THE CYTOPLASM ORIGIN INFLUENCE ON EAR AND KERNEL TRAITS FOR THE STUDIES MAIZE SINGLE CROSSES

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Abstract: *The isonucleus inbred lines study has been initiated from the demand of clarifying if the cytoplasm source has a positive or negative influence on the corn ears, plants, grain traits and some maize cultural features (RACZ et al, 2011). Studies conducted on different male cytoplasm sterile inbred lines have highlighted differences between the various cytoplasm sources inbred lines and also differences in regarding the obtained single crosses behavior (GRACEN and collab., 1979; HAŞ and collab., 1999). The research has been conducted in the experimental field provided by the Maize Breeding laboratory from Agricultural Research and Development Station Turda in 2009.There have been studied the following maize ear traits for isonucleus inbred lines: ear weight (g), kernel weight per ear (g), kernel rows per ear, kernel number per raw, ear diameter (cm), rachides diameter (cm), thousand kernel weight (g), kernel depth and the kernel yield per ear. 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). For all the 11 studied traits there have been determined significances of the corresponding variance for cytoplasm and „cytoplasm x testers" interaction. The cytoplasm has had a significant influence in the hereditary transfer in the case of ear length in four out of five clusters from the studied isonucleus lines and the „cytoplasm x testers" interaction has been significant for all the five tested clusters. The thousand kernel weight has been statistically significant differenced due to cytoplasm influence in four of the five tested clusters and the „cytoplasm x testers" interaction in one single case. The mean kernel number/ear has been influenced by the cytoplasm source in four of the five tested groups and the „cytoplasm x testers" interaction has had significant figures in four tested clusters. Although the study assumption was that different cytoplasm sources are influencing the kernel depth, this hypothesis hasn't been confirmed.*

Key words**:** *cytoplasm, single crosses, maize, ear traits*

INTRODUCTION

In the specialty literature is mentioned that most of the traits which are yield determinative (the ear size, length, kernel rows/ear, kernel number/raw, thousand kernel weight) are genetically induced mostly at nucleus level, but there are also assertions saying that the heritability of some of these traits is due to some genes located in the cytoplasm (STUBER şi colab., 1992; HAŞ, 1992; CĂBULEA şi colab., 1994; CĂBULEA şi colab., 1999; TROYER, 2001; CĂBULEA, 2004; SARCA, 2004; HAŞ, 2004).

MATERIAL AND METHODS

There have been studied the following maize ear traits for isonucleus inbred lines: ear weight (g), kernel weight per ear (g), kernel rows per ear, kernel number per raw, ear diameter (cm), rachides diameter (cm), thousand kernel weight (g), kernel depth and the kernel yield per ear. 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 (CHICINAȘ 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 (RACZ et al, 2011).

RESULTS AND DISCUSSIONS

The results summary as regarding the variances significance for different ears and kernels traits while testing the different cytoplasm sources for the five isonucleus lines clusters are represented in table 1.

For all the 11 studied traits there have been determined significances of the corresponding variance for cytoplasm and „cytoplasm x testers" interaction.

As regarding the ear weight the cytoplasm variance has been statistically significant for the clusters generated by TC 243 isonucleus lines (**) and TB 367 isonucleus lines (*), and the „cytoplasm x testers" interaction for TC 209 (**) and D 105 (**) clusters.

For the kernel weight/ear trait the cytoplasm influence variance has been statistically significant in the case of two of the five isonucleus clusters (TB 367 and D 105), and the „cytoplasm x testers" interaction in the case of TC 209 and D 105 clusters.

The cytoplasm has had a significant influence in the hereditary transfer in the case of ear length in four out of five clusters from the studied isonucleus lines and the „cytoplasm x testers" interaction has been significant for all the five tested clusters.

The mean number of kernel rows/ear has had significant figures for cytoplasm variance in four cases of the five tested clusters and the „cytoplasm x testers" interaction has been distinctive significant in three of five studied clusters.

The differences induced by cytoplasm have been significant in four out of five isonucleus lines as regarding the kernel number/row and the „cytoplasm x testers" interactions have been statistically significant in all cases.

The ear diameter has been influenced both by the cytoplasm origin and the „cytoplasm x tester” interactions in three of five clusters at cytoplasm level and in two groups by the „cytoplasm x tester” interaction; in the rachides diameter case the cytoplasm influence has been statistically significant in four of the five isonucleus tested lines and the „cytoplasm x testers” interaction in three cases.

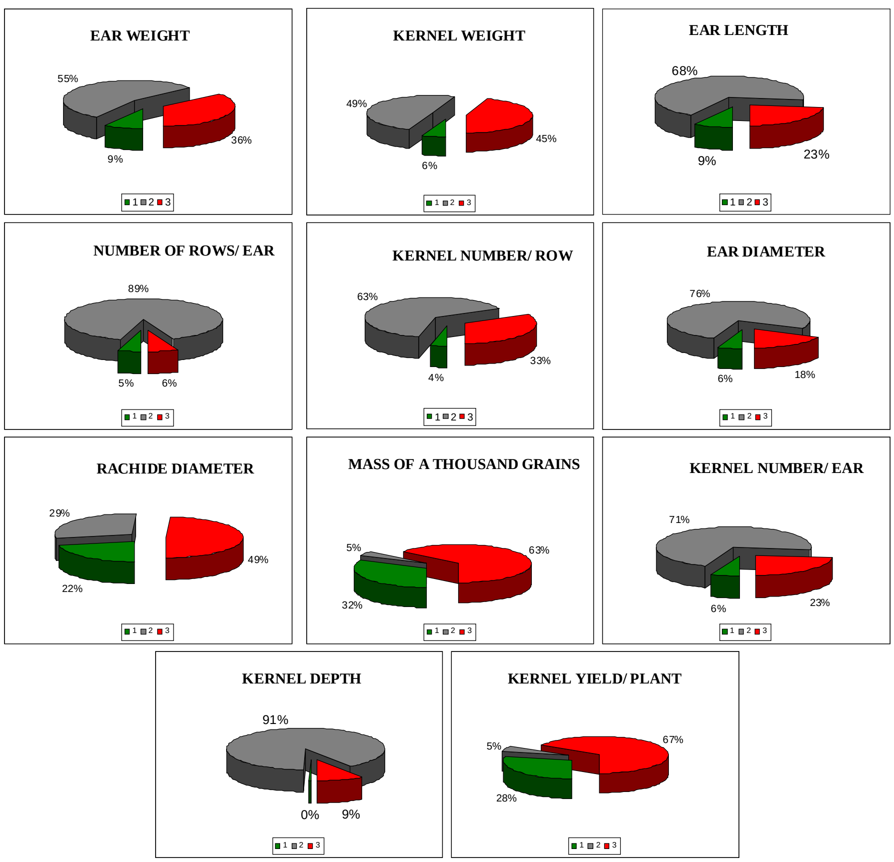
Table 1

The results summary on variance significance for ear traits induced by the cytoplasm origin for five inbred lines (ARDS Turda, 2009)

Analyzed trait	Variability source	Tested inbred isonucleus lines				
		TC 209	TC 243	TC 221	TB 367	D 105
Ear weight	-genotype	**	**	ns	**	**
	- cytoplasm	ns	**	ns	*	ns
	- tester	**	**	ns	**	**
	- interaction "cytoplasm x tester"	**	ns	ns	ns	**
Kernel mean weight	-genotype	**	*	ns	**	**
	- cytoplasm	ns	ns	ns	**	*
	- tester	**	**	ns	**	**
	- interaction "cytoplasm x tester"	**	ns	ns	ns	**
Ear meanlength	-genotype	**	**	**	**	**
	- cytoplasm	*	*	**	*	ns
	- tester	**	**	ns	**	**
	- interaction "cytoplasm x tester "	*	**	*	**	**
Mean rows number/ ear	-genotype	**	**	**	**	**
	- cytoplasm	**	ns	**	*	*
	- tester	**	**	**	**	**
	- interaction "cytoplasm x tester "	**	ns	**	**	ns
Mean kernel number/ row	-genotype	**	**	**	**	**
	- cytoplasm	ns	**	**	**	ns
	- tester	**	**	ns	*	**
	- interaction "cytoplasm x tester	*	**	*	*	*
Mean ear diameter	-genotype	**	**	*	**	**
	- cytoplasm	ns	**	ns	**	*
	- tester	**	**	**	*	**
	- interaction "cytoplasm x tester	ns	*	ns	ns	**
Rachides mean diameter	-genotype	**	**	*	**	**
	- cytoplasm	*	*	ns	*	*
	- tester	**	**	**	**	ns
	- interaction "cytoplasm x tester "	*	ns	ns	*	**
Mass of a thousand grains (g)	-genotype	ns	*	*	**	**
	- cytoplasm	*	**	ns	*	**
	- tester	ns	ns	**	**	**
	- interaction "cytoplasm x tester	ns	ns	ns	*	ns
Mean kernel number/ ear	-genotype	**	**	**	**	**
	- cytoplasm	**	*	**	**	ns
	- tester	**	**	**	**	**
	- interaction "cytoplasm x tester "	**	ns	**	*	*
Kernel mean depth (cm)	-genotype	**	**	**	**	**
	- cytoplasm	ns	ns	ns	ns	ns
	- tester	**	**	**	**	**
	- interaction "cytoplasm x tester "	ns	ns	ns	*	**
Mean kernel yield	-genotype	ns	**	**	**	**
	- cytoplasm	ns	**	ns	**	*
	- tester	ns	*	**	*	**
	- interaction "cytoplasm x tester	ns	ns	**	ns	**

The thousand kernel weight has been statistically significant differenced due to cytoplasm influence in four of the five tested clusters and the „cytoplasm x testers" interaction in one single case. The mean kernel number/ear has been influenced by the cytoplasm source in four of the five tested groups and the „cytoplasm x testers" interaction has had significant figures in four tested clusters. Although the study assumption was that different cytoplasm sources are influencing the kernel depth, this hypothesis hasn't been confirmed. Thus, the differences between the isolines were not significant in any tested cluster; on the other hand there have been significant the „cytoplasm x testers" interactions for the TB 367 (*) and D 105 (**) clusters. The grain yield, one of the most dynamic production trait, has been influenced at cytoplasm level in three of the five tested clusters and the „cytoplasm x testers" interaction has been distinctive significant in the case of TC 221 and D 105 clusters.

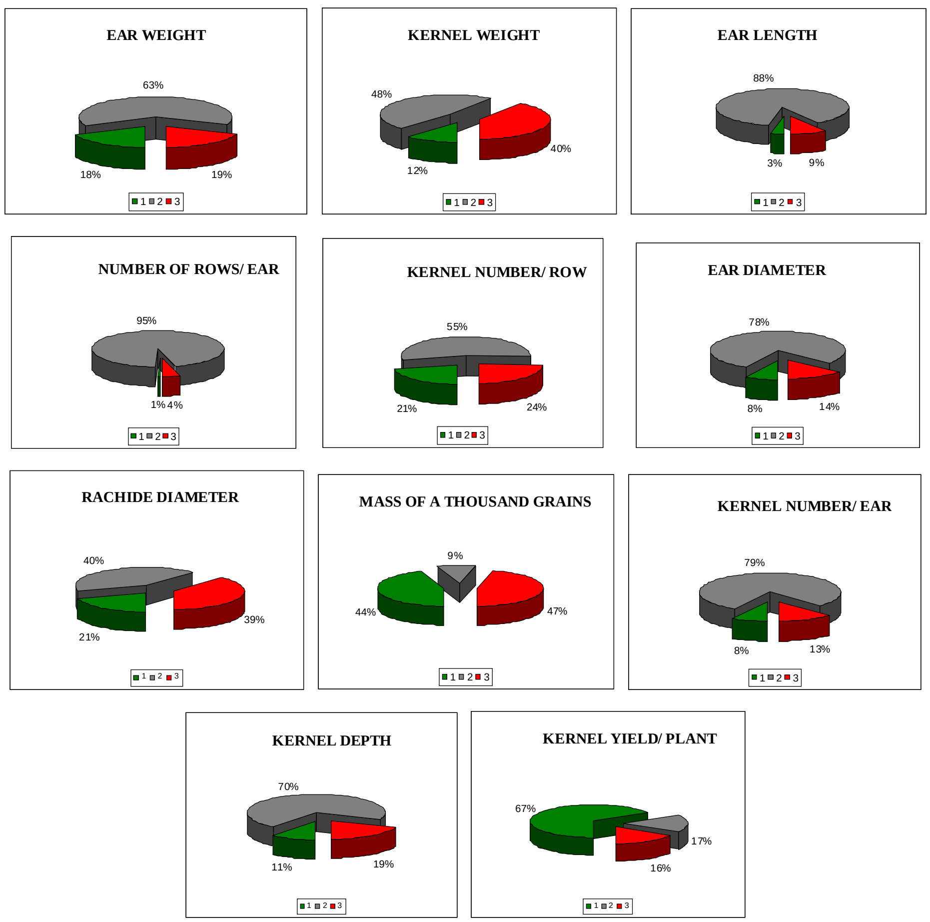
Both for ear and kernel traits, it was calculated the share of cytoplasmic effect variance, the share tester effect variance and the share „cytoplasm x tester" interaction effect variance. The results for the five tested inbred isonuclear lines are presented in figures 1-5.



1- the share of cytoplasmic effect variance; 2 - the share tester effect variance; 3 - / the share "cytoplasm x tester" interaction effect variance

Figure 1. The factors share on isonuclear lines TC 209

For the isonucleus lines cluster TC 209 the results regarding the share of different factors in the genotypes variance are presented in figure 1. The share of cytoplasmic effect variance ranged between 1 % for kernel depth and 32 % for mass of thousand grains. High values of the share of cytoplasmic effect variance registered for kernel yield/ plant (28%) and for rachide diameter (22%). The variance induced by the „cytoplasm x tester" interaction has had shares of 6% at number of rows/ ear and 67% at kernel yield/ plant. High values of the share „cytoplasm x tester" interaction effect variance had even the following traits: mass of a thousand grains (63%), rachide diameter (49%), ear weight (36%) and kernel number/ row.

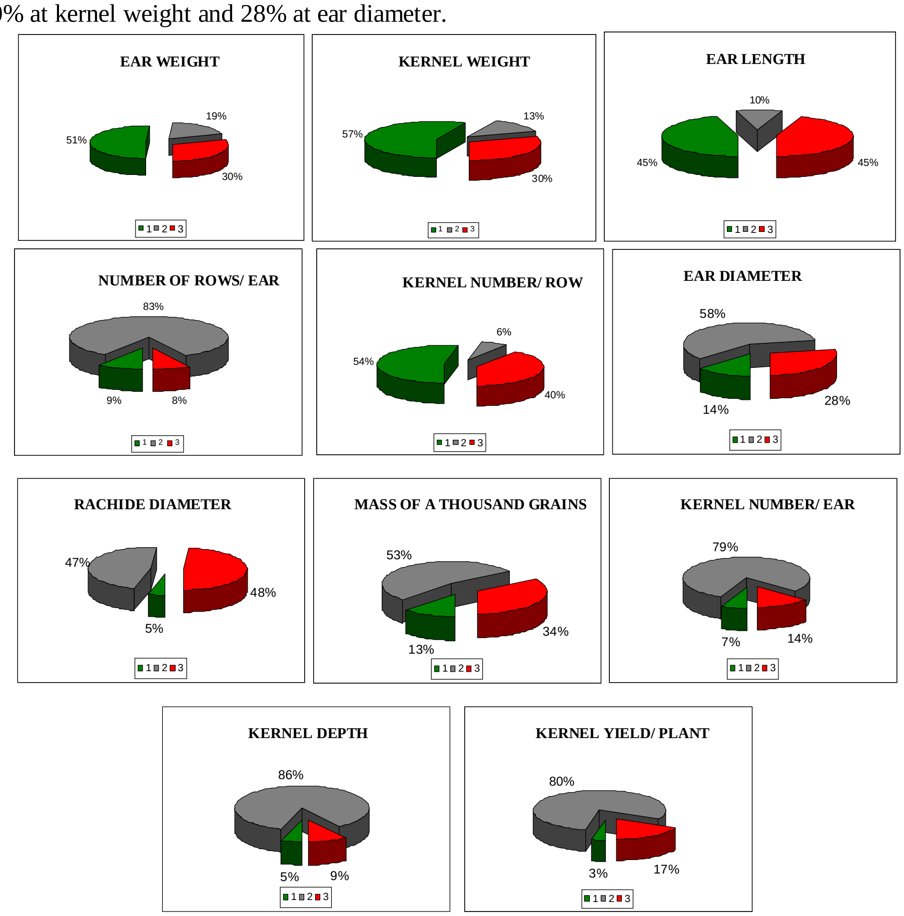


1- the share of cytoplasmic effect variance; 2 - the share tester effect variance; 3 - ponderea varianței interacțiunilor „citoplasme x testeri" / the share "cytoplasm x tester" interaction effect variance

Figure 2. The factors share on isonuclear lines TC 243

For the isonucleus lines cluster TC 243 the results regarding the share of different factors in the genotypes variance are presented in figure 2. The cytoplasm induced variance has had shares of 1% at number of rows/ ear and 44 % at mass of thousand grains. High values of the share of cytoplasmic effect variance registered for kernel number/ row (21%), rachide diameter (21%), kernel yield/ plant (16%) and for ear weight (18%). The variance induced by the „cytoplasm x tester" interaction has had shares of 4% at number of rows/ ear and 47% at mass of thousand grains. High values of the share „cytoplasm x tester" interaction effect variance registered in case of rachide diameter (39%), kernel weight (40%), kernel number/ row (24%) and kernel depth (19%).

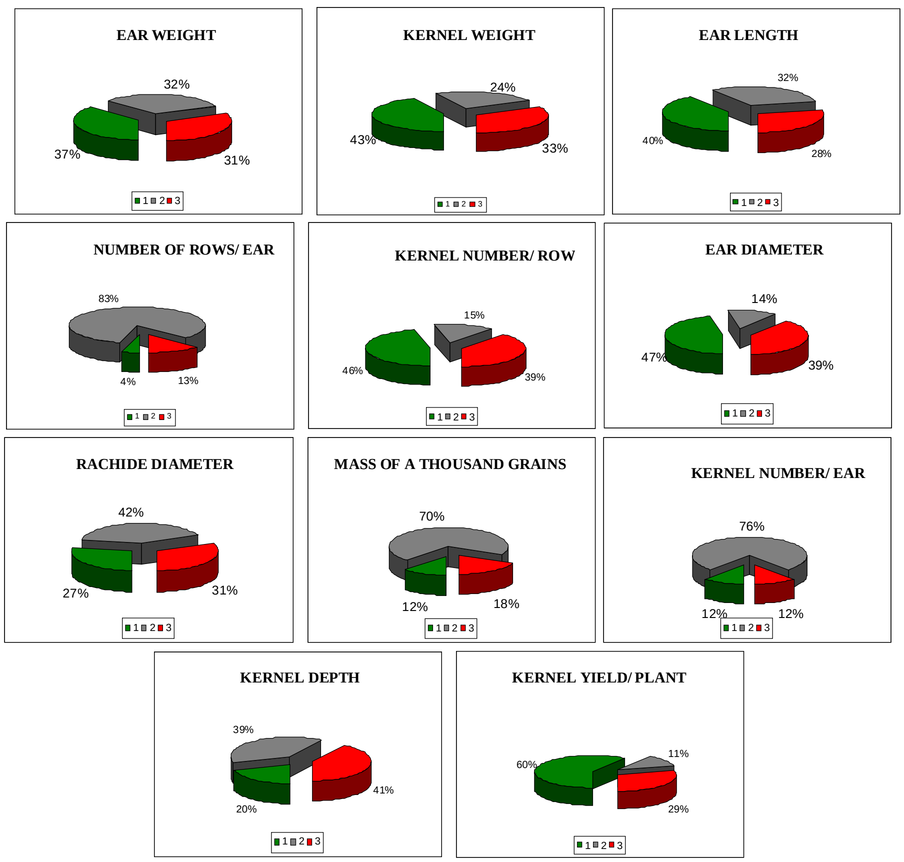
In case of the isonucleus lines cluster TC 221 the results regarding the share of different factors in the genotypes variance are presented in figure 3. The share of cytoplasmic effect variance ranged between 3% for kernel yield/ plant, 5% for rachide diameter and kernel depth and 57% for kernel weight. The cytoplasm induced variance has had a high share at kernel number/ row (54%), ear weight (51%), ear length (45%). The share "cytoplasm x tester" interaction effect variance ranged between 8% at number of rows/ ear and 48% at rachide diameter. The variance induced by the „cytoplasm x tester" interaction has had shares of 45% at ear length, 40% at kernel number/ row, 34 % at mass of thousand grains, 30% at ear weight, 30% at kernel weight and 28% at ear diameter.



1- the share of cytoplasmic effect variance; 2 - the share tester effect variance; 3 -the share "cytoplasm x tester" interaction effect variance

Figure 3. The factors share on isonuclear lines TC 221

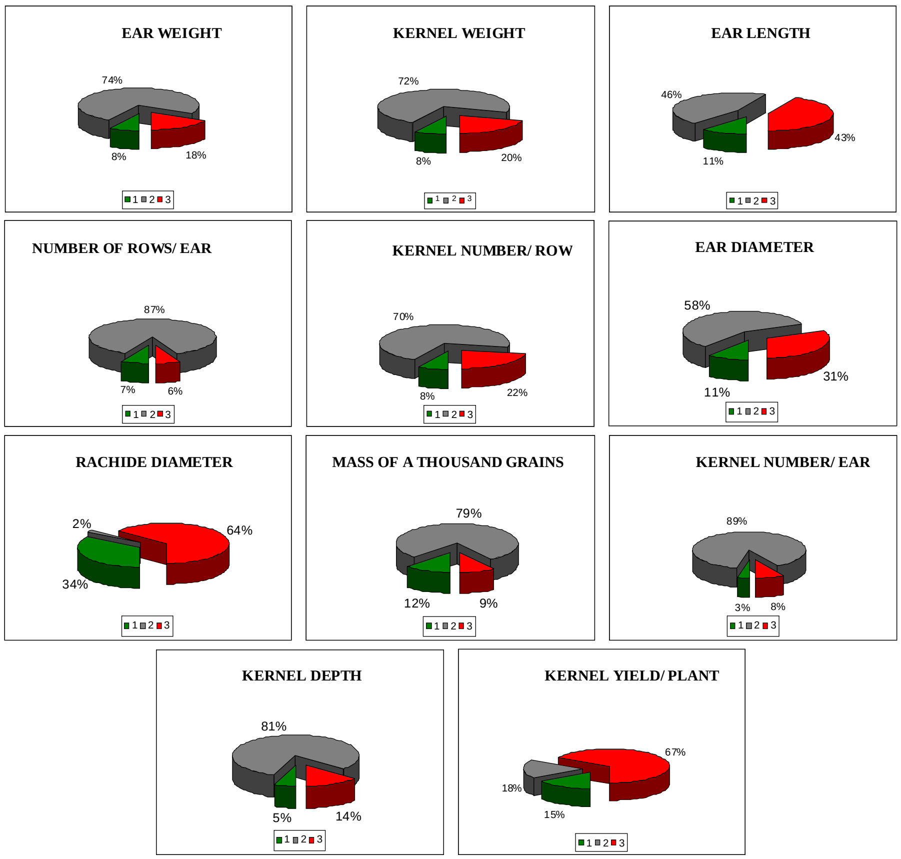
As regarding the isonucleus lines cluster TB 367, the share of different factors in the genotype variance are presented in figure 4. Even in this case, the lowest value of the share of cytoplasmic effect variance registered for number of rows/ ear (4%). The highest value of the share of cytoplasmic effect variance registered for kernel yield/ plant (60%). High values for the share of cytoplasmic effect variance registered even for ear diameter (47%), kernel number/ row (46%), kernel weight (43%), ear length (40%) and ear weight (37%). The variance induced by the „cytoplasm x tester" interaction has had shares of 12% at kernel number/ear, 13% at number of rows/ ear and 41% at kernel depth. High values for the share „cytoplasm x tester" interaction effect variance registered for kernel number/ row (39%), kernel weight (33%), ear weight (31%) and rachide diameter (31%).



1-the share of cytoplasmic effect variance; 2 - the share tester effect variance; 3 - the share "cytoplasm x tester" interaction effect variance

Figure 4. The factors share on isonuclear lines TB 367

For the isonucleus line cluster D 105, the results regarding the share of different factors in the genotypes variance are presented in figure 5. The share of cytoplasmic effect variance for kernel and ear traits ranged between 3% for kernel number/ ear and 34% for rachide diameter. Likewise the isonucleus line cluster TC 209, in case of the isonucleus line cluster D 105, the share of cytoplasmic effect variance has had the lowest values for kernel and ear traits. Instead, the share "cytoplasm x tester" interaction effect variance has quite high values, ranged between 6% at number of rows/ ear and 67% at kernel yield/ plant, respectively 64% at rachide diameter.



1-the share of cytoplasmic effect variance; 2 - the share tester effect variance; 3 - the share "cytoplasm x tester" interaction effect variance

Figure 5. The factors share on isonuclear lines D 105

CONCLUSIONS

1. For ears and kernels traits the cytoplasm and "cytoplasm x tester" interaction influence is more visible in the most analyzed traits in the case of isonucleus lines.

2. The share of cytoplasm and "cytoplasm x tester" interaction variance is rather high for the most analyzed ears and kernels traits. Among the tested traits the lowest share both for cytoplasm and "cytoplasm x tester" interaction variance has been registered for rows number/ear.

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