Asian J Agric & Biol. 2019;7(4):583-592.

AJAB

Original Article

Evaluation of yield and yield components of some Turkish maize landraces grown in south eastern Anatolia, Turkey by biplot analysis

Ferhat Kizilgeci[1], Onder Albayrak[2], Mehmet Yildirim[2], Cuma Akinci[2], Behiye Tuba Bicer[2]
[1]Kiziltepe Vocational School, Mardin Artuklu University, Mardin, Turkey
[2]Department of Field Crops, Faculty of Agriculture, Dicle University, Diyarbakir, Turkey

Received:
June 13, 2019
Accepted:
October 12, 2019
Published:
December 31, 2019

**Corresponding author email:*
ferhat_kizilgeci@hotmail.com

Abstract
Maize has comparatively high genetic diversity. Thus, we evaluated yield and yield traits on 92 maize landraces collected from Black Sea and Marmara Regions of Turkey and investigated three maize hybrids for yield and some morphological traits under Diyarbakir conditions in 2016 growing season. Mean value of plant height varied between 131-270 cm among maize landraces, 62.33-177cm for first ear height, 13.07-24.70 mm for stalk thickness, 9.04-22 cm for ear length, 10.70-44.16 mm for ear diameter, 7.33-16.80 for row number of ear^{-1}, 10-44.60 for the number of kernels in row^{-1}, 16.43-27.46 mm for rachis diameter and 1387-18226.7 kg ha^{-1} for grain yield. According to our finding of the hybrid and the local maize genotypes, the grain yield, the number of grains in the cob and the weight of the cob, plant height, and number of rows were collected in the single group in the biplot chart. DZM-194-2 and DZM-11 local maize genotypes were found more stable for all investigated traits. DZM-7, DZM-194-2, DZM-11 and DZM-222-4 genotypes shown superiority to other genotypes in terms of grain yield.

Keywords: Biplot, Yield components, Grain yield, Maize landrace

How to cite this:
Kizilgeci F, Albayrak O, Yildirim M, Akinci C and Bicer BT, 2019. Evaluation of yield and yield components of some Turkish maize landraces grown in south eastern Anatolia, Turkey by biplot analysis. Asian J. Agric. Biol. 7(4):583-592.

Introduction

Maize (*Zea mays* L.) is an important grain crop, and it ranks third in rank next to wheat and barley in terms of planting area in Turkey. Most maize production in Turkey laid in the Marmara and Black Sea Regions between the years of 1950-1980, while the rest of the production oriented toward to the Aegean and the Mediterranean Region in the 1980s (Anonymous, 2018). In South-eastern Anatolia Region, a significant increment of maize cultivation was achieved with an increase of irrigated areas in recent years. In 2017, around 5.9 million tons of maize was produced in 643.319 hectares of land in Turkey. In this part of the production area, 68% of the maize is produced as grain corn, while the remaining 32% is produced as silage corn (TUIK, 2017). Local maize populations from past to present have been well adapted to the region that they belong to due to traditional methods of bulk selection by farmers in many years. These local maize genotypes, also known as village populations, are highly rich in genetic diversity. The local populations, which have been shaped by natural and cultivator selection for many years in the region, have adapted to the climate and other environmental factors of the region. At the same time, these genotypes are resistant to extreme conditions (drought, cold damage, disease and pests, etc.) of the environment in which they exist (Beck et al., 1996; Olaoye et al., 2009; Peter et al., 2009; Hellin et al., 2014; Yildirim et al., 2017).

Due to extreme weather events, it is considered that developing new maize varieties is resistant to abiotic stress conditions with the increase in global climate change (El Sabagh et al., 2018) Therefore, it is of great importance to use local populations as an important source of genetic material in breeding studies. As one of the main statistical methods for the analysis of genotype environmental data is GGE biplot analysis performed by Yan et al. (2000), developed by Yan and Kang (2002) and Yan and Tinker (2006). The method is based on biplot, which was originally developed by Gabriel (1971) and is a popular data representation tool in many fields of science (agriculture, medicine, work science, sociology, etc.). The biplot method has become increasingly popular among plant breeders and agricultural researchers since it has been used in variety assessment and mega-environmental research. The two most commonly used biplot views to identify genotypes that yield best across environments would be useful to breeders. The first of these views focuses on the environmental analysis, while the second one is able to show the mean values and stability of varieties at the same time. The objectives of the present study were to assess some morphological characteristics of local maize populations collected from Marmara and Black Sea regions and to evaluate the associations between population and characteristics by biplot analysis method in Diyarbakir conditions.

Material and Methods

This study was carried out at the Faculty of Agriculture at Dicle University, Turkey (latitude 37°53'N, longitude 40°16'E, altitude 670 m) in 2016. In this study, 92 local maize populations and 3 hybrid maize (Gariz, Elioso, Excel) were used as materials. Information on the local maize populations as materials is shown in Table 1. The soil structure of the experimental area of the Faculty of Agriculture at Dicle University is very poor in terms of the amount of organic matter (1.5%) and phosphorus (1.32 kg da^{-1}) while its pH is close to the neutral between 7.19-7.24. The experiment was established on 27.06.2016 with a trial order of 70 cm and a row length of 6 m, each of which will consist of two rows each parcel, with 80 pieces of seed falling to each plot. In the pre-planting area, fertilizer was applied with 20:20:0 (N: P: K) compound fertilizers as 100 kg ha^{-1} nitrogen and phosphorus as base fertilizer doses. After sowing, the irrigation was done by sprinkler irrigation system to ensure the germination. After the exhumation, drip irrigation system was laid in the period when the plants were 5-6 leaves and irrigation was done with 4 days' intervals until the plants reached the harvest maturity. As a top fertilizer, 7 equal parts of urea (46% N) with drip irrigation system were applied for total 140 kg ha^{-1} N. During the trial period, the sprinkler irrigation system was drilled with 128 mm drip irrigation system and 435 mm drip irrigation and rain, during the vegetation period, was 22.6 mm (Table 2).The trial was manually harvested on 16.11.2016. Plant height, first ear height and stalk thickness measurements were recorded in the sample plants. The properties of ear and yield values were measured at post-harvest laboratory conditions. The single ear threshing machine was used for harvest.

Statistical analyses

The data was subjected to simple statistical analysis and frequency analysis performed using SPSS 21 package. Four different GGE-biplot graphs were created in order to visualize relations among properties. All of these graphs were created in the GGE-biplot V.7 package program (Yan, 2014).

Table-1: Information about collected local populations of maize

Code	Region	Code	Region
DZ-M-5	Trabzon-Akçaabat-Dörtyol	DZ-M-100	Karabük-Safranbolu-Yukarıçiftlik
DZ-M-6	Trabzon-Akçaabat-Dörtyol	DZ-M-101	Ordu-Fatsa
DZ-M-7	Trabzon-Akçaabat-Dörtyol	DZ-M-104	Amasya-Merkez-Kovabayır
DZ-M-9	Trabzon-Akçaabat-Dörtyol	DZ-M-107	Ordu-Fatsa-Ilıcakavaklar
DZ-M-11	Trabzon-Sürmene-Merkez	DZ-M-110	Karabük-Ovacuma-Merkez
DZ-M-12	Trabzon-Sürmene-Merkez	DZ-M-112	Samsun-Merkez
DZ-M-13	Rize-Fındıklı-Ihlamurlu-Merkez	DZ-M-115	Ordu-Fatsa-IlıcaMerkez
DZ-M-16	Trabzon-Of-Yenimahalle	DZ-M-117	Amasya-Merkez-Takuncak
DZ-M-19	Trabzon-Of-Yenimahalle	DZ-M-119	Giresun-Bulancak-Kışla
DZ-M-20	Trabzon-Düzköy-Çayırbağ	DZ-M-122	Karabük-Eskipazar-Ova
DZ-M-21	Trabzon-Düzköy-Çayırbağ	DZ-M-125	Sinop-Gerze-Bolalı
DZ-M-23	Trabzon-Yomra-Çamlıyurt	DZ-M-128	Amasya-Merkez-Kovabayır
DZ-M-24	Trabzon-Yomra-Çamlıyurt	DZ-M-130	Giresun-Bulancak-Kışla
DZ-M-26	Rize-Fındıklı-Sulak	DZ-M-133	Samsun-Bafra-Dededağ
DZ-M-27	Rize-Çayeli-Beşikçiler	DZ-M-145	Çorum-Laçin-Gökgözler
DZ-M-29	Rize-Fındıklı-Sulak	DZ-M-146	Rize-Güneysu-Kıbledağı
DZ-M-30	Rize-Merkez-	DZ-M-159-1	Düzce-Kaynaşlı-Tavak
DZ-M-31	Artvin-Arhavi-Güngören	DZ-M-159-2	Düzce-Kaynaşlı-Tavak
DZ-M-32	Rize-Güneysu-Ortaköy	DZ-M-167-1	Düzce-Çilimli-Yeniköy
DZ-M-33	Rize-Güneysu-Ortaköy	DZ-M-167-2	Düzce-Çilimli-Yeniköy
DZ-M-34	Rize-Fındıklı-Merkez	DZ-M-191	Kocaeli-Kaynarca-Havuçlu
DZ-M-35	Rize-Güneysu-Ortaköy	DZ-M-192-1	İstanbul-Ağva-
DZ-M-36	Trabzon-Merkez-	DZ-M-194-2	İzmit-Kandıra-Hediyeli
DZ-M-37	Trabzon-Şalpazarı-	DZ-M-196-1	İzmit-Karasu-Büyükyanık
DZ-M-38	Rize-Merkez-	DZ-M-197	Sakarya-Akçakoca-Tahirli
DZ-M-39	Rize-Hemşin-Hilal	DZ-M-200	Zonguldak-Ereğli-İzcepınar
DZ-M-40	Rize-Hemşin-Hilal	DZ-M-201	Zonguldak-Ereğli-Külahköy
DZ-M-42	Artvin-Arhavi-Güngören	DZ-M-202	Zonguldak-Ereğli-Külahköy
DZ-M-43	Artvin-Arhavi-Güngören	DZ-M-203	Zonguldak-Ereğli
DZ-M-44	Artvin-Borçka-Düzköy	DZ-M-204	Zonguldak-Ereğli-Çaylıoğlu
DZ-M-48	Artvin-Arhavi-Güngören	DZ-M-208	Zonguldak-Devrek
DZ-M-51	Rize-Ardeşen-Kurtuluş	DZ-M-215	Zonguldak-Çaycuma-Kışla
DZ-M-52	Rize-Ardeşen-Kurtuluş	DZ-M-216	Zonguldak-Çaycuma-Kışla
DZ-M-53	Artvin-Arhavi-Güngören	DZ-M-217	Zonguldak-Çaycuma-Kışla
DZ-M-54	Artvin-Arhavi-Kavak	DZ-M-220-3	Bartın-Amasra-Göçgün
DZ-M-55	Rize-Ardeşen-Seslikaya	DZ-M-221-1	Bartın-Amasra-Kurucaşile
DZ-M-56	Rize-Ardeşen-Seslikaya	DZ-M-221-2	Bartın-Amasra-Kurucaşile
DZ-M-57	Rize-Ardeşen-Seslikaya	DZ-M-222-1	Bartın-Amasra-Kurucaşile
DZ-M-58	Trabzon-Çaykara	DZ-M-222-2	Bartın-Amasra-Kurucaşile
DZ-M-59	Trabzon-Çaykara	DZ-M-222-3	Bartın-Amasra-Kurucaşile
DZ-M-62	Rize-Pazar	DZ-M-222-4	Bartın-Amasra-Kurucaşile
DZ-M-69	Artvin-Borçka-Düzköy	DZ-M-225	Kastamonu-Cide-Uğurlu
DZ-M-76	Artvin-Merkez	DZ-M-227	Kastamonu-İnebolu-Köroğlu
DZ-M-77	Karabük-Eskipazar-Ova	DZ-M-230	Sinop-Boyabat-Çuhalı
DZ-M-98	Karabük-Safranbolu-Düzce	DZ-M-231	Sinop-Boyabat-Çuhalı
DZ-M-99	Karabük-Ovacuma-Merkez	DZ-M-233	Sinop-Boyabat-Uzunçay

Table-2: Maize growing season climate data for Diyarbakir province in 2016

	Temperature (°C)				Rain (mm)		Relative Humidity (%)			
Months	**Max.**	**Min.**	**Mean**	**Long term**	**Mean**	**Long Term**	**Max.**	**Min.**	**Mean**	**Long term**
June	40	12	26	26.2	18.4	8.0	56.70	10.11	33.40	35.0
July	42	18	31	31.1	0.0	0.7	38.96	7.25	23.10	26.0
August	42	18	31	30.4	0.0	0.4	38.90	6.74	22.82	26.0
September	37	7	24	24.9	0.0	3.9	47.43	10.40	28.91	30.0
October	31	6	19	17.3	0.0	10.7	53.16	14.96	34.06	48.0

Source: Diyarbakir Regional Directorate of Meteorology

Results and Discussion

The average values of hybrid varieties and local populations for the yield and other related traits showed highly significant differences and a wide variation among the maize population in terms of yield and yield related components (plant height, first ear height, stalk thickness, ear weight, ear length, ear diameter, row number of ear, the number of kernels in row and rachis diameter) (Table 3). The wide variation in local population is of great importance especially in breeding studies.

Plant height

As the regards of plant height is a hereditary property in maize plant and is closely related to plant density and lodging resistance (Kizilgeci et al., 2018). Plant height values of the local populations and hybrid varieties examined in the study are shown in Table 3. The plant height of the populations ranged from 131.0 cm (DZM-204) to 270.0 cm (DZM-56).

It was found that, plant height showed wide range variation. As reported by de Carvalho et al. (2008), it showed a wide variation in the plant height by studying of the morphological characteristics of local populations in Portugal. The average plant height of the local population was 216.7 cm, the hybrid varieties were 195.3 cm, and the general average was 214.7 cm. As a result of the study, it was determined the number of local populations that exceeded the average of the hybrid varieties in terms of plant height was 72, the number of the population that exceeded the average of the local population was 49, and the number of the population that passed the general average was 51 (Table 3, Figure 1A). The average plant height of the local populations obtained in this study was lower than the mean plant height of Oner and Gulumser (2014) and Kizilgeci et al. (2018). However, the results were found to be higher than the findings of Ruiz de Galarreta and Alvarez (2001).The plant height in maize is not a desirable feature. However, this feature is desired for silage maize forms/varieties. The increased plant height increases the area of leaves, and leaves per plant, thus also increases the area of assimilation. The increase in the area of assimilation affects the grain yield positively (Vartanli and Emeklier 2007).

First ear height

First ear height is a feature that varies depending on the genotypes and environmental conditions. The data of the first ear heights of the populations discussed in the study are shown in Table 3. The first ear height values of the populations ranged from 62.33 cm (DZM-204) to 177.00 cm (DZM-43). The average of the first ear height of the local populations was 117.33 cm, and the average of the first ear height of the hybrid varieties was 80.34 cm, and the general average was 114.04 cm. As a result of the study, the number of local populations that exceeded the average of the hybrid varieties in terms of the height of the first ear was found to be 81, the number of the population that exceeded the average of the local populations was 42, and the number of the population exceeding the general average was 48 (Table 3, Figure 1B). Among the populations used in the study, 24 of these populations were found to be 100.00-120.00 cm, which was accepted as ideal by Babaoglu (2003), while 28 populations were lower than these values and 40 populations had higher values.

Table-3: Average values of hybrid varieties and local populations in terms of investigated characteristics and genotype numbers that have passed averages

Features	Min.	Max.	Means			Number of genotypes passing the average of hybrid varieties	Number of genotypes passing the average of local population	Overall average number of genotypes
			Population	Hybrids	General			
PH(cm)	131	270	216.66	195.31	214.76	72	49	51
FEH (cm)	62.33	177	117.33	80.34	114.04	81	42	48
ST (mm)	13.07	24.70	18.27	18.56	18.30	44	45	45
EL (cm)	9.04	22	15.17	17.14	15.35	23	46	42
ED (mm)	10.70	44.16	33.60	36.89	33.89	18	39	39
RNE	7.33	16.80	10.38	13.87	10.69	11	35	29
NKR	10.00	44.60	24.81	36.77	25.88	7	43	38
RD (mm)	16.43	27.46	21.77	23.28	21.90	24	44	42
GY (kg ha^{-1})	1387.0	18226.7	5565.8	11310.8	6077.7	5	39	35

PH: Plant Height, **FEH:** First Ear Height, **ST:** Stalk Thickness, **EL:** Ear Length, **ED:** Ear Diameter, **RNE:** Row Number of Ear, **NKR:** Number of Kernels in Row, **RD:** Rachis Diameter, **EY:** Ear Yield, **GY:**Grain Yield

In this context, the first ear height is an important factor in terms of the suitability of the machine harvest, the balance against lodging. Gunes (2017) reported that the first ear height is an important factor in the resistance to lodging in the plant, which is an important criterion for silage maize. The first ear height average obtained in local populations was lower than the reported ear height of Kizilgeci et al. (2018), similar to the findings of Salami et al. (2007), and that was higher than Ruiz de Galarreta and Alvarez's (2001) and Oner and Gulumser's (2014) studies.

Stalk thickness

Stalk thickness values may vary according to the genetic characteristics of the used varieties and the applied agronomic procedures (Han, 2016). The data of the stalk thickness of the studied populations are given in Table 3. Stalk thickness values of the populations ranged from 13.07 mm (DZM-26) to 24.70 mm (DZM-110). The larger thickness of the stalk provides an important advantage in terms of increasing the resistance of maize plant to lodging. Kizilgeci et al. (2018) observed that the thickness of the stalk was significantly affected by environmental conditions during the steam elongation period. The mean of stalk thickness of local populations was 18.27 mm, and the stalk thickness of hybrid varieties was 18.56 mm, but the general average was 18.30 mm. The local population number which exceeds the average of hybrid varieties in terms of stalk thickness was 44, the number of the population that exceeded the average of the local population was 45 and the number of the population exceeding the general average was 45 (Table 3, Figure 1C).

Ear length

The ear length of the populations was varied between 9.04 cm (DZM-40) and 22.00 cm (DZM-167-2). The average length of the ear of the local populations was 15.17 cm, while the average length of the hybrid varieties was 17.14 cm and the general average was 15.35 cm. (Table 3). It was determined that the number of local populations that exceeded the average of hybrid varieties in terms of the length of the ear was 23, the number of the population that exceeded the average of the local population was 46, and the number of the population exceeding the general average was 42 (Table 3, Figure 1D). In our study, it was observed a wide variation between the local populations in terms of ear length. Onasanya et al. (2009) and Kizilgeci (2019) reported that genotype, location, ear and fertilizer application had an effect on the ear length. In studies with native maize ear length has been reported to vary between the values of 14.5-22.7cm (Beyene et al., 2005) and 13.6-20.7cm for Ethiopia and Turkey populations, respectively (Ilarslan et al., 2002). The length of the ear produced in our study was higher than Ruiz de Galarreta and Alvarez (2001)'s study and similar to the results of Kizilgeci et al. (2018).

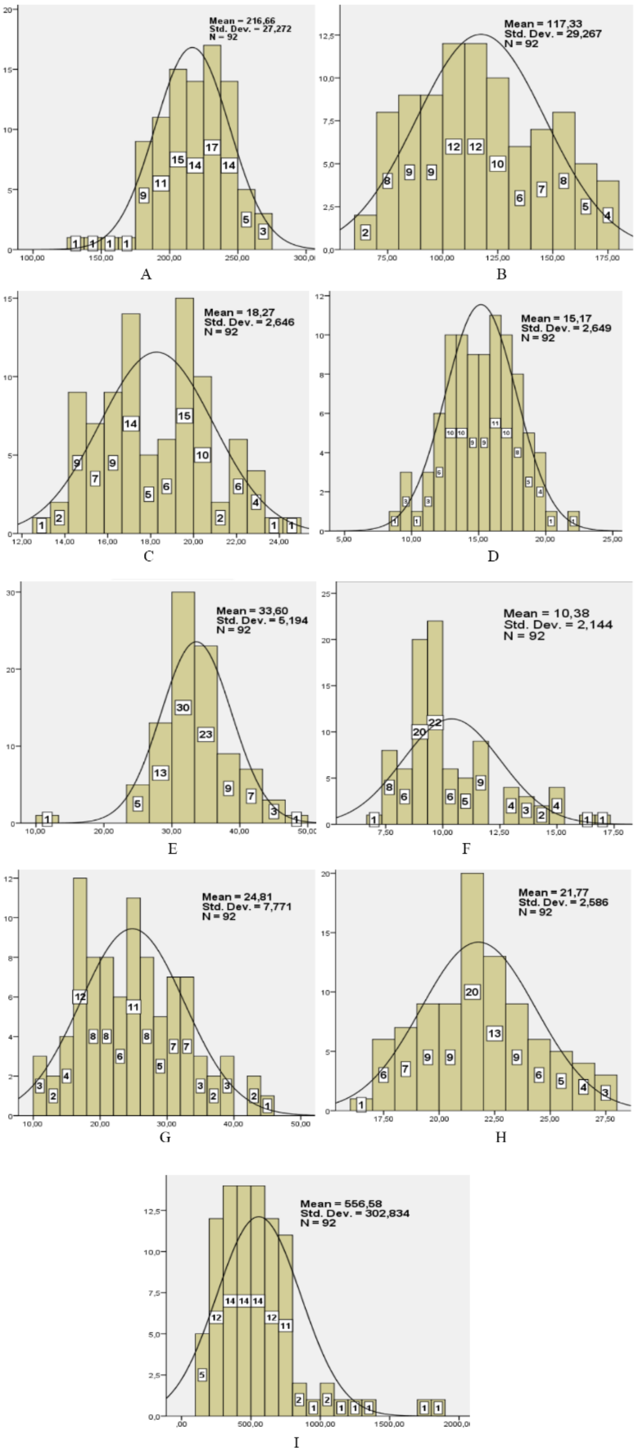

Figure-1 Frequency plots of the examined characteristics of local populations.
A: Plant height (cm), B: First ear height (cm), C: Stalk thickness (mm), D: Ear length (cm), E: Ear diameter (mm), F: Row number of the ear (number), G: Number of kernels in the row (numbers), H: Rachis diameter (mm), I: Grain yield (kg da^{-1})

Ear diameter
The diameter of the populations was varied between 10.70 mm (DZM-76) and 47.44 mm (DZM-222-4). While the average for diameter of the local populations was found 33.60 mm and the average diameter of the hybrid populations was 36.89 mm, it was found 33.89 mm for mean of the all populations. The number of local population who crossed the average of hybrid varieties in terms of the diameter of the ears was 18, the number of the population that exceeded the average of the local population was 39, and the number of the population exceeding the general average was 39 (Table 3, Figure 1E). Several researchers who studied local populations have revealed that the diameter of the ear varies according to the genotype and environmental conditions (Hartings et al., 2008; Kizilgeci et al., 2018; Lucchin et al., 2003).

Row number of ear
The higher row number of ears leads to more grain and this situation is important for grain yield. The row number in the ear of the populations varied between 7.33 (DZM-221-1) and 16.80 (DZM-130). The average row number of ear of local populations in the maize was 10.38 and the row number of ear of hybrid varieties in the maize was 13.87 and the overall average was 10.69. The result of the study also revealed that the number of local populations that exceeded the average of the hybrid varieties in terms of row number of ears was 11, the number of the population that exceeded the average of the local population was 35, and the number of the population exceeding the general average was 29 (Table 3, Figure 1F). The average row number of ear in the local population was lower than Ruiz de Galarreta and Alvarez (2001) and Oner and Gulumser's (2014) studies; higher than Kizilgeci et al. (2018) study.

Number of kernels in row
There is a strong phenotypic relationship between grain yield and number of kernels in a row (Pavlov et al., 2012). The number of kernels in a row of the populations was found between 10 (DZM-23) and 44.60 (DZM-167-2). The average number of kernels in a row of the local populations and hybrid varieties was 24.81 and 36.7, respectively. However, the average of the total number of kernels was 25.88 (Table 3). The number of local populations that exceeded the average of the hybrid species in terms of

number of kernels in a row was 7, the number of the population that exceeded the average of the local population was 43, and the number of the population exceeding the general average was 38 (Table 3, Figure 1G). In the study of the local maize populations, Kizilgeci et al. (2018) indicated that the number of kernels in a row was varied between 5.0-45.6 under Diyarbakir conditions. Saglamtimur et al. (1994) reported that the delay sowing time in maize had a negative effect on the number of kernels in a row.

Rachis diameter

The rachis diameter of the populations ranged from 16.43 mm (DZM-204) to 27.46 mm (DZM-40). The mean diameter of rachis of the local populations was 21.77 mm and the mean diameter of the rachis was 23.28 mm for the hybrid ones and the average was 21.90 mm (Table 3).The result of the study also revealed that the number of local populations which exceeded the average of the hybrid varieties in terms of rachis diameter was determined as 24, the number of the population that exceeded the average of the local population was 44, and the number of the population exceeding the general average was 42 (Table 3, Figure 1H). The mean diameter of the rachis obtained from the local population was found to be higher than the average diameter of the rachis as reported by Kizilgeci et al. (2018) in the local maize populations under Diyarbakir conditions.

Grain yield

One of the most important elements of increasing the yield in maize is the selection of suitable varieties and cultivation techniques (Konuskan et al., 2015). The data of the grain yield of the populations is given in Table 3. The grain yield values of the populations ranged from 1387.0 kg ha^{-1} (DZM-110) to 18226.7 kg ha^{-1} (DZM-167-2). The average grain yield of the local population and hybrid varieties was 556.58 and 11310.8 kg ha^{-1}, respectively, while the general average was 6077.0 kg ha^{-1}. The average number of local populations that exceeded the average of the hybrid varieties in terms of grain yield was determined as 5, the number of the population that exceeded the average of the local population was 39, and the number of the population exceeding the general average was 35 (Table 3, Figure 1I).

Interactions between the features

Correlation among properties was given in Table 4. Positive and statistically significant relationship between the grain yield with ear weight (r = 0.918**), ear length (r = 0.651**), ear diameter (r = 0.594**), row number of ear (r = 0.367**), number of kernels in a row (r = 0.757**), rachis diameter (r = 0.330**) was found in this study. Salami et al. (2007) found a significant relationship between plant height and grain yield, while a negative association was observed in our study. In addition, a negative but significant relationship was found between the row number of ear and plant height (r = -0.248) and the first ear height (r = -0.242*) (Table 4). Positive and very important (r = 0.821**) relation was determined between plant height and first ear height. Similarly, Kizilgeci et al. (2018) observed a significant relationship between height of plant and height of the first ear.

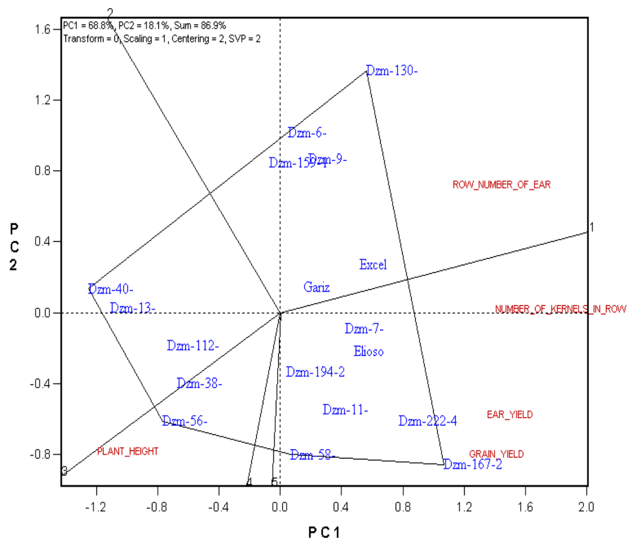

Figure-2: Grouping of genotypes and properties through means.

Table-4: Correlation between examined features

Features	Ear Yield	Grain Yield	Ear Lenght	Ear Diameter	Row Number of Ear	Number of Kernels in Row	Rachis Diameter	Plant Height	First Ear Height
Grain Yield	0.918^{**}								
Ear Lenght	0.730^{**}	0.651^{**}							
Ear Diameter	0.730^{**}	0.594^{**}	0.385^{**}						
Row Number of Ear	0.472^{**}	0.367^{**}	0.297^{**}	0.394^{**}					
Number of Kernels in Row	0.804^{**}	0.757^{**}	0.760^{**}	0.462^{**}	0.459^{**}				
Rachis Diameter	0.452^{**}	0.330^{**}	0.137	0.755^{**}	0.375^{**}	0.121			
Plant Height	-0.043	-0.005	-0.186	0.238^{*}	-0.248^{*}	-0.149	0.263^{*}		
First Ear Height	-0.085	-0.042	-0.242^{*}	0.199	-0.242^{*}	-0.154	0.242^{*}	0.821^{**}	
Stalk Thickness	0.198	0.107	0.354**	0.120	0.254*	0.272**	0.153	-0.020	-0.294**

*, **, *** P<0.5, P<0.01, P<0.001, respectively.

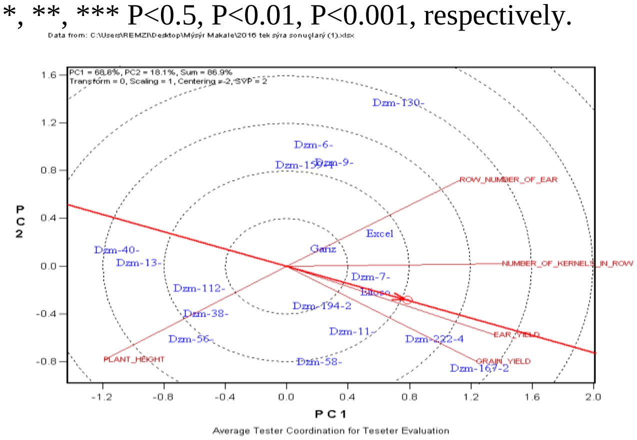

Figure-3: Relationship between properties by scatter biplot method

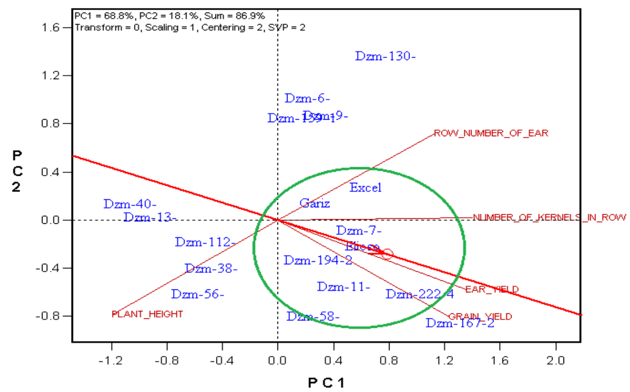

Figure-5: Determination of ideal genotypes in terms of properties examined by Scatter biplot method

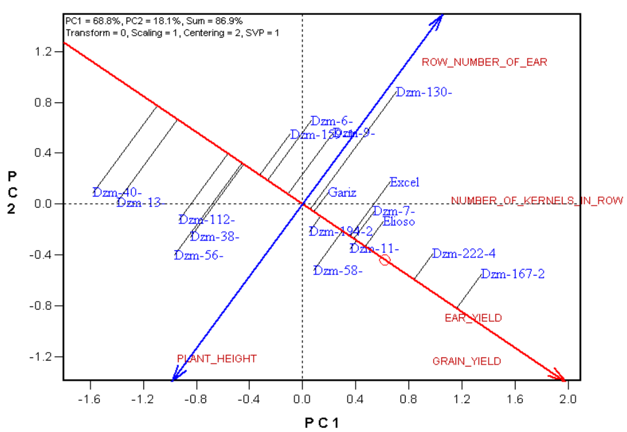

Figure-4: Stability of genotypes in terms of properties examined with Ranking biplot method.

Conclusion

The findings revealed that the genotypes and traits, and interaction trait was significant. It was observed in present investigation different plant characteristics of hybrid and the local maize genotypes under environments that grain yield, the number of grains in the cob and the weight of the cob, plant height, and number of rows were collected in the single group in the biplot chart. DZM-194-2 and DZM-11 local maize genotypes were found more stable for all investigated traits. DZM-7, DZM-194-2, DZM-11 and DZM-222-4 genotypes shown superiority to other genotypes in terms of grain yield. Generally, GGE biplot method might reliably be used in evaluation of diverse characteristics of maize genotypes grown in various environments.

Disclaimer: None
Conflict of Interest: None
Source of Funding: None.

References

Anonymous, 2018. (http://www.zmo.org.tr/genel/bizden_detay.php?kod=26263&tipi=38&s).

Babaoglu M, 2003. Comparative evaluation of maize genotypes having different origins in terms of some agronomical and quality characteristics. Ph D dissertation, Trakya University, Edirne, Turkey.

Barutcular C, EL Sabagh A, Koç M and Ratnasekera D, 2017. Relationships between grain yield and physiological traits of durum wheat varieties under drought and high temperature stress in Mediterranean conditions. Fresenius Environ. Bull. 26 (6): 4282-4291.

Beck D, Betrán FJ, Bänziger M, Willcox M and Edmeades GO, 1996. From landrace to hybrid: Strategies for the use of source populations and lines in the development of drought tolerant cultivars. In Developing Drought and Low N-Tolerant Maize. Proceedings of a Symposium pp. 369-382. In G.O. Edmeades et al. (ed.) Drought- and low N-tolerant maize. Proceedings of a Symposium, El Batan. 25–29 March 1996, CIMMYT, El Batan, Mexico.

Beyene Y, Botha AM and Myburg AA, 2005. A comparative study of molecular and morphological methods of describing genetic relationships in traditional Ethiopian high land maize. Afr. J. Biotechnol. 4(7): 586-595.

de Carvalho MAAP, Ganança JFT, Abreu I, Sousa NF, Dos Santos TMM and Vieira MRC, 2008. Evaluation of the maize (Zea mays L.) diversity on the Archipelago of Madeira. Gen. Resour. Crop Evolut. 55(2): 221-233.

El Sabagh A, Hossain A, Barutçular C, Abdelaal K, Fahad S, Anjorin F, Islam MS, Ratnasekera D, Kizilgeci F, Yadav G, Yildirim M, Konuskan O and Saneoka H, 2018. Sustainable Maize (*Zea mays* L.) production under drought stress by understanding its adverse effect, survival mechanism and drought tolerance indices. J. Exp. Biol. Agric. Sci. 6: 282-295.

El Sabagh A, Barutçular C, Hossain A, Islam MS, 2019. Response of maize hybrids to drought tolerance in relation to grain weight. Fresenius Environ. Bull. 27: 2476–2482.

Gabriel KR, 1971. The biplot graphic display of matrices with application to principal component analysis. Biometrika. 58:453-467.

Gunes A, 2017. Determination of silage yield and quality characteristics of some silage maize (Zea mays L.) varieties. M.S. thesis, Ordu University, Turkey.

Han E, 2016. The determination of grain yield with silage and quality characteristics of some maize varieties. M.S. thesis, Ordu University, Turkey.

Hartings H, Berardo N, Mazzinelli GF, Valoti P, Verderio A and Motto M, 2008. Assessment of genetic diversity and relationships among maize (Zea mays L.) Italian landraces by morphological traits and AFLP profiling. Theor. Appl. Genet. 117(6): 831.

Hellin J, Bellon MR and Hearne SJ, 2014. Maize landraces and adaptation to climate change in Mexico. J. Crop Improv. 28(4): 484-501.

Ilarslan R, Kaya Z, Kandemir I and Bretting PK, 2002. Genetic variability among Turkish pop, flint and dent corn (Zea mays L. spp. mays) races: Morphological and agronomic traits. Euphytica. 128(2):173-182.

Kizilgeci F, Yildirim M, Albayrak O, Bicer BT, Hossain A, EL Sabagh A and Akinci C, 2018. Evaluation of Turkish maize landraces through observing their yield and agro-morphological traits for genetic improvement of new maize cultivars. Acta fytotechnica et zootechnica. 21(2): 31-43.

Kizilgeci F, 2018. Evaluation of performance of bread wheat genotypes using GGE-Biplot method, pp. 170-177. In Proceedings, International Engineering and Natural Sciences Conference, 14-17 November 2018, Diyarbakır, Turkey.

Konuskan O, Atis I and Gozubenli H, 2015. Yield and yield components of some dent maize genotypes grown as main- crop in Amik Plain conditions. J. Agric. Fac. Mustafa Kemal Univ. 20(2):1-6.

Lucchin M, Barcaccia G and Parrini P, 2003. Characterization of a flint maize (Zea mays L. convar. mays) Italian landrace: I. Morpho-phenological and agronomic traits. Genet. Resour. Crop Evolut. 50(3):315-327.

Oner F and Gulumser A, 2014. Determination of some agronomical characteristics of local flint corn (Zea mays L. indurata) genotypes in The Black Sea Region of Turkey. Turkish J. Agric. Natur. Sci. 2: 1800-1804.

Olaoye G, Menkir A, Ajala SO and Jacob S, 2009. Evaluation of local maize (Zea mays L.) varieties from Burkina Faso as source of tolerance to drought. J. Appl. Biosci. 17: 887-898.

Onasanya RO, Aiyelari OP, Onasanya A, Oikeh S, Nwilene FE and Oyelakin OO, 2009. Growth and yield response of maize (Zea mays L.) to different rates of nitrogen and phosphorus fertilizers in southern Nigeria. World J. Agric. Sci. 5(4): 400-407.

Pavlov J, Delić N, Šurlan-Momirović G, Branković G, Grčić N, Božinović S and Kandić V, 2012. Relationship between grain yield, yield components and morphological traits in maize (Zea mays L.). pp. 307. In Proceedings. 47th Croatian and 7th International Symposium on Agriculture, 13-17 February 2012, Opatija, Croatia.

Peter R, Eschholz TW, Stamp P and Liedgens M, 2009. Swiss Flint maize landraces—A rich pool of variability for early vigour in cool environments. Field Crops Res. 110(2): 157-166.

Ruiz de Galarreta JI and Alvarez A, 2001. Morphological classification of maize land races from northern Spain. Genet. Resour. Crop Evolut. 48: 391-400.

Saglamtimur T, Tansı V and Kizilsimsek M, 1994. A research on the determination of the most suitable planting time in maize in Cukurova conditions. pp.1-5. In Proceedings. Field Crops Congress, 25-29 April 1994, Izmir, Turkey,

Salami AE, Adegoke SAO and Adegbite OA, 2007. Genetic variability among maize cultivars grown in Ekiti-State, Nigeria. Middle-East J. Sci. Res. 2(1): 9-13.

TUIK, 2017. https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr.

Vartanli S and Emeklier HY, 2007. Determination of the yield and quality characteristics of hybrid maize varieties under Ankara conditions. J. Agric. Sci. 13(3): 195-202.

Yan W, Hunt LA, Sheng Q and Szlavnics Z, 2000. Cultivar evaluation and mega-environment investigation based on GGE biplot. Crop Sci. 40:597- 605.

Yan W and Kang MS, 2002. GGE biplot analysis: A graphical tool for breeders, geneticists, and agronomists. 1st. ed. CRC pres, Boca Raton.

Yan W and Tinker NA, 2006. Biplot analysis of multi-environment trial data: principles and applications. Can. J. Plant Sci. 86: 623-645.

Yan W, 2014. Crop variety trials: Data management and analysis. John Wiley & Sons, London, UK.

Yassin M, Fara SA, Hossain A, Saneoka H and El Sabagh A, 2019. Assessment of salinity tolerance bread wheat genotypes: using stress tolerance indices. Fresenius Environ. Bull. 28 (5): 4199-4217.

Yildirim M, Albayrak O, Akinci C Kizilgeci F, Basdemir F, 2017. Water use efficiency of Turkish maize landraces for drought tolerance in field conditions. pp. 28. In Proceedings, InterDrought-V congress 21-25 September 2017, Hyderabad, India.

Yildirim M, Barutcular C, Hossain A, Koc M, Dizlek H, Akinci C, Toptas I, Basdemir F, Islam MS and EL Sabagh A, 2018. Assessment of the grain quality of wheat genotypes grown under multiple environments using GGE biplot analysis. Fresenius Environ. Bull. 27(7): 4830-4837.

Contribution of Authors

Kizilgeci F: Designed, Carried out the research, analyzed the data and also wrote the manuscript.
Albayrak O: Collected local maize populations, Designed, Carried out research and analyzed the data
Yildirim M: Collected local maize populations, helped to assess the data and conducted an intensive scientific revision.
Akinci C: Helped to assess the data, conducted an intensive scientific revision.
Bicer BT: Assisted collecting local maize