COMPARATIVE STUDY OF EARLY AND MID-EARLY GRAIN MAIZE HYBRIDS IN THE CONDITIONS OF SOUTHERN DOBROGEA.

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***Abstract**: The experiment was conducted through the period 2007 - 2009 in the region of the town Gen. Toshevo, Dobrogea, Bulgaria. The test was conducted in block method in four repetitions with size of the experimental plot - 25 m2. The tested corn hybrids are divided into 2 groups – early (FAO 200-299) and mid-early (FAO 300-399). In years with unfavorable weather conditions, grain yields were almost equal in both maize groups. In years with favorable conditions for development of the crop, yields on mid-early hybrids have proven different, but early hybrids did not show different productivity. The height of formation of the first cob is affected to a greater extent on the conditions of the year. At high temperatures and drought, due to the early development of the culture, the index is at lower values. In comparison with a year, where the genotype has less influence. Early hybrids released moisture more rapidly, especially in hot and dry conditions and are harvested at a lower moisture level than the standard. Middle-early hybrids were harvested at higher moisture than standard 13%.*

***Key words:** maize, Dobrogea, yield, grain moisture.*

INTRODUCTION

Maize (*Zea mays* L.) is an agricultural cereal crop grown mainly for grain, green fodder and silage. The annual stable yields of maize grain depend both on the specific meteorological conditions during the respective economic year and on the used agronomy practices for growing of the crop (YANKOV ET AL., 2014).

Specifics of weather in maize growing in Dobrogea is mainly related to the available soil and air moisture, needed for building of the crop because of the inability to irrigate crops in the region (DRAGOMIR AND PARTAL, 2014; DELIBALTOVA, 2009). This requires the production of corn to rely solely on rainfall. The cultivation of corn without irrigation overall in this agroclimatic regions is possible because of the proximity of the Black Sea and the flat nature of the region. This is the main reason for the high air moisture during the growing season, which somewhat provides the water regime of the culture (CIOCAZANU ET AL., 1995; POPESCU, 1994; HAS ET AL., 2012; POPOVA ET AL., 2015).

MATERIAL AND METHODS

Plan material.

The experiment was conducted through the period 2007 - 2009 in the region of the town Gen. Toshevo, Dobrogea, Bulgaria.The test was conducted in block method in four repetitions with size of the experimental plot - 25 m^2. The tested corn hybrids are divided into 2 groups:

(i) Early (FAO 200-299) – Valuta (standard) Pioneer, USA; Anjou 292(standard) Limagrain, France; KXA 5373 - KWS, Germany; KXA 2347 - KWS, Germany; KXA 7461 - KWS, Germany

(ii) Mid-early (FAO 300-399) – Clarica (standard) Pioneer, USA; Furio (standard) Syngenta, Switzerland; KXA 5374 - KWS, Germany; KXA 5383 - KWS, Germany; KXA 5387 - KWS, Germany

Tested indicators.

Determined are inter-phase germination periods - silking and silking - maturity, the sum between them represent the number of days needed for the total vegetation of culture.

Grain yield is reported from representative plots with size of the harvest area of 15 m^2 standard equated to 13% moisture, determined the height of the first cob. Moisture at harvest, presented in %, is determined by grain moisture meter.

For following proven quantitative and qualitative changes of the studied signs among hybrids was performed dispersion analysis. Statistical package SPSS version 16.0 has been used.

Soil and climatic conditions

Southern Dobrogea occupies the northeastern part of Bulgaria and is bordered on the north by Romania, on the east by the Black Sea to the west with Ludogorsko plateau and south valley of Varna-Provadian area. In geographical terms it represents the southern part of the Dobrogea plateau, which continues north in Romania to the Danube Delta. Dobrich Province is located in the northeastern part of Bulgaria and falls within the European continental climatic zone, temperate continental climatic zone and eastern climatic region of the Danube Valley and the North Coast. Predominantly in the area have an average powerful typical, leached chernozems. Groundwater are very deep and can reach depth of 50-80 m.

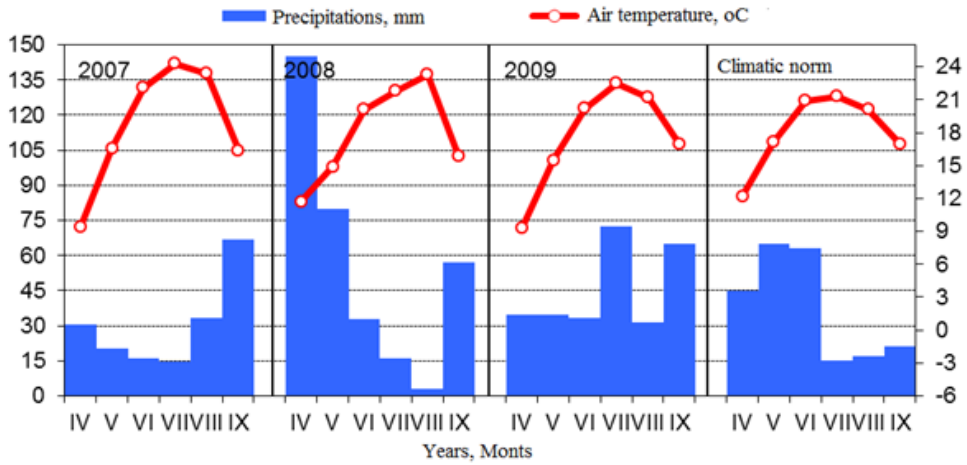

Figure 1. Meteorology conditions (climograph) of the studied years.

Especially specific in terms of climate is 2007. It was characterized by very low rainfall as in the spring and during the active growing season combined with high temperatures. The second year of the study was characterized by high rainfall and low temperatures in the beginning of the corn vegetation. In 2009, rainfall was fairly evenly enough for the development of the culture.

RESULTS AND DISCUSSION

Phenological development of maize is described as a termed inter-phase periods germination - silking and silking – maturity. The sum between them represent the number of days for total vegetation of culture (Fig. 2). Inter-phase period germination - silking of corn hybrids in the early group (FAO 200-299) ranges between 45 days during the dry 2007, while the difference in 2008 and 2009 was only one day because of the close climatic conditions of these two years during the months and these phases that occur in the corn development.

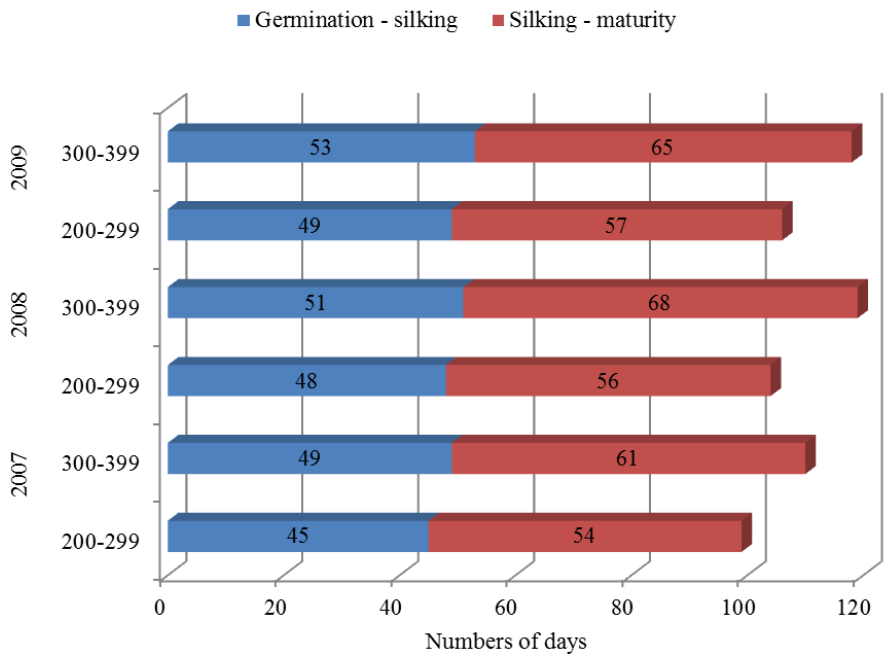

Figure 2. Vegetation period of early and medium early corn hybrids.

At the medium early hybrids (FAO 300-399) group silking stage occurs later compared to earlier hybrids per year as follows: four days in 2007, three days in 2008, four days in 2009. These results indicate that the silking stage in maize occurs at the same time regardless of the precipitation and temperature conditions of the year and the greater difference (3-4 days) between the two groups of hybrids indicate that the role of the genotype is determinative in respect to the occurrence of silking stage.

Inter-phase period silking - maturity is shorter in early hybrids - 54 days in 2007, 56 days in 2008 and 57 days in 2009. In mid-early hybrids the same period was as the shortest in 2007 - 61 days, and the longest in the second year of the study - 68 days. Despite the differences in the years, like inter-phase period germination - silking differences between the two groups is greater than the differences between the years of study.

The total vegetation of the maize, defined as the sum of days from germination to maturity is shorter in the early hybrids and maturity at medium early hybrids occurs 13 days later, on average for 3 years. To establish the influence of agro-climatic conditions on the duration of the growing season of maize, the number of days from germination to maturity are averaged for all hybrids in the years. The length of the vegetation period is the shortest in the first year of the study, characterized by extreme droughts - 104 days. The remaining two years of the study (2008 and 2009) have relatively equal rainfall and temperature conditions during the vegetation of the culture, which is the reason that the maturity occurs in 112 days after corn emergence. Comparing the two inter-phase periods, defining the overall growing season for maize, with a greater proportion determining the total vegetation belongs to inter-phase period silking - maturity - 60 days on average for all hybrids for the period of three years against inter-

phase period germination - silking, with an average duration of 49 days on average for all of the tested hybrids.

Table 1.

Grain yield from early mature corn hybrids (FAO 200-299), kg/da.

Hybrids		Years			Average
		2007	2008	2009	
Valuta		129	815	832	592
Anjou 292		125	800	807	577
KXA 5373		177***	818	865 **	620*
KX 2347		155*	773	857 **	595
KXA 7461		171**	813	853 *	612
LSD	5%	28,7	38,2	39,4	35,4
	1%	38,5	50,9	51,8	47,1
	0,1%	50,7	66,3	67,7	61,6

*,**,*** - Significance at P= 5, 1 and 0,1%

Grain yields are compared with conventional FAO standards for the relevant group. The reason for the separate comparison of the two groups of FAO is the well known fact that early hybrids shown low productive potential compared to the medium early hybrids. This requires them to compare them separately.

Table 2.

Grain yield from middle-early mature corn hybrids (FAO 300-399), kg/da.

Hybrids		Years			Average
		2007	2008	2009	
Valuta		193	867	1050	703
Anjou 292		245	854	1040	713
KXA 5373		187	913**	1100**	733
KX 2347		292***	918**	1138***	783***
KXA 7461		263***	887	1058	736
LSD	5%	30,2	40,4	45,5	38,7
	1%	41,1	54,2	55,7	50,3
	0,1%	52,4	68,7	69,3	63,5

*,**,*** - Significance at P= 5, 1 and 0,1%

Since maize was grown without irrigation, in early hybrids during the first year of the study, characterized by extreme drought yields did not exceed 177 kg / da. The highest yield in 2007 was derived from hybrid KXA 5373. The lowest yields in the first year of the study were obtained from the standards of this group Valuta (129 kg/da) and Anjou 292 (125 kg/da). In 2008, the productivity of the tested hybrids were similar and differences in grain yield between hybrids was statistically unproven. This indicates that under the climatic conditions of this year hybrids did not show different productivity in spite of the relatively high yields on average per the year. In 2009 the highest yield was obtained from hybrid KXA 5373-865 kg/da, and the lowest yields in the third year of the study were obtained from standards Anjou 292 (807 kg/da) and Valuta (832 kg/da). Average for the three years of the study the highest yield obtained from hybrid KXA 5373 - 620 kg/da and hybrids KXA 2347 and KXA 7461 compared with the standard could not prove differences in yield.

Grain yields of mid-early corn hybrids in 2007 did not exceed 292 kg/da, because of the drought combined with high temperatures. The highest yield for the year was derived from hybrid KXA 5383, compared with the standard Clarica, the difference in yield is proven in confidence level 0.1%. The lowest yield in the first year of the study was obtained from hybrid

KXA 5374, but the difference compared to the standard is unproven. In 2008 there is a large amount of rainfall and the optimum temperature for development during the growing season of maize. During this year hybrid KXA 5383 had the highest yield, followed by hybrid KXA 5374. Compared with the standard Clarica, they have a confidence level of 1%. With no evidence of a difference to the standard was the hybrid KXA 5387. In the last year of the study climatic conditions were good for cultivation of the crop as a result of which yields were the highest of the three years of the study. The values of yields in all tested hybrids exceeded 1000 kg/da, and the best - performing hybrids showed KXA 5383 (1138 kg/da). Average for the period 2007-2009 in the group of medium early hybrids the lower grain yield was obtained from standard Clarica - 703 kg / da, and the higher from KXA 5383-783 kg / da.

Table 3.

Height of the first cob, cm

Hybrids	2007	2008	2009	Average
Early mature corn hybrids (FAO 200-299)				
Valuta	55,2a	87,2b	89,7b	77,4a
Anjou 292	57,2a	88,7b	90,2b	78,7a
KXA 5373	60,3b	89,0b	90,8b	80,0b
KX 2347	57,8a	84,5a	85,2a	75,8a
KXA 7461	59,8b	87,6b	88,6b	78,7a
Mid-early mature corn hybrids (FAO 300-399)				
Clarica	60,3c	88,7a	89,7a	79,6a
Furio	61,2c	89,1a	90,9a	80,4b
KXA 5374	58,2b	87,5a	88,6a	78,1a
KXA 5383	51,4a	92,3b	93,2b	79,0a
KXA 5387	53,2a	93,4b	95,2c	80,6b

*Values with the same letters do not differ significantly

The indicator height of the first cob is essential when choosing a hybrid. Mainly on this indicator depends the stability of the crop and its resistance to lodging. In early hybrids height of the cob in 2007 ranged 55,2 cm for Valuta and 60,3 cm for KXA 5373. This low height was determined by unfavorable weather conditions - extreme drought accompanied by high air temperatures. In 2008 the cobs were formed higher, due to more favorable weather conditions - high amount of rainfall. The standard Valuta was with the lowest cob height -87,2 cm, compared with KXA 5373 – 89,0cm. In the last year of the study values of the cob height were similar to previous 2008, due to close weather conditions. Average for the three years investigated earlier hybrids establish that the standard Valuta formed the cob with the lowest height of 77,4 cm, and hybrid KXA 5373 – 80,0 cm. On mid-early hybrids parallel differences in various years were observed.

Table 4.

Grain moisture at harvest, %

Hybrids	2007	2008	2009	Average
Early mature corn hybrids (FAO 200-299)				
Valuta	12,3	14,3	15,7	14,1
Anjou 292	12,4	14,7	15,4	14,2
KXA 5373	12,3	14,1	15,4	13,9
KX 2347	12,6	14.2	15,5	14,1
KXA 7461	12,7	14.4	15,8	14,3
Mid-early mature corn hybrids (FAO 300-399)				
Clarica	15,4	17,3	18,2	17,0
Furio	15,6	17,2	17,8	16,9
KXA 5374	15,7	17,5	18,3	17,2
KXA 5383	15,2	17,3	17,8	16,8
KXA 5387	15,8	17,6	17,9	17,1

Grain moisture is an important indicator to determine the time of harvest. This indicator largely determines the price of maize as a commercial product. In all cases, corn harvested at moisture above the standard (13%) has a lower cost. Moisture depends on the length of the vegetation period and the climatic conditions in the region. In 2007, all explored early hybrids were harvested with low moisture content of grain from the standard 13%. The lowest moisture content of grain in this year showed hybrid KXA 5373 compared with the standard Valuta with value of 12,3%. These dues to the conditions of the year - little rainfall and high temperatures. The highest moisture measured in 2008 was in the standard Anjou 292 - 14.7% and the lowest in hybrid KXA 5373 -14.1%. This is due to the high moisture and lower temperature during the growing season. 2009 was favorable for the development of maize. The lowest moisture was measured in the standard Anjou 292 -15.4% and hybrid KXA 7461 - 15.8%. This high moisture due to rainfall fell immediately before the period of harvesting. Average for the first three years in the early hybrids, there are no extreme variation in moisture of grain corn. This is due to the lack of rainfall in 2007. Despite the dry and hot 2007 medium early hybrids moisture of the grain is higher than the standard, and in none of them was less than 15%. The mid-early hybrids were characterized by high moisture due to the late ripening. Hybrid KXA 5383 has 15.2% moisture, which is the lowest value in 2007. In 2008 hybrid KXA 5387 is up to 17.6% and standard Furio - 17,2%. The standard Furio and hybrid KXA 5383 were with the lowest moisture - 17.8%, and by hybrid KXA 5374 it raised up to 18.3% in 2009. Average for the three years moisture of hybrid KXA 5383 was 16.8%, and hybrid KXA 5374 -17.2%.

CONCLUSIONS

Silking stage in maize occurs at the same time regardless of the conditions of the year and the genotype has a stronger influence on the occurrence of silking.

In years with unfavorable weather conditions, grain yields were almost equal in both maize groups. In years with favorable conditions for development of the crop, yields on mid-early hybrids have proven different, but early hybrids did not show different productivity.

The height of formation of the first cob is affected to a greater extent on the conditions of the year. At high temperatures and drought, due to the early development of the culture, the index is at lower values. In comparison with a year, where the genotype has less influence.

Early hybrids released moisture more rapidly, especially in hot and dry conditions and are harvested at a lower moisture level than the standard. Middle-early hybrids were harvested at higher moisture than standard 13%.

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