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Genetic Variability of some Maize Inbred Lines (*Zea mays* L.) in Agroecological Conditions of Kosovo

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Abstract

The aim of this study, conducted during the years 2005 (Y1) and 2006 (Y2), was to investigate the variability and appearance of genotype reaction in maize inbred lines. In the investigation were included 10 maize inbred lines obtained from the University of Tirana-Albania, department of Agronomy. The experiment was based on a ranomized complete block design (RCBD) with three replications in the locality of Ferizaj. The variability and genotype reaction was analysed for quantitative parameters for plants as following: Ear height (EH); plant height (PH), ear leaf area (LA) and leaf area index (LAI). The experimental average values μ for investigated parameters were: EH was 60.46 cm, PH (169.88 cm), LA (446.2 cm^2) and LAI (3.23 plant m^{-2}) respectively. The inbred lines between them for EH at the first year (Y1) and the second year (Y2) had show the variability 52.59% and 43.16%, respectively. The highest value for EH was shown by inbred L4 (76.10 cm), which differs from the value μ for +25.86%. While the lowest value was recorded at the inbred L5 (44.30 cm) that difference was a reduction of– 26.72%. In the Y2 the same values were repeated but with minimal differences. The maize inbred L7 for the Y1 had a greater total plant height (196.5 cm), while for the Y2 was obtained 206.7cm. The minimal average value for PH were shown by the inbred L8 and L2, while the total variability between all inbred lines for PH were Y1 (32.61%) and Y2 (36.55%) respectively. Average values of the two years investigation for ear leaf area (LA) were obtained by inbred L7 (544.1cm2 plant-1), whereas lowest values were showed by maize inbred L10 (356.9cm2plant-1). Variability between inbred lines was 41.95 %. The highest value of LAI was obtained for inbred L7 on coefficient 3.9 plant m2 (Y1) and 4.0plant m-2(Y2) whereas the lowest LAI was realised on maize inbred L10 (2.5 plant m^{-2}) at the Y1, while for the Y2 was obtained at maize inbred L8 (2.6 plant m^{-2}).

Keywords: Maize inbred line, ear height, plant height, leaf area, leaf area index

Introduction

Maize (*Zea mays* L.) is one of the most significant cereal crops of Kosovo, based on area and production it ranks second in cereals next winter wheat. The breeding for hybrid development was begun in the early 1900s with the work of (Shull, East 1908,1909) and others, but a primitive type of breeding was conducted for thousands of years by the American Indians before the European colonists began settlement in the New World .The major focus of maize breedings is the same stated by (Shull ,1909) "the object of the maize breeder should not be to find the best pure line , but to find and maintain the best hybrid combination (Hallauer *et al*.,1988). Jenkins (1978) gives information that less than 3% of maize inbred lines during years 1936s are obtained from crossing elite maize line. Based from some researches (Hallauer, 1985), the recorent methods at maize inbred lines was suiTab. in development of parent material (germplasme).The use of comericial hybrid single cross (SC) are condition from parent material (Vujevič and Brkič, 1990). The inbred-hybrid concept (East, 1908; Shull, 1909; Hayes, 1963) and the population- hybrid (Carena, 2005) concepts were developed in the public sector. The most successful maize germplazm was Iowa Stiff Stalk Synthetic or BSSS (Sprague 1946), a genetically broad-based population. According to the date of Carena (2008) its successful derivation, B73 was derived after five cycles of half-sib recurrent selection (Russel, 1972). The use of heterozise in the world has started since year 1933 when in USA were planted about 1% of the total surfaces, while latter in year 1953 the hetorzyses of the maize hybrids were expanded up to 96% (Sprague *et al*.,1988). The cultivation of the hybrids started after the year 1960 in about 4.38%, and the seed was provided by the USA. Now, in Kosovo about 95% of of surfaces are planted with different types of hybrids. Statistics of Kosovo (2005-2006) maize was grown on a total area of 60.000-70.000 ha-1with a total production of 292.50 thousand tones with average yield 4.5t ha-1. The activity for development of new hybrids in territory of Kosovo has started during the seventies, and more intensively has been working during the year 1980-1987, this activity has not end up successefull and these research work continue after year 1999 (Aliu, 2006). The main objectives of the study therefore were conducted to determine the genetic variability for some quantitative traits suited to agro-ecological condition of Kosovo.

Tab. 1. The investigated materials of inbred line, nomination and line symbol

No.	Maize inbred line	Line symbol
1	Libe 501	(L1)
2	Kws varjeta x hybrid 321 x dek 361	(L2)
3	Funk 4834 x FR 206 x dek 361	(L3)
4	1087 x OH 43 rf x ZPSK7095 x Mashkullor x Asgrow 55	(L4)
5	ILB 42-6	(L5)
6	Rozafa 506	(L6)
7	H-95 x B-73	(L7)
8	W 64 A x Lo Tu x Funk 364 x Reci 1657 x 306	(L8)
9	Sintetica 1	(L9)
10	21-12 Lo Turota	(L10)

Materials and methods

Plant material and experimental design

Ten (10) maize inbred lines selected with medium maturity, originating from the Agriculture University of Tirana (AUT)- Albania (see Tab. 1). The observation for plant material of the maize inbred lines were planted during vegetation year 2005 (Y1) and 2006(Y2) at the locality of Ferizaj, with altitudes 560 m.a.s.l. The experimental design was a ranomized complete block (RCB) with three replications. The plant distance was 70 cm apart with 25 cm plant to plant distance or 57000 plants per ha^{-1}. The seeds were placed 3-5 cm deep, while the plot sizes were 28 m^2 per each replications x 3 Replications (R) =84 m^2. The combination formula in our study was; 10 inbred line x 3 Replications x1 Locality = 30 Experimental plots (EP). In order to determine green ear leaf area (LA) we measured dimensions of the leaf blade growing from the some node as the ear. LA was determined according to the formula of Montgomery (1911) as following: A= LxWx0.75, were L- represent leaf length, W is leaf width and 0.75 is the factor used for determination of LA in maize, while Leaf Area Index per plant (LAI) was calculated by Watson (1964). Under the growing conditions of these experiment to determine phenotypic traits per plant ear height (EH), plant height (PH), leaf area (LA) and leaf area index (LAI) we measured at field and laboratory the average of ten (10) plants were randomly harvested from one of the four middle rows (10 plants x 3R= 30 plants x 10 inbred lines =300 plants). The investigated inbred lines are presented at Tab. 1

The data for all the trials were analysed by ANOVA. Differences for means of various characters were computed using least significance differences (LSD) at 0.05 and 0.01 level of probability Duncan's multipe range test while dendrogram by cluster analyses was used with single linkage. Correlation factor was calculated by the Pearson. Model using statistical analyses package were conducted program MINITAB version 14.

Results and discussion

Depending from objective on cultivation of the maize inbred lines, the ear height of the plant (EH) is correlated

Tab. 2.The morphological traits of the maize inbred lines during years 2005 and 2006

	L.S.	EH (cm)			PH (cm)			LA (cm^2plant^{-1})		
	Line	Y1	Y2	X	Y1	Y2	X	Y1	Y2	X
1	L1	50.7	52.8	51.75E	149.2	160.4	154.80F	450	420.1	435.1E
2	L2	64.6	49.3	56.98B	173.5	144.6	159.08D	518.2	428.2	473.2B
3	L3	61.2	56.5	58.85C	164.9	163.8	164.35E	450.1	510.7	480.4E
4	L4	76.1	64.4	70.28A	179.2	174.5	176.85C	480.1	518.2	499.1D
5	L5	44.3	55.9	50.13F	166.8	158.0	162.40E	398.2	382.5	390.3G
6	L6	59.7	72.0	65.85C	183.6	180.2	181.90B	510.7	375.7	443.2C
7	L7	65.8	68.9	67.35B	196.5	206.7	201.63A	532.5	555.7	544.1A
8	L8	64.5	52.8	58.65B	141.9	152.6	147.28G	398.2	315.7	356.9G
9	L9	56.2	54.0	55.10D	176.1	155.3	165.70C	405.1	442.5	423.8F
10	L10	64.1	75.4	69.78B	177.5	192.4	184.95C	345.7	487.5	416.6H
X	μ	60.72	60.2	60.46	170.9	168.8	169.89	448.8	443.6	446.2
Year	LSDp=0.05	2.11	CV=14.88%		6.17	CV=10.55%		101.71	CV=15.28%	
	LSDp=0.01	3.031	SD=±9.0		8.86	SD=±17.86		118.31	SD=±68.15	
			SE=2.85			SE= 5.65			SE= 21.55	
Line	LSDp=0.05			4.37			10.36			110.86
	LSDp=0.01			5.75			13.64			137.46

Note: Y1-First year, Y2-second year, LS- line symbol, EH- Ear height, PH- Plant height and LA- ear leaf area

with the plant height (PH) and leaf area (LA). Such a genotypic trait determines the morphological and production parameters of the hybrid lines. The Pearson correlation factor between parameters EH and PH was significant (r = 0.75*). Experimental results allowed to identify the genetic variability among the 10 inbred lines for EH. Investigations on estimation of EH in our stady showed that inbred line realised more EH the second year (Y2) than in the first year (Y1). Minimum average value of EH was obtained by the maize inbred L5 (50,13cm), compared with experimental value μ (60.72cm) distinction were -10.33 cm or 17% respectively, while for the maximum EH was recorded at the maize inbred L4 (70.28 cm) or + 9.82 cm respectively 17% more than value μ. Results are presented in Tab. 2.

The differences between genotypes for extreme values were 20.15 cm or 34%, which was statistically significantly different. The quantitative traits are variable and are determine from the poligenes and ecological factors, this was the main reason for defferences showed among the investigated genotypes. The comparison of the extreme values in two directions (minimal and maximal) for the investigated treatments is of the genetic and practical interest. The differences between minimal values were higher and important from the statistical and practical point of view. The two year results of the investigated maize inbred lines for the placement of ear enabled the clasification of the respective lines under different classes(see Tab. 3).

The significant differences were shown between different maize inbred lines at level LSDp0.05 = 4.37 and LSDp0.01= 5.75. The maize inbred L4 was characterized with higher significant differences compare to other inbred lines for 11.4 up to 20.15 cm, while when comparing with maize inbred L6 the variations were significantly only for the 0.05 level of probability. The maize inbred L4 was realised maximal average value for EH, compare to other maize inbred L7 and L10 the differences were non significant, because these inbred lines had quantitaive phenotypic values close between them. The higher significant differences were registered for L2 (15.3 cm), while for L3 and L8 the difference was of the same level with 11.7 cm. Detail are presented in Tab. 2. The maize inbred L8, but other lines as well during the investigations (Salillari *et al*., 1987), were systemized in the group of the lines with EH of plant from 61 to 80 cm, which in our study on agri-ecological conditions of Ferizaj location were 52.8 to 64.5 cm. This showed that our results with minimum differences complay with those above mentioned. Thes maize inbred line and others have been studied by other outhors as well, (Plavsčak, 1993) found that EH was 55.3 cm, which compared with our results is in fully compliance. If comparing with the results of Aliu (2006) for the EH on 45 different hybrid of F1 combination with medium maturity, that had average genotyp value μ (84,55cm), than can be seen a high variations aproximately +24 cm per plant. These results are different with those from our study because to hybrid combination is present vigority (heterosis). The plant height (PH) showed that were differences for the investigated factors and their interaction in favor of one or other factor. Results are presented in Tab. 2. For the PH of the maize inbred lines were found significant differences on level LSDp0,05 =10.36 and LSDp0,01=13.64. The highest PH of 196.5cm or +25.58 cm or 14.96% more than genotype value (170.9cm) was noted at the maize inbred L7. Whereas minimal average values was maize inbred L8 (141.9cm) with differences -29.02 cm or 20.45% compared with average genotype value. The difference for extreme values between maize inbred lines was 54.6 cm or 35.41% which was statistically significantly different at level of probability 0.01. In the second year with minimal average value was obtained at maize inbred L2 (144.6 cm) if compared with average genotype value (168.8cm) the differences were –24.25 cm or 14.36%. Variability for minimal PH value from the Y1 to Y2 was only +2.7 cm. The differences between L7 (206.7 cm) and L2 (144.6cm) were +62 cm or 36.77%, this is relatively highest significantly value. Many researchers have reported different results for PH depending from inbred lines, year and location. Plasčak (1993) based on the fifteen year results concluded that the PH of the different lines and is influenced by environmetal factors. In the favor of the growth of internodes and its growth of the plant an important effect play also the warm nights (the minimal low temperatures) in the earlier stages of the maize growth and a minimal high temperatures during the day, during the studies in the Institute of Osijek - Croatia, found the different PH of maize inbred lines from 80 to 151cm, which varied from our results, especially for the minimal average values of the inbred lines. It is important to mention that line L8, which showed the PH with variation from 72 to 97,7cm, in Ferizaj this value was from 141-152 cm, and the differences between them were approximately 50% higher that in Osijek. This could

Tab. 3. Clasification of the maize inbred lines for EH

Group	The level of interval (cm)	Maize inbred line	Frequence
I	50.13-54.15	L5 and L1	2
II	54.16-58.18	L2 and L9	2
III	58.19-62.21	L3 and L8	2
IV	62.22-66.24	L6	1
V	66.25-70.28	L7, L10 and L4	3

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Tab. 4. Clasification of the inbred lines for the PH

Group	The level of Interval (cm^2)	Maize inbred lines	Frequency
I	147.28-158.14	L8 and L1	2
II	158.15-169.01	L2,L3,L5,L9	4
III	169.02-179.88	L4	1
IV	179.89-190.75	L6, and L10	2
V	190.76-201.63	L7	1

be explained as an effect of environmental conditions. The estimation and quantification of the parameters enables a classification based on standard method in the five phenotypic level of interval are presented in Tab. 4.

The green ear leaf area (LA) is designated by physiological proceses and its duration is importante for photosynthesis a plant especially in maize, these are also measurements of growth of plants and plant physiological processes. Effects on LA at the different maize inbred line are presented in Tab. 2. Differences were found between the 10 maize inbred lines for investigations parameters had highly significant at 0.01 level of probability. Estimation of LA showed that maize inbred produced larger LA the first year (448.8cm^2 plant-1) than the second year (443.6cm-2plant-1) on differences 5.2cm-2plant-1. Minimal average value was realised at theY1 where maize inbred L10 obtained value 345.7cm2plant-1, if compared with total experimental value μ (446.2 cm2plant-1) L10 was lowest for-100.5 cm2plant-1 respectively there was reduction of 22.52%. The maximal average value on LA was realised by the maize inbred L7 (532.5 cm2plant-1) if compared with value μ differences between there are +86.3cm2plant-1 respectively +19.34%. The difference among extreme values for investigated parameters was 186.8cm2plant-1 or 41.86% significantly different. For the second year Y2 the minimal average value was obtained on the maize inbred L8 with value 315.7cm2plant-1, compared with value μ distinction was -130.5cm2plant-1 or 29.24%. Maximal average value for LA was realised maize inbred L7 (555.7cm2plant-1) or +109.5cm2plant-1 respectivly 24.54 % higher from value μ. Differences between extreme values were 240cm2 plant-1or 53.78 % showed highest significance. For two years of the study the maize inbred L7 was differenciate as a superior genotype and was characterised by the largest LA. In the modification of this trait a higher influence had the environmental factors which play also a important role. In the first year the largest of LA expect L7, had also the lines L2, L4 and L6, while for the second year lines L4, L3 dhe L10. Such a phenomen can be used as criteria for estimation and classification for the investigated parameters (the size of leaf) and through this can be calculated the genetic yield potential (GYP). The estimation and quantification of the parameter enables a classification based on standard method in the five phenotypic level of interval with differences group to group. These results are presented in *Tab.*5. The results from our study agree with those from (Salillari *et al*., 1987), which realized the inbred line values for this parameter from 300.75 to 600.72 cm^2. Aliu (2008) in his researches with some hybrid combination found that the total LA was from 558.9-788.6 cm2 $plant^{-1}$. This parameter also was investigate by Jakovljevič (1989), who stated the values of 594.2cm2; thes result minimaly varied from ours.

According to the dendogram (Fig. 1), results for LA produced by cluster analysis, maize inbred lines are separated into two main and three secondary groups. L7, L4, L3, and L2 inbred line showing the hierarchial similarity and formed first group which is different from the others, while the second main group is formed by the other separates into two secondary groups. The most similar inbred line are: L1 and L6, L9 and L10, L5 and L8, L2 and L3.

Leaf area index (LAI) per plant is an other important character in maize which ultimately play important role of photosynthetic maschinery. The total average values at our results were 3.23plant m-2. The maize inbred L7 had the highest average value value for LAI (3.9 plant m-2), which was significantly different from the other genotypes.While the lowest LAI (2.3plant m-2) was obtained at the L8. If compared experimental average value μ with maximal and minimal were +0.67plant m-2 and –0.93 plant cm-2 or 20.74 respectivelly 28.79%. The differences for extreme average values between maize inbred were +1.3 plant m2. According to Subedi and MA (2005) in their researches at the some different hybrids obtained results for LAI from 3.5 till 4.9 plant m-2. These values are presented in table6.

Tab. 5. Clasification of the inbred lines for the LA

Group	The level of Interval (cm^2)	Maize inbred lines	Frequency
I	147.28-158.14	L8 and L1	2
II	158.15-169.01	L2,L3,L5,L9	4
III	169.02-179.88	L4	1
IV	179.89-190.75	L6, and L10	2
V	190.76-201.63	L7	1

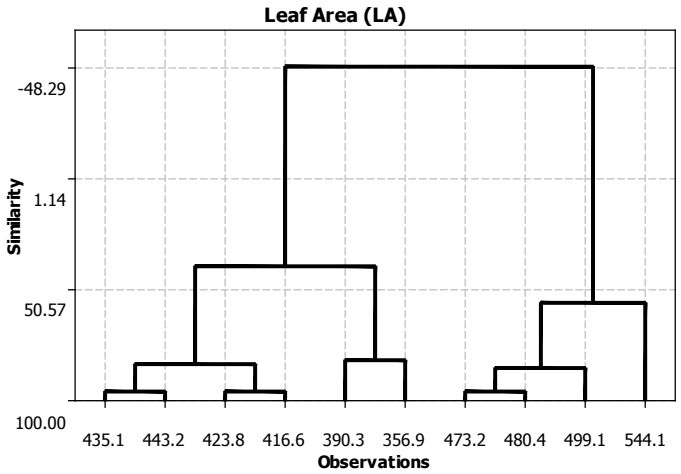

Fig.1. Dendogram by cluster analysis of ten maize inbred line for LA.

Conclusions

The results of this study for quantitative traits of the maize inbred line in agro-ecological conditions of Kosovo for two years duration period have confirmed; the existence of significant variability of the characteristics depending on the base of inheritance and the effect of ecological factors. It is no wonder that the 10 maize inbred lines differed significantly in several parameters measured, they come from some distinct genetic and morphological backgrounds. The our field and laboratory investigation suggest that some of maize inbreds line represent a highly valuable genetic material for EH, PH, LA and LAI, that could be successively used for further breeding program include diallel crossing methods, can be a good baze for development of the hybrid combination for needs of Kosovo.

Tab. 6. Leaf Area Index (LAI) of ten maize inbred line for leaf area

Maize inbred line	LAI (plant m-2)			Differences vs mean ±
	Y1	Y2	$\overline{X}$	
L1	3.3	3.0	3.1	-0.13
L2	3.7	3.1	3.4	+0.17
L3	3.3	3.7	3.5	+0.27
L4	3.5	3.7	3.6	+0.37
L5	2.9	2.8	2.8	-0.43
L6	3.7	2.7	3.2	-0.03
L7	3.9	4.0	3.9	+0.67
L8	2.9	2.3	2.6	-0.63
L9	2.9	3.2	3.05	-0.18
L10	2.5	3.5	3.0	-0.23
Grand mean (μ)	3.26	3.2	3.23	-
	CV=13.81% SD=±0.45	CV=16.47% SD=±0.52	CV=12.14% SD=±0.39	
LSDp=0.05		0.93		
LSDp=0.01		1.34		

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