishas with 5.3%. The grain yield dispersion analysis showed a strongly statistically proven influence of both the genetic hybrids of the hybrids and the years with their specific climatic conditions (Table 3). There is also a well-proven interaction between Hybrid and Year.

Table 3. Analysis of variance ANOVA

Source of Variation	Sum of Square	df	Mean Square	F	P-value	F crit
Years**	4908790	2	2454395	246,6591	0,000	3,204317
Hybrid**	9104407	4	2276102	228,7412	0,000	2,578739
Interactions**	481443,3	8	60180,42	6,047945	0,000	2,152133
Within	447775	45	9950,556			

* F-test significant at P<0.05; ** F-test significant at P<0.01; ns - non-significant

Table 4 presents the mass data per 1000 grains and the specific mass over the years of testing and averaged over the period. The results show that these indicators are influenced by both the genetic hybrids and the climatic conditions of the year. Not so favourable for the development of corn in 2016, created the preconditions mass of 1000 grains range from 240 g in hybrid Ambishas to 350 g at - Iridium, while in 2015 the values of this indicator are on average 5.8% higher. The highest mass of 1000 grains tested hybrids in 2017 from 260 to 380 g.

Table 4. Physical properties of the grain

Hybrid	Thousand kernel (grain) weight, g				Test weight, kg			
	Years of study			Average	Years of study			Average
	2015	2016	2017		2015	2016	2017	
Ambishas	254^{a}	240^{a}	260^{a}	251	71,4^{a}	61,8^{a}	73,8^{b}	69,9
Canzas	300^{b}	280^{b}	315^{b}	298	71,7^{a}	57,2^{a}	72,0^{a}	67,0
Cobalt	335^{c}	320^{c}	340^{c}	332	75,4^{b}	68,2^{b}	76,0^{c}	73,2
Ulises	350^{c}	340^{d}	355^{d}	348	74,7^{b}	66,0^{b}	75,2^{c}	72,0
Iriduun	370^{d}	350^{a}	380^{a}	367	77,0^{c}	75,4^{c}	78,3^{d}	76,9
Mean values for Years	322	306	330	319	74.0	65.7	75.1	71.6

*Means within columns followed by different lowercase letters are significantly different
(P<0.05) according to the LSD test

During the period of the 2015-2017 experience with the wholesale grain features hybrid Iridium (367 g), followed hybrids Ulises (348 g), Cobalt (332 g) and Cansas (298 g). The smallest grains formed hybrid Ambishas.

The results of the ANOVA for the effects of the factors and their interaction on the physical characteristics of the grain are shown in Table 5. For the indicator "mass of 1000 grains" are accounted for reliable variance factors - year and hybrid reliability of p≤0.01 and the interaction between the two.

Table 5. Analysis of variance ANOVA

	Source of Variation	Sum of Square	df	Mean Square	F	P-value	F crit
Thousand kernel (grain) weight, g	Years**	5878,63	2	2939,32	13,4526	0,000	3,20432
	Hybrid**	100134	4	25033,5	114,573	0,000	2,57874
	Interactions n.s	511,2	8	63,9	0,29246	0,965	2,15213
	Within	9832,25	45	218,494			
Test weight, kg	Years**	1028,272	2	514,136	703,4928	0,000	3,204317
	Hybrid**	704,465	4	176,116	240,98	0,000	2,578739
	Interactions *	214,228	8	26,7785	36,64105	0,000	2,152133
	Within	32,8875	45	0,730833		0,000	3,204317

* F-test significant at P<0.05; ** F-test significant at P<0.01; ns - non-significant

The results of the analyses of the data on the hectolitre mass show that the most significant influence on the variation of the trait was the hybrid and the conditions of the year. The interaction of the two factors is less pronounced, p≤0.05

CONCLUSIONS

The highest values of elements of productivity (length of the cob, number of the row per cob, number of the grains per row, mass of the cob and mass of the grains per cob) were reported with the hybrid Iridium and the lowest - with the Cansas hybrid.

On average during the period of the study (2015-2017), the highest grain yield was

obtained from Iridium - 8007 kg/ha, followed by Ulises - 7690 kg/ha and the lowest - from hybrid Cansas - 6893 kg/ha.

The highest weight of thousand kernel (grain) and test weight of maize grain was reported for Iridium hybrid (367 g and 76.9 kg).

Out of the studied maize hybrids grown in the region of North-Eastern Bulgaria, it is recommended to cultivate hybrid Iridium, as it proved to be more productive than hybrids Ambishas, Cansas, Cobalt and Ulises in climatically different years.

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