PHENOTYPIC CARACTERIZATION OF MAIZE INBRED LINES DIFFERENTIATED THROUGH CYTOPLASM

CARACTERIZAREA FENOTIPICĂ A UNOR LINII CONSANGVINIZATE DE PORUMB CU CITOPLASMĂ DIVERSIFICATĂ

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Abstract: *In this paper are studied the phenotypic differences between inbred isonuclear lines obtained by transformation through backcross of the genotypes TC 209, TC 316, TC 243, TC 221, TC 367 and D 105, during the year 2008. Were subjected to analysis the following characters: plant height, height of insertion of principal ear, the total number of leaves/ plant, number of ramifications/ tassel. It was also determined the stalk lodging of plants and the vegetation period of plants. By changing the cytoplasm, were observed favourable influence in terms of plant height, the stalk lodging of plants and resistance of the ear to Fusarium sp.*

Rezumat: *În această lucrare sunt studiate deosebirile fenotipice între liniile consangvinizate isonucleare obţinute prin transformarea prin retroîncrucişare a genotipurilor TC 209, TC 316, TC 243, TC 221, TC 367 şi D 105, pe parcursul anului 2008. Au fost supuse analizei următoarele caractere: înălţima plantei, înălţimea de inserţie a ştiuletelui principal, numărul total de frunze/ plantă, numărul de ramificaţii/ panicul. De asemenea, s-a determinat rezistenţa plantelor la frângere, precum şi perioada de vegetaţie a plantelor. Prin schimbarea citoplasmei în cadrul liniilor, s-au observat influenţe favorabile în ceea ce priveşte înălţimea plantelor, rezistenţa la frângere a plantelor, precum şi rezistenţa ştiuleţilor la Fusarium sp.*

Key words**:** *phenotypical variability, inbred isonuclear lines, cytoplasm*
Cuvinte cheie**:** *variabilitate fenotipică, linii consangvinizate isonucleare, citoplasmă*

INTRODUCTION

Maize is one of the most important crop plants on our planet, thanks to its high productivity and multiple uses of its products in human nutrition, animal husbandry and in industry. According to FAO statistics, the distribution of consumption is 21% in food, 72% in animal feed and 7% in industry. With large areas which they occupy, especially productions made by, mankind is dependent on the corn in the feeding. The importance of maize as food and forage plants, as well as nutritional value of grains and other organs of the plant, are determined by their chemical composition in general (CERNEA, 2008). The phenotypic and genetic analysis of the diversity of the maize inbred lines can offer relative classification indices in heterotic groups. Thus, it can ensure a greater efficiency of line breeding, through recombination and selection within the group and through the forecast of the hybridizing formula with high genetic performance by means of crossing among genotypes from differentiated groups (COPÂNDEAN ANA, I. CĂBULEA, 2004). Backcross breeding in maize (*Zea mays L.*) has been extensively used to transfer favorable alleles for monogenic traits from donor genotypes to elite inbred lines (OPENSHAW et al., 1994) but high heritability polygenic traits have also been transferred through this method (LASRY BENCHIMOL LUCIANA et al., 2005). Practical maize breeding, first of all, means creating of commercial maize hybrids, which outstrip expanded standards by most important agronomic traits. The main goal of maize

breeders is to empirically detect lines with good general and specific combining ability, through combined breeding on phenotypic level (BRKIĆ et al., 2008).

MATERIAL AND METHODS

The study began in 8 May 2008 and it was performed on inbred lines from the collection of germoplasm from ARDS Turda and the nucleus of each one of these inbred lines was transferred, by 9 backrosses on 14 cytoplasms (A 665, T 291, T 248, W 633, TB 329, TC 243, TC 208, TC 177, TC 221, D 105, K 1080, K 2051, TC 209, TC 316). In these transformations has not been involved male cytoplasmic sterility. These types of cytoplasm used come from early maize germoplasm of *Zea mays convar. indurata* from Central Europe, from the Central part of Romania and from *Zea mays convar. dentiformis* from the Corn Belt of the United States or southern United States. In this way provided a great cytoplasmatic diversity. During the period of vegetation were performed phenotypic observations for the following characters: plant height, height of insertion of principal ear, the total number of leaves/ plant, number of ramifications/ tassel. It was also determined the stalk lodging of plants and the vegetation period of plants. Plants were harvested individually to determine the ear length, number of rows/ ear, number of grains/ row, grain's type, grain' colour and colour cob. It was also determined the resistance of the ear to *Fusarium sp*.

RESULTS AND DISCUSSIONS

In what follows will be highlighted the phenotypic characteristics of plants and ears of maize inbred lines with diversified cytoplasms.

Table 1

The phenotypic characterization of ears and plants at TC 209 inbred line with diversified cytoplasm

No	The name of maize inbred line with differentiated cytoplasm	The phenotipic characterization of ears							The phenotipic characterization of plants					
		Ear's length (cm)	Num-ber of rows/ ear	Number of grains/ row	The resistance of the ear to *Fusarium sp*. (notes)	Grain's type	Colour		Plant height (cm)	Height of insertion of principal ear (cm)	The total number of leaves/ plant	Number of ramifications/ tassel	Rate of stalk lodging plants	Heat sum of degrees (∑tu > 10ºC) (sowing-flourished
							grain	cob						
1.	TC 209	15,8	18,0	30,4	9	Di	ny	red	154,6	56,8	12,4	5,0	4	604
2.	TC 209 (cit. A665)	16,2	18,0	38,0	8	Di	ny	red	171,6	63,4	12,8	5,8	4,1	604
3.	TC 209 (cit. T 291)	14,4	17,6	29,6	8	Di	ny	red	163,8	55,0	11,8	5,8	0	624
4.	TC 209 (cit. T 248)	15,5	18,0	31,2	7	Di	ny	red	152,6	58,4	12,6	4,8	11,5	604
5.	TC 209 (cit. W 633)	17,5	16,8	36,0	8	Di	ny	red	164,2	55,0	12,6	4,2	0	624
6.	TC 209 (cit. TB 329)	14,4	17,6	31,0	9	Di	ny	red	167,8	60,2	12,4	4,4	6,9	594
7.	TC 209 (cit. TC 243)	15,5	16,0	33,0	8	Di	ny	red	172,8	61,6	12,6	4,2	6,5	594
8.	TC 209 (cit. TC 208)	14,3	17,6	26,6	9	Di	ny	red	159,6	54,2	12,6	5,4	5,9	624
9.	TC 209 (cit. TC 177)	16,3	17,2	34,6	8	Di	ny	red	161,8	54,2	12,4	5,4	3,6	604
10.	TC 209 (cit. TC 221)	15,9	18,4	34,2	8	Di	ny	red	162,8	59,0	12,8	5,6	13,7	604
11.	TC 209 (cit. D 105)	16,1	15,6	29,6	9	Di	ny	red	154,2	59,2	12,4	2,8	3,4	594

* Di=semident; ny=normal yellow; notes: 1=very sensitive; 9=very resistant

In table 1 is found as, for the line TC 209, by changing the cytoplasm with W 633, the ear length increased by 1,7 cm from the original line, while at the same time decreased the number of rows. If change the cytoplasm with TC 208, the ear length decreased by 1,5 cm from the original line. By changing cytoplasm with A 665 and TC 243, increased plant height (with 17 cm, respectively 18,2 cm from the original line) and height of insertion of ear (with 6,6 cm, respectively 4,8 cm). By changing cytoplasm with D 105 is observed to decrease to half the number of ramifications to tassel, compared with the original line. A favourable effect on TC 209 line had W 633 and T 291 cytoplasms, by increasing the stalk lodging and the growth of vegetation period.

Table 2

The phenotypic characterization of ears and plants at TC 316 inbred line with diversified cytoplasm

No.	The name of maize inbred line with differentiated cytoplasm	The phenotipic characterization of ears							The phenotipic characterization of plants					
		Ear's length (cm)	Number of rows/ ear	Number of grains/ row	The resistance of the ear to *Fusarium sp.* (notes)	Grain's type	Colour		Plant height (cm)	Height of insertion of principal ear (cm)	The total number of leaves/ plant	Number of ramifications/ tassel	Rate of stalk lodging plants	Heat sum of degrees (∑tu > 10ºC) (sowing-flourished
							grain	cob						
1.	TC 316	19,5	14,0	30,4	8	Di	dy	red	178,0	50,0	11,0	8	4,5	624
2.	TC 316 (cit. A665)	21,1	14,0	30,8	6	Di	dy	red	183,0	46,6	11,6	6	0	594
3.	TC 316 (cit. T 248)	20,8	13,2	32,4	5	Di	dy	red	167,2	39,6	11,0	7	0	594
4.	TC 316 (cit. W 633)	20,2	13,6	31,4	5	Di	dy	red	165,4	43,6	11,4	6,2	0	594
5.	TC 316 (cit.TB 329)	15,3	13,0	24,5	9	D	dy	red	166,4	47,4	10,6	5	0	604
6.	TC 316 (cit. TC 243)	19,8	13,2	34,0	7	Di	dy	red	182,4	51,4	11,8	6,8	3,4	594
7.	TC 316 (cit. TC 177)	20,3	12,0	28,0	8	D	dy	red	168,0	39,8	10,6	6,8	0	604
8.	TC 316 (cit. TC 221)	19,7	12,8	30,4	7	D	dy	red	161,0	41,4	11,0	6,6	0	604
9.	TC 316 (cit. D 105)	19,5	14,0	30,8	7	Di	dy	red	162,2	32,6	10,2	4,6	8,7	614
10.	TC 316 (cit. K 1080)	20,0	13,2	31,0	6	Di	dy	red	170,0	40,8	11,6	6,6	0	594
11.	TC 316 (cit. K 2051)	19,6	13,2	32,4	5	D	dy	red	163,8	48,4	11,4	6,8	0	594

*Di=semident; D=dent; dy=dark yellow; notes: 1=very sensitive; 9=very resistant

As can be seen in table 2, for the line TC 316, by changing the cytoplasm with TC 177, the ear length decreased by 4,2 cm and in case of A 665 cytoplasm, the ear length increased by 1,6 cm. The height of insertion of the ear decreased, compared to the original line, with 17,4 cm by changing the cytoplasm with D 105. By changing cytoplasm with A 665, T 248, W 633, TB 329, TC 177, TC 221, K 1080 and K 2051, significantly improved the resistance of stalk lodging of the plant. Only if the change cytoplasm with D 105, was observed a sensitization of the line, in terms of stock lodging. Changing the cytoplasm with D 105 had a negative impact on the number of ramifications on tassel, it decreased to half compared the original line. The vegetation period decreased from the original line by changing cytoplasm with A 665, T 248, W 633, TC 243, K 1080 and K 2051.

Table 3

The phenotypic characterization of ears and plants at TC 243 inbred line with diversified cytoplasm

No.	The name of maize inbred line with differentiated cytoplasm	The phenotipic characterization of ears							The phenotipic characterization of plants					
		Ear's length (cm)	Number of rows/ ear	Number of grains/ row	The resistance of the ear to *Fusarium sp.* (notes)	Grain's type	Colour		Plant height (cm)	Height of insertion of principal ear (cm)	The total number of leaves/ plant	Number of ramifications/ tassel	Rate of stalk lodging plants	Heat sum of degrees (∑tu > 10ºC) (sowing-flourishe)
							grain	cob						
1.	TC 243	15,4	13,6	29,8	5	D	ny	white	141,0	43,4	11,4	6,2	4,3	594
2.	TC 243 (cit. A 665)	15,0	12,7	27,3	6	D	ny	white	144,6	43,4	12,2	5,8	0	614
3.	TC 243 (cit. T 291)	15,2	13,2	31,4	6	D	ny	white	145,8	47,2	11,8	5,6	0	604
4.	TC 243 (cit. T 248)	15,2	12,4	31,8	7	D	ny	white	143,4	46,4	11,2	5,8	0	604
5.	TC 243 (cit. W 633)	13,5	14,0	27,6	8	D	ny	white	134,6	40,2	11,2	6,2	3,6	594
6.	TC 243 (cit. TB 329)	15,8	12,4	32,2	7	D	ny	white	144,2	42,2	11,6	5,4	3,0	594
7.	TC 243 (cit. TC 208)	14,8	14,0	28,0	7	D	ny	white	140,4	40,2	11,6	5,8	0	594
8.	TC 243 (cit. TC 177)	15,4	13,6	30,2	8	Di	ny	white	143,0	40,6	11,4	5,2	0	594
9.	TC 243 (cit. TC 221)	15,6	13,2	34,0	7	D	ny	white	144,4	44,8	11,8	6,2	7,1	604
10.	TC 243 (cit. D 105)	14,7	12,8	31,6	8	D	ny	white	144,2	39,4	11,8	4,2	5,6	614
11.	TC 243 (cit. TC 209)	15,5	12,5	30,5	6	D	ny	white	142,6	42,2	11,6	5,6	3,6	594
12.	TC 243 (cit. K 1080)	16,0	13,5	35,3	6	D	ny	white	144,4	42,6	11,2	5,2	0	614
13.	TC 243 (cit. K 2051)	15,3	12,5	27,8	7	D	ny	white	141,4	41,6	11,2	5,4	0	614
14.	TC 243 (cit. TC 316)	15,3	13,6	30,0	7	D	ny	white	134,8	40,8	11,4	4,8	0	589

*D=dent; Di=semident; ny= normal yellow; notes: 1=very sensitive; 9=very resistant

For the TC 243 line, the change of cytoplasm had no considerable influence on the ear length, they have size close to the original line. TC 243 is a line very sensitive to *Fusarium sp.* By changing cytoplasm with W 633, TC 177 and D 105, is found a positive influence in terms of resistance to *Fusarium sp*., compared with the original line. The cytoplasms A 665, T 291, TC 208, TC 177, K 1080, K 2051 and TC 316 were contributed by increasing the stalk lodging

of plants, compared by the original line. Changing the cytoplasm with TC 221 the stalk lodging of the plants was reduced compared the original line. The vegetation period increased when changing cytoplasm with A 665, D 105, K 1080 and K 2051, as can be seen in table 3.

Table 4

The phenotypic characterization of ears and plants at TC 221 inbred line with diversified cytoplasm

No.	The name of maize inbred line with differentiated cytoplasm	The phenotipic characterization of ears							The phenotipic characterization of plants					
		Ear's length (cm)	Number of rows/ ear	Number of grains/ row	The resistance of the ear to *Fusarium sp.* (notes)	Grain's type	Colour		Plant height (cm)	Height of insertion of principal ear (cm)	The total number of leaves/ plant	Number of ramifications/ tassel	Rate of stalk lodging plants	Heat sum of degrees (∑tu > 10ºC) (sowing-flourished)
							grain	cob						
1.	TC 221	18,5	14,8	34,2	8	I	orange	white	182,4	63,8	13,2	16,4	37,5	624
2.	TC 221 (cit. T 248)	20,1	14,4	34,2	9	I	orange	white	200,6	73,2	13,8	17,4	31,0	635
3.	TC 221 (cit. TC 243)	18,9	14,0	33,2	8	I	orange	white	193,0	67,4	13,4	16,6	18,5	624
4.	TC 221 (cit. TC 208)	20,1	13,6	33,2	8	I	orange	white	189,6	71,8	13,0	15,4	35,7	631
5.	TC 221 (cit. TC 209)	19,9	14,0	33,8	8	I	orange	white	182,2	64,2	13,4	19,4	28,6	620
6.	TC 221 (cit. K 1080)	19,5	14,4	34,8	9	I	orange	white	178,4	61,2	13,4	17,8	9,5	635
7.	TC 221 (cit. TC 316)	20,8	13,6	36,0	8	I	orange	white	182,8	74,4	13,8	18,2	16,6	614

*I=indurat; notes: 1=very sensitive; 9=very resistant

The table 4 show that for the line TC 221, by changing the cytoplasm with TC 316, the ear length increased by 2,3 cm compared to the original line. Plant height increased by 18,2 cm by changing cytoplasm with T 248, and height of insertion of ear grew by 10,6 cm by changing cytoplasm with TC 316, compared to the original line. If change the cytoplasm with T 248 and K 1080, increased the resistance to *Fusarium sp*.of the ear. Regarding the stalk lodging of plants, is found that increased by changing cytoplasm with K 1080, compared with the original line.

Table 5

The phenotypic characterization of ears and plants at TB 367 inbred line with diversified cytoplasm

No.	The name of maize inbred line with differentiated cytoplasm	The phenotipic characterization of ears							The phenotipic characterization of plants					
		Ear's length (cm)	Number of rows/ ear	Number of grains/ row	The resistance of the ear to *Fusarium sp.* (notes)	Grain's type	Colour		Plant height (cm)	Height of insertion of principal ear (cm)	The total number of leaves/ plant	Number of ramifications/ tassel	Rate of stalk lodging plants	Heat sum of degrees (∑tu > 10ºC) (sowing-flourished
							grain	cob						
1.	TB 367	17,1	12,8	26,0	7	I	dy	red	160,2	61,0	14,8	15,2	0	589
2.	TB 367 (cit. T 248)	16,4	12,8	28,8	7	I	dy	red	156,6	55,8	15,0	13,0	0	589
3.	TB 367 (cit. TB 329)	16,9	13,2	26,2	8	I	dy	red	165,2	56,4	13,4	15,2	3,3	589
4.	TB 367 (cit. TC 208)	16,1	12,8	26,4	7	I	dy	red	158,6	63,2	13,8	16,8	7,1	589
5.	TB 367 (cit. TC 177)	18,3	13,2	26,6	8	I	dy	red	159,6	57,8	13,0	12,6	0	604
6.	TB 367 (cit. TC 221)	17,4	13,6	28,4	8	I	dy	red	151,0	62,2	14,0	19,8	0	589
7.	TB 367 (cit. TC 209)	17,9	13,2	29,2	9	I	dy	red	151,6	58,8	14,4	15,2	3,2	589
8.	TB 367 (cit. K 2051)	17,7	12,8	30,6	7	I	dy	red	150,2	48,8	13,4	12,2	5	589

*Dy=dark yellow; I= indurat; notes: 1=very sensitive; 9=very resistant

Dates presented in table 5 indicates that for the line TB 367, the ear length increased by 1,2 cm by changing the cytoplasm with TC 177, compared to the original line. Height of insertion of the ear fell by 12,2 cm by changing the cytoplasm with K 2051, compared to the original line. Regarding the resistance to *Fusarium sp*., it increased by changing the cytoplasm with TC 209. The stalk lodging of the plants decreased when changing cytoplasm with TC 208, compared with the original line. The vegetation period increased if change with cytoplasm TC 177.

The results presented in table 6 show that regarding the line D 105 by changing the cytoplasm with K 1080, decreased plant height by 12,8 cm and increased by 1,6 cm by changing the cytoplasm with TB 329. Regarding the stalk lodging of the plants, after changing the cytoplasm with T 291 it was observed a sensitization of the line and by changing the

cytoplasm with TC 316 increased the stalk lodging, compared with the original line. By changing the cytoplasm with TC 208 is to find a positive influence in terms of resistance to *Fusarium sp*., compared with the original line. The number of ramifications/ tassel decreased when changing the cytoplasm with TC 208 and increased by changing the cytoplasm with TC 243, and the vegetation period was reduced if change the cytoplasm with K 1080.

Table 6

The phenotypic characterization of ears and plants at D 105 inbred line with diversified cytoplasm

No.	The name of maize inbred line with differentiated cytoplasm	The phenotipic characterization of ears							The phenotipic characterization of plants					
		Ear's length (cm)	Number of rows/ ear	Number of grains/ row	The resistance of the ear to *Fusarium sp.* (notes)	Grain's type	Colour		Plant height (cm)	Height of insertion of principal ear (cm)	The total number of leaves/ plant	Number of ramifications/ tassel	Rate of stalk lodging plants	Heat sum of degrees (∑tu > 10°C) (sowing-flourishd
							grain	cob						
1.	D 105	12,8	11,2	23,4	7	I	ny	white	155,6	58,4	10,8	14,2	9,7	589
2.	D 105 (cit. T 291)	12,3	10,0	22,6	7	I	ny	white	150,2	48,8	9,8	10,6	31,2	589
3.	D 105 (cit. TB 329)	12,4	10,0	22,0	7	I	ny	white	157,2	59,6	10,2	14,0	10,5	589
4.	D 105 (cit. TC 243)	11,5	10,4	21,8	6	I	ny	white	135,2	48,2	10,0	15,8	21,4	589
5.	D 105 (cit. TC 208)	11,4	11,0	18,3	9	I	ny	white	144,6	46,0	9,6	10,0	16,6	589
6.	D 105 (cit. TC 209)	12,4	11,2	19,8	8	I	ny	white	151,8	57,2	10,0	14,6	16,6	589
7.	D 105 (cit. K 1080)	11,4	11,5	20,5	8	I	ny	white	142,8	52,4	9,6	15,0	10,0	582
8.	D 105 (cit. TC 316)	11,1	11,0	20,5	7	I	ny	white	148,2	51,2	10,4	16,4	7,7	582

*I=indurat; ny=normal yellow; notes: 1=very sensitive; 9=very resistant

CONCLUSIONS

The experimental results revealed the following:

For the line TC 209 a favourable effect on ear length had changing the cytoplasm with W 633, and changing the cytoplasm with A 655 and TC 243 increased the plant height and the height of insertion of principal ear.

As regarding the line TC 316, changing the cytoplasm with A 665, T 248, W 633, TB 329, TC 177, TC 221, K 1080 and K 2051, is found a increase of stalk lodging of the plants.

The line T 243 is a line very sensitive to *Fusarium sp.* and by changing the cytoplasm with W 633, TC 177 and D 105, the line became more resistant to *Fusarium sp.*

For the line T 221, by changing the cytoplasm with T 248 increased the plants height and the resistance to *Fusarium sp.* increased also, and by changing the cytoplasm with K 1080 increased the resistance of the plants to *Fusarium sp*. and the stalk lodging of the plants.

As regarding the line TB 367, a favourable influence on the vegetation period of the plants had changing the cytoplasm with TC 177.

For the line D 105, the plant height increased by changing the cytoplasm with TB 329, and by changing the cytoplasm with TC 316 increased the stalk lodging of the plants.

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