UDC (UDK) 633.15(496.5)

Doriana BODE,
Fetah ELEZI, Belul GIXHARI, Destemona SHEHU, Valbona HOBDARI [1]

EVALUATION OF SOME MORPHOLOGICAL CHARACTERISTICS IN MAIZE (*ZEA MAYS* L.)

SUMMARY

The characterisation and evaluation of the available maize germplasm is a necessary first step to facilitate breeding efforts. Eighteen maize accessions (labelled as AGB plus number), each part of the Albanian Gene Bank collection, were characterized by agro morphological descriptors. An estimated 25 morphological traits (15 quantitative and 10 qualitative) were based on the IBPGR Descriptors for maize. Variation of morphological characteristics among accessions ranged from 5.63% for days-to-tasseling to 24.29% for ear height. Accessions with the highest values of morphological traits were identified: AGB 1021 for days-to-tasseling (55), AGB 1035 for days-to-silking (59), AGB 1034 for plant height (265 cm), AGB 1031 for ear height (87 cm), AGB 1032 for number of leaves above the uppermost ear including ear leaf (6.1), ear diameter (3.8 cm), kernel width (0.9 cm), and weight of 1000 kernels (448.9 g), AGB 1038 for the number of kernels per row and kernel length. The analysis correlation coefficients among descriptors showed a positive significant association (0.90) between days-to-silking and days-to-tasseling, and a positive correlation (0.83) was observed between the number of kernels per row and ear length traits. Morphological relationships among 18 genotypes were clarified on a dendrogram by the complete linkage method. Results from the hierarchical cluster analysis show that there is significant variation among the 18 genotypes, suggesting that the maize germplasm collection of the Albanian Gene Bank is a rich source of material with adequate variation for future use in breeding programs.

Keywords: accessions, characterization, descriptors, maize (Zea mays), germplasm

INTRODUCTION

Maize (*Zea mays* L.) is a monoecius species, which has separate staminate and pistillate flowers on the same plant. The male inflorescence (tassel) arises from the shoot apical meristem, while the female inflorescences (ears) originate from the axillary bud apicies (Maiskomitee, 2003).

According to Edwards & Leng (1965), maize landraces in south-eastern Europe have different origins than those in the other parts of Europe. On the other hand, Leng et al. (1962) concluded that the origin of maize in south-eastern

[1] Doriana BODE, (corresponding author: b_dori23@yahoo.com), Fetah ELEZI, Belul GIXHARI, Destemona SHEHU, Valbona HOBDARI, Gene Bank, Genetic Resources Centre, Agricultural University, Tirana, Albania

Europe is generally unclear, but suggested a common origin for all maize landraces present in Europe. The same authors have claimed that maize had been first introduced into Balkan by the Turks during expansion of their empire. This presumption has been supported by the similarity of the names used for the maize by all the nations in the region. However, as Gouesnard et al. (2005) suggested, it is necessary to conduct a more exhaustive survey of the diversity among the eastern European maize landraces since most of the data used in the existing studies have been related to the western European maize populations. The development of high yielding hybrids and so enhancing productivity is the most important objective of any maize breeder (Yadav et al. 2010). The Albanian Gene Bank has a total of 2700 accessions part of its collection, where maize accessions occupy approximately 690 accessions. The aim of this study was to discover possible genetic diversity in maize accessions using morphological characters, information can be used for the planning conservation, and the utilization of these resources for future use in breeding programs.

MATERIAL AND METHODS

Plant material and field experiment:

Eighteen maize accessions were part of the active seed collection of the Albanian Gene Bank, and the Tirana University of Agriculture were used for setting up the field experiment. The samples tested were labelled according to bank numbers: *AGB 1021, AGB 1022, AGB 1023, AGB 1024, AGB 1025, AGB 1026, AGB 1027, AGB 1028, AGB 1029, AGB 1030, AGB 1031, AGB 1032, AGB 1033, AGB 1034, AGB 1035, AGB 1036, AGB 1037* and *AGB 1038.* In order to characterize the accessions, a field experiment was set up within the Centre of Technology Transferring, in Shkodër (Latitude: 42°04'N, Longitude: 19°30'E), with an annual average temperature of 16.3°C and an annual precipitation of 2148 mm (128 days/year rainfall). Sowing was conducted in 2009.

Morphological characterization:

The plants were characterized for morphological and productive traits following the guidelines of the "Descriptors for maize (IBPGR, 1991)". The morphological and agronomical characteristics measured were: days to tasseling (DT), days to silking (DS), plant height (PH), ear height/cm (EH), number of leaves above the uppermost ear including ear leaf (NLUC), ear length/cm (EL), ear diameter/cm (ED), cob diameter/cm (CD), rachis diameter/cm (RD), number of kernels per row (NK/R), cob colour (CC), kernel length/cm (KL), kernel width/cm (KW), kernel thickness/cm (KTH), weight of 1000 kernels in g (W), kernel colour (KC), number of rows kernels (NRK), shape of upper surface of kernel (SHK), shape of uppermost ear (SHE), foliage (F), sheath pubescence (SHP), tassel type (TT), husk cover (HC), kernel row arrangement (KRA), ear damage (Ed). Statistical analyses were conducted using the Multi Variance Statistical Program 3.1 (2000) and Excel (2007).

RESULTS AND DISCUSSION

The analysed morphological characteristics of eighteen maize accessions are presented in Table 1. An estimation of 25 morphological traits (15 quantitative and 10 qualitative) was based on the IBPGR "Descriptors for Maize" (IBPGRI, 1991). Eighteen maize accessions, the object of our study, presented low variability (5.63%) for the DT descriptor where AGB 1021 was the accession that needed a maximum of 55 days to tassel. The same we can say for the DS trait too, where accessions presented an average of 52.83 days to silk, and a maximum of 59 days (AGB 1035). Regarding the PH trait, maize plants showed a variation of 16.01% where AGB 1027 presented the lowest value (145cm) and plants of AGB 1034 reached the highest value at the level of 265 cm. Our PH results are higher than those recorded by Kandil & Sharief (2009) for 4 maize hybrids. The variation of the plant's height was from 177.1cm to 190.3cm.

Data recorded per ear, ranged from 5.85% for ED, 14.87% for EL, to 24.29% for ear height. AGB 1032 presented the highest values for NLUC (6.1) and for ED (3.8cm), meanwhile AGB 1037 recorded the highest value for EL (18cm). Maize accessions presented an average of 2.21 cm for CD with a variation from 1.8 cm to 2.6 cm (AGB 1030). Variability is foundational for traits like RD (15.16%), NK/R (19.88%), KL (14.98%) and a mass of 1000 kernels (15.52%). Results obtained for EL and ED are lower from those published in the Kandil & Sharief (2009) study, while results for NKR and the number of kernels per row grows higher, and the data pertaining to kernel length and width gleaned from our study are within the limits reported from these authors for the same traits. Most of the maize accessions show regular kernel arrangement (Figure 1), and only AGB 1031 presented straight arrangement.

Figure 1. Variability found in kernel arrangement

Referring to the qualitative descriptors of maize, the germplasm presented uniform kernel colour within accession but spread out in 4 different colour among them (Table 2). Variability is found for the SHP trait, while 8 among 18 accessions represent intermediate sheath pubescence. We encountered low

variability for TT and ED traits, while only one of the accessions presented a poor husk cover (AGB 1025).

Table 1. Morphological characteristics data recorded for *Zea mays* accessions

Acc. AGB	*DT*	*DS*	*PH*	*EH*	*NLUC*	*EL*	*ED*	*CD*	*RD*	*NK/R*	*KL*	*KW*	*KTH*	*W*	*F*	*SHP*	*TT*	*HC*	*Ed*	*CC*	*SHE*	*SHK*	*KRA*	*NRK*	*KC*
1021	55	58	203	82	5.5	13.7	3.7	2.2	1.2	28	1	0.7	0.4	308.8	3	5	3	5	3	1	2	1	4	10	2
1022	49	53	154	49	5.5	17.5	3.5	2.3	1.6	35	0.8	0.9	0.4	276.7	3	5	3	5	3	1	3	4	2	16	2
1023	49	52	183	56	5.6	12.7	3.3	2	1.3	25	0.8	0.9	0.3	294.3	3	7	3	7	3	4	3	4	1	10	2
1024	49	52	166	55	5.1	12.5	3	2.1	1.3	26	0.9	0.7	0.4	245.1	3	4	3	7	3	4	3	4	4	8	3
1025	52	58	182	59	4.4	13.2	3.7	2.3	1.5	26	0.9	0.7	0.3	278.2	5	3	2	3	3	1	4	4	2	8	2
1026	48	52	184	61	5.3	12.1	3.6	2.3	1.8	26	0.7	0.9	0.3	308.6	3	7	3	5	3	4	4	4	2	8	5
1027	48	52	145	48	4.9	16.2	3.5	2	1.5	34	0.8	0.8	0.3	342.9	3	5	2	7	3	1	3	4	4	8	2
1028	48	52	170	66	4.8	15.7	3.5	2.3	1.1	30	0.9	0.8	0.3	288.2	3	7	3	7	3	1	2	1	2	9	1
1029	49	53	185	49	6	15.6	3.3	2.1	1.2	25	0.7	0.8	0.4	309.4	5	5	3	7	3	1	3	4	1	12	1
1030	46	48	167	42	4.7	11.4	3.6	2.6	1.6	21	0.7	0.9	0.6	359.7	3	6	3	7	3	4	3	4	2	10	2
1031	46	50	228	87	5.4	16.8	3.6	2.5	1.6	34	1	0.9	0.5	291.4	7	7	3	5	7	4	3	4	3	10	1
1032	49	52	203	52	6.1	16.4	3.8	2.3	1.3	29	1	0.9	0.5	448.9	5	7	3	5	3	1	2	4	2	12	1
1033	47	49	150	31	5.1	13.8	3.4	2.1	1.4	30	0.7	0.9	0.4	326.5	3	3	2	7	3	4	3	4	2	10	2
1034	45	49	265	43	5	12.5	3.3	1.8	1.2	20	1	0.8	0.3	248.3	3	5	3	7	3	4	3	4	2	12	1
1035	52	59	210	70	4.5	15.7	3.5	2.5	1.6	34	0.9	0.9	0.4	295.7	5	3	3	5	3	4	3	4	2	10	1
1036	45	49	181	50	4.6	12.5	3.2	2.1	1.2	27	0.9	0.7	0.4	247.1	3	5	2	7	3	4	4	4	2	12	2
1037	52	57	200	56	5.6	18	3.5	2.2	1.2	35	0.7	0.6	0.5	305.8	5	5	3	5	3	1	3	4	1	10	1
1038	52	56	221	56	5	17.8	3.7	2.1	1.1	44	1.1	0.9	0.3	312.1	5	3	3	7	3	1	3	4	1	10	1

Table 2. Data recorded on qualitative traits for eighteen maize accessions

Descriptor	***Code***		***Frequency***	***Cumulative percentage***
KC	1	white	8	44.44%
	2	yellow	8	88.89%
	3	purple	1	94.44%
	5	brown	1	100.00%
F	3	small	11	61.11%
	5	intermediate	6	94.44%
	7	large	1	100.00%
SHP	3	sparse	4	22.22%
	5	intermediate	8	66.67%
	7	dense	6	100.00%
TT	2	1-secondary	4	22.22%
	3	$1\text{-}2^0\text{-}3^0$	14	100.00%
ED	3	little	17	94.44%
	7	severe	1	100.00%
HC	3	poor	1	5.56%
	5	intermediate	7	44.44%
	7	good	10	100.00%
KRA	1	regular	4	22.22%
	2	irregular	10	77.78%
	3	straight	1	83.33%
	4	spiral	3	100.00%
SHE	2	cylindrical-conical	3	16.67%
	3	conical	12	83.33%
	4	round	3	100.00%
SHK	1	shrunken	2	11.11%
	4	rounded	16	100.00%
CC	1	white	9	50.00%
	4	purple	9	100.00%

Regarding interrelationships among quantitative descriptors, days-to-silking appears to be highly and significantly correlated to days-to-tasseling (r = 0.9), showing that DT has significant influence over DS (Table 3). Malik et al. (2005) found that these two traits were strongly correlated ($P \leq 0.05$) in studying genetic correlation among 36 maize hybrids. Moreover, we found an additional high correlation coefficient among the NK/R and EL trait (r = 0.84). This result goes in accordance with those of Čamdžija et al. (2012), where the strongest positive correlation was obtained between grain yield and ear length (P=0.01), and ear length and number of kernels per row (P=0.001). These two traits are the most likely to help improve grain yield. Another positively strong relation is recorded between plant height and kernel length (r = 0.61) as well as within ED

and the weight of 1000 kernels (r = 0.62). Medium correlation is recorded among DT and traits as EH (r = 0.43), ED (r = 0.41) and NK/R (r = 0.41). In our study we didn't find any highly negative correlation amid traits, though the highest negative value that was recorded was between RD and KL (r = -0.37). This seems to suggest that as one characteristic increases, the other decreases.

Table 3. Genotypic correlation coefficient (Pearson) among quantitative descriptors in *Zea mays* accessions.

	DT	***DS***	***PH***	***EH***	***NLUC***	***EL***	***ED***	***CD***	***RD***	***NK/R***	***KL***	***KW***	***KTH***	***W***
DT	1													
DS	0.94	1												
PH	0.05	0.14	1											
EH	0.43	0.48	0.36	1										
NLUC	0.12	-0.03	0.09	0.04	1									
EL	0.34	0.39	0.09	0.22	0.34	1								
ED	0.41	0.37	0.17	0.33	0.08	0.36	1							
CD	0.11	0.15	-0.11	0.42	-0.15	0.12	0.49	1						
RD	-0.17	-0.08	-0.25	0.08	-0.17	-0.16	0.24	0.56	1					
NK/R	0.41	0.44	-0.01	0.26	0.02	0.84	0.35	0.13	-0.06	1				
KL	0.19	0.21	0.62	0.46	-0.11	0.19	0.24	-0.09	-0.37	0.28	1			
KW	-0.29	-0.33	0.01	-0.09	0.11	0.06	0.28	0.29	0.45	0.13	0.01	1		
KTH	-0.12	-0.19	-0.01	0.01	0.25	0.09	0.15	0.59	0.17	-0.07	-0.19	0.02	1	
W	0.09	-0.04	-0.13	-0.14	0.42	0.24	0.63	0.31	0.12	0.11	-0.07	0.39	0.42	1
NRK	-0.18	-0.17	0.12	-0.24	0.38	0.29	-0.04	-0.05	-0.11	0.05	0.04	0.22	0.23	0.01

Based on the single linkage method, measured with Euclidean distance, the dendrogram (Figure 2) and the matrix of dissimilarity suggested two accessions with the lowest level of divergence among them. These are AGB 1026 (G 06) and AGB 1029 (G 09). These accessions are clustered together due to trait similarities, especially in traits like KL, TT, ED and SHK. For this group, maintaining a dissimilarity level of 17.44 is joined by AGB 1023 (G 03). This genotype is notably similar to AGB 1029 in the DT, ED, NK/R, TT, HC, KTH, SHE, SHK, and KRA traits.

Another similar group includes AGB 1024 (G 04) and AGB 1036 (G 16), homogenous for EL, CD, KL, KW, KTH, F, CC and SHK, but different from each other, especially in ED and W where AGB 1024 received the lowest values measured. Grouped separately for similarity in descriptors were EL, CD, KL, KTH, KW, with qualitative traits like F, HC, CC and SHK including accessions AGB 1025 (G 05) and AGB 1028 (G 08). Differences among them are significant especially in NLUC, RD and EL descriptors. Accessions AGB 1035 (G 15) and AGB 1037 (G 17) differ from each other in the traits DS, EH, EL, CC, KL and KW but are similar in others, DT, ED, F, TT. Together with these accessions is included AGB 1021 (G 01) which is homogenous for CD, RD, KTH, TT but very different for DT (this accession has the highest value among all the other maize accessions), KRA, NK/R, EL and EH. Another group of

maize genotypes gathered at the 24.686 level of dissimilarity is formed by AGB 1027 (G 07) and AGB 1033 (G 13), which differs in the traits PH, EH, EL, KL and KTH. Further up, AGB 1030 is joined to this chain of similarity in KL, KW, F, HC and SHE, but is set apart from them by the traits PH, EL, CD, NK/R, W and EH.

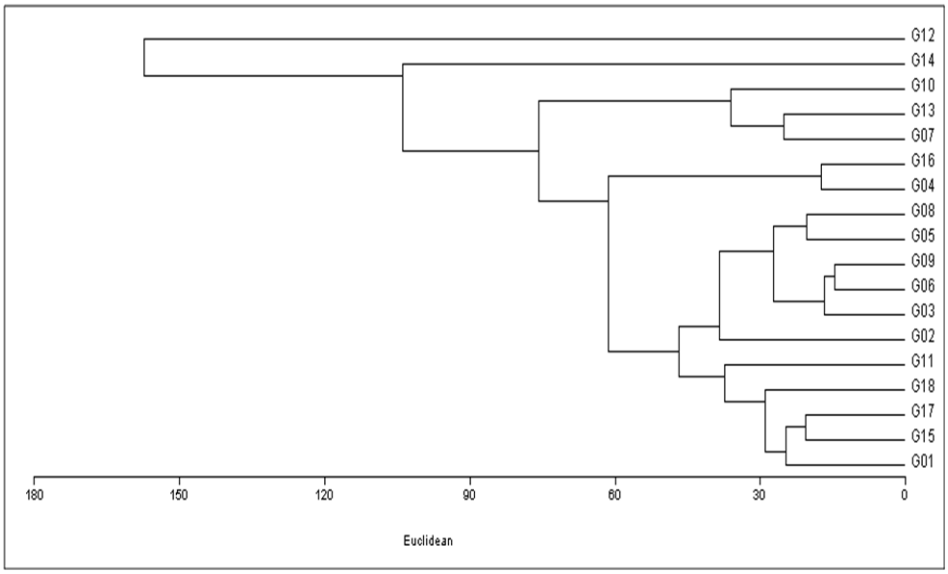

Figure 2. Single linkage dendrogram for 18 *Zea maize* accessions.

AGB 1038 (G 18) is associated to a three member group, for similarity in qualitative traits but differences in NK/R, W, PH, KL, NLUC, EL, RD and KTH. Apart from the other 16 maize genotypes is AGB 1034 (G 14), for distinction in PH (maize plants with the higher value), CD, NK/R and KTH. Major dissimilarities are found in AGB 1032 (G 12) which is completely different from all the other 17 accessions, particularly as it has the highest values in the traits NLUC, ED, KW and W. The morphological differences that were noticed should be confirmed by characterization using molecular markers; some authors, like Tolera et al. (2008) and Tosti & Negri (2005), have reported generally low levels of variability in the legume after using molecular markers.

CONCLUSIONS

The results obtained in this study indicate that the maize accessions are part of an active collection in the Gene Bank (Agricultural University of Tirana) and they show significant morphological diversity, especially in the traits RD (15.16%), NK/R (19.88%), KL (14.98%) and the mass of 1000 kernels (15.52%). Eighteen maize accessions present low variability for DT and DS traits. The data recorder on each ear ranged from 5.85% for ED, 14.87% for EL, and up to 24.29% for ear height.

In regard to interrelationships among quantitative descriptors, days-to-silking appears to be very highly and significantly correlated to days-to-tasseling (r = 0.9), showing that DT has a definite influence on DS. We found one other highly correlative coefficient among NK/R and EL trait (r = 0.84).

This study suggests that studying genetic diversity in maize accessions through morphological characters can yield information for planning the conservation and utilization of these resources for future breeding programs.

REFERENCES

Čamdžija, Z. Mladenović, drinić S. Filipović, M. Stevanović, M. Pavlov, J. Božinović, S. (2008): Genetic variability among maize hybrids for yield and yield components. Proceedings. 46th Croatian and 6th International Symposium on Agriculture. Opatija. Croatia :388-390.

Edwards, R.J. & Leng, E.R. (1965): Classification of some indigenous maize collections from southern and southeastern Europe. Euphytica 14: 161-169.

IBPGR (1991): Descriptors for Maize. International Maize and Wheat Improvement Center, Mexico City/International Board for Plant Genetic Resources, Rome. ISBN 92-9043-189-1.

Kandil, A.A. & Sharief, A.E. (2009): Morphological and Physical-chemical Characteristics Identification of Some Summer Oil Crops Genotypes, Journal of Applied Sciences Research, 5(10): 1313-1319.

Maiskomitee, A. (2003): Fachinfo Morphologie. htpp://www.maskomitee.de/fb_fachinfo.htm.

Tolera, T. Karlovsky, P. & Maass, B. L. (2008): Genetic diversity in tropical legumes: cowpea (*Vigna unguiculata* (L.) Walp.) and lablab (*Lablab purpureus* (L.)Sweet). Australian Society of Agronomy. Online. http://www.regional.org.au/au/asa/2008/poster/biotechnology/5907_angessatt.htm.

Tosti, N. & Negri, V. (2005): On-going on-farm micro evolutionary processes in neighbouring cowpea landraces revealed by molecular markers. Theoretical and Applied Genetics 110, 1275-1283.

Yadav, K.V. & Singh, S.I. (2010): Comparative evaluation of maize inbred lines (*Zea mays* l.) according to dus testing using morphological, physiological and molecular markers. Agricultural Sciences Journal, Vol.1, No.3, 131-142 (2010). Available at http://www.scirp.org/journal/AS/.

Leng, E.R. Tavcˇ AR, A. & Trifunovic, V. (1962): Maize of south-eastern Europe and its potential value in breeding programs elsewhere. Euphytica 11: 263-272.

Gouesnard, B. Dallard, J. Bertin, P. Boyat, A. Charcosset, A. (2005): European maize landraces: Genetic diversity, core collection definition and methodology of use. Maydica 50: 225-234.

Doriana BODE,
Fetah ELEZI, Belul GIXHARI, Destemona SHEHU, Valbona HOBDARI

EVALUACIJA NEKIH MORFOLOŠKIH KARAKTERISTIKA KOD KUKURUZA (ZEA MAYS L.)

SAŽETAK

Karakterizacija i evaluacija raspoložive germplazme kukuruza je prvi, neophodan korak u procesu oplemenjivanja. Osamnaest aksešena kukuruza iz banke biljnih gena Albanije karakteriše 25 agro morfoloških osobina prema IBPGR "deskriptorima za kukuruz". Aksešen sa najvišim vrijednostima nekoliko morfoloških osobina je AGB 1032, a to su broj listova iznad najvišeg klipa uključujući i list klipa (6,1), prečnik klipa (3,8 cm), širina zrna (0,9 cm) i težina 1000 zrna (448.9 g). Dva aksešena sa najnižim nivoom divergencije su AGB 1026 (G 06) i AGB 1029 (G 09). Ovi aksešeni su u istoj grupi zbog u sličnosti u mnogim osobinama, ali posebno u osobinama poput KL, TT, ED i SHK. Na kraju, najveći broj razlika prisutan je kod AGB 1032 (G 12) koji se razlikuje od svih ostalih 17 aksešena, posebno kada je riječ o najvećim vrijednostima osobina kao što su NLUC, ED, KV i V. Analiza korelacije koeficijenata među deskriptorima pokazala je značajnu povezanost na nivou r = 0,9 između DS i DT, a pozitivna korelacija (r = 0,83) je takođe uočena između osobina NK/R i EL.

Ovim istraživanjem se preporučuje genetička raznovrsnost kod aksešena kukuruza primjenom morfoloških karakteristika, a informacije se mogu koristiti u budućim programima oplemenjivanja.

Ključne riječi: aksešeni , karakterizacija, deskriptori, kukuruz (Zea mays), germplazma