MAIZE LOCAL LANDRACES USED LIKE PREBREEDING MATERIAL FOR SIMULTANEOUS IMPROVMENT OF MAIN AGRONOMIC TRAITS

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Abstract

In the maize breeding programs the local maize landraces shows a particular interest, especially as useful sources for adapting capacities, physiological, agronomic and valuable quality traits.
A morpho-physiological evaluation of main germplasm genepool represented by 200 local maize landraces was achieved through a CEEX Project (2006-2008). Characterization of maize local populations was done in an appropriate experimental system based on morpho-physiological descriptors edited by the International Institute of International Plant Genetic Resources (BIOVERSITY) located in Rome (www.bioversityinternational.org). (www.bioversityinternational.org).
Evaluation of maize genetic resources is found in the online database http// www. scdasuceava. ro/ biomaize which includes information concerning the value of biological material with useful genes for breeding programs.
It was noticed some maize local landraces which can be used like initial genetic material for breeding of main traits (precocity, resistance to low temperatures, elements of productivity and resistance to root and stalk lodging , diseases) such as: Rodna16, Botiza12, Ivăneasa1, Solca3, Vama7, Gersa11, Tiha Bargaului 8 Moisei 5, Valea Mare 2, Bucerdea, Putna 3 Pojorâta, Brodina 1.
Of a particular interest are local populations valuable like rebreeding material for simultaneous improving of some important agronomic traits: Rodna 16 for cold resistance and disease resistance Botiza 12 for low temperatures resistance, resistance to root and stalk lodging, small percentage of sterile plants Moisei 5 and Valea Mare 2 for productivity, low temperature resistance, precocity, resistance to diseases and others locale landraces that may be selected from the mentioned database.

Key words: germplasm, genetic resources, morphological descriptors, cold test index

In the maize breeding the local landraces could presented a special interest, evenly like useful gene sources for adapting capacity and for physiological and agronomical traits and for valuable quality.

In the present, all researchers says that the genetic resources represented by local landraces, coming from different areas, represent main useful gene sources for breeding of this species. The exploration of these resources can be possible only through complexes studies and measures which will determine the biodiversity keeping and the sustainable use of this.

The local landraces shows a great adapting capacity and physiological traits specifics for some areas, and productivity capacity and own quality traits too (Moşneagă and collab., 1957; Ulinici, 1961; Gologan, 1965; Mureşan, 1972; Cristea, 1972 b, 1975; Suba, 1973; Căbulea and collab., 1975; Hallauer and Miranda, 1981).

After Manoliu (1966), Brieger defined the local landrace like „a community of individuals occupying a certain area, is reproduced in the same way, the same hereditary variations and suffered the same selection actions. Romanian local populations are very different, growth in very different environmental conditions in our country under the influence of which were formed and over which were superimposed the effects of empirical selection made by thousands of growers, each in its own way. Although the local landraces are very heterogeneous, they are grouped into distinct races, each occupying a specific area (Cristea, 1977).

Reconsideration of evaluation, documentation and use of maize genetic resources activities represented by the ancient local populations, unstudied or poorly studied, it is a necessity in the present, at nationally and internationally level. The report of the working meeting in Rome, Italy (1996) have noted two major needs for collaboration on maize genetic resources:

- identification of old local populations, valuable for their agronomic characters;
- establish of a joint prebreeding program.

Important collections of old local populations are maintained in gene banks. Thus, Suceava Genebank, holds a rich collection of over 4300 samples collected in mountain and submountain areas of Romania. These local populations are characterized but in a very small proportion (less than 20%).

There are few national studies that highlight the value and usefulness of these resources for process improvement in maize. Cabulea and collab. (1998), presents the current state of genetic resources of maize in Transylvania. Murariu et al., (1999 and 2001) analyzes the aspects of precocity of local populations preserved in Suceava Genebank, and make an inventory and evaluation of local population of Bukovina. Undeniable importance and usefulness of these resources is emphasized also by Cristea (2006).

A comprehensive evaluation of these genetic resources can be achieved through characterization of morphological, physiological, biochemical and molecular, subordinated to one significant purpose, such as: highlight of the incontestable value to maize local populations concerning the genetic hereditary with breeding values and practical use of these resources to promote sustainable agriculture. This opportunity arises from the finding that the use of local resources in particular is currently much too low. Therefore it is necessary to reconsider this attitude, particularly in complex studies that highlight the useful genetic potential of this biologic material.

In all breeding programs the maize landraces play an important role both in creating of hybrids and inbred lines and in the breeding of these populations. A valuable germplasm has high genetic variability and proper performance.

All these represent the scientific reasons that led to the development of a complex evaluation system able to emphasize the genetic variability and identification of some forms with performance in the main breeding directions.

MATERIAL AND METHOD

A morpho-physiological evaluation of main genetic fond, represented by a total of 198 local maize populations, was achieved through a CEEX project (2006-2008).

Characterization of local maize populations was performed in an appropriate experimental system based on morpho-physiological descriptors edited by the International Institute of International Plant Genetic Resources (BIOVERSITY), Rome Italy,(www.bioversityinternational.org).

In this project it presented the following morphological descriptors: plant height, height of insertion of ear, minimum and maximum diameter of stem, total number of leaves, length of panicle, length of ear, maximum and minimum diameter of ear, No of kernel rows , No of kernel per row, Kernel weight/on ear, 1000 kernel weight. Between physiological descriptors were analyzed: plant resistance to low temperatures, plant vigor, useful temperature sum until the occurrence of silk, plant resistance to root and stalk lodging and Fusarium resistance. These descriptors were evaluated by observations and measurements made in field and laboratory. In the laboratory we determined resistance of maize plantlets to the low temperatures in a genetic fond represented by 198 accessions. Assessment was performed after Debbert (1988) method, quoted by Rotari and Comarov (1992).

With this method each variant was established in two samples: sample for testing at low temperatures and control sample. This was done at sowing of each accession in two containers (30 seeds each). After emergence were left 25 plants which grew in the best conditions in the laboratory (T^0 = 25^0C, 10 -15 000 lx light, day - 14 hours and in the night -10 hours) for 14-15 days until third leaf development. At this stage, one container of each accession was transferred to growth chamber LabTech which was acquired in this project. Here, each accession was grown for seven days under the same conditions but with two temperature regimens: 4-5^0C at night, and 8-9^0C during the day. Chamber growth achieved in successive cycles automated day - night, with implementation scheduled parameters light, temperature and humidity. After the seven days of treatment with low temperature the containers from the growth chamber were again transferred to the laboratory for 6-7 days besides to the second replication of each accessions which grown in the laboratory conditions.

Finally were cut 20 plantlets from each accession (seedlings subjected to low temperatures in growth chamber) and 20 seedlings of control (seedlings grown under optimal conditions in the laboratory). All samples were dried in the oven until constant weight. Cold test index was appreciated by dry mass accumulation index calculated as:

Ki = dry mass ratio of the experimental sample to control sample, using the following scale:

- resistant genotypes> 80%;
- semi resistant genotypes 60 -79%;
- slightly resistant genotypes 40 -59%;
- sensitive genotypes <40%.

Evaluation of these maize genetic resources is found in the online database http// www.scdasuceava.ro/biomaize which includes information on the amount of biological material with useful genes in the main directions for improvement.

In this paper it presented the value of 50 old local maize populations selected on basis of coldtest index determined in laboratory (coldtest index > 78%).

The cold-test index with high values coincide in the most cases with higher FAO notes

(7,8,9) given in the field for plant resistance to low temperatures.

For a total of 13 morphological descriptors and seven physiological descriptors were calculated, the following statistical data: average (x), amplitude of variation, variance (s2) and coefficient of variation (s%) (Ceapoiu, 1968). Dispersion of the results concerning the morpho-physiological descriptors of maize local populations give a conclusive analysis of existing genetic diversity within this germplasm, insufficiently exploited.

RESULTS AND DISCUSSIONS

Morphological descriptors values at the old 50 maize local selected on the basis cold test index of more than 78-80% of the 198 populations characterized morphological and physiological in the experimented systemis found in the online database http// www. scdasuceava. ro/ biomaize.

The analysis results shows some level of dispersion of the values of descriptors which characterize the architecture of plants and ears, very important elements for improved choices of initial material sources for breeding process.

Plant height recorded an average on 195,4 cm., which shows that maize populations analyzed, in general, a medium-sized to high. It notes, however, populations with very high class, over 220 cm. .(La Căşi, Cormaia 5, Rodna 26, Gersa 11, Caldău, Ciocăneşti, Unirea, Runcu) and populations with low and very low plant height, under 160 cm. (Slatina 22, Valea Stânei 203, Săcel 8).

Insertion height of the main ear has on average, about 60cm., with large variations between populations, at populations on very high class from 105 cm. until 28 cm., at populations on very short class (Valea Stânei 203).

Maximum and minimum diameter of the stem, and total number of leaves are naturally higher at populations of high-class and lower at populations of short class.

Panicle length shows a medium value of about 63 cm., with a small variation at the 50 analyzed populations, between 70 and 53 cm, whatever of plant height.

Descriptors, the length of ear and the maximum and minimum diameter of ear emphasize many populations with large ears: : Rodna 16, Pîrteştii de Sus 1, Cormaia 2, Cormaia 5, Rodna 26, Gersa 11, Tiha Bârgăului 8, Saradis 3, Caldău, Bucerdea, Arduşat 1, Ciocăneşti, Bretam, Unirea, Putna 3, DDD 1581 86, Berindu 195, Sacalaia. The values of descriptors concerning the dimensions of ears confer an image on the productivity of analyzed local maize populations. In assessing of productivity it add other two important descriptors: kernel weight/on ear 1000 kernels weight.

Kernel weight/on ear recorded an average of 113.5 grams with a large amplitude variation 212 + 63 gr. There are some populations with high values for this descriptor, over 140 grams. (Rodna 16, La Căşi, Gersa 11, Vama 31, Saradis 3, Caldău, Bucerdea, Ciocăneşti, Unirea). The greatest value of kernel weight per ear has local population Ciocăneşti, 212 cm.

1000 kernels weight emphasize maize local populations with values over 300 grams: Rodna 16, La Căşi, Solca 3, Rodna 26, Gersa 11, Saradis 3, Caldău, Bucerdea, Ciocăneşti, Bretam, F 2315, DDD 1581 86, Runcu, Feleacu 2.

Mmorphological descriptors variances of maize local populations and the corresponding coefficients of variations (Table 2) showing different levels of dispersion of the values of these descriptors. Coefficients of variation are found for medium size at the descriptors: plant height, minimum and maximum diameter of the stem, the total number of leaves, length of the ear and number of kernels per row.

High coefficients of variation recorded for the insertion height of the main ear, kernel weight/ear, and 1000 kernel weight. The low coefficient of variations was recorded at the descriptors: panicle length and maximum diameter of ear.

Determination of the cold test index in the laboratory in year 2007, at 198 local maize populations, has led in obtaining of information concerning the resistance of the plantlets to the low temperatures. For more humid and cooler areas in Romania this physiological feature is particularly important in order to ensure successful of the maize crop.

From analysis of the cold test indexes for local populations of whole experimental system (see Biomaize database), results shows that the most maize populations are semi-resistant to low temperatures, with the cold test index values comprises between 60-79%. But, in this biological material were detected, resistant and very resistant populations (cold test index> 80%). These populations very resistant to low temperatures and few populations with cold test index of 78-79%, are the subject of this study (*table 2*). The following maize local landraces have very high values of the cold test index: Bucerdea, Unirea, CN-3283-59, DDD-1581-86, Botiza 12, Deseşti 6, Telciu 4, Slatina 22, Vama7, Gersa 11, Vama 31, Straja 14, Tiha Bârgăului 8, Frumosu 12, Moisei 5, Valea Mare 2.

Many of these landraces shows a good vigor and a very good growth being very resistant in the seedlings stage, and in the field. These populations represent valuable sources of genes for improving of resistance to low temperatures.

Table 1

The values of morphological descriptors for the old local landraces characterized at Suceava in year 2006

Estimators	Plant height (cm)	Insertion height of the main ear cm.	Maximum diameter of stem (mm)	Minimum diameter of stem (mm).	Total number of leaves	Length of panicle (cm)	Length of ear (cm)	Maximum diameter of ear (cm)	Minimum diameter of ear (cm)	No of kernel rows	No o kerne per ro	Kernel weight/on ear (g)	1000 kernels weight (g)
198 experimented local maize populations													
X	194,8	60,6	18,5	8,1	9,4	62,9	16,4	42,5	32,1		32,6	114,8	271,4
Max.	246,0	105,0	25,0	12,0	14,0	71,0	23,7	52,6	39,9	22	43,0	212,0	484,0
Min.	132,0	27,0	11,0	5,0	6,0	39,0	10,5	32,2	22,2	10	23,0	48,0	108,0
S^2	509,9	209,2	5,7	1,5	1,7	22,2	7,5	12,0	10,6		21,1	1116,2	4490,9
S%	11,6	23,9	12,9	15,2	13,8	7,5	16,7	8,1	10,2		14,1	29,1	24,7
50 local maize populations with superior values of the cold test index (< 78%)													
X	195,4	61,2	18,7	8,3	9,4	63,2	16,2	42,8	31,9		33,3	113,5	259,2
Max.	246,0	105,0	23,0	10,0	14,0	70,0	22,4	51,4	39,3	20	42,0	212,o	456,0
Min.	154,0	28,0	14,0	5,0	7,0	53,0	11,8	35,3	22,6	10	27,0	63,0	108,0
S^2	414,5	198,5	3,6	1,3	1,5	12,3	6,1	9,5	11,7		14,9	988,8	4361,1
S%	10,4	23,0	10,2	13,8	13,0	5,5	15,2	7,2	10,7		11,6	27,7	25,5

Table 2

The values of the cold test index and of the physiological descriptors of 50 analyzed local maize populations (Suceava and Turda, 2007)

Accession name	Origin	Cold test index (%)	The grows vigor (FAO notes)	Resistance to low temperatures in the field in Suceava (FAO note)	Useful temperatures sum until silking phase in Suceava (tu⁰ C)	Useful temperatures sum until silking phase in Turda (tu⁰ C)	Average Suceava+ Turda (tu⁰ C)	Rooted and lodged plants at harvesting (%)	Steril plants (%)	Resistance to Fusarium (FAO notes)
0	**1**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Lunca Ilvei 3	Suceava	81	8,5	8,5	488,2	577,4	532,8	29,4	23,5	4
Rodna 16	Suceava	85	9	7,5	531,5	554,6	543,1	41,6	5,5	7
Botiza 12	Maramures	87	9	8,5	477,0	533,6	505,3	46,6	18,7	6
Pîrteştii de Sus 1	Suceava	79	7	7,5	531,5	611,o	571,3	24,0	16,0	7
La Căşi	Bistrita Nasaud	80	7	7	624,9	636,5	630,7	24,0	28,0	8
Ivăneasa 1	Bistrita Nasaud	85	7,5	7,5	488,2	543,8	516,0	36,3	9,1	4
Frumosu 32	Suceava	82	7	7,5	518,7	533,6	526,2	22,5	25,0	6
Botiza 1	Maramures	83	8	6	507,5	554,6	531,1	30,0	20,0	6
Valea Drăganului 2	Cluj	83	6,5	6,5	507,5	554,6	531,1	31,6	27,3	6
Solca 3	Suceava	84	7,5	7,5	557,1	566,5	561,8	19,3	3,8	5
Deseşti 6	Maramures	95	8,5	6,5	531,5	611,0	571,3	31,0	28,6	4
Telciu 4	Bistrita Nasaud	88	9	7,5	570,4	577,4	573,9	27,3	31,8	4
Cormaia 2	Bistrita Nasaud	81	5,5	6,5	557,1	543,8	550,5	24,0	28,0	5
Slatina 2	Suceava	90	6,5	8	570,4	611,0	590,7	37,0	8,7	4
Vama 7	Suceava	94	6,5	7	570,4	554,6	562,5	33,3	27,8	7
Cormaia5	Bistrita Nasaud	80	7	6,5	595,4	611,0	603,2	25,0	29,2	3
Rodna 26	Suceava	83	7,5	8	570,4	641,7	606,1	34,1	4,5	4
Gersa 11	Bistrita Nasaud	89	6,5	7	570,4	543,8	557,1	22,5	35,0	8
Vama 31	Suceava	97	6	5,5	544,5	512,4	528,5	18,2	36,4	4
Straja 14	Suceava	85	7,5	6,5	518,7	566,5	542,6	34,8	13,0	6
Tiha Bârgăului 8	Bistrita Nasaud	96	8	7	544,5	566,5	555,5	36,8	10,5	3
Saradis3	Cluj	84	5,5	6,5	624,9	651,6	638,3	11,9	14,3	6
Frumosu 12	Suceava	85	7	6,5	531,5	512,4	522,0	33,3	23,8	5
Moisei 5	Maramures	88	7,5	6,5	518,7	512,4	515,6	37,5	16,7	7
Valea Mare 2	Bistrita Nasaud	86	7,5	7	498,2	543,8	521,0	27,2	13,6	8
Caldău	Bistrita Nasaud	80	7	8	583,6	599,3	591,5	35,3	11,8	5
Săcel 8	Maramures	84	7,5	7,5	518,7	589,1	553,9	27,8	22,2	9
Bucerdea	Alba	97	8	8	570,4	566,5	568,5	40,0	30,0	4
Arduşat 1	Maramures	80	7,5	7,5	595,4	577,4	586,4	38,1	23,8	5
Frumosu 166	Suceava	81	7	6	570,4	589,1	579,8	27,8	16,7	5
Ciocăneşti	Suceava	84	6,5	6	645,5	636,5	641,0	18,0	8,0	5
Bretam	Bistrita Nasaud	80	6	6,5	583,6	533,6	558,6	23,8	19,0	4
Brodina 1	Suceava	86	7	5	557,1	554,6	555,9	28,3	7,7	6
Valea Stânei 203	Suceava	80	6	4,5	557,1	554,6	555,9	17,5	15,0	6
Pojorâta	Suceava	92	4	6	518,7	533,6	526,2	27,3	18,2	7
Unirea	Bistrita Nasaud	97	5	5	645,5	641,7	643,6	30,8	38,5	4
CN 42 85	Cluj	83	5,5	6,5	645,5	646,6	646,1	28,3	30,4	4
CN 3283 59	Cluj	93	5,5	6	668,1	672,1	670,1	26,3	47,4	6
F 2315	Cluj	82	6	7,5	605,7	605,7	605,7	28,4	22,7	6
Putna 3	Suceava	81	7	8	570,4	623,4	596,9	20,4	18,5	7
DD 1581 86	Maramures	91	7	6	583,6	636,5	610,1	31,8	18,2	3
Gura Haitii	Suceava	87	6	5,5	518,7	543,8	531,3	26,3	15,8	6
CN 41	Cluj	81	4,5	3,5	645,5	641,7	643,6	34,1	9,1	4
Berindu 195	Cluj	82	7	7,5	570,4	566,5	568,5	25,2	16,7	4
Ceahlău 155	Neamt	78	6,5	5	570,4	589,1	579,8	32,2	17,5	5
Runcu	Suceava	79	6,5	6,5	614,2	566,5	590,4	26,2	9,1	6
Câmpulung 267	Suceava	78	7	7	531,5	533,6	532,6	41,1	17,9	6
Feleacu 2	Cluj	78	7	6,5	557,1	543,8	550,5	37,5	40,0	5
Sacalaia	Cluj	80	7	4,5	624,9	599,3	612,1	34,0	8,0	6
Slătioara 4	Maramures	78	8	6,5	557,1	599,3	578,2	30,0	25,0	7

The sum of useful temperatures (^{0}C) from the sowing period to the appearance of the silk is an indirect indicator of precocity of maize populations. Averaging of this indicator and of the other development processes and precocity, determined in Suceava and Turda, highlights a number of earlier maize populations until this phase, requiring less than 550 ^{0}C u.t. until silky phase. We identified the following populations with this important traits: Botiza 12, Ivăneasa 1, Frumosu 32, Botiza 1, Valea Drăganului 2, Gersa 11, Lunca Ilvei 3, Cormaia 2, Vama 31, Straja 14, Frumosu 12, Moisei 5, Valea Mare 2, Pojorâta, Gura Haitii, Câmpulung 267, Feleacu 2.

Such populations may be a valuable initial genetic material for improving of maize precocity. Plant resistance to root and stalk lodging is a technological indicator very important for this crop. Analyzing the obtained results in Suceava and Turda mean that the majority of the studied populations have a low resistance on these traits, explained that due the maize local populations is an old non breeding genetic material. It is noted only few maize population which have a small percent of rooted and stalk lodged on 25 and below 25%: **Pîrteştii de Sus 1, La Căşi, Frumosu 32, Solca 3, Cormaia 2, Cormaia 5, Gersa 11, Vama 31, Saradis 3, Ciocăneşti, Bretam, Valea Stânei 203, Putna 3.**

Plant sterility assessed by the percentage of the sterile plants and the Fusarium resistance noted with FAO notes in the climatic conditions from Turda, where these traits were affected stronger then in Suceava, have been complete physiological characterization of local maize populations, being of interest to breeders of this species.

Of particular interest are maize local populations which can be used like initial genetic material for concomitant improving of main agronomical traits, such as: **Rodna 16** for resistance to low temperatures and diseases, **Botiza 12** for resistance to low temperatures, resistance to root and stalk lodging and small percentage of sterile plants, **Moisei 5 şi Valea Mare 2** for productivity, resistance to low temperature, precocity, resistance to disease and the others that may be selected from the mentioned database.

CONCLUSIONS

Analysis of the results of this study led to the following conclusions of great interest to maize breeders:

It is noted local maize populations of interest as starting material for the improvement of important characters (precocity, resistance to low temperatures, elements of productivity and resistance to root and stalk lodging, resistance to diseases: Rodna16, Botiza12, Ivăneasa1, Solca 3, Vama 7, Gersa 11, Tiha Bârgăului 8, Moisei 5, Valea Mare 2, Bucerdea, Putna 3, Pojorâta, Brodina1.

Maize Local populations as a valuable starting material for concomitant improvement of important agronomic characters, have been identified, such as: **Rodna 16** for resistance to low temperatures and diseases, **Botiza 12** for resistance to low temperatures, resistance to root and stalk lodging and small percentage of sterile plants, **Moisei 5 şi Valea Mare 2** for productivity, resistance to low temperature, precocity, resistance to disease and others that may be selected from the mentioned database.

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