THE CYTOPLASM ORIGIN INFLUENCE, THE TESER INFLUENCE AND THE NUCLEUS-CYTOPLASM INTERACTIONS INFLUENCE ON PLANT TRAITS FOR ISONUCLEAR LINES

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Abstract: *The maize is one of the most important crops in the world due to its high productivity and multiplexing usage in human nutrition, animal breeding and industry. In the developing countries the human consumption stands to a high share (50-60%) while in the developed countries this feature is very much lower and there is an up-trend for utilization in the industrial and animal breeding sectors. The biggest part of the maize production is used in animal breeding (75-80%) as concentrated forage, silage or grazing fodder. The maize sprouts are used to obtain a high quality diet oil which prevents the blood cholesterol accumulation. Furthermore, the grain maize stalks are used in animal feeding. By adding urea and molasses the silo stalks gain higher feeding value and can be used as staple dry forage for ruminants in winter time. Also good results in animal feeding were obtained using the secondary processing matters (off-corn, draft from distiller's wash, residual oils, a.s.o.). The stalks and the rachis of the female inflorescences are used in the cellulose industry or as heating material, the maize husks for packages and netting handicrafts, and the stigmas in the traditional medicine Extrachromosomal heredity at maize was highlighted for the first genetic research developed on this plant and reffered to the maternal inheritance of leaf pigmentation due to the different types of chlorophyll in vairegate plants. It was later revealed that the hereditary transmission of the mutation determined of iojap gene located on chromosome 7 is carried out exclusively in the cytoplasm interaction. The cell nucleus trasfer activity for 12 elite inbred lines on various cytoplasm types has begun in 1992 starting from the assumption that among cytoplasm of different origin could exist differences in genetic value. The research was conducted using inbred isonuclear lines provided by The Laboratory of Maize Breeding from Agricultural Research and Development Station Turda. It has pursued further research on the differences between the isonuclear lines obtained by the transferring of nucleus on different types of cytoplasm and identify cytotipes to interact with the new nucleus and to improve the maternal transmission ability on certain traits of ears and kernels.*

Key words**:** *inbred isonuclear lines, the cytoplasm source influence, genetic determinism*

INTRODUCTION

It is acknowleged in the speciality literature (CĂBULEA, 2004; SARCA, 2004) that the majority of the maize traits are transferred at nucleus level and that in some features determination are implicated both oligogenes and polygenes.

From the maize traits, the following have been studied: plant height (cm), main ear insertion height (cm), number of branches/tassel, number of leaves/plant, main ear leaf length and width and the main ear leaf surface. This last trait has been studied because it is well known the strong correlation between the main ear leaf surface and the overall foliar surface (0,78 **) (**FRANCIS**, 1980).

MATERIAL AND METHODS

The research has been conducted in the experimental field provided by the Maize Breeding laboratory from Agricultural Research and Development Station Turda in 2009. The

cell nucleus transfer activity for 12 elite inbred lines on various cytoplasm types has begun in 1992 starting from the assumption that among cytoplasm of different origin could exist differences in the genetic value.

The transfer has been realized through 10 cross-breeding procedures with the nucleus donor inbred line in 1992-2004 time period. After that, the isonucleus inbred lines maintenance has been realized through self-pollination and SIB pollination. Through the 10 times cross-breeding procedures with the nucleus donor line we can appreciate that the nucleus has been transferred 99,9% on the new cytoplasm (CHICINAŞ et al., 2009). The nucleus donor inbred lines were: TC 209, TC 243, TC 221, TB 367 şi D 105, and the cytoplasm sources inbred lines were: T 248, TC 243, TC 298, TC 209, K 1080, TC 316, TB 329, TC 221, K 2051, T 291, A 665, W 633 şi TC 177. Each nucleus donor inbred line has been studied on six cytoplasm sources, the nucleus donor line being assumed as control line. The name assignment for the new created lines has been done after the nucleus donor line and the cytoplasm source has been mentioned in brackets: TC 209 (cyt. A 665), TC 243 (cyt. T 248), TC 221 (cyt. K 1080), TB 367 (cyt. K 2051), D 105 (cyt. TB 329). Testing inbred isonuclear lines was done by crossing each of the inbred lines with tester inbred lines. Tester inbred lines were: TC 344, LO3 Rf, TB 329, TD 233, T 291 and TC 209. The results of the experimental field and laboratory measurements and determinations have been than statistically processed through the ANOVA test (CIULCĂ, 2006). For the comparing crops where the common „inbred line x tester" cross-breeds have been studied the genotypes variance has been orthogonally split in the following categories: the cytoplasm source influence, the tester influence, the "cytoplasm x tester" interaction influence. For each studied single cross and trait the phenotypic value is described by the following relation:

$HS_{cit.\ i\ x\ tester\ j} = \mu + \hat{g}_{cit.\ i} + \hat{g}_{tester\ j} + \hat{s}_{ixj,}$ where:

-μ= experimental mean;

-$\hat{g}_{cit.\ i}$= the overall combining capacity of the mother inbred lines with the „i" cytoplasm, respectively the overall „i" cytoplasm combining capacity;

-$\hat{g}_{tester\ j}$= the „j" tester inbred line overall combining outcomes;

-$\hat{s}_{ixj}$= the peculiar combining capacity outcomes between the „i" mother cytoplasm source and the „j" tester gene.

RESULTS AND DISCUSSIONS

Although the differences due to the cytoplasms were significant only in a few test fields, especially for main ear leaf width and the main ear leaf surface, are interesating the results for all plant traits. These results are presented in the tables below.

In table 1 are presented the cytoplasm origin influence on plant height on the maize single crosses between isonuclear line TC 243. The cytoplasm origin influence have ranging from 4,83 cm to TC 243 (cyt. T 248) and -6,12 cm to TC 243. The value of -6,12 cm means that in average, single crosses will have a smaller height than the comparative if the maternal parent line is TC 243. In contrast, if the maternal parent will be TC 243 (cyt. T 248), single crosses will present an upward trend in average with 4,83 cm above experience average.

More important are the tester influences, testers data from +12,43 cm for TC 344 to -10,64 cm for TD 233. The nucleus-cytoplasm interactions influence ranged between -9,15 cm and 8,09 cm.

At the height of the highest single-cross (252,67 cm), TC 243(cyt. A 665) x TC 344, contributed:

252,67 cm= 230,65 cm (μ) + 3,96 cm ($\hat{g}_{cit.}$) +12,43 cm ($\hat{g}_{tester}$) + 5,62 cm ($\hat{s}_{cit.x\ tester}$)

At the height of the shortest single-cross TC 243 x TD 233 (213,53 cm), contributed:

213,53 cm= 231,65 cm (μ) - 6,12 cm ($\hat{g}_{cit.}$) - 10,64 cm ($\hat{g}_{tester}$) - 0,36 cm ($\hat{s}_{cit.x\ tester}$).

In table 2 are presented the results of experiments for main ear insertion height at single-crosses between isonuclear line TC 221. The cytoplasm origin influence ranged between -4,00 cm for TC 221 and + 8,25 cm for TC 221 (cyt. TC 243). The tester influence ranged between -10,24 cm for TD 233 and + 12,67 cm for T 291 and the nucleus-cytoplasm interactions influence ranged between -6,09 cm and +11,66 cm.

In genetic determinism of the main ear insertion height at single-cross with the highest main ear insertion, TC 221 (cyt. TC 316) x T 291 (107,27 cm) contributed:

107,27 cm= 90,02 cm (μ) + 0,43 cm ($\hat{g}_{cit}$) + 12,67 cm ($\hat{g}_{tester}$) + 4,16 cm ($\hat{s}_{cit.x\ tester}$)

At single-cross with the lower main ear insertion TC 221(cit. TC 208) x TD 233 contributed the following factors:

73,90 cm= 90,02 cm (μ) - 0,84 cm ($\hat{g}_{cit}$) - 10,24 cm ($\hat{g}_{tester}$) - 5,04 cm ($\hat{s}_{cit.x\ tester}$)

Table 1

The influence of the type of cytoplasm on the plant height for hybrids with isonuclear lines TC 243 (ARDS Turda, 2009)

tester (t) ♂ / cytoplasm (c) ♀	TC 344		Lo3 Rf		TB 329		TD 233		Cytoplasm average	
	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{g}_{cit.}$
TC 243	242,40	5,44	217,67	-9,15	224,53	4,07	213,53	-0,36	224,53	-6,12
TC 243(cit. A665)	252,67	5,62	232,13	-4,76	232,00	1,46	221,67	-2,31	234,62	3,96
TC 243(cit. T248)	234,53	-7,60	240,07	8,09	224,60	-1,03	219,60	0,54	229,70	-0,95
TC 243(cit. TC208)	248,67	0,75	237,67	-0,10	230,60	-0,81	225,00	0,15	235,48	4,83
TC 243(cit. TC221)	240,33	-1,43	234,00	2,39	226,00	0,74	217,00	-1,70	229,33	-1,32
TC 243(cit. K1080)	241,00	-0,51	233,67	2,30	218,00	-7,01	223,67	5,22	229,08	-1,57
TC 243(cit. K2051)	242,00	-2,26	235,33	1,22	230,33	2,57	219,67	-1,53	231,83	1,18
Tester average $\hat{g}_t$	243,09	12,43	232,93	2,28	226,58	-4,07	220,02	-10,64	230,65	

LDS P=5%	19,29
LDS P=1%	25,72
LDS P= 0,1%	33,21

Table 2

The influence of the type of cytoplasm on the main ear insertion height for hybrids with isonuclear lines TC 221 (ARDS Turda, 2009)

tester (t) ♂ / cytoplasm (c) ♀	T 291		TC 209		TD 233		Cytoplasm average	
	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{g}_{cit.}$
TC221	95,93	-2,74	80,57	-3,02	81,53	5,76	86,01	-4,00
TC 221(cit. T 248)	102,37	2,01	81,17	-4,10	79,53	2,08	87,69	-2,33
TC 221(cit. TC 243)	105,37	-5,57	107,50	11,66	81,93	-6,09	98,27	8,25
TC 221(cit. TC 208)	104,27	2,42	89,37	2,61	73,90	-5,04	89,18	-0,84
TC221(cit. TC 209)	98,47	-2,01	84,57	-0,82	80,40	2,83	87,81	-2,20
TC221(cit. K 1080)	105,10	1,72	86,90	-1,39	80,13	-0,34	90,71	0,70
T 221(cit. TC 316)	107,27	4,16	83,07	-4,95	81,00	0,80	90,44	0,43
Tester average $\hat{g}_t$	102,68	12,67	87,59	-2,43	79,78	-10,24	90,02	

LDS P=5%	18,06
LDS P=1%	24,14
LDS P= 0,1%	31,74

Tassel size at maize single-crosses has been reconsidered in recent years in the context in which it competes ear to achieve yield. For this reason, at modern single-crosses, tassel size tends to be lower (CIOCĂZANU et al., 1998; MORENO-GONZALES, 1999; TROYER, 2001).

For this reason it was studied how the different cytoplasms involved in this trait determinism. Experimental results for single-crosses for the line TB 367 are shown in table 3.

The cytoplasm source influence and the tester influence have relatively small values, statistically insignificant. The nucleus-cytoplasm interaction influence have also relatively small values, ranged between -1,76 and +1,29.

At the single-cross with the most branches in tassel TB 367 (cyt. K 2051) x TD 233, the contribution of nuclear effects as follows:

$17,87=12,38\ (\mu) + 1,69\ (\hat{g}_{cit}) + 2,50\ (\hat{g}_{tester}) + 1,30\ (\hat{s}_{cit.x\ tester})$

At the single-cross with the fewest branches in tassel - TB 367 x TC 209- the contribution of nuclear effects as follows:

$7,50= 12,38\ (\mu) - 1,77\ (\hat{g}_{cit}) - 2,68\ (\hat{g}_{tester}) - 0,43\ (\hat{s}_{cit.x\ tester})$

Table 3

The influence of the type of cytoplasm on the number of branches/ tassel for hybrids with isonuclear lines TB 367 (ARDS Turda, 2009)

tester (t) ♂ / cytoplasm (c) ♀	T 291		TC 209		TD 233		Cytoplasm average	
	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{g}_{cit.}$
TB 367	12,07	1,27	7,50	-0,43	12,27	-0,84	10,61	-1,77
TB 367(cit. T 248)	12,63	0,57	8,67	-0,53	14,33	-0,04	11,88	-0,50
TB 367(cit. TB 329)	10,80	-1,60	10,37	0,83	15,50	0,78	12,22	-0,16
TB 367(cit. TC 208)	12,57	0,01	10,70	1,00	13,87	-1,01	12,38	0,00
TB 367(cit. TC 221)	15,20	1,29	10,53	-0,52	15,47	-0,77	13,73	1,35
TB 367(cit. TC 209)	10,20	-1,76	10,27	1,17	14,87	0,59	11,78	-0,60
TB 367(cit. K 2051)	14,47	0,22	9,87	-1,52	17,87	1,30	14,07	1,69
Tester average $\hat{g}_t$	12,56	0,18	9,70	-2,68	14,88	2,50	12,38	

LDS P=5%	4,12
LDS P=1%	5,51
LDS P= 0,1%	7,24

The number of leaves/ plant is correlated with the vegetation period of single-crosses and in the determinism of this trait are involved less than 8-10 nuclear genes (TROYER, 1999; CĂBULEA, 2004). In table 4 it is presented a comparative study at comparative culture where are the single-crosses between isonuclear line D 105.

Trait amplitude was a single-cross with 10,20 leaves and another with 12,40. The cytoplasm source influence ranged between -0,40 for D 105 (cyt. T 243) and +0,35 for D 105 (cyt. K 1080), the difference between the two values being statistically significant. For the tester influence, values ranged between -0,72 for TD 233 and +0,44 for T 291. The nucleus-cytoplasm interactions influence ranged between -0,37 şi +0,38.

For single-cross with the highest number of leaves/ plant, D 105 (cyt. K 1080) x TC 209, the contribution of genetic factors was:

$12,20= 11,54\ (\mu) +0,35\ (\hat{g}_{cit}) +0,27\ (\hat{g}_{tester}) +0,24\ (\hat{s}_{cit.x\ tester})$

For single-cross with the lowest number of leaves/ plant D 105 (cyt. TC 243) x TD 233 the contribution of genetic factors was:

$10,20= 11,54\ (\mu) - 0,40\ (\hat{g}_{cit}) - 0,72\ (\hat{g}_{tester}) - 0,22\ (\hat{s}_{cit.x\ tester})$

Table 4

The influence of the type of cytoplasm on the number of leaves/ plant for hybrids with isonuclear lines D 105 (ARDS Turda, 2009)

tester (t) ♂ / (cytoplasm (c) ♀	T 291		TC 209		TD 233		Cytoplasm average	
	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{g}_{cit}$
D 105	12,00	0,04	11,47	-0,32	11,07	0,27	11,51	-0,03
D 105 (cit. T 2941)	11,80	-0,04	11,80	0,13	10,60	-0,08	11,40	-0,14
D 105 (cit. T 248)	12,07	0,13	12,00	0,24	10,40	-0,37	11,49	-0,05
D 105 (cit. T 243)	11,93	0,36	11,27	-0,14	10,20	-0,22	11,13	-0,40
D 105 (cit. TC 209)	12,20	0,16	11,80	-0,07	10,80	-0,08	11,60	0,06
D 105 (cit. K 1080)	12,00	-0,33	12,40	0,24	11,27	0,10	11,89	0,35
D 105 (cit. TB 329)	11,87	-0,31	11,93	-0,07	11,40	0,38	11,73	0,20
Tester average $\hat{g}_t$	11,98	0,44	11,81	0,27	10,82	-0,72	11,54	
		LDS P=5%		0,75				
		LDS P=1%		1,00				
		LDS P= 0,1%		1,32				

The genetic determinism of main ear leaf length (table 5) it was studied on inbred isonuclear line obtained for the nucleus transfer on different cytoplasm types of inbred line D 105.

Trait amplitude of the cytoplasm source influence range between -2,21 cm for D 105 (cyt. T 291) şi +3,14 cm la D 105. Transmission ability of the highest leaf length had the tester T 291 (+3,11 cm) and the lowest TD 233 (-3,11 cm). For the nucleus-cytoplasm interactions influence ranged between -5,36 şi +3,98.

The single-cross with the highest leaf length was D 105(cyt. TC 243) x T 291. On this trait determinism were involved the following factors:

$93,33 = 87,52$ cm $(\mu) - 0,97$ cm $(\hat{g}_{cit}) + 3,11$ cm $(\hat{g}_{tester}) + 3,66$ cm $(\hat{s}_{cit.x\ tester})$

For single-cross with the shortest leaf length, D 105(cyt. TC 243) X TC 209, were involved the following effects:

$81,20 = 87,52$ cm $(\mu) - 0,97$ cm $(\hat{g}_{cit}) + 0,00$ cm $(\hat{g}_{tester}) - 5,36$ cm $(\hat{s}_{cit.x\ tester})$

Table 5

The influence of the type of cytoplasm on the main ear leaf length for hybrids with isonuclear lines D 105 (ARDS Turda, 2009)

tester (t) ♂ / cytoplasm (c) ♀	T 291		TC 209		TD 233		Cytoplasm average	
	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{g}_{cit}$
D 105	88,00	-3,96	91,67	2,82	86,87	1,14	88,84	1,32
D 105 (cit. T 2941)	88,53	0,11	88,53	3,22	78,87	-3,33	85,31	-2,21
D 105 (cit. T 248)	88,60	-1,34	90,80	3,98	81,07	-2,64	86,82	-0,70
D 105 (cit. T 243)	93,33	3,66	81,20	-5,36	85,13	1,69	86,56	-0,97
D 105 (cit. TC 209)	91,87	1,97	86,87	0,09	81,60	-2,06	86,78	-0,75
D 105 (cit. K 1080)	91,60	0,80	83,80	-3,89	87,67	3,09	87,69	0,17
D 105 (cit. TB 329)	92,53	-1,25	89,80	-0,87	89,67	2,11	90,67	3,14
Tester average $\hat{g}_t$	90,64	3,11	87,52	0,00	84,41	-3,11	87,52	
		LDS P=5%		9,35				
		LDS P=1%		12,50				
		LDS P= 0,1%		16,43				

The cytoplasm source influence on the main ear leaf width is presented for the comparative culture where are the single-crosses between isonuclear line TC 209 (table 6).

The difference between the lowest value of combining ability for this trait (-0,34 cm at TC 209 (cyt. W 633)) and the biggest one (+0,47 cm at TC 209 (cyt. D 105)) is statistically significant. The highest value of the tester influence for the main ear leaf width registered at LO3Rf (+0,73 cm) and the lowest one at TD 233 (-0,86 cm). Both values are statistically significant. The nucleus-cytoplasm interactions influence for this trait ranged between -0,36 and +0,41.

For the single-cross with the biggest main ear leaf width (10,72 cm)- TD 209(cyt. D 105) X Lo3Rf were involved in this trait determinism the following effects:

$10,72 \text{ cm} = 9,43 \text{ cm } (\mu) + 0,47 \text{ cm } (\hat{g}_{cit}) + 0,73 \text{ cm } (\hat{g}_{tester}) + 0,10 \text{ cm } (\hat{s}_{cit.x\ tester})$

For the single-cross with the lowest main ear leaf width (8,30 cm) –TC 209(cyt. T 291) x TD 233 it were involved the following effects:

$8,30 \text{ cm} = 9,43 \text{ cm } (\mu) - 0,07 \text{ cm } (\hat{g}_{cit}) - 0,86 \text{ cm } (\hat{g}_{tester}) - 0,11 \text{ cm } (\hat{s}_{cit.x\ tester})$

Table 7 presents the study of the cytoplasm source influence and the nucleus-cytoplasm interactions influence on the main ear leaf surface for the comparative culture where are the single-crosses between isonuclear line TC 243.

The cytoplasm source influence ranged between -35,94 cm^2 for TC 243 and 36,29 cm^2 for TC 243(cyt. K 1080). The values for the tester influence on this trait ranged between 59,36 cm^2 for TC 344 and -71,96 cm^2 for TD 233, and the nucleus-cytoplasm interactions influence for this trait ranged between -53,80 cm^2 and 29,82 cm^2.

The single-cross with the biggest main ear leaf surface was TC 243(cyt. TC 208) x TC 344 of 683,73 cm^2. On this trait were involved the following effects:

$683,73 \text{ cm}^2 = 631,52 \text{ cm}^2 (\mu) + 9,46 \text{ cm}^2 (\hat{g}_{cit}) + 59,36 \text{ cm}^2 (\hat{g}_{tester}) + 1,40 \text{ cm}^2 (\hat{s}_{cit.x\ tester})$

The single-cross with the smallest main ear leaf surface was TC 243(cyt. T 248) x TD 233. On this surface genetic determinism were involved:

$504,47 \text{ cm}^2 = 613,52 \text{ cm}^2 (\mu) - 20,75 \text{ cm}^2 (\hat{g}_{cit}) - 71,96 \text{ cm}^2 (\hat{g}_{tester}) - 16,34 \text{ cm}^2 (\hat{s}_{cit.x\ tester})$

Table 6

The influence of the type of cytoplasm on main ear leaf width for hybrids with isonuclear lines TC 209 (ARDS Turda, 2009)

tester (t) ♂ / cytoplasm (c) ♀	TC 344		Lo3 Rf		TB 329		TD 233		Cytoplasm average	
	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{g}_{cit}$
TC 209	10,53	0,39	10,70	0,27	9,03	-0,36	8,53	-0,30	9,70	0,27
TC 209(cit A665)	9,80	0,00	10,20	0,12	8,90	-0,15	8,53	0,04	9,36	-0,07
TC 209(cit T291)	9,43	-0,28	10,03	0,03	9,33	0,36	8,30	-0,11	9,28	-0,15
TC 209(cit 248)	9,60	-0,16	9,77	-0,28	9,03	0,02	8,87	0,41	9,32	-0,11
TC 209(cit W633)	9,53	0,00	9,57	-0,25	8,97	0,18	8,30	0,07	9,09	-0,34
TC 209(citTC177)	9,80	-0,01	10,10	0,01	8,93	-0,13	8,63	0,13	9,37	-0,06
TC 209(cit D105)	10,40	0,06	10,72	0,10	9,67	0,08	8,80	-0,23	9,90	0,47
Tester average $\hat{g}$ $\hat{s}_{cxt}$	9,87	0,44	10,16	0,73	9,12	-0,31	8,57	-0,86	9,43	

LDS P=5%	0,48
LDS P=1%	0,65
LDS P= 0,1%	0,83

Table 7

The influence of the type of cytoplasm on the main ear leaf foliar area for hybrids with isonuclear lines TC 243 (ARDS Turda, 2009)

tester (t) ♂ / cytoplasm (c) ♀	TC 344		Lo3 Rf		TB 329		TD 233		Cytoplasm average	
	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{s}_{cxt}$	cm	$\hat{g}_{cit}$
TC 243	632,83	-4,11	577,93	-18,46	586,00	14,63	513,57	7,95	577,58	-35,94
TC 243(cit. A665)	682,17	18,15	618,00	-5,46	600,57	2,13	517,87	-14,82	604,65	-8,87
TC 243(cit. T248)	652,37	0,24	602,67	-8,91	611,57	25,01	504,47	-16,34	592,77	-20,75
TC 243(cit. TC208)	683,73	1,40	658,80	17,02	605,80	-10,97	543,57	-7,45	622,98	9,46
TC 243(cit. TC221)	669,60	-20,15	674,47	25,27	632,90	8,73	544,57	-13,85	630,38	16,86
TC 243(cit. K1080)	714,27	5,10	687,50	18,88	589,80	-53,80	607,67	29,82	649,81	36,29
TC 243(cit. K2051)	675,20	-0,63	606,93	-28,34	624,53	14,28	559,20	14,70	616,47	2,95
Tester average $\hat{g}_t$	672,88	59,36	632,33	18,81	607,31	-6,21	541,56	-71,96	613,52	

LDS P=5%	54,13
LDS P=1%	72,17
LDS P= 0,1%	93,18

CONCLUSIONS

For the plant height trait were involved the environmental effects, the tester influence and in some cases the nucleus-cytoplasm interactions influence.

For the genetic determinism of main ear insertion height are involved the environmental effects, the tester influence and to a lesser extent, the nucleus-cytoplasm interactions influence.

On number of leaves/plant genetic determinism the environmental effects is important, the tester influence and in a lesser degree the nucleus-cytoplasm interactions influence.

For the trait number of branches/ tassel are important the environmental effects, the tester influence and in a lesser extent the cytoplasm source influence.

In main ear leaf length are involved the the environmental effects and the nucleus-cytoplasm interactions influence.

In genetic determinism of main ear leaf width are involved the environmental effects, the tester influence, the nucleus-cytoplasm interactions influence and in some cases the cytoplasm source influence.

On main ear leaf surface are involved the environmental effects, the tester influence and in a lesser extent, the cytoplasm source influence.

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