The Genetic Progress Realized in the Creation of Maize Hybrids at the A.R.D.S. Turda

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ABSTRACT

This paper presents the study of the maize hybrids created at A.R.D.S. Turda that belongs to three vegetation period: very early, early and semi-early. The hybrids were studied in three experiences: PG 1, PG 2, PG 3 in 2011 and 2012. The climatic conditions of the 2011 and 2012 years were totally different for the maize crop: the year 2011 can be considered in terms of the rainfall as very favourable for the maize crop, while the year 2012 was a particularly dry year. There were studied hybrids from each group by comparison to the older released hybrid in order to observe the progress made in the breeding process for maize hybrids production, for stalking resistance and also precocity. For the characterization of the hybrids there were also followed other characters such as a thousand grain weight, silking data, physiological maturity date, the type of maturation, *Ostrinia nubilalis* attack resistance, hectolitre weight. Higher yield ability and better resistance to lodging was observed for the following hybrids included in the study: Turda SU 182 (very early hybrid), Turda Mold 188 (early hybrid), Turda Favorit and Turda Star (semi early hybrids). On the latest hybrids created at A.R.D.S. Turda it was noticed an improved resistance to lodging and stalking, but with a slight extension of the period of vegetation.

Keywords: *hybrid, production capacity, physiological maturity*

INTRODUCTION

Annually in Romania the maize crop occupies over 2,5 million hectares, this being the highest surface in the EU area, the cultivated areas being relative. The need to get higher productions in maize, but also constant productions, undertakes the scientific research to provide growers competitive maize hybrids and also seed with high genetic value.

The pedoclimatic conditions in the centre of the country require the cultivation of a wider range of hybrids, from the semi early hybrids to the group of very-early hybrids.

In the last 10 years (1991-2011) (Grecu *et al.*, 2011) the climatic characteristics from the central and northern Romania changed by higher average temperature than the multiannual average of 9°C

(1957-2010) as well as by the alternation between periods (May-June) with low temperatures and heavy rainfall up to flowering phenophase and the appearance of stigmata, followed by (July) high temperatures (above normal), soil drought and atmospheric drought especially during pollination and grain filling period. Also the climatic characteristics changed through the appearance of favourable conditions for breaking strains in autumn and cobs infected with *Fusarium* (rainfall, high relative humidity, high diurnal temperature amplitudes) (Haș, 2001).

The genetic progress in maize breeding has become a common practice for most breeding centres including ARDS Turda because it offers the opportunity to estimate the stage it reached and

allows the taking of some decisions in the creation of hybrids in the future.

The grain yield undoubtedly remains a feature subjected to study (Russell, 1979; Căbulea and Grecu, 1982; Russell, 1986; Cosmin *et al.*, 1987; Grecu and Căbulea, 1989).

Also attention has given to other important features as plant resistance to breaking and falling when harvesting and to the production elements of cobs and grains that contribute to the formation of the harvest.

MATERIALS AND METHODS

The biological material consisted in 12 hybrids of maize that were certified and created at A.R.D.S. Turda. The hybrids were experimented in three cultures PG 1, PG 2, PG 3 in two experimental years 2011 and 2012 (Tab. 1).

The hybrids were grouped based on the experiences of the growing season. The experimental plots were placed in the blocks method, in three replicates at a density of 70,000 plants / ha.

The experimental data was assessed using the analysis of variance specific to the experiences with one or two factors. The interpretation of the data was made using the program Polifact.

The production stability analysis was done on all three groups of precocity by interpreting the genotypic adaptability depending on the regression coefficient and the average production.

This paper compares the production capacity and production elements of maize hybrids homologated at ARDS Turda belonging to different groups of precocity

RESULTS AND DISCUSSION

The production capacity and some yield components differed being closed related with the vegetation period. The hybrids with a longer vegetation period (FAO 300-400) achieved higher productions values compared to the hybrids with lower vegetation period (PG-1: 5830 kg/ha; PG-2: 6780 kg/ha; PG-3: 7242 kg/ha). In this group of hybrids in order to achieve the production of grains, the mass of a thousand grains, the yield and the better breaking plant resistance at harvest had a favourable contribution but also the grain moisture at harvest was higher.

After analyzing the data from table 2 we can see that the maize hybrids from very early group to early group recorded significant genetic progress, simultaneously, for all the three major features in the characterization of a hybrid (grain yield, earliness and resistance to breaking strains). Particularly the SU Turda 182 stands out, by exceeding the control hybrid Turda 200 in the two years of experimentation, both in their production capacity and also in the other two characteristics observed, as reflected by the selection index 109%/2011 and 127%/2012.

In 2012, the SU 182 Turda hybrid significantly exceeded the production of the control hybrid

Tab. 1. The hybrids taken under study

The experience	Hybrid	Type of hybrid	Year of certification
PG 1	Turda 200 (control)	Double	1976
	Turda 100	Double	1979
	Turda SU 181	Simple	2000
	Turda SU 182	Simple	2000
PG 2	Elan (control)	Trilinear	1992
	Turda Mold 188	Trilinear	2001
	Turda 165	Trilinear	2002
	Turda 145	Trilinear	2004
PG 3	Saturn (control)	Simple	1994
	Turda 201	Trilinear	2002
	Turda Favorit	Simple	2001
	Turda Star	Trilinear	2005

with 26% which highlights the stability of this hybrid production, even in drought conditions. The simple hybrid Turda SU 181 has achieved a superior production compared with the control,

increasing by 1% / 2011 and 4% / 2012 even though it is an early hybrid.

The early hybrids stood out through the high grain yield compared to the hybrids with shorter vegetation period (Tab. 3.). Of the early maize

Tab. 2. Very early and early hybrids FAO 100-230

Hybrid	Year of homologation	Grain yield		Dry matter in the grain at harvest		Unbroken mature plants		Selection Index
		kg/ha	% Mt	%	% Mt	%	% Mt	% Mt
PG – 1, in year 2011								
Turda 200Mt.	1976	6449	100	81.0	100	80.5	100	100
Turda 100	1979	6069	94	84.4	104	79.0	98	96
Turda SU 181	2000	6509	101	80.7	100	95.6	119	119
Turda SU 182	2000	6631	103	81.5	101	84.9	105	109
Average		6415	-	81.9	-	85.0	-	-
DL 5%		1069	16	9.6	12	16.2	23	-
PG – 1, in year 2012								
Turda 200 Mt.	1976	5074	100	83.9	100	93.7	100	100
Turda 100	1979	5361	106	82.5	98°	70.5	75°°	78
Turda SU 181	2000	5287	104	84.9	101	87.3	93	98
Turda SU 182	2000	6373	126*	83.1	99°	95.9	102	127
Turda 165	2002	4124	81°	83.5	100	92.6	99	80
Average		5244	-	83.6	-	88.0	-	-
DL 5%		1073	19	0.9	1.0	12.3	17	-

Tab. 3. Early hybrids FAO 250-290

Hybrid	Year of homologation	Grain yield		Dry matter in the grain at harvest		Unbroken mature plants		Selection Index
		kg/ha	% Mt	%	% Mt	%	% Mt	% Mt
PG – 2, in year 2011								
Elan	1992	6877	100	79.4	100	97.4	100	100
Turda Mold 188	2001	8305	121**	79.1	100	96.1	99	119
Turda 165	2002	7214	105	80.8	102	84.3	87	92
Turda 145	2004	8953	130**	80.2	101	98.1	101	132
Average		7837	-	79.9	-	94.0	-	-
DL 5%		1571	19	1.5	2	14.8	19	-
PG – 2, in year 2012								
Elan	1992	5840	100	84.0	100	88.9	100	100
Turda Mold 188	2001	6348	109	84.4	100	91.7	103	113
Turda 165	2002	4760	82°	83.8	100	93.2	105	85
Turda 145	2004	5578	96	83.9	100	93.4	105	100
Turda 201	2002	6087	104	83.1	99	95.3	107	111
Average		5723	-	83.8	-	92.5	-	-
DL 5%-		987	16	1.1	1	10.7	14	-

hybrids Turda Mold 188 stood out through grain yield in both experimental years 2011 and 2012 with a production increase significantly distinct to the control hybrid Elan. The hybrid Turda 145 was characterized through a high production capacity achieved in 2011, through which the hybrid significantly exceeded the control with a

30%. Also from the selection index point of view the hybrids Turda Mold 188 and Turda 145, in 2011 were superior to the control hybrid Elan with an increase of 19% respectively 32%. In 2012 the hybrid Turda 201 stood out both through production capacity but also through plant resistance to breaking.

Tab. 4. Semi early hybrids FAO 300-390

Hybrid	Year of homologation	Grain yield		Dry matter in the grain at harvest		Unbroken mature plants		Selection Index
		kg/ha	% Mt	%	% Mt	%	% Mt	% Mt
PG – 3, in year 2011								
Saturn	1994	8155	100	76.9	100	96.8	100	100
Turda 201	2002	6342	78 ^{oo}	79.0	103*	96.2	99	79
Turda Favorit	2001	7430	91	76.7	100	93.7	97	88
Turda Star	2005	7565	93	78.1	102*	96.2	99	94
Average		7373	-	77.7	-	95.7	-	-
DL 5%		796	10	1.2	2	15.9	20	-
PG – 3, in year 2012								
Turda 201	2002	5376	100	83.0	100	97.1	100	100
Turda Favorit	2001	7599	141***	80.3	97 ^{oo}	87.7	90	124
Turda Star	2005	7393	138***	82.3	99 ^o	86.2	89	121
Turda 248	2012	6478	120**	81.2	98 ^{oo}	94.9	98	115
Turda 332	-	8706	162***	82.2	99 ^o	99.3	102	164
Average		7110		81.8	-	93.0	-	-
DL 5%		1014	14	0.6	1	10.2	13	-

Tab. 5. Observations performed on the very early - early hybrids

Hybrid	Vegetative vigour notes*	Plants attacked by <i>Ostrinia nubilalis</i> % appearance of stigmata	DATA			Efficiency %	MMB g	Hectolitre weight kg/hl	
			physiological maturity date	The type of aging (notes)*					
PG - 1, in year 2011									
1. Turda 200	8	47.8	6.07	24.08	6	80	268	64.9	
2. Turda 100	8	49.9	2.07	21.08	6	80	252	66.6	
3. Turda SU 181	7	24.6	8.07	19.08	7	80	265	69.1	
4. Turda SU 182	6	44.5	7.07	23.08	7	77	258	63.1	
Average of experience	7.3	41.7	-	-	-	79	261	65.9	
PG - 1, in year 2012									
1. Turda 200	6	91.1	12.07	20.08	7	80	268	64.9	
2. Turda 100	8	86.6	08.07	18.08	4	80	252	66.6	
3. Turda SU 181	5	93.7	14.07	20.08	5	80	265	69.1	
4. Turda SU 182	6	94.4	13.07	22.08	5	77	258	63.1	
5. Turda 165	7	90.3	13.07	20.08	4	79	240	67.6	
Average of experience	6.4	91.2	-	-	-	79	256	66.3	
Notes* 9 = very good									

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The production capacity for semi-early hybrids was higher than that of the hybrids with shorter vegetation period. From Table 4, we can observe the genetic progress achieved by the semi-early hybrids (tested in 2012) which was significantly superior to the control hybrid Turda 201.

For this group in particular the progress recorded in order to improve the production capacities (332 Turda, Turda Favorit, Star Turda, Turda 248), but with a slight increase in both grain moisture at harvest and plant susceptibility to breaking.

The observations made during the growing season revealed the influence of the year 2012, compared with 2011, regarding the percentage of affected plants by *Ostrinia nubilalis* pest for all three groups of hybrids (Tab. 5., Tab 6., Tab 7).

In the course of year 2011 the sensibility of the studied hybrids was in a close relationship with the vegetation period, the percentage of

attacked plants varied from 29.4% in the case of the semi early hybrids, to 41.7% attacked plants in the case of the very early hybrids. The climatic conditions of 2012, which was considered a very dry year, given the lack of rainfall over four months (June to September), favoured pest attack *Ostrinia nubilalis*, which led to percentages of attacked plants over 90% in all three groups of hybrids.

The production quality analysis of the maize hybrids grains

The analysis of the chemical composition of the grain from the hybrids taken under study shows the presence of small differences between genotypes, regardless of the FAO group they belong to. The starch content shows average amplitudes between 69.9% for Turda 200 to 71.6% for Turda 201 (Table 8). The protein content varies between lower limits of 10.1% for Turda 165 and 10.7% for Turda 201 to slightly higher values of 11.5% for Turda 200 and Turda 248. The fat content was

Tab. 6. Observations performed on the early hybrids

Var. No	Hybrid	Vegetative vigour notes*	Plants attacked by <i>Ostrinia nubilalis</i> %	DATA			Efficiency %	MMB g	Hectolitre weight kg/ hl
		Physiological maturity							
		appearance of stigmata	date	The type of aging (notes)*					
PG - 2, in year2011									
1.	Elan	7	33.4	7.07	27.08	5	285	82	68.3
2.	Turda Mold 188	7	30.0	9.07	27.08	6	234	81	64.1
3.	Turda 165	9	49.3	8.07	24.08	6	240	79	67.6
4.	Turda 145	8	33.2	7.07	24.08	6	259	85	68.1
Average of experience		7.8	36.9	-	-	-	254	81	67.0
PG - 2, in year 2012									
1.	Elan	8	95.4	8.07	20.08	5	264	81	70.8
2.	Turda Mold 188	8	94.2	11.07	21.08	4	232	83	66.3
3.	Turda 165	8	99.3	12.07	22.08	4	241	79	68.6
4.	Turda 145	7	87.4	12.07	22.08	4	292	82	67.3
5.	Turda 201	7	94.6	15.07	24.08	6	247	78	67.1
Average of experience		7.6	94.2	-	-	-	255	80	68.0

Notes* 9 = very good

Tab. 7. Observations performed on the semi-early hybrids

Var. no	Hybrid	Vegetative vigour notes*	Plants attacked by <i>Ostrinia nubilalis</i> %	DATA			Efficiency %	MMB g	Hectoliter weight kg/hl
				Appearance of stigmata	Physiological maturity				
					Date	The type of aging (notes)*			
PG - 3, in year 2011									
1.	Saturn	7	27.7	10.07	27.08	6	260	80	64.9
2.	Turda 201	8	27.1	15.07	24.08	5	247	78	67.1
3.	Turda Favorit	7	34.1	17.07	28.08	6	241	81	65.9
4.	Turda Star	8	34.6	10.07	28.08	5	255	83	65.5
Average of experience		7.2	29.4	-	-	-	251	81	65.9
PG - 3, in year 2012									
1.	Turda 201	8	91.7	15.07	26.08	6	247	78	67.1
2.	Turda Favorit	7	97.3	11.07	23.08	6	243	81	65.9
3.	Turda Star	7	92.9	13.07	25.08	6	255	83	65.5
4.	Turda 248	8	82.3	11.07	23.08	6	241	79	68.6
5.	HST 131	8	85.6	13.07	25.08	6	292	82	67.3
Average of experience		7.6	90.0	-	-	-	256	81	66.9

Notes* 9 = very good

Tab. 8. Chemical composition of the grains of registered maize hybrids (the grains come from self pollinated cobs - 2012)

Hybrid	The humidity of grains (%)	The composition of the grains:		
		Starch (%)	Proteins (%)	Fats (%)
PG – 1				
Turda 200	14.6	69.9	11.5	4.2
Turda 100	14.5	70.7	11.0	4.0
Turda SU 181	13.5	70.9	10.6	4.2
Turda SU 182	13.9	70.7	10.9	4.0
Turda 165	14.1	70.9	10.7	4.1
PG – 2				
Elan	13.9	70.8	11.0	4.0
Turda Mold 188	14.2	70.9	10.4	4.3
Turda 145	14.5	70.6	10.6	4.5
Turda 165	14.0	71.2	10.1	4.2
Turda 201	14.3	71.3	10.1	4.2
PG – 3				
Turda 201	13.7	70.9	10.7	4.0
Turda Favorit	14.0	70.6	11.4	3.8
Turda Star	13.6	70.5	11.2	4.0
Turda 248	14.1	70.1	11.5	4.2
Turda 332	14.0	71.0	10.7	3.9

recorded between 3.8% for Turda Favorit and 4.5% for Turda 145.

Figure 1 presents five very early maize hybrids classified by grain yield / ha and the regression coefficient. Therefore the hybrid Turda SU 182 from the third quadrant associates the value of the high average production to the subunit values

of the regression. It is expected that the hybrid in the frame to perform well in a wide range of environmental conditions.

Finlay KW, Wilkinson GM (1963).

In the figure 2 are presented the five early hybrids studied, which by the grain yield kg / ha and the regression coefficient were grouped in 3 of

Fig. 1. The relationship between the grain yield (kg/ha) at 5 very early certified hybrids x 2 experimental years (2011-2012) and the regression coefficient between the average and each hybrid

Fig. 2. The relationship between the grain yield (kg/ha) of the 5 early certified hybrids x 2 experimental years (2011-2012) and the regression coefficient between the average and each hybrid
Finlay KW, Wilkinson GM (1963).

Fig. 3. The relationship between the grain yield (kg/ha) at 6 semi early certified hybrids x 2 experimental years (2011-2012) and the regression coefficient between the average and each hybrid. Finlay KW, Wilkinson GM (1963).

the 4 quadrants of the graph. Thereby it is observed a total lack of hybrids in quadrant III, meaning those that associate the production superior to the average value with the subunit values of the regression coefficient. Only two hybrids in this group had above average yields (Turda 145, Turda Mold 188), and therefore achieving high yields in the case of these hybrids depends on the achievement of optimal culture conditions.

Figure 3 presents six semi-early hybrids studied regarding the grain yield kg / ha and the regression coefficient. Thus, the hybrids Turda Star, Turda Favorit and Turda 332 associate high average values of the production with the subunit values of the regression. It is expected that these hybrids to be efficient or to have a better performance in a wide range of environmental conditions. The Saturn hybrid although give a production higher to the average, with above unit "b" values this hybrid will perform well only under favourable conditions.

CONCLUSIONS

The pedoclimatic conditions of the west area of the Transylvanian Plain (micro area Turda – Plain Turda) are favourable to grow early and semi-early maize hybrids.

The climatic conditions of the years 2011 and 2012 were very different for maize culture.

Among the hybrids created at ARDS Turda in the last period, the best results were recorded for these hybrids:

Turda SU 182 from the very early hybrids group, whose production was superior to the control hybrid Turda 200, with 103% in 2011 and 126% in 2012;

Turda Mold 188 exceeded the production of Elan hybrid with 121% in 2011 and 109% in 2012;

Turda Favorit and Turda Star achieved average yields, on the two years of experimentation, that exceeded the control hybrid Turda 201;

In the case of the hybrids create recently at ARDS it is observed an improvement in their resistance to lodging and breaking;

The analysis of the production stability shows that the Turda SU 182 hybrid, besides his higher production, even higher than the control hybrid

Turda 200 also has good production stability in all environmental conditions.

The hybrids Turda Star, Turda Favorit and Turda 332 have significantly higher yields compared to the control Turda 201 and these productions are also stable in various environmental conditions.

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