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Original Paper

Evaluation of Turkish maize landraces through observing their yield and agro-morphological traits for genetic improvement of new maize cultivars

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For protection of diverse genetic resources of local landraces and to get the benefit for next generation, research works should be continuing through screening of local landraces by using with local germplasm; which will be very useful to conserve the genetic variability and will provide to economic profits to the farmers by improving their uses. In the context, One hundred twenty-five maize landraces with two commercial maize hybrids ('Kalumet' and 'Katone') were evaluated for yield and agro-morphological performance for genetic improvement of future maize varieties. The landraces were collected from the Black Sea Region of Turkey and were evaluated under the augmented complete design under Diyarbakir agro-ecological conditions during 2015. After observation, it was observed that all genotypes showed significant variations for all traits especially for yield and yield attributes. Considering the overall performance of all landraces, the days to tasseling and silking were varied from 39.5 to 64.5 and from 49.5 to 70.5 days; while the SPAD meter were varied from 37.8 to 70 unit, the plant height from 165 to 315.5 cm, the ear height from 55.8 to 190 cm, the stalk thickness from 11.3–26 mm, the ear length from 6.21 to 25.38, the ear diameter 14.13 to 48.92 mm, the ears per row from 2.33 to16.3, seeds per row, the ear weight from 10.2 to 285.26 g, the rachis diameter from 11.58 to 39.51mm and the grain yield from 63.68 to 1,498.13 kg ha^{-1}. Where, the range for all traits in landraces varied huge and exceeded commercial check genotypes. Therefore, it was determined that the genotypic distinction of the landraces may be used as pre-breeding material for developing the suitable maize varieties for sustainable maize production in diverse agro-ecological conditions of Mediterranean region including Turkey.

Keywords: maize, landraces, yield, morphological traits, phenotyping, *Zea mays* L.

1 Introduction

Maize is one of the world's most sıgnificant crops for food security, cultivated for human consumption as well as animal feeding and also in recent years, is progressively playing an essential role as a source of biofuel (Lana et al., 2017). Maize is cultivated in a wide range of environmental conditions, due to its wider range adaptibility. However, in recently from selection schemes of commercial breeding is extremely decreased the number of genetic diverse cultivars of the crop.

The concepts of genetic erosion and the maintenance of plant genetic resources are rooted in the first decade of the twentieth century (Palumbo et al., 2017). A landrace is an ancient population of a cultivated crop that has become adaptedto the local conditions and to the agronomic practices of farmers (Palumbo et al., 2017). Most frequently, landraces are characterized by high diversity and thus provide a valuable source for potentially useful traits and an irreplaceable bank of co-adapted genotypes (Brush,1995). The evaluation of genetic diversity and genetic structure of landraces could provide to prevent genetic erosion as well as to sustain landraces (Shanbao et al., 2009).

Genus of Zea has the five species of large grasses under the family Poaceae and their native is Mexico and Mesoamerica. Among them, four species namely, *Zea mays*, *Zea luxurians*, *Zea perennis* and *Zea diploperennis*. Where, the best-known species is corn, or maize (*Zea*

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mays L.) and the species has the highest importance, which was derived from one of the Mexican teosintes (likely *Z. mays* parviglumis) in pre-Columbian times more than 6,000 years ago (Editors of Encyclopaedia Britannica, 2016). Because of its divergent types, maize cultivation has been distributed over a wide range of climatic conditions. The major portion of corn is produced between 30º latitude to 55º latitude (from tropical and sub-tropical to temperate regions), with little portion of corn is grown at 47º latitudes anywhere in the world (Shaw, 1988). While, several wild species are considered to be endangered or endangered.

In Turkey, maize occupies around 680,000 hectares with annual production of 6.4 million tones with an average yield 940 kg ha^{-1} (Turkish Statistical, 2017). While to meet the food demand of the people of the twenty-first century, maize crop will become a strategic product in Turkey as well as in the world. Maize area and production is increasing day by day in all over the world and also in Turkey due to its high yield potential of commercial hybrids.

Among the corn growing countries, Turkey is the foremost countries, where corn has been cultivating since prehistoric period of the world. As a result, many corn varieties derived from different sub-species are found in almost every region of Turkey; mainly in coastal regions of Turkey. According to initial findings on maize material collected in Turkey during the years 1925 to 1927, 'flint corn' (*Zea mays* indurate Sturt) was spread everywhere in Turkey (Zhukovsky, 1951). However, due to farmers in the black sea region are still cultivating/popular local landraces cultivars as a traditional manner and use for household consumption, hybrid maize in the region is not very much popular. Generally, landraces cultivars are genetically diverse and have been under farmer's selection for many years in terms of adaptation, plant characteristics, yield, biotic and abiotic stress tolerance or resistance (Wasala et al., 2013).

There is great growing trend in different countries for adaptability of maize cultivars to achieve the requirement of market demand. At the same time, due to the restriction of genetic diversity in modern varieties, it should be emphasized for maintaining the diverse genetic traits for future plant breeding program. While to protect the diverse genetic resources of local landrace and to benefit the use of next generation, research works should be continuing through screening of local landraces by using with local germplasm; which will be very useful to conserve the genetic variability, improve their uses and will provide economic profits to the farmers (Kumar et al., 2015). Considering the vital issue, the present study was undertaken to evaluate the agro-morphologic performance of maize landraces and to find out their potentiality in maize breeding for developing the suitable maize varieties for different agro-ecological conditions.

2 Materials and methods

2.1 Experimental site, design treatments and experimental procedure

The field study was conducted at research area of the Faculty of Agriculture, Dicle University, Turkey during the maize growing season of 2015. One hundred twenty-five maize landraces with two commercial maize hybrids as check genotypes ('Kalumet' and 'Katone') were used as plant material, collected from various locations in the Black Sea Region of Turkey (Table 1). The experiment was laid out in augmented complete design with two rows and each row was 5 m long with intra row plant spacing of 0.70 × 0.25 m. Seedbed was prepared using a cultivator and later disked for a proper seedbed. All maize genotypes were sown with sowing machine on 28th June 2015. Fertilizer, diammonium-phosphate (DAP, containing 46% total phosphorus and 18% nitrogen) was applied at the rate of 100 kg ha^{-1}, and ammonium nitrate (33%) was applied at 150 kg ha^{-1}.

Table 1 Maize landraces collected from the Black Sea Region of Turkey.

Accession number	Province -District	Accession number	Province -District
DZ-M-1	Artvin-Murgul-Küre	DZ-M-64	Artvin-Borçka-Çtdüzköy
DZ-M-2	Rize- Çayeli- Çınartepe	DZ-M-65	Artvin-Borçka-Çatdüzköy
DZ-M-3	Rize- Çayeli- Sefalı	DZ-M-66	Artvin-Borçka-Çatdüzköy
DZ-M-4	Artvin -Arhavi-Zeytinlik- Güngören	DZ-M-67	Artvin-Borçka-Çatdüzköy
DZ-M-5	Trabzon -Akçaabat-Dörtyol	DZ-M-68	Artvin-Hopa-Çamurlu
DZ-M-6	Trabzon -Akçaabat-Dörtyol	DZ-M-69	Artvin-Merkez
DZ-M-7	Trabzon -Akçaabat-Dörtyol	DZ-M-70	Artvin-Merkez
DZ-M-8	Trabzon -Akçaabat-Dörtyol	DZ-M-71	Karabük-Eskipazar- Ova
DZ-M-9	Trabzon- Akçaabat-Dörtyol	DZ-M-72	Giresun-Merkez

Table 1 Continued 1

Accession number	Province -District	Accession number	Province -District
DZ-M-10	Trabzon- Sürmene	DZ-M-73	Zonguldak-Ereğli-Yazıcılar
DZ-M-11	Trabzon -Sürmene	DZ-M-74	Ordu-Fatsa-Ilıca
DZ-M-12	Trabzon -Sürmene	DZ-M-75	Samsun-Merkez
DZ-M-13	Rize -Fındıklı-Ihlamurlu	DZ-M-76	Giresun-Görele-Hürriyet
DZ-M-14	Rize -Fındıklı-Yeniköy	DZ-M-77	Giresun-Merkez-Mesudiye
DZ-M-15	Trabzon -Of-Yenimahalle	DZ-M-78	Tokat- Erbaa
DZ-M-16	Trabzon -Of-Yenimahalle	DZ-M-79	Samsun-Merkez-Hacınaipli
DZ-M-17	Trabzon- Of-Yenimahalle	DZ-M-80	Amasya-Göynücek-Ulusu
DZ-M-18	Trabzon- Of-Yenimahalle	DZ-M-81	Samsun-Atakum-engiz
DZ-M-19	Trabzon Of-Çayırbağ	DZ-M-82	Tokat-Atakum-Ataköy
DZ-M-20	Trabzon Of-Çamlıyurt	DZ-M-83	Tokat -Turhal-Sarıçiçek
DZ-M-21	Trabzon -Yomra-Çamlıyurt	DZ-M-84	Karabük-Safranbolu-Düzce
DZ-M-22	Trabzon -Yomra-Çamlıyurt	DZ-M-85	Samsun-Bafra-Dededağ
DZ-M-23	Rize- Çayeli-Buzlupınar	DZ-M-86	Karabük-Safranbolu-Düzce
DZ-M-24	Rize- Fındıklı-Sulak	DZ-M-87	Karabük-Ovacuma
DZ-M-25	Rize- Çayeli-Haytebeşikçiler	DZ-M-88	Karabük-Safranbolu-Yukarıçiftlik
DZ-M-26	Artvin -Murgul-Küre	DZ-M-89	Ordu-Fatsa-YukarıMah.
DZ-M-27	Rize-Fındıklı-Gültepe-Sulak	DZ-M-90	Tokat -Turhal
DZ-M-28	Rize-Merkez-Emekçiler	DZ-M-91	Samsun-Bafra-Dededağ
DZ-M-29	Artvin-Arhavi-Zeytinlik-Güngören	DZ-M-92	Amasya-Merkez-Kovabayır
DZ-M-30	Rize-Güneysu-Ortaköy	DZ-M-93	Tokat -Erbaa-Yenimahalle
DZ-M-31	Rize-Güneysu-Ortaköy	DZ-M-94	Ordu-Fatsa-Ilıcakavaklar
DZ-M-32	Rize-Fındıklı	DZ-M-95	Trabzon -Merkez
DZ-M-33	Rize-Güneysu-Ortaköy	DZ-M-96	Karabük-Ovacuma
DZ-M-34	Trabzon-Merkez	DZ-M-97	Zonguldak-Merkez
DZ-M-35	Trabzon-ŞalpazarıÜzümözü	DZ-M-98	Samsun-Merkez
DZ-M-36	Rize-Merkez-Alipaşa	DZ-M-99	Samsun-Merkez-Sarayköy
DZ-M-37	Rize-Hemşin-Hilal	DZ-M-100	Ordu-Fatsa-Ilıca
DZ-M-38	Rize-Hemşin-Hilal	DZ-M-101	Tokat- Niksar
DZ-M-39	Rize-Güneysu-Ortaköy	DZ-M-102	Amasya-Merkez-Takuncak
DZ-M-40	Artvin-Arhavi-Zeytinlik-Güngören	DZ-M-103	Giresun-Bulancak-Kışla
DZ-M-41	Artvin-Arhavi-Zeytinlik-Güngören	DZ-M-104	Samsun-Tekkeköy
DZ-M-42	Artvin-Borçka-Caniti-Düzköy	DZ-M-105	Giresun-Bulancak-Kışla
DZ-M-43	Rize-Fındıklı-Gültepe-Sulak	DZ-M-106	Karabük-Eskipazar- Ova
DZ-M-44	Artvin-Hopa-Madenli-Çamlıköy	DZ-M-107	Sinop-Gerze-Bolalı
DZ-M-45	Artvin-Hopa-Madenli-Çamlıköy	DZ-M-108	Artvin-Arhavi-Kireçli
DZ-M-46	Artvin-Arhavi-Zeytinlik-Güngören	DZ-M-109	Tokat- Zile
DZ-M-47	Artvin-Borçka-Caniti-Düzköy	DZ-M-110	Amasya-Merkez-Kovabayır
DZ-M-48	Rize-Ardeşen-Kurtuluş	DZ-M-111	Trabzon-Of-Bölümlü
DZ-M-49	Rize-Ardeşen-Kurtuluş	DZ-M-112	Giresun-Bulancak-Kışla
DZ-M-50	Artvin-Arhavi-Zeytinlik-Güngören	DZ-M-113	Samsun-Kavak-Alaçam

Table 1 Continued 2

Accession number	Province -District	Accession number	Province -District
DZ-M-51	Artvin-Arhavi-Lome-Kavak	DZ-M-114	Zonguldak-Devrek-Yazıcık
DZ-M-52	Rize-Ardeşen-Seslikaya	DZ-M-115	Samsun-Bafra-Dededağ
DZ-M-53	Rize-Ardeşen-Seslikaya	DZ-M-116	Samsun-Tekkeköy
DZ-M-54	Rize-Ardeşen-Seslikaya	DZ-M-117	Samsun-Merkez-Hacıismail
DZ-M-55	Trabzon-Çaykara	DZ-M-118	Zonguldak-Devrek-Yazıcık
DZ-M-56	Trabzon-Çaykara	DZ-M-119	Tokat- Turhal-Sarıçiçek
DZ-M-57	Trabzon-Çaykara	DZ-M-120	Samsun-Merkez-Daracak
DZ-M-58	Rize-Fındıklı-Aksu	DZ-M-121	Zonguldak-Merkez
DZ-M-59	Artvin-Arhavi-Lome-Kavak	DZ-M-122	Giresun-Merkez-Esentepe
DZ-M-60	Rize-Fındıklı-Sümer	DZ-M-123	Samsun-Kavak-Ahırlı
DZ-M-61	Artvin-Borçka-Tepe-Düzköy	DZ-M-124	Çorum-Laçin-Gökgözler
DZ-M-62	Artvin-Borçka-Tepe-Düzköy	DZ-M-125	Rize-Güneysu-Kıbledağı
DZ-M-63	Artvin-Borçka-Çat-Düzköy		

2.2 Data, their recording procedure and analysis

Data on SPAD value, plant height (cm), ear height (cm), tasseling period (days), ear-silking period (days), stalk thickness (mm), ear length (cm), ear diameter (mm), row number ear^{-1}, the number of kernels row^{-1}, ear weight, rachis diameter (mm) and grain yield (kg ha^{-1}) were recorded during the study period.

2.2.1 Data collection procedure

SPAD readings were measured with a 'SPAD 502' chlorophyll meter (Minolta Osaka, Japan). During harvesting data on ear length, ear diameter, row number ear^{-1}, the number of seeds row^{-1} and ear weight were assessed from 10 randomly selected apical ears in each experimental plot by using standard procedure.

The height of randomly selected ten plants was measured (cm) and then averaged. Number of cobs was counted from ten plants selected at random from each plot and average was calculated. Total grains of the ten cobs were counted and grain weight of all the cobs selected from each plot was taken by using triple beam balance and averaged and thousand grain weights (gm) were done. For grain yield, cobs of each plot after removing were shelled with the help of an electric Sheller and were weighed to have grain yield plot^{-1}. Then yield was converted from kg plot^{-1} into t ha^{-1}. Biological yield was calculated in kilograms by deducting seed yield from the total biomass of each plot and converted into tonnes per hectare. Collected data were then analyzed using the computer program JMP 10 and Excel (SAS Institute Inc., 1989).

3 Results and discussion

Maize is both phenotypically and genetically diverse. Genetic variability among individuals in population should follow the effective selection to get desirable characters of a specific genotype (Rather et al., 2003). Phenology such as days to 50% anthesis, days to 50% silk emergence, days to maturity; yield traits such as grain weight and grain yield, ear height, % tryptophan content, cob length and 1000-kernel weight; ear length and diameter, ear aspects, plant height, and number of diseased cobs (Hoque et al., 2008; Kadir, 2010; Muchie and Fentie, 2016), can contribute to genetic diversity assessment. Whereas, these characters are variables due to different genetic makeup of the specific variety and their growing environment. However, under the changing environmental, the performance of maize genotypes vary according to their adaptability in a specific environment. Therefore, to get desirable genotypes for a specific environment, a rigorous breeding program is important to take into account the consequences of environment and exploring and developing more competitive maize genotypes (Ferdoush et al., 2017). In the present study, for genetic improvement of new maize cultivars for sustainability of maize production under changing climate of Mediterranean region including Turkey, one hundred twenty-five maize landraces with two commercial maize hybrids ('Kalumet' and 'Katone') were evaluated through observing their tasseling period (days), ear-silking period (days), SPAD value, plant height (cm), ear height (cm), stalk thickness (mm), ear length (cm), ear diameter (mm), row number ear^{-1}, the number of kernels row^{-1}, ear weight, rachis diameter (mm) and grain yield (kg ha^{-1}), which are described as follows (Table 2).

Table 2 Mean performance of phenology, growth and yield attributes of maize landraces

Accessions	TP	ESP	SPAD	PH	EH	ST	EL	ED	RPE	NKRE	KWE	GY	RD
DZ-M-1	59.0	62.0	54.5	230.0	111.6	18.4	15.37	30.19	15.0	37.3	85.16	312.6	19.19
DZ-M-2	58.5	65.5	52.7	310.8	170.8	21.9	16.63	32.79	7.4	17.7	74.50	371.0	22.89
DZ-M-3	55.5	62.5	52.3	260.8	127.5	18.2	13.00	29.25	9.0	17.5	40.57	77.7	20.70
DZ-M-4	58.5	66.5	57.7	299.1	185.8	23.2	19.80	38.15	11.5	32.1	133.46	700.4	24.65
DZ-M-5	58.0	66.0	59.0	269.1	117.5	16.9	19.65	44.86	14.4	44.9	217.19	1028.7	24.98
DZ-M-6	55.5	64.5	68.9	205.3	108.3	18.5	14.84	40.74	12.9	27.2	127.01	729.36	24.24
DZ-M-7	58.0	63.5	54.7	246.6	125.8	19.9	16.65	43.51	14.3	36.6	184.45	1498.1	25.11
DZ-M-8	57.5	65.5	62.1	244.1	120.8	20.9	15.75	39.21	11.9	29.7	131.93	735.9	23.24
DZ-M-9	58.0	66.0	63.8	270.8	112.5	24.5	17.77	45.55	14.9	33.9	187.33	1190.8	25.48
DZ-M-10	55.5	64.0	64.3	270.8	144.1	20.7	14.58	33.39	8.4	17.4	91.95	723.0	26.42
DZ-M-11	58.5	64.5	70.0	258.3	86.6	20.9	20.16	48.92	14.6	41.0	285.26	940.0	22.82
DZ-M-12	58.5	67.0	52.8	308.3	190.0	22.3	17.85	35.45	9.6	30.7	102.87	615.4	21.27
DZ-M-13	56.0	63.5	41.0	257.5	124.1	20.1	16.58	34.05	10.3	36.0	120.56	697.8	20.46
DZ-M-14	61.0	67.0	46.9	282.5	159.1	19.5	15.35	33.72	8.5	26.0	93.95	544.6	21.96
DZ-M-15	57.5	64.0	52.3	255.8	133.3	17.9	15.64	31.5	8.4	24.5	83.60	427.7	20.63
DZ-M-16	55.5	61.0	58.8	284.1	146.6	22.2	13.31	39.33	11.5	23.3	118.41	758.7	23.10
DZ-M-17	52.0	63.0	61.5	274.1	137.5	19.2	16.28	36.00	7.2	21.6	103.20	693.9	23.40
DZ-M-18	57.0	64.0	61.7	295.0	165.0	21.0	16.71	37.20	10.0	29.0	128.44	828.9	23.04
DZ-M-19	39.5	50.0	53.4	225.0	96.6	20.7	12.25	34.25	9.3	28.8	82.92	508.4	18.51
DZ-M-20	49.0	57.0	57.1	243.3	100.0	16.8	14.06	34.90	9.0	17.4	120.60	418.9	24.40
DZ-M-21	43.0	50.0	43.7	244.1	88.3	20.4	12.31	32.97	9.7	17.6	68.33	414.2	21.77
DZ-M-22	45.0	53.5	52.3	254.1	104.1	16.2	12.22	36.54	7.2	19.4	69.39	378.4	22.04
DZ-M-23	55.5	62.5	50.9	271.6	138.3	19.8	14.63	37.14	10.3	21.5	115.66	767.5	23.34
DZ-M-24	60.0	67.0	43.4	293.3	180.0	18.5	18.63	34.23	8.6	24.5	116.23	542.7	22.06
DZ-M-25	55.5	61.5	59.1	252.5	129.1	16.1	15.40	35.76	8.4	28.1	97.59	510.6	21.07
DZ-M-26	54.5	61.5	55.1	272.5	135.0	20.0	15.46	40.43	9.7	29.4	139.21	1028.0	23.82
DZ-M-27	49.0	56.0	54.6	281.6	132.5	21.9	18.15	40.32	8.0	38.8	183.54	956.4	20.96
DZ-M-28	56.5	64.0	52.3	274.1	133.3	19.3	13.99	32.93	10.1	27.2	90.15	517.1	21.32
DZ-M-29	56.0	63.5	63.0	241.6	159.1	20.9	10.38	32.67	9.0	17.2	45.53	315.6	20.16
DZ-M-30	54.0	61.0	43.2	295.8	163.3	22.2	13.08	35.84	9.4	21.4	96.94	614.8	23.86
DZ-M-31	58.0	62.0	53.9	275.0	145.8	12.0	18.00	22.71	13.6	34.8	10.2	848.2	25.12
DZ-M-32	57.5	63.5	50.5	314.1	174.1	21.9	13.30	30.38	5.8	13.2	67.49	590.1	21.80
DZ-M-33	59.0	65.0	37.9	265.0	140.8	18.3	12.86	32.46	8.4	19.4	77.61	414.7	17.82
DZ-M-34	58.5	65.0	47.0	294.1	167.5	21.1	16.76	33.07	7.4	20.1	91.45	589.3	22.70
DZ-M-35	58.0	64.0	53.1	280.0	145.0	17.1	14.72	30.15	8.1	20.9	78.95	509.3	21.34
DZ-M-36	57.0	66.0	47.8	257.5	128.3	17.6	21.97	35.63	8.0	16.4	77.36	845.4	24.63
DZ-M-37	56.5	62.5	42.6	290.8	168.3	18.3	16.55	36.27	9.4	35.5	118.60	668.9	22.97
DZ-M-38	58.5	66.5	54.6	299.1	179.1	20.8	15.65	39.37	9.3	26.0	113.49	704.4	29.20
DZ-M-39	56.5	61.0	48.1	268.3	148.3	17.0	15.66	34.66	10.4	32.8	122.19	549.0	20.11
DZ-M-40	52.5	60.0	54.2	272.5	154.0	17.8	14.82	34.94	9.3	27.2	104.28	718.2	21.49
DZ-M-41	61.0	67.0	46.7	211.6	126.6	17.0	18.97	34.00	10.0	30.1	122.57	682.8	20.27

Table 2 Continued 1

Accessions	TP	ESP	SPAD	PH	EH	ST	EL	ED	RPE	NKRE	KWE	GY	RD
DZ-M-42	56.5	63.0	44.4	265.8	130.0	17.6	16.97	35.29	8.4	24.8	100.33	451.5	24.41
DZ-M-43	57.0	63.5	51.7	295.8	155.0	20.7	14.35	30.45	6.25	10.0	48.34	176.4	23.12
DZ-M-44	56.5	64.5	47.2	290.0	175.0	15.1	17.15	35.88	10.6	30.7	127.70	814.7	21.13
DZ-M-45	57.5	66.5	46.7	290.0	175.8	19.0	14.04	33.58	9.9	21.0	84.82	671.1	22.05
DZ-M-46	56.5	65.5	56.0	296.6	155.8	17.1	15.47	32.65	10.3	28.3	103.38	541.8	18.56
DZ-M-47	54.5	61.5	54.7	262.5	142.5	18.9	16.47	34.98	9.6	32.8	112.46	629.9	20.30
DZ-M-48	44.0	51.5	63.3	256.6	110.0	16.8	17.64	38.30	10.6	30.4	136.10	494.7	16.64
DZ-M-49	55.0	62.0	37.8	310.0	130.0	22.2	21.50	41.56	9.2	42.6	192.24	1189.0	23.52
DZ-M-50	57.5	63.5	58.4	218.3	90.8	20.1	16.91	29.56	16.3	34.0	98.40	736.5	20.90
DZ-M-51	54.0	59.5	51.9	261.6	136.6	16.2	16.94	37.47	10.0	29.2	114.54	620.2	22.40
DZ-M-52	64.5	70.5	53.1	270.8	157.5	16.3	12.63	34.24	7.6	16.3	78.11	489.4	25.68
DZ-M-53	58.0	66.0	47.8	289.1	154.1	17.3	12.00	31.26	6.4	14.2	57.61	317.4	19.94
DZ-M-54	59.5	65.5	53.8	298.3	188.3	20.4	14.12	37.32	14.0	28.2	107.26	807.9	23.58
DZ-M-55	54.0	60.5	51.8	251.6	125.8	20.9	16.71	38.68	11.7	33.2	151.95	1235.4	23.91
DZ-M-56	56.0	62.0	51.8	260.0	135.0	19.6	14.85	34.24	12.1	23.0	92.95	990.6	22.58
DZ-M-57	53.5	59.5	53.8	269.1	111.6	23.5	17.69	38.64	10.7	30.4	144.3	1006.5	23.05
DZ-M-58	57.5	65.5	47.3	308.3	181.6	19.7	14.50	33.27	9.4	21.8	88.26	567.5	19.90
DZ-M-59	56.0	64.0	43.2	280.0	155.0	21.9	17.40	39.28	12.0	40.8	139.92	848.5	24.04
DZ-M-60	55.0	62.0	44.0	180.0	140.0	21.5	14.60	39.70	15.0	34.0	142.78	150.7	22.10
DZ-M-61	51.5	60.0	55.9	253.8	116.6	19.3	16.80	31.92	8.2	36.4	88.98	524.8	18.98
DZ-M-62	46.5	54.0	59.1	239.1	122.5	20.0	13.92	30.78	7.7	22.7	75.35	538.7	19.29
DZ-M-63	55.0	63.0	51.1	273.3	145.8	20.6	19.34	38.49	10.8	38.2	156.29	1000.6	23.36
DZ-M-64	56.0	63.5	57.2	264.1	118.3	17.1	16.18	32.65	10.3	26.7	78.37	590.6	20.31
DZ-M-65	57.5	66.5	43.1	276.6	131.0	15.6	17.00	31.78	8.6	35.1	93.73	531.1	18.09
DZ-M-66	53.0	62.0	47.8	285.0	61.6	16.8	25.38	33.54	11.8	45.6	156.53	777.7	17.36
DZ-M-67	57.5	64.0	52.6	265.0	105.8	17.9	21.00	33.70	9.4	37.4	122.90	450.9	19.74
DZ-M-68	59.5	66.0	44.8	295.0	148.3	20.3	17.47	33.40	7.7	17.4	100.32	173.1	23.32
DZ-M-69	50.5	57.0	53.9	225.8	77.9	19.1	13.37	29.95	8.0	19.0	54.46	100.3	19.35
DZ-M-70	45.5	54.0	51.2	250.8	100.83	17.9	12.32	31.39	8.8	13.9	59.08	264.9	21.81
DZ-M-71	47.5	55.5	49.1	263.3	117.5	20.1	14.90	30.53	10.2	26.7	85.56	590.4	18.55
DZ-M-72	44.0	51.0	55.9	230.8	95.5	17.3	16.04	32.76	9.2	26.4	107.60	580.5	18.31
DZ-M-73	56.0	63.0	62.8	287.5	137.5	21.4	15.28	33.34	8.0	18.4	98.01	429.0	22.36
DZ-M-74	46.0	54.5	49.6	214.1	90.0	18.3	10.12	34.70	11.2	18.5	45.81	177.0	23.775
DZ-M-75	57.0	66.0	56.9	297.5	149.17	21.6	11.99	36.54	7.7	14.1	85.05	473.1	24.22
DZ-M-76	60.0	70.0	54.2	286.6	176.7	26.0	17.60	29.60	9.6	43.8	73.80	312.0	17.96
DZ-M-77	43.0	50.0	55.9	165.0	60.0	15.4	10.72	26.97	6.25	11.2	35.60	562.5	17.85
DZ-M-78	56.0	62.0	48.5	255.8	141.7	15.1	8.89	31.54	10.8	17.2	52.18	335.9	19.57
DZ-M-79	55.0	61.0	62.8	282.5	102.5	24.8	15.30	36.16	12.0	28.0	96.58	534.7	23.68
DZ-M-80	41.0	50.0	55.4	255.8	108.3	18.0	14.90	31.22	9.6	22.8	65.32	263.5	19.12
DZ-M-81	49.0	59.0	44.1	216.6	80.0	17.6	12.30	33.18	10.0	20.8	59.35	348.6	21.24
DZ-M-82	52.0	61.0	48.6	276.6	144.1	24.8	15.79	32.96	9.4	24.4	90.10	279.6	18.95

Table 2 Continued 2

Accessions	TP	ESP	SPAD	PH	EH	ST	EL	ED	RPE	NKRE	KWE	GY	RD
DZ-M-83	50.5	69.0	44.7	285.8	137.5	21.5	14.76	28.29	8.3	17.9	70.78	324.4	18.60
DZ-M-84	63.0	70.0	52.6	230.0	135.0	18.6	15.56	28.76	11.3	29.6	89.11	219.1	16.86
DZ-M-85	44.5	53.0	54.5	254.1	102.5	18.7	12.48	28.14	5.2	14.6	50.30	267.6	20.64
DZ-M-86	59.0	65.0	54.2	270.0	120.0	18.9	17.90	26.20	4.0	6.0	41.77	504.0	21.60
DZ-M-87	56.0	63.5	54.9	286.6	138.3	17.9	15.96	31.60	8.6	20.2	87.91	946.1	22.88
DZ-M-88	52.0	59.0	56.1	243.3	136.7	18.6	13.95	30.68	10.3	26.1	67.66	495.5	19.28
DZ-M-89	40.5	50.0	49.9	194.1	55.8	14.8	12.24	25.95	4.3	11.2	38.97	201.9	19.25
DZ-M-90	56.0	62.5	53.7	305.0	147.5	21.3	14.37	34.27	9.9	22.0	94.25	513.0	20.17
DZ-M-91	47.5	54.0	51.5	224.1	74.1	19.3	12.67	28.29	6.7	16.1	44.76	153.3	19.36
DZ-M-92	46.0	53.5	55.8	241.6	95.0	18.1	20.12	35.70	11.6	30.0	103.32	463.3	23.9
DZ-M-93	61.0	69.0	54.1	315.5	160.0	23.2	13.58	25.73	6.6	16.4	65.99	104.1	24.47
DZ-M-94	45.5	53.5	53.2	200.0	76.6	18.1	14.68	24.48	4.2	10.4	43.49	1217.7	26.12
DZ-M-95	50.0	59.0	47.1	260.0	129.1	21.3	11.93	31.49	8.5	18.6	75.72	636.3	22.86
DZ-M-96	60.5	67.0	52.8	282.5	179.1	18.6	18.64	30.12	7.4	29.0	91.31	410.0	20.22
DZ-M-97	50.0	58.0	57.0	240.0	97.5	19.1	14.50	29.63	8.3	22.3	68.84	200.4	18.73
DZ-M-98	56.5	64.5	52.7	267.5	124.1	23.0	15.20	34.09	8.9	21.5	90.97	495.0	25.09
DZ-M-99	43.0	53.5	55.8	232.5	92.5	18.6	15.62	28.84	7.8	22.0	74.84	421.7	19.02
DZ-M-100	40.5	49.5	50.9	245.8	86.6	16.1	10.96	33.00	7.2	14.4	58.56	342.1	20.56
DZ-M-101	58.5	65.5	54.2	275.0	180.0	16.1	13.91	30.06	7.1	19.5	67.68	226.1	18.19
DZ-M-102	50.5	58.0	45.4	200.8	97.5	16.3	15.00	32.72	10.5	27.3	82.28	502.9	20.81
DZ-M-103	61.5	69.5	41.5	286.6	148.0	18.9	14.08	33.02	10.2	23.0	97.93	610.3	20.20
DZ-M-104	46.5	54.5	59.9	204.1	82.9	20.4	12.50	14.13	2.3	5.0	10.57	528.0	39.51
DZ-M-105	58.0	66.0	51.7	281.6	140.8	25.8	17.07	31.39	11.6	27.3	89.01	301.0	20.81
DZ-M-106	59.0	66.0	53.4	270.0	112.5	20.2	8.90	25.85	5.0	7.0	32.28	73.8	17.30
DZ-M-107	59.0	68.0	51.9	296.6	164.1	20.9	15.64	35.28	7.4	13.8	95.97	531.1	23.32
DZ-M-108	61.0	67.0	50.2	260.0	125.0	22.9	14.56	34.13	8.6	19.0	85.32	255.9	21.40
DZ-M-109	47.5	55.0	57.1	224.1	87.8	20.8	12.52	32.96	8.0	23.6	76.75	554.7	21.58
DZ-M-110	47.5	54.5	54.5	250.8	125.8	16.8	14.09	34.67	10.0	21.9	84.14	519.9	22.41
DZ-M-111	54.5	61.0	55.9	269.1	141.6	15.0	16.20	33.00	10.6	29.6	92.61	594.1	21.36
DZ-M-112	47.0	54.0	46.2	259.1	113.3	18.4	17.35	32.83	9.3	33.5	102.52	451.9	19.15
DZ-M-113	46.5	55.5	58.7	252.5	131.2	19.9	9.55	33.15	6.5	10.0	45.41	63.6	20.50
DZ-M-114	49.0	56.5	57.6	247.5	87.5	19.4	14.09	30.58	9.3	18.8	80.78	232.8	18.99
DZ-M-115	41.5	49.5	53.2	214.1	80.8	15.8	13.38	28.51	5.4	12.6	61.18	258.9	18.49
DZ-M-116	43.0	50.5	57.7	185.8	79.1	15.7	12.93	25.75	6.1	16.5	48.31	149.4	16.07
DZ-M-117	56.0	60.0	49.4	307.5	115.0	22.4	11.30	32.90	8.5	16.0	63.18	122.1	20.05
DZ-M-118	55.5	64.0	43.9	299.1	160.0	19.1	17.30	30.84	10.8	34.2	91.49	507.1	18.32
DZ-M-119	58.5	66.5	54.2	283.3	135.8	18.6	17.32	32.67	10.7	30.6	93.96	522.6	22.75
DZ-M-120	59.0	65.0	49.0	292.5	140.8	19.6	15.70	31.49	8.5	23.1	84.01	423.7	18.18
DZ-M-121	50.0	59.0	57.7	205.0	71.6	19.8	16.24	33.78	7.6	25.8	84.69	506.2	21.76
DZ-M-122	45.0	53.0	56.3	258.3	100.8	22.2	13.84	31.19	8.0	19.8	71.00	433.4	19.46
DZ-M-123	58.5	66.0	48.0	277.5	165.8	17.1	17.55	29.43	7.8	24.5	78.63	417.3	17.70

Table 2 Continued 3

Accessions	TP	ESP	SPAD	PH	EH	ST	EL	ED	RPE	NKRE	KWE	GY	RD
DZ-M-124	60.5	67.0	53.9	167.5	105.8	11.3	6.21	24.43	12.7	21.0	20.93	134.7	11.58
DZ-M-125	55.5	62.0	59.1	280.8	136.6	19.2	11.44	32.84	11.4	19.0	72.03	821.4	22.06
KALUMET	60.0	61.7	54.2	268.3	102.5	19.6	20.22	48.48	16.1	45.1	264.28	1451.9	27.13
KATONE	59.3	61.8	57.9	252.2	98.4	19.6	20.82	47.83	15.5	43.2	272.93	1467.4	26.28
Mean ML	53.8	61.3	52.7	261.9	128.8	19.2	15.18	33.29	9.3	24.4	92.75	537.6	21.44
Mean HM	59.6	61.7	56.0	260.2	100.4	19.6	20.52	48.15	15.8	44.1	268.60	1459.65	26.70
Std Dev	5.71	5.32	5.92	31.67	30.82	2.54	2.87	4.95	2.51	8.84	45.37	295.62	3.08

ML – Mean of Maize landraces; HM – Mean of hybrid maize; Std Dev. – Standard Deviation; TP – Tasseling period; ESP, Ear Silking period; PH – Plant height (cm); EH – Ear height (cm); ST – Stalk thickness (mm); EL – Ear length (cm); ED – Ear diameter (mm); RPE – Rows ear^{-1}; NKRE – kernel rows ear^{-1}; KWE – Kernel weight ear^{-1} (g ear^{-1}); GY – grain yield (kg ha^{-1}); RD – Rachis diameter (mm)

3.1 Phenological variation (days)

Phenological variation of tasseling and ear-silking stage of all genotypes were varied significantly due to different genetic makeup of the specific genotype. Among the landraces, cultivar 'DZ-M-52' took the longest time (64.5 and 72.5 days) for tasseling and ear-silking, while, cultivar 'DZ-M-19' took the shortest period (39.5 days) for tasseling and cultivar 'DZ-M-100' took 49.5 days for ear-silking. Variation of tasseling and ear-silking period of all landraces were due to the different genetic makeup of the tested genotypes that ultimately influenced under different environmental conditions (Table 2). The assumption of the result related to phenological variation also supported by Idikut and Kara (2011), who reported that tasseling period varied according to genotype and environmental conditions. Similarly, Gokmen et al. (2001) also reported that tasseling period decreased with increasing sowing density and nitrogen dose.

3.2 Variation of SPAD value

Chlorophyll (the green pigment of the leaf) in plants is considered one of the most important compounds, which can transform light energy into chemical energy through a process known as photosynthesis. Whereas, photosynthetic rate in plants is directly depended on leaf chlorophyll content as well as environmental factors such as light intensity. Chlorophyll meter (SPAD meter) is a decision making tools and good indicator for determining the photosynthetic activity in plant (Akhter et al., 2016). In the present study, cultivar 'DZ-M-011' recorded the maximum SPAD value (70 unit), and while cultivar 'DZ-M-049' showed the lowest unit of SPAD value (37.8). However, mean SPAD value of check cultivar was 56.1 (Table 2). Indicated that some landraces have the high rate of photosynthesis capacity than check cultivars.

3.3 Variation of plant height (cm)

Plant height is a heritable trait in maize and is closely associated with plant density and lodging resistance. Exceeding plant height is an undesirable feature in maize for grain yield causes lodging (Peiffer et al., 2014). However, varieties/cultivars cultivate for silage are a desirable feature. In the present study, cultivar 'DZ-M-093' (315.5 cm) was found the tallest and cultivar 'DZ-M-77' was found the shortest among the all genotypes. Whereas, mean plant height of check cultivars was 260.3 cm. Indicating that the cultivar 'DZ-M-77' was lodging tolerant, while cultivar 'DZ-M-093' may be susceptible to lodging (Table 2). Although, plant height of a cultivar/species is depend on genetic makeup, while environmental condition can also influence the plant height, which is confirmed by many studies in earlier. Oner and Gulumser (2014) and Oner (2015) reported that plant height of maize varied within the range of 102 to 374 cm in Turkey; whereas 102 to 324 cm in Spain (de Galarreta and Alvarez, 2001), 215.5 to 274.8 cm in America (Azar et al., 1997), 180 to 300 cm in Brazil (Goodman and Paterniani, 1969).

3.4 Variation of yield traits

After observation, it was observed that all genotypes showed a significant variations for all characters especially for yield and yield attributes (Table 2).

3.4.1 Ear height (cm)

In the present study, the maximum ear height was recorded in 'DZ-M-012' (190 cm) and the shortest was found in 'DZ-M-89' (55.8 cm) (Table 2). Generally, landraces had higher ear height then check cultivars. Ear height is highly influenced by genetic factors and varies according to the varieties and significantly affected by growing environment during ear elongation. Similar to plant height and ear height is also a very important characters for describing new varieties of maize, as well as green and dry matter production, finally for grain yield (Zsuzsanna et al., 2002). While, ear height feature is important for machine harvesting and should not below a meter (Tuten et al., 1984; Erden, 1991; Santos et al., 1993; Gokmen, 1995).

3.4.2 Stalk thickness/stem diameter (mm)

Stem diameter is strongly influenced by environmental conditions during stem elongation (Yilmaz et al., 2007), while declined due to genotypic variations in stem diameter of corn (Konuskan, 2000; Gozubenli et al., 2001, 2003; Turgut et al., 2005). Some researchers reported that stem diameters of corn is higher in hybrids maize as compared with local varieties, and influences by growing environment (Gozubenli et al., 2001, 2003; Turgut et al., 2005; Yilmaz et al., 2007). In the present study, the highest stalk thickness was determinate from cultivar 'DZ-M-076' with 26 mm and the lowest at 'DZ-M-124' with 11.3 mm. Stalk thickness was significantly affected by environmental conditions during stem elongation. In the study, all landraces were generally narrow stalk thickness then check cultivar (Table 2). Sharifi et al. (2009) reported that stalk thickness decreased with the increasing plant density. Stem diameter and plant height could also be considered for selection in forage corn breeding (Ahmadi et al., 2014).

3.4.3 Ear length (cm)

Some researchers indicated that ear length was influenced by the genotypes, plant density, location, year and nitrogen fertilizer (Goodman and Paterniani, 1969). In the present study, in terms of ear length, considerable variation was observed among the landraces. Among the genotypes, the maximum ear length (25.38 cm) was recorded for landrace 'DZ-M-066' and the minimum value (6.21 cm) was recorded for 'DZ-M-124'. However, ear length of 53 landraces had higher than check cultivar. Similar results in same location (Black Sea Region) related to ear length for landraces also was confirmed by Oner and Gulumser (2014).

3.4.4 Ear diameter (cm)

Carvalho et al. (2017), found the phenotypic, genetic and environmental linear positive correlation between the grain yield and ear diameter as well as grains mass ear^{-1} with. They also identified the genotype × environment interaction, and heritability in a broad sense for the grain yield, ear diameter, grains row^{-1} and also stem diameter (Carvalho et al., 2017). The results of the previous study, indicated that ear diameter has a positive correlation with the final grain weight of maize. In the present research, the maximum ear diameter (48.92) was determined at 'DZ-M-011' landrace and while the minimum (14.13) was from 'DZ-M-104'. It was also noted that ear diameter of landraces was generally thiny than check cultivar.

3.4.5 Row/ear, kernels/row(no)

The highest row number per ear was observed in DZ-M-050 with 16.3 mm, while the lowest row number per ear was in DZ-M-104 with 2.33 mm. 'DZ-M-050' was unique landrace which was superior to check cultivars. In case of number of kernels row^{-1}, the maximum (45.6) was observed in cultivar 'DZ-M-066', while the minimum number of kernels row^{-1} (5) was observed in 'DZ-M-104'. Therefore, cultivar 'DZ-M-066' and 'DZ-M-05' were superior in respect of rows ear^{-1} and kernels row^{-1} to check cultivars. Boćanski et al. (2009). Found a significant correlation between grain yield, on one side and number of kernels per row, ear length, kernel row number and ear height. Similar result also confirmed by Avlov et al. (2012), in their study they found strong phenotypic correlation between grain yield and cob weight, plant height, ear height, ear length, kernel number row^{-1} and 100-kernel weight.

3.4.6 Ear weight (g)

Ear weight of maize has positive correlation with the final grain yield of maize (Pavan et al., 2011) and vary from genotype to genotype of maize (Fetahu et al., 2015). In the present research, the maximum ear weight (285.26) was recorded from 'DZ-M-111' and the minimum ear weight (10.2) was observed for 'DZ-M-031'. Indicating that landrace 'DZ-M-111' was unique landrace to superior check cultivar. Path analysis revealed that ear weight could be used as a selection criterion because of its highly positive direct effects on forage yield (Ahmadi et al., 2014).

3.4.7 Grain yield (kg ha^{-1})

Stable performance of maize cultivars for a specific growing region is critical for obtaining the high and stable yield (Boshev et al., 2013; Nzuve et al., 2013). In the context, one hundred twenty-five maize landraces with two commercial maize hybrids ('Kalumet' and 'Katone') were evaluated for yield and agro-morphological performance for genetic improvement of future maize varieties. After observation, the maximum grain yield (1498.1 kg ha^{-1}) was recorded from the landrace 'DZ-M-007, and while the lowest grain yield (63.6 kg ha^{-1}) was recorded from 'DZ-M-113'. In the present study, grain yield of all genotypes showed a wide range of variation, due to genotypic and phenotypic variability of the tested landraces that ultimately influenced under environmental condition. Grain yield was affected by climatic factors as reported by Galarreta and Alvarez (2001). Similar results have been also reported by Oner and Gulumser (2014) in landrace maize.

3.4.8 Rachis diameter (mm)

Rachis Diameter was measured with calipers on the lower half of the broken ear. It was measured from the base of an upper glume on one side of the cob to the base of an upper glume directly opposite. Since the base of the glume is usually somewhat below the rim of the cupule, this measurement does not represent the maximum diameter of the rachis but rather its diameter to the points at which the upper glume arises (Ulysses, 1963). Maize ear architecture is significant and positive correlated with ear fasciation, defined as abnormal flattened ears with high kernel row number. Mendes-Moreira et al. (2015) found a highly significant correlation between ear fasciation and some ear (rachis diameter) and cob diameters and row number traits. They also reported that the quantitative abnormal character is widely present in most of maize landraces. In the present study, rachis diameter was varied from 11.58 to 39.51 mm and it is closely related to the grain yield. Because, if the rachis diameter is large, and therefore the ear diameter will be large. There will be an increase in the yield of the grain, since there will be more kernels and number of kernels in the large cob. Knowledge of the genes affecting maize ear architecture lead to improve the grain yield. Therefore, future studies should focus on a valuable source of genes or allelic variants for yield improvement and elucidation of the genetic basis of ear fasciation traits.

3.5 Correlation analysis

The measurement of relationship coefficient is essential in plant breeding because it measures the degree of correlation between two or more traits (Dewey and Lu, 1959). Ferdoush et al. (2017) noticed that correlation co-efficient analysis had positive and significant association with yield plant^{-1} (g) and other traits such as ear girth (cm), 1000-kernel weight (g), yield plot^{-1} (g), grain yield (tha^{-1}) with dry weight. In the presence of great relationship between two traits, selection in one trait will cause a change in its mean through additive gene influence of selected individuals and simultaneously cause an indirect modify in the mean of the other trait (Kumar et al., 2015). Results show that there are strongly positive correlations between the TP with all traits except SPAD and RD. The ESP shows positive correlation with the PH, FEH, ST, EL, ED, RPE, NKRE and KW. A very strong positive correlation appeared between the PH with the FEH, ST, EL and KW. It showed that strong positive effect between the SD with the FEH, KW and RD. The EL has strong positive correlations with the ED, RPE, NKRE, KW, GY, and RD. It found very strong positive correlations between the ED with the RPE, NKER, KW, GY, and RD. The RPE showed a significant positive correlation between with NKRE, KW, and GY. The NKRE was significantly and positively correlated with the KW and GY. KW was significantly correlated with GY and RD. There was a strong positive relationship between the GY with the RD (Table 3). The results of the present study, related to significant and positive correlation between grain yield and other traits also confirmed by Khodarahmpour (2012) and Ferdoush et al. (2017), who reported that grain yield, grains row^{-1}, grains ear^{-1}, ear height, ear-down leaves, total leaves, grain depth, grain dry matter weight and 1000-grain weight had significant and positive correlation. Therefore, correlation between yield and other characters can be used as basis of suitable characters selection for future breeding program to develop desirable variety in future. Similarly, Ahmadi et al. (2014) found a significant and positive correlation between forage yield with stem diameter, ear weight, kernels row^{-1}, ear length, days to silk emergence and days to physiological maturity. While, in

Table 3 Correlation coefficients between investigation features

	TP		ESP		SPAD		PH		FEH		ST		EL		ED		RPE		NKRE		KW		GY	
TP	1																							
ESP	0,95	***	1																					
SPAD	-0,11		-0,14		1																			
PH	0,52	***	0,55	***	-0,19	*	1																	
FEH	0,65	***	0,68	***	-0,22	*	0,74	***	1															
ST	0,18	*	0,23	*	0,08		0,40	***	0,24	**	1													
EL	0,30	**	0,28	**	-0,04		0,31	**	0,13		0,13		1											
ED	0,24	**	0,18	*	0,13		0,25	**	0,14		0,27	**	0,44	***	1									
RPE	0,32	**	0,24	**	0,12		0,01		0,05		0,07		0,35	***	0,61	***	1							
NKRE	0,27	**	0,22	**	-0,02		0,14		0,10		0,09		0,70	***	0,59	***	0,73	***	1					
KW	0,29	**	0,22	*	0,12		0,22	**	0,07		0,24	*	0,66	***	0,88	***	0,62	***	0,75	***	1			
GY	0,21	*	0,14		0,12		0,17		0,07		0,11		0,53	***	0,61	***	0,47	***	0,54	***	0,71	***	1	
RD	0,15		0,12		0,17	*	0,16		0,10		0,28	**	0,19	*	0,27	**	0,05		-0,01		0,26	**	0,47	***

TP – Tasseling period; ESP – Ear Silking period; PH – Plant height (cm); FEH – Ear height (cm); ST – Stalk thickness (mm); EL – Ear length (cm); ED – Ear diameter (mm); RPE – Rows ear^{-1}; NKRE, kernel rows ear^{-1}, RD – Rachis diameter (mm); KWE – Kernel weight in ear (g ear^{-1}); GY – grain yield (kg ha^{-1})

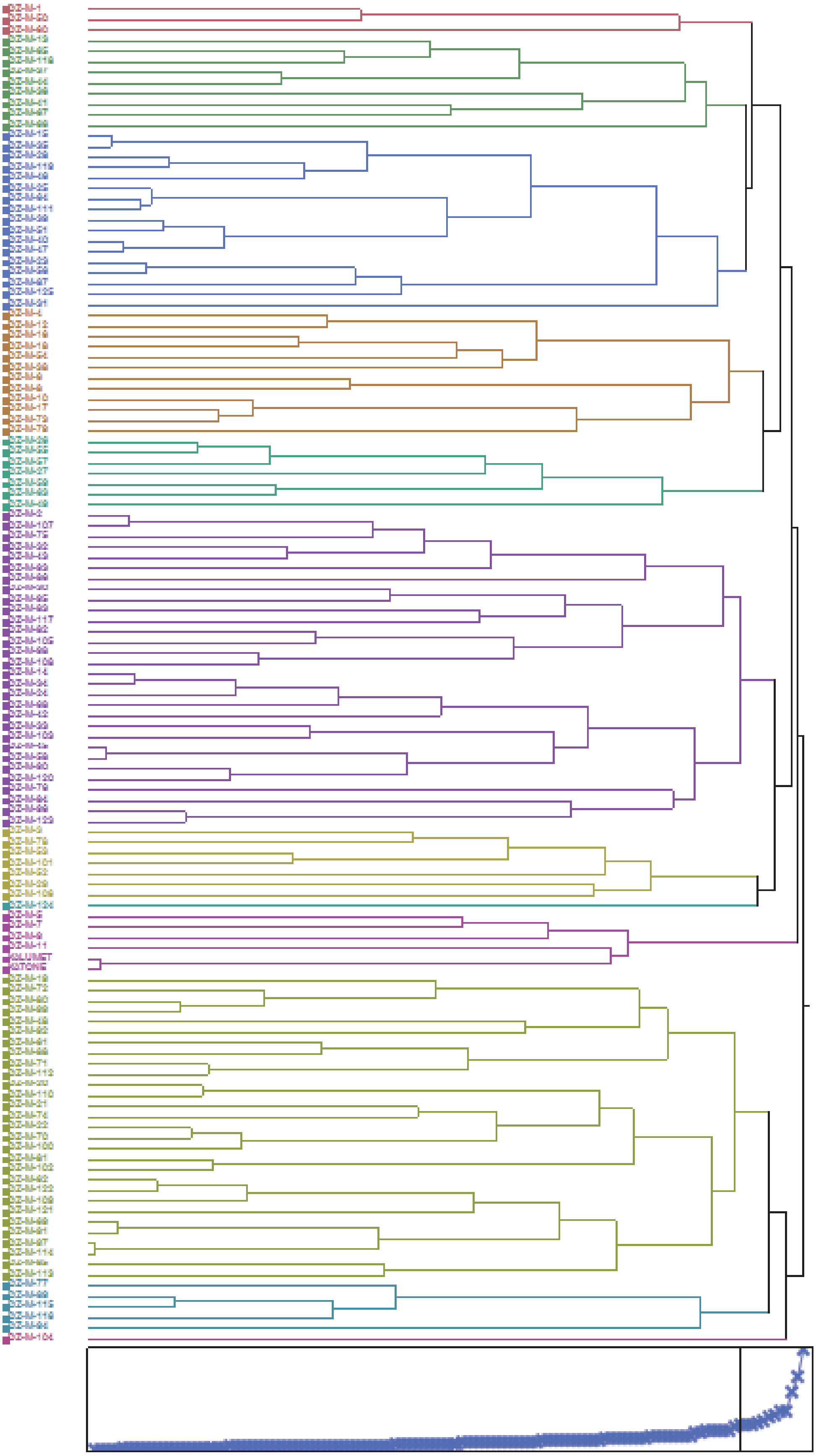

Figure 1 Dendrogram of the centroid clustering of 125 maize landraces and two commercial maize genotypes ('Kalumet' and 'Katone') based on twelve traits observed in agro-ecological region of Diyarbakır, Turkey

the regression analysis in respect of stem diameter, ear weight, and plant height remained in the final model of regression analysis and were considered as the effective components on the forage yield.

3.6 Cluster analysis

Understanding the extent and patterns of genetic diversity within germplasm accessions, particularly landraces of a particular region, is essential for successful future collection, improvement of conservation strategies of these genetic resources (Frankel et al., 1995). To determine the genetic distance between the populations and the variation within the population, the hierarchical analysis method was applied. According to morphological data, the hierarchical dendrogram differed grouped into 12 clusters (Figure 1), although some maize landraces collected in same area are included in different groups because of their different characteristics. Agronomic and ecological properties impact the genotypic constitution of landraces during domestication, and hence a relation exists between the agro-ecology of the exploration sites and the morpho-physiological make-up of the landraces (Kumar et al., 2015).

4 Conclusions

From the results and discussion of the present study, it can be concluded that all maize landraces collected Black Sea Region of Turkey had very large range for all traits (as compared with two commercial genotypes). Therefore, it was determined that they have potential to be used for developing the suitable maize varieties as well as to plan new genetic improvement program for different agro-ecological conditions.

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