Journal of Animal & Plant Sciences, 34(1): 2024, Page: 157-167
ISSN (print): 1018-7081; ISSN (online): 2309-8694
https://doi.org/10.36899/JAPS.2024.1.0704

MORPHOLOGICAL CHARACTERIZATION OF ORCHARDGRASS (*Dactylis glomerata* L.) NATURALLY SPREAD IN EASTERN ANATOLIA, TÜRKİYE

Ö. Arvas[1] and A. Nabhan[2]

[1]Van Yüzüncü Yıl University, Department of Field Crops, Van, Türkiye
[2]Van Yüzüncü Yıl University, Institute of Natural and Applied Sciences Van, Türkiye
[1]https://orcid.org/0000-0001-8713-2388 [2]https://orcid.org/0000-0002-8125-8913
*Corresponding author e-mail: osmetarvas@yyu.edu.tr

ABSTRACT

Orchardgrass (*Dactylis glomerata* L.) is a cold-resistant, perennial and one of the main forage species of meadows and pastures. A total of 9 morphological traits were considered for the morphological characterization of the orchardgrass, which is naturally distribusted in the flora of 43 different locations in 8 provinces of the Eastern Anatolia of Türkiye. According to the analysis of variance; significant differences were determined between genotypes in terms of the morphological traits examined. These differences resulted in a high degree of phenotypic variation. In addition, correlation coefficient analysis showed a significant ($P<0.01$) and positive relation between most of the traits examined. The highest correlation coefficient was between plant height and peduncle length (0.864^{**}), flag leaf length and flag leaf width (0.765^{**}), flag leaf length and panicle length (0.734^{**}) The first five Principal components (PCA) explained 70.31 % of the total variation in orchardgrass genotypes. The highest plant height and maximum number of tillers, which are important for grass yield and reproduction, were determined in M75 (77.57 cm) and R163 (27.85 per/plant) respectively. The high morphological variation among orchardgrass genotypes indicates the existence of a rich genetic population and can be considered as breeding material.

Keywords: Türkiye, Eastern Anatolia, morphological characterization, phenotypic variation, *Dactylis glomerata*, orchardgrass.

Published first online November 12, 2023 Published final January 20, 2024

INTRODUCTION

Orchardgrass *(Dactylis glomerata* L.*)* is one of the most important forage plants for temperate and cold climates regions on the world (Sanada *et al.*, 2010; Last *et al.*, 2014; Yan *et al.*, 2016). Forthermore, It is a high agronomic value in the eastern region of Türkiye and other regions with a continental climate (Madesis *et al.*, 2014; Yan *et al.*, 2016). The high productivity and resistance to disease in variable climatic conditions is the main factor in the high economic value of orchardgrass, therefore it is widely used for grazing and hay production all over the worlde (Xie *et al.*, 2012; Jiang *et al.*, 2013; Bakhtiari *et al.*, 2019).

Information on the genetic relationship between genotypes can be used at the beginning of the breeding program to improve breeding populations as complementary to phenotypic information (Santalla *et al.*, 1998; Abthai *et al.*, 2018 ; Bougrine, 2022). Genetic diversity between genotypes can help to decide what the breeder will use as materials when creating new genetic combinations (Hallden *et al.*, 1994; Azar et all., 2021; Haliloğlu *et al.*, 2023).

Plant breeding is based on genetic diversity and the use of selection methods to increase plant production. More than 50% of the world's agricultural production has been achieved through traditional plant breeding (Kumar, 1999). However, as the human population increases, human pressure in the environment increases, and as a result, arable agricultural land decreases due to the changing climate. Therefore, it is inevitable to accelerate genetic progress in plant breeding (Kumar, 1999; Comertpay, 2008; Saeidnia *et al.*,2022).

The orchardgrass is of great importance with regard to the restoration of natural pastures and the establishment of intensive pastures (Msiza *et al.*, 2021) . It is also an important source of genetic diversity. However , this plant has not been sufficiently studied and research on the possibility of cultivating the genotypes of this plant still limited. So there is a need for the characterization of those genotypes widely found in the natural grasslands. The comprehensive characterization of orchardgrass is very important, especially with regard to rehabilitation of natural pastures and breeding programs to obtain new varieties high yield for sustainable development of forage production in the

changing world (Aygün *et al.*, 2009) .This study aimed to determine the morphological diversity among the genotypes of orchardgrass distributed on the natural plant cover of the Eastern Anatolia Region of Türkiye.

MATERIALS AND METHODS

Materials

Climatic characters: The study was conducted in the experimental field and greenhouse of department of field crops, Faculty of Agriculture, Van Yuzuncu Yil University. The Climate factors of the experiment field were recorded during the2019 growing season. The Monthly total rainfall (mm), monthly average temperature (C°) and long years average values were given in Table 1.

Soil characteristics: Some physical and chemical properties of the soil of experimental area was determined in the labarotory of department of Soil Since of the faculty and results given in Table 2.

Plant material: Study material *Dactylis glomerata* L. genotypes were collected from 43 various sites, which are across the Eastern Anatolian Region of Türkiye during July and August in 2018. *D. glomerata* (Amba) cultivar was used as a control in our study. (Table 3).

Methods: Only one genotype was taken from each location. Furthermore, the seeds of genotypes that were collected from each location were planted in pots in the greenhouse at the beginning of December 2018. The plants were transferred to the field at the beginning of February 2019. In the field, the plants were planted with the distance between the lines 50 cm and between plants 30 cm with seven replication randomly. After transferring the plants to the field, the plant was practices irrigation and weed control when it was nedeed. In addition, nitrogen and P_2O_5 fertilizer was added when plant transplanted and manure was applicated before soil cultivation.

During the season 2019, observations of morphological characteristics as follow were made: plant height (cm), leaf length (cm), leaf width (mm), length of peduncle(cm), node number (number), number of tillers per plant (number), panicle length (cm), number of spikelet per panicle (spikelet/panicle), 1000 seed weight (g) (Davis, 1985; Amirouche and Misset, 2007; Özköse and Tamkoc, 2014; L Zhouri *et al.*, 2017; Zhouri *et al.*, 2019).

Statistical Analysis of Morphological Data: Statistical analysis was performed with Microsoft Excel, SPSS v23 (IBMSPSS statistic for windows version 23.0), and SAS (Statistical Analysis Software). A descriptive summary of morphological traits was calculated for each trait, and means were compared by ANOVA test. Also, the means were compared using Duncan multiple comparison test. Principal component analysis (PCA) was used to detect phenotipic groups and to estimate the contribution of each variable to the analysis. Correlation tests were performed between morphological traits studied.

Table.1. Climatic information for the studied area (Temperature (C°) and rainfall (mm) for the studied area (Van city) during the growing season and through the long term).

Month	During the growing season in 2019				Long term (C°)			
	Temperature (C°)			Rainfall	Temperature (C°)			Rainfall
	Max	Min	Average	(mm)	Max	Min	Average	(mm)
February	2.6	-7.1	-2.5	33.4	-6.3	2.8	-2.4	31.9
March	6.5	-2.8	1.5	46.4	6.8	-2.1	1.9	48.9
April	12.8	2.5	7.6	55.6	12.9	3.3	8.1	53.2
May	18.5	7.0	13.1	45.9	18.2	7.6	13.2	48.3
June	23.9	10.8	18.2	18.6	23.9	11.7	18.6	17.9
July	28.2	14.6	22.2	6.2	28.0	15.5	22.5	6.2
August	28.4	14.6	22.1	5.8	28.1	15.4	22.1	4.2
September	24.3	10.7	17.8	15.8	24.1	11.5	17.5	14.0

Table.2. Some physical and chemical properties of agricultural soils in experiment site

Depth	pH *Sat.*	*Clay* %	*Silt* %	*Sand* %	*Lime* %	CEC me/100g	*Organic Matter* %
0-20	8.16	45.08	31.95	25.97	21.06	16.00	1.87
20-40	8.30	40.76	27.88	29.39	21.41	17.00	1.69

Table 3. The genotypes used in the study and geographical regions where they were collected.

Sequence No	Genotype No	Location	Latitude	Longitude	Height (m)
1	H2	Hakkari - Merzan	37° 33.639'	043°41.629'	2166
2	H3	Hakkari - Ademan	37° 33.502'	043° 40.417'	2543
3	H5	Hakkari - Kamışlı köyü	37° 34.259'	043° 32.195'	1717
4	H6	Hakkari - Cevzdibi köyü	37° 32.511'	043° 29.609'	1575
5	H9	Hakkari - Mergereş -Adaman	37° 33.888'	043° 39.352'	2283
6	H21	Hakkari- Durankaya	37° 37.980'	043° 37.165'	2999
7	H23	Hakkari - Durankaya	37° 37.015'	043° 37.718'	2932
8	H26	Hakkari - Durankaya	37° 34.835'	043° 38.185'	2499
9	H27	Hakkari - Durankaya	37° 37.648'	043° 37.355'	3011
10	H41	Hakkari - Merkez	37° 43.755'	043° 58.169'	2347
11	H43	Hakkari - Merkez	37° 40.449'	043° 58.635'	1870
12	H45	Hakkari - Merkez	37° 43.478'	043° 59.139'	2238
13	H47	Hakkari - Merkez	37° 43.872'	043° 59.270'	2202
14	M61	Muş-Varto	39° 08.007'	041° 42.258'	2163
15	M67	Muş-Varto	39° 08.652'	041° 42.228'	2160
16	M71	Muş-Varto	39° 12.570'	041° 41.411'	1916
17	M72	Muş-Varto	39° 12.569'	041° 41.481'	1649
18	M74	Muş-Varto	39° 09.297'	041° 41.311'	2073
19	M75	Muş-Varto	39° 09.489'	041° 41.010'	2088
20	M79	Muş-Varto	39° 06.385'	041° 43.835'	2268
21	M80	Muş-Varto	39° 06.442'	041° 45.848'	2259
22	M81	Muş- Merkez	38° 35.980'	041° 33.786'	1438
23	M85	Muş- Merkez	38° 42.874'	041° 29.540'	1763
24	M110	Muş-Bulanık	38° 52.128'	041° 56.754'	1766
25	M113	Muş - Tiğem	38° 47.539'	041° 23.257'	1260
26	M115	Muş-Bulanık	38° 49.314'	041° 72.540'	1532
27	A121	Ağri -Patnos	39° 14.116'	042° 54.890'	1637
28	V141	Van-Erçiş	39° 05.549'	043° 37.911'	1750
29	R163	Iğdır -Merkez	38° 49.922'	043° 40.526'	1725
30	R175	Iğdır -Merkez	38° 49.111'	043° 40.311'	1680
31	V181	Van-Kampüs	38° 34.032'	043° 16.869'	1658
32	V189	Van-Kampüs	38° 57.119'	043° 28.818'	1665
33	V202	Van-Bostanci	38° 52.552'	043° 44.658'	1688
34	V207	Van-Bostanci	38° 52.890'	043° 44.995'	1692
35	K225	Kars-Dağpınar	40° 46.940'	043° 31.527'	2100
36	K240	Kars-Dağpınar	40° 47.510'	043° 31.681'	2119
37	V241	Van- Gevaş	38° 29.934'	043° 10.640'	1750
38	V247	Van- Gevaş	38° 30.179'	043° 10.777'	1752
39	V253	Van- Gevaş	38° 30.925'	043° 11.174'	1760
40	B261	Bitlis-Merkez	38° 42.022'	042° 12.354'	1558
41	B269	Bitlis-Merkez	38° 42.623'	042° 12.291'	1595
42	E283	Erzurum-Merkez- Saltuklu	39° 90.226'	041° 97.740'	1870
43	E288	Erzurum-Merkez	39° 91.692'	041° 25.672'	1860
44	Control				

RESULTS

Morphological Characteristics Analysis: The results of the morphological characteristics showed a significant variance between the studied genotypes for all the studied characteristics (Table 4).

Plant height: As a result of the measurements, the mean plant height of the genotypes was determined as 60.44 cm (Table 5). The genotype M75 had the highest plant height (77.57) cm, while the genotype had the shortest H27 (47.42 cm) plant height.

Flag leaf length: The average flag leaf length of orchardgrass genotypes was 11.67 cm (Table 5). Genotype M61 (16.28 cm) had the longest flag leaf length. While genotype V207 (7.80 cm) had the shortest flag leaf length.

Flag leaf width: The mean flag leaf width was 5.60 mm (Table 5). Genotype A121 (6.92 mm) had the longest flag leaf width. While genotype E288 and E283 (4.21 mm) had the shortest flag leaf width.

Number of tillers per plant: The mean number of tillers per plant was 9.72 (Table 5). Genotype R163 (27.85) had the highest tillers number while genotype M81 (2.28) had the lowest tillers number.

Node number: The average node number was 2.80 (Table 5). Genotypes H5, M75, M79, M110, M113, M115, V189, V202, V207, K225, K240, and V247 (3) had the highest node number while genotypes H27 (2.14) had the lowest node number.

Length of peduncle: The average length peduncle was found as 13.41 cm (Table 5). Genotypes M75, V189 (17.57cm) had the longest length of peduncle while genotypes H9 and H3 (9.64 cm) had the shortest length of peduncle.

Panicle length: The average panicle length was found as 10.87 cm (Table 5). Genotype M67 and H5 (16.28 cm) had the longest panicle length while genotype E288 (8.02 cm) had the shortest panicle length.

Number of spikelet perpanicle: The average number of spikelet per panicle was found as 183.45 (Table 5). Genotype M67 (260.57) had the highest spikelet number per panicle while Genotype R175 (115.86) had the lowest number of spikelet per panicle.

1000 seed weight: The average of 1000 seed weight was 0.816 g (Table 5). Genotype B269 (1.18 g) had the highest 1000 seed weight while genotype H6 (0.55 g) had the lowest 1000 seed weight.

Correlation Coefficient Analysis: The results showed significant ($p<0.01$) and positive correlations between Plant height and the number of tillers per plant (0.599^{**}), plant height and length of peduncle (0.864^{**}), plant height and 1000 seed weight (0.473^{**}), flag leaf length and flag leaf width (0.765^{**}), flag leaf length and panicle length (0.734^{**}), flag leaf length and number of spikelet per panicle (0.484^{**}), flag leaf width and panicle length (0.655^{**}), number of tillers per plant and length of the peduncle (0.580^{**}), number of tillers per plant and 1000 seed weight (0.391^{**}), length of the upper internode and 1000 seed weight (0.468^{**}), panicle length and number of spikelet per panicle (0.680^{**}) (Table 6).

Principal Components Analysis: Principal components analysis revealed that five components had Eigenvalues greater than one (Table 7). The factors with Eigen values greater than one were considered to determine the number of factors (Kaiser, 1960). An Eigenvalue greater than one indicates that weighted values of the relevant principal component are reliable (Mohammadi and Prasanna, 2003).

Analyses showed that the first principal component, explaining 21.85 % of the total variation, was composed of flag leaf length, flag leaf width, length of the peduncle, panicle length, number of spikelet per panicle. The second principal component, representing 18.84 % of the total variation, was number of spikelet per panicle. The third principal component, representing 11.63 % of the total variation, was due to flag leaf length, flag leaf width. The fourth principal component, representing 10.89 % of the total variation, plant height, number of tillers, node number, length of the upper peduncle and 1000 seed weight. The Fifth principal component, representing 7.09 % of the total variation, was the node number.

Table 4. The ANOVA table for the studied characteristics.

Characteristics	d.f	Mean Square	F Value	Pr > F
Plant height (cm)	43	455.52039	7.52	<.0001
Flag leaf length (cm)	43	30.811534	3.81	<.0001
Flag leaf width (mm)	43	3.4620560	4.38	<.0001
Number of tillers	43	294.52756	6.92	<.0001
Node number	43	0.24063727	1.57	0.0186
Length of peduncle (cm)	43	32.338843	5.29	<.0001
Panicle length (cm)	43	24.18169	4.68	<.0001
Number of spikelet per panicle	43	8665.6342	5.70	<.0001
1000 seed weight (g)	43	0.15756076	10.51	<.0001

Table 5. Summary statistics for each genotype for studied characteristics.

No	Genotype No	Plant height (cm)	Flag leaf length (cm)	Flag leaf width (cm)	Number of tiller/plants	Node number/plant	Length of peduncle	Panicle length (cm)	Number of spikelet per panicle	1000 seed weight (g)
1	H2	55.43 L-S	10.79 H-N	5.50 E-K	7.43 G-N	2.86 A-B	11.35 I-M	9.21 J-P	138.6 J-N	0.66 P-V
2	H3	48.57 R-S	11.39 G-M	5.79 B-J	4.14 J-N	2.86 A-B	9.64 M	10.64 C-N	149.0 I-N	0.67 P-V
3	H5	72.28 A-D	14.85 A-E	6.50 A-D	8.86 E-N	3.00 A	16.35 A-C	16.28 A	195.4 C-H	0.84 G-N
4	H6	49.57 R-S	12.14 E-K	5.93 B-H	7.86 G-N	2.71 A-C	11.00 J-M	9.79 H-P	117.4 M-N	0.55 V
5	H9	50.00 Q-S	13.71 A-G	6.71 A-B	2.42 M-N	2.86 A-B	9.64 M	11.93 B-G	155.1 I-N	0.73 M-R
6	H21	55.57 L-R	10.71 H-N	6.43 A-E	5.86 H-N	2.86 A-B	13.00 E-K	10.14 F-P	152.4 I-N	0.57 U-V
7	H23	59.86 H-O	13.21 C-H	6.29 A-F	6.71 H-N	2.71 A-C	13.42 E-J	11.57 B-I	185.1 E-I	0.69 O-U
8	H26	59.57 I-O	13.07 C-I	6.14 A-G	8.57 F-N	2.71 A-C	13.14 E-K	12.79 B-C	198.6 B-F	0.81 I-O
9	H27	47.42 S	10.29 I-O	5.86 B-I	6.29 H-N	2.14 D	10.17 L-M	10.67 C-N	154.9 I-N	0.62 R-V
10	H41	54.71 N-S	11.86 F-L	5.36 F-M	4.57 J-N	2.57 B-C	11.50 I-M	10.64 C-O	181.0 E-I	0.59 T-V
11	H43	52.86 O-S	10.00 J-O	5.14 H-N	5.71 I-N	2.86 A-B	11.00 J-M	9.00 L-P	153.0 I-N	0.62 R-V
12	H45	58.14 K-P	12.21 E-J	6.29 A-F	9.57 E-K	2.86 A-B	12.21 G-M	10.93 C-M	196.7 C-G	0.76 L-Q
13	H47	55.71 L-R	11.43 G-M	5.79 B-J	5.00 J-N	2.71 A-C	11.85 H-M	10.57 D-P	197.7 B-G	0.61 S-V
14	M61	71.14 A-E	16.28 A	6.14 A-G	8.86 E-N	2.86 A-B	16.14 A-D	11.71 B-H	187.4 D- I	0.85 G-M
15	M67	62.43 F-N	14.86 A-E	6.64 A-B	10.29 E-J	2.57 B-C	12.21 G-M	16.28 A	260.6 A	0.65 Q-V
16	M71	60.57 H-O	12.36 D-J	5.43 F-L	6.86 H-N	2.86 A-B	11.00 J-M	12.50 B-F	237.6 A-B	0.86 G-M
17	M72	55.29 M-S	11.43 G-M	4.93 I-N	3.86 J-N	2.71 A-C	12.71 G-M	11.07 B-M	210.3 B-E	0.91 D-I
18	M74	48.43 R-S	10.29 I-O	4.50 L-N	3.29 K-N	2.86 A-B	10.71 K-M	8.93 M-P	134,0 K-N	0.70 O-T
19	M75	77.57 A	15.57 A-C	6.57 A-C	7.00 H-N	3.00 A	17.57 A	12.07 B-G	175.1 E-J	0.90 F-K
20	M79	65.71 D-J	10.93 G-N	5.64 C-K	9.29 E-L	3.00 A	13.85 C-I	9.14 K-P	173.7 E-K	0.77 K-Q
21	M80	49.00 R-S	10.64 H-O	4.93 I-N	4.00 J-N	2.86 A-B	11.42 I-M	11.29 B-L	225.7 A-D	0.81 I-O
22	M81	55.86 L-R	12.36 D-J	5.93 B-H	2.28 N	2.71 A-C	12.57 F-L	13.14 B-C	256.4 A	0.82 I-O
23	M85	61.43 G-N	15.14 A-D	6.29 A-F	3.57 K-N	2.71 A-C	13.42 E-J	11.57 B-J	235.3 A-C	0.78 J-P
24	M110	70.42 A-F	12.29 E-J	5.93 B-H	11.86 E-I	3.00 A	15.57 A-E	11.64 B-I	213.7 B-E	0.96 C-H
25	M113	64.00 E-K	16.07 A-B	5.93 B-H	8.86 E-N	3.00 A	13.64 D-I	12.57 B-E	226.3 A-D	0.89 F-K
26	M115	63.14 E-M	10.07 J-O	5.86 B-I	9.00 E-M	3.00 A	12.42 G-L	8.33 O-P	125.0 L-N	0.93 D-I
27	A121	76.28 A-B	14.64 A-F	6.92 A	15.29 C-E	2.86 A-B	17.21 A	12.60 B-C	212.7 B-E	0.96 C-G
28	V141	62.71 F-N	9.86 J-O	5.36 F-M	7.00 H-N	2.71 A-C	14.50 B-G	11.43 B-J	205.7 B-E	0.85 G-M
29	R163	69.00 A-G	10.93 G-N	5.36 F-M	27.85 A	2.57 B-C	14.21 B-H	12.00 B-G	156.0 H-M	0.89 F-K
30	R175	75.28 A-C	9.11 L-O	4.93 I-N	25.28 A-B	2.86 A-B	16.64 A-B	8.25 O-P	115.9 N	1.03 B-E
31	V181	67.71 B-I	9.24 L-O	4.79 K-N	22.71 A-B	2.57 B-C	16.42 A-C	8.24 O-P	158.1 G-L	0.83 H-N
32	V189	67.00 D-I	11.86 F-L	5.29 G-M	13.71 D-G	3.00 A	17.57 A	11.40 B-K	182.4 E-I	0.74 L-R
33	V202	58.43 K-P	12.21 E-J	5.07 H-N	2.71 L-N	3.00 A	13.68 D-I	10.21 E-P	174.7 E-J	0.87 F-L
34	V207	51.29 P-S	7.80 O	5.00 H-N	8.29 G-N	3.00 A	14.24 B-H	10.21 E-P	163.4 F-L	0.90 E-J
35	K225	67.29 B-I	11.64 G-M	6.43 A-E	15.00 C-F	3.00 A	15.14 A-F	11.24 B-L	180.3 E-I	0.99 C-F
36	K240	57.71 K-Q	10.93 G-N	5.36 F-M	6.29 H-N	3.00 A	12.42 G-L	9.36 I-P	159.1 F-L	1.06 A-C
37	V241	48.00 R-S	9.00 M-O	4.47 M-N	6.57 H-N	2.71 A-C	13.50 E-J	8.64 N-P	164.1 F-L	0.84 G-N
38	V247	64.57 D-K	10.97 G-N	4.86 J-N	19.57 B-D	3.00 A	14.50 B-G	9.84 G-P	206.6 B-E	0.72 N-S
39	V253	63.43 E-L	9.96 J-O	4.93 I-N	12.43 E-H	2.86 A-B	14.28 B-H	10.26 E-P	198.0 B-G	0.83 I-N
40	B261	59.00 J-P	13.39 B-H	6.14 A-G	3.86 J-N	2.86 A-B	12.92 F-K	12.14 B-G	230.7 A-C	1.13 A-B
41	B269	63.29 E-M	11.31 G-M	5.57 D-K	21.28 A-C	2.86 A-B	14.28 B-H	12.60 B-D	213.1 B-E	1.18 A
42	E283	55.29 M-S	9.36 K-O	4.21 N	7.71 G-N	2.57 B-C	11.50 I-M	9.26 J-P	176.7 E-J	0.68 P-V
43	E288	60.00 H-O	8.14 N-O	4.21 N	20.57 B-C	2.43 C-D	13.50 E-J	8.02 P	176.9 E-J	1.03 B-D
44	CON	68.42 A-G	9.31 K-O	4.85 J-N	19.71B-C	2.57 B-C	16.78 A-B	8.53 N-P	161.14 F-L	0.83 I-N
Min		47.42	7.80	4.21	2.28	2.14	9.64	8.02	115.86	0.55
Max		77.57	16.28	6.92	27.85	3.00	17.57	16.28	260.57	1.18
Mean		60.44	11.67	5.60	9.72	2.80	13.41	10.87	183.45	0.82
St Dev.		8.07	2.10	0.70	6.49	0.19	2.15	1.86	35.18	0.15
CV (%)		13.35	17.97	12.57	66.71	6.62	16.02	17.08	19.18	18.37

Table 6. Correlation Coefficients.

	Flag leaf length (cm)	Flag leaf width (mm)	Number of tillers per plant	Node number	Length of peduncle (cm)	Panicle length (cm)	N.spikelet per panicle	1000 seed weight (g)
plant height (cm)	,346*	,265	,599**	,281	,864**	,246	,166	,473**
Flag leaf length (cm)	1	,765**	-,283	,246	,144	,734**	,484**	-,001
Flag leaf width (mm)		1	-,236	,205	,068	,655**	,264	-,060
Number of tillers per plant			1	-,120	,580**	-,161	-,164	,391**
Node number				1	,273	,091	,014	,296
Length of peduncle (cm)					1	,101	,089	,468**
Panicle length (cm)						1	,680**	,065
N.spikelet per panicle							1	,207

** Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level.

Table 7. Principal component analysis of orchardgrass genotypes: loading of characters on the first five axes and explained.

	PC1	PC2	PC3	PC4	PC5
Eigen value	3.3965	2.6244	1.7012	1.1721	1.0532
Proportion of variance %	21.851	18.844	11.633	10.894	7.088
Cumulative variance %	21.851	40.694	52.327	63.221	70.31
Observation	PC1	PC2	PC3	PC4	PC5
Plant Height (cm)	0.31148	-0.29015	0.18426	**0.33702**	-0.0272
Flag Leaf Length (cm)	**0.34685**	0.12986	**0.40915**	-0.04549	-0.1099
Flag Leaf Width (mm)	**0.30046**	0.0509	**0.42865**	-0.12887	-0.05129
Number of Tillers	0.03138	-0.42209	-0.09449	**0.20778**	-0.18504
Node Number	0.05719	-0.05256	0.23045	**0.29297**	**0.54828**
Length of the Upper Internode (cm)	**0.24189**	-0.31453	0.13329	**0.35836**	-0.07023
Panicle Length (cm)	**0.41974**	0.18395	0.05751	-0.20047	0.04146
Number of Spikelet Per Panicle	**0.37916**	**0.24774**	-0.04857	-0.04579	0.07907
1000 Seed Weight (g)	0.23224	-0.10092	-0.32623	**0.26371**	0.15059

DISCUSSION

Morphological Characteristics Analysis: The genetic diversity of orchardgrass has been evaluated in different geographical locations through the previous studies, and it has been found that are differences between the evaluated genotypes with regard to investigated characteristics (Sağsöz *et al.*, 1996; Garcia and Lindner, 1998; Sahuquillo and Lumaret, 1999; Ayan *et al.*, 2010; Tuna *et al.*, 2004; Mut and Ayan, 2008; Peng *et al.*, 2008; Uysal *et al.*, 2015; Bristiel *et al.*, 2019).

To determine the genetic diversity of orchardgrass in this study, the genotype were collected from various locations of the Eastern Anatolia, Türkiye, and then planted in the same site, in order to neutralize the effect of environmental factors. The method used in the current study is consistent with that used in previous researcers (Ayan *et al.* 2006; Mut and Ayan 2008; Uysal *et al.* 2015; Hodkinson *et al.*, 2019). Many studies determined the genetic variability of orchardgrass genotypes in collected from different locations. Uysal *et al.* (2015) determined the genetic diversity of orchardgrss in the Eastern Anatolia region that where the genotypes collected from natural grassland of Agrı, Ardahan, Artvin, Bayburt, Bingol, Erzurum, Kars and Mus to evaluate the genotypes available for breeding. Moreover, Mut and Ayan (2008) have collected orchardgrass genotypes from different locations of Ondokuzmayıs University Kurupelit campus to evaluate the genetic diversity of these plants. Sağsöz *et al.* (1996) found significant differences among orchargrass genotypes collected from the different locations of Erzurum, concerning morphological and biological traits.

The plant heights ranged between 47.42 (H27) to 77.57 (M75) cm with an average of 60.44 cm (Table 5). Our findings were consisted with results of Mika *et al.* (2002), Mut and Ayan (2008), and Uysal *et al.* (2015) who were obtained similar results due to studies in ecologically similar locations (59.8-64.5 cm, 67.20-71.36 cm, 75.3 cm) respectively. On the other hand, it was lower compared to other studies 74.7-101.47 cm (Tosun and Sagoz, 1994), 49.1- 95 cm (Aygün *et al.*, 2009),

63.00 -160.00 cm (Ayan *et al.*, 2010), and 76.6 cm (Copani *et al.*, 2013). This can be explained by the differences among genotypes and locations. In this study, the measurement of the lowest plant height were recorded the material collected from high altitude area (3011 m) of Hakkari. It has been reported that as the altitude increases, the atmosphere layer becomes thinner and the effectiveness of short wavelength rays increases, which causes short stature in plants (Andic, 1999). Finlly, this conditions can be cause a genetically differences in the material in long term period (Zang *et al.*, 2018). Consequently, plant height become shorter.

The average flag leaf length of orchardgrass genotypes was 11.67 cm, ranging from 7.80 cm (V207) to 16.28 cm (M61) (Table 5). The variation between genotypes in terms of flag leaf length is significant for yield and quality. Furthermore, it could give an alternative to select the suitable genotypes for breeding programs. In previous studies, flag leaf length was reported between 14.99- 27.40 cm (Tosun and Sagoz, 1994), 7.0–20.5 cm (Aygün *et al.*, 2009), 7.0- 26 cm (Uysal *et al.*, 2015), in a part of Eastern Anatolia, and 2.00 - 36.00 cm (Ayan *et al.*, 2010) in Middle Black Sea Region, respectively. Leaf length is affected by many factors such as climatic conditions, genotypes and growing practices. The number of cells has less impact on leaf length, while there are some factors that increase leaf length such as increased cell size, long days, low light intensity and normal temperature. On the other hand, extreme temperature negatively affect the leaf length. Morever, the deficiency of water reduces the overall leaf area (Hazard and Ghesquiere, 1997).

The flag leaf width was ranged from 4.21 mm (E288 and E283) to 6.92 mm (A121) with an average of 5.59 mm (Table 5). Similarly, Tosun and Sağsöz (1994), Aygün *et al.* (2009), Ayan *et al.* (2010) and Msiza *et al.* (2021) results showed different leaf widths ranging from 7-10 mm, 5- 11 mm, to 2.7-10 mm and 6.01 and 4.46 mm respectively. The results obtained by the current study indicated highly significant differences among the locations concerning flag leaf length and flag leaf width (Table 4). Orchardgrass 29 genotype evaluated in this study was collected from where have higher evaluation than 2000 meters. Altitude increases the duration and intensity of lighting, causing the leaf cells to shrink, resulting in the formation of small leaves and leaflets (Andiç, 1999; Zhang *et al.*, 2017; Zhang *et al.*, 2018). İn general, in most types of grass plants, the leaf width is small, however, it is preferable to have a large leaf width for forage plants. Therefore, the precense of variability between the averages of the leaf width will provide an advantage for selecting suitable plants for breeding programs.

The average of number tillers of orchardgrass genotypes was 9.72. This trait ranged from 2.28 (M81) to 27.85 (R163) (Table 5), the results indicated that there is a highly significant difference among the genotypes (Table 4). Mut and Ayan (2008) reported that the number of tillers to samples collected from Ondokuz Mayis University campus area was found between 15 - 54. In contrast Ayan *et al.* (2006) reported that the average of number of tillers was between 10 - 10.3. It is estimated that the low number of tillers in our study is due to the determination of the number of tillers in one-year-old plants. One of the most important factors affecting the number of tillers in orchardgrass is plant age (Demirkol and Asci, 2017; Msiza *et al.*, 2021)

Node number per plant was significantly different among the genotypes (Table 4), where the node number of orchardgrass genotypes was between 2.14 (H27) and 3 (H5, M75, M79, M110, M113, M115, V189, V202, V207, K225, K240, V247) (Table 5). We found lower values for this parameter compared to other studies where it was determined between 2.7- 4.0 nodes/plant by Tosun and Sagoz, (1994), 4.6 - 4.91 nodes/plant by Mut and Ayan (2008) 3 - 6 nodes/plant by Ayan *et al.* (2010), and 3-5 per plant by Uysal *et al.* (2015).

The length of peduncle was between 9.64 cm (H9 and H3) to 17.57 cm (M75, V189) with an average of 13.41 cm (Table 5), indicating a highly significant difference among our genotypes (Table 4). In previous studies, Mut and Ayan (2008), stated that the length of the peduncle was between 13.60 -18.26 cm in humid condition. Uysal *et al.* (2015) indicated that the length of the peduncle was 15-27 cm. The highest correlation between the length of peduncle and the height of the plant among investigated genotypes in the study. This properties can be used as selection criteria because as plant height increase plant yield increase (Tosun *et al.*, 1996)

The average panicle length of orchardgrass genotypes was found as 10.87 cm ranged from 8.02 cm (E288) to 16.28 cm (M67, H5) (Table 5). These results consisted with Uysal *et al.*, (2015)'s findings. Similarly, Mika *et al.* (2002), Ayan *et al.* (2006), and Copani *et al.* (2013) were reported the panicle length of genotypes collected from different locations varied between 10.5-13.0 cm.

Regarding the number of spikelets per panicle**,** our results ranged from 115.86 to 260.57 with an average of 183.45 (Table 5). The results was partly similar to the other researchers findings (Tosun *et al.*, 1996; Ayan *et al.*, 2006). The number of spikelets per spike is affected by genotypes rather than environmental factors.

The average of 1000 seed weight of the varied significantly between 0.55 g and 1.18 g (Table 5). These results consistent with previously conducted research findings (Manga *et al.*, 2002; Tükel and Hatipoglu, 1994). In the correlation test, 1000 grain weight was not

correlated with panicle length and number spikilet per panicle. The significantly correlation coefficient was determined between 1000 seed grain weight and plant height (0.473**) in this study. This findings could play an important role in the breeding programs if the genotypes with a high 1000-seed weight were selected.

The study results showed a significant wide range of variation between genotypes of orchardgrass regarding of examined all traits. Although the plants were grown under the same ecological conditions, the variation observed among genoytpes must be originated from genetical differences (Madesis *et al.*, 2014; Zirak *et al.*, 2019).

The results of this study were similar to findings of Erdoğdu *et al.*, (2018), where indicated that there is a significant positive correlation between plant height and with flag leaf length, flag leaf width, node number, length of the upper internode. Moreover, the findings are in confirmation with the results of (Copani *et al.*, 2013), which indicated that the plant height observed a high positive and significant correlation with flag leaf length, flag leaf width.

Our result are in similar with that of Tosun *et al.* (1996) and Abtahi *et al.* (2018) who reported positive and significant correlations between some morphological traits such as hay yield and plant height, leaf length. A study conducted by Zahid (1996), found thousand seed weight and florets/spikelet were found to be negatively correlated with seed yield. Therefore, the number of reproductive tillers at anthesis, not florets/spikelet, that had the most significant influence in determining seed yield in orchardgrass; the higher the reproductive tiller number the higher the seed yield.

Principal components represented 70.31 % of the total variation observed in orchardgrass genotypes and the number of principal components was five (Table 7). While determining the number of principal components, it is reported that should be in number to explain at least 67% of total variation (Karaagaç and Balkaya, 2010).

Our findings are in complete agreement with the finding Uysal *et al.*, (2015) and Hodkinson *et al.*, (2019) where the principal components represented 72.66% of total variation observed in orchardgrass ecotypes, collected from natural pastures part of the Eastern Anatolia Region and some of them province have not same ecological feature.

Conclusion: Because natural plant covers are an unique genetic resources, they have greates resource for crop breeding programs. Although the eastern Anatolia region of Türkiye has only continental climate characteristics with highly variable due to rolling topography (especiallay elevation), large variations were determined in the morphological characterization of the orchardgrass. This result shows that orchardgrass species distributed in the natural flora of the Eastern Anatolia region have a great genetical diversity. This is a pleasing findings with respect to plant breeding programs plant height, peduncle height and tiller number are promisingly related to higher yield. Thus, the plants, observed inthis study, have the value over the average mentioned these 3 properties can be include breeding programs and further progress.

REFERENCES

Abthai, M., M.M. Majidi, B. Behnam Hoseini, A. Mirlohi B. Araghi and N. Hughes (2018). Genetic variation in an orchardgrass population promises successful direct or indirect selection of superior drought tolerant genotypes. Plant Breeding. 137 (6): 928-935. doi: 10.1111/pbr.12657

Amirouche, N. and M.T. Misset,. (2007). Morphological variation and distribution of cytotypes in the diploid-tetraploid complex of the genus *Dactylis* L.(Poaceae) from Algeria. Plant Systematics and Evolution. *264*(3–4): 157–174. doi: 10.1007/s00606-006-0502-1

Andiç, C. (1999). Tarımsal ekoloji. atatürk university faculty of agriculture lecture notes. No 106, Offset Publications. p. 17-19.

Ayan, I., H. Mut, Z. Acar and M. O. Tongel (2006). Determination of some agricultural and cytological characters of natural cocksfoot plants (*Dactylis glomerata ssp. glomerata* L.). Pakistan J. Bio. Sci., *9*(12): 2298–2302. doi:10.3923/pjbs.2006.2298.2302

Ayan, I., H. Mut, O. O. Asci, U. Basaran and O. Tongel (2010). Morphological traits of orchard grass accessions in Black Sea Region of Türkiye. Options Méditerranéennes-The Contributions of Grasslands to the Conservation of Mediterranean Biodiversity *A*. *92*: 121–124.

Aygun, C., Ş. Çakal and A. Kara, (2009). Characterization of some coksfoot (*Dactylis glomerata* L.) lines from the natural rangelands of Eastern Anatolia. Biol. Diver. Cons., *2*(2): 57–64.

Azar, S.S., M. Nouraein and M. Reza (2021). Evaluation of variation in *Dactylis glomerata* L. Populations in terms of yield and related traits under climatic conditions of Tabriz. Iranian J. Rangelands and Forests Plant Breed. Genetic Res., 29 (2): 297-316. doi 10.22092/IJRFPBGR.2022.357006.1402

Bakhtiari, M. A., Saeidnia F., Majidi M. M., Mirlohi A. (2019). Growth traits associated with drought survival, recovery and persistence of cocksfoot (*Dactylis glomerata*) under prolonged drought treatments. Crop & Pasture Science, 70: 85–94. doi:10.1071/CP18473

Bougrine, H., A. Mebarkia and S. Bechkri (2022). Genetic Diversity Associated with Eco-geographical Parameters, Morphological Characteristics and Soil Analyzes of Common Vetch (*Vicia sativa* L.) in Algeria. Agricultural Science Digest. *42(3):* 317-321. doi10.18805/ag.DF-404

Bristiel, P., C. Roumet, C. Violle and F. Volaire (2019). Coping with drought: root trait variability within the perennial grass Dactylis glomerata captures a trade-off between dehydration avoidance and dehydration tolerance. Plant Soil. (434):327‑342. doi:10.1007/s11104-018-3854-8

Comertpay, G. (2008). Characterization of polinated turkish maize populations using morphological traits and ssrs molecular marker. *PhD Thesis.* Department of Field Crops, Graduate School of Natural and Applied Sciences, Çukurova University, Turkiye

Copani, V., G. Testa, A. Lombardo and S. L. Cosentino (2013). Evaluation of populations of Dactylis glomerata L. native to Mediterranean environments. Crop and Pasture Science. *63*(12): 1124–1134. doi:10.1071/CP12276

Davis, P. H. (1985). Why is the flora of Türkiye interesting and important? *The Kew Magazine*, 357–367.

Demirkol, G. and Ö. Ö. Asci (2017). The Evaluation of Genetic Diversity in Orchardgrass (*Dactylis glomerata* L.) Populations. Ordu University J. Sci. Techno., 7(2): 289–294.

Erdoğdu, I., A. L. Sever, C. Aygün and M. Tuna (2018). Determination of Some Characteristics of Cocksfoot (*Dactylis glomerata* L.) Populations Collected from Natural Areas of Eskisehir for Breeding Purposes. Anadolu J. Aegean Agri. Res. Institute. *28*(1): 45–51.

Garcia, A. and R. Lindner (1998). Dactylis glomerata genetic resources: Allozyme frequencies and performance of two subspecies on an acid sandy loam with summer drought. Euphytica. *102*(2): 255–264. doi:10.1023/A:1018377513189

Hodkinson, T.R., A. Perdereau, M. Klaas, P. Cormican and S. Barth (2019). Genotyping by Sequencing and Plastome Analysis Finds High Genetic Variability and Geographical Structure in *Dactylis glomerata* L. in Northwest Europe Despite Lack of Ploidy Variation. Agronomy. 9(7):1-16. doi:10.3390/agronomy9070342

Haliloğlu, K., A.Türkoğlu, A. Oztürk, G. Niedbała, M. Niazian, T. Wojciechowski and M. Piekutowska (2023). Genetic Diversity and Population Structure in Bread Wheat Germplasm from Türkiye Using iPBS-Retrotransposons-Based Markers. Agronomy. 13: 255. doi: 10.3390/agronomy13010255

Hallden, C., N. O. Nilsson, I. M. Rading and T. Säll (1994). Evaluation of RFLP and RAPD markers in a comparison of Brassica napus breeding lines. Theoretical and Applied Genetics. *88*(1): 123–128. doi:10.1007/BF00222404

Hazard, L. and M. Ghesquiere (1997). Productivity under contrasting cutting regimes of perennial ryegrass selected for short and long leaves. Euphtica. 95 (3): 295-299. doi:10.1023/A:1003048316012

Jiang, L. F., X. Q. Zhang, X. Ma, L. K. Huang, W. G. Xie, Y. M. Ma and Y. F. Zhao (2013). Identification of orchardgrass (*Dactylis glomerata* L.) cultivars by using simple sequence repeat markers. Genetics and Molecular Res., *12*(4): 5111–5123. doi:10.4238/2013.october.29.5

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. Educational and Psychological Measurement. *20*(1): 141–151. doi:10.1177/001316446002000116

Karaağaç, O. and A. Balkaya (2010). Populasyonlarinin [Capsicum Annuum L. Var. Conoides (Mill.) Irish] Tanimlanmasi Ve Mevcut Varyasyonun Değerlendirilmesi 5.2.3. Anadolu Tarım Bilimleri Dergisi. *25*(1): 10–20.

Kumar, L. S. (1999). DNA markers in plant improvement: an overview. Biotechnology Advances. *17*(2–3): 143–182.

Last, L., G. Lüscher, F. Widmer, B. Boller and R. Kölliker (2014). Indicators for genetic and phenotypic diversity of Dactylis glomerata in Swiss permanent grassland. Ecological Indicators. *38*: 181–191. doi: 10.1016/s0734-9750(98)00018-4

Madesis, P., E. M. Abraham, A. Kalivas, I. Ganopoulos and A. Tsaftaris (2014). Genetic diversity and structure of natural *Dactylis glomerata* L. populations revealed by morphological and microsatellite-based (SSR/ISSR) markers. Genetics and Molecular Res., 13(2): 4226–4240. doi:10.4238/2014.June.9.8

Manga, I., Z. Acar and I. Ayan (2002). Grass herbage crops. Ondokuz Mayis University Agricultural Faculty Textlesson. *6*: 286. (In Turkish)

Mika, V., A. Kohoutek and V. Odstrcilova (2002). Characteristics of important diploid and tetraploid subspecies of Dactylis from point of view of the forage crop production. Rostlinna Vyroba. *48*(6): 243–248. https://doi.org/10.17221/4234-pse

Mohammadi, S. A., and Prasanna, B. M. (2003). Analysis of genetic diversity in crop plants salient statistical tools and considerations. Crop Science, *43*(4), 1235–1248. doi:10.2135/cropsci2003.1235

Mut, H. and I. Ayan (2008). Determination of Some Morphological and Agricultural Characters of Natural Orchardgrass Plants (*Dactylis glomerata ssp. glomerata* L.) Collected from Different Places of Ondokuz Mayis University Campus Area, Türkiye. Asian J. Chem., *20*(3): 2405.

Msiza, N.H., K.E. Ravhuhali, H.K. Mokoboki, S. Mavengahama and L.E. Motsei (2021). Ranking Species for Veld Restoration in Semi-Arid Regions Using Agronomic, Morphological and Chemical Parameters of Selected Grass Species at Different Developmental Stages under Controlled Environment. Agronomy. 11(52): 1-14. doi:10.3390/agronomy11010052

Özköse, A. and A. Tamkoc (2014). Morphological and agronomic characteristics of perennial ryegrass (Lolium perenne L.) genotypes. Turkish J. Field Crops. *19*(2): 231–237. doi:10.17557/tjfc.15567

Peng, Y. A. N., X. Zhang, Y. Deng and X. Ma (2008). Evaluation of genetic diversity in wild orchardgrass (*Dactylis glomerata* L.) based on AFLP markers. Hereditas. *145*(4): 174–181. doi:10.1111/j.0018-0661.2008.02038.x.

Saeidnia, F., M. M. Majidi, A. Mirlohi and B. Ahmadi (2022). Association analysis revealed loci linked to post-drought recovery and traits related to persistence of smooth bromegrass (*Bromus inermis*). Plos One. 17(12): 1-18. doi:10.1371/journal.pone.0278687

Sağsöz, S., M. Tosun and I. Akgun (1996). Determination of some phenological, morphological and biological characteristics of orchardgrass (*Dactylis glomerata* L.) collected from different locations. Turkiye 3. Cayir-Mer'a ve Yembitkileri Kongresi, Erzurum (Türkiye). 17-19 Jun 1996.

Sahuquillo, E. and R. Lumaret (1999). Chloroplast DNA variation in *Dactylis glomerata* L. taxa endemic to the Macaronesian islands. Molecular Ecology. *8*(11): 1797–1803. doi:10.1046/j.1365-294x.1999.00755.x

Sanada, Y., M. C. Gras and E.van Santen (2010). Cocksfoot. In *Fodder crops and amenity grasses* (Springer). 317–328 p.

Santalla, M., J. B. Power and M. R. Davey (1998). Genetic diversity in mung bean germplasm revealed by RAPD markers. Plant Breeding. *117*(5): 473–478.

Tosun, M., and S. Sagoz (1994). Determination of some morphological and phenotypic characters of orchardgrass (*Dactylis glomerata var. hispanica (Roth*) Nyman). Field Crops Congress. *3*: 39–43.

Tosun, M., S. Sağsöz and I. Akgun (1996). Determination of some chemical characters of hay, hay and seed yield of wild orchard grass (*Dactylis glomerata* L.). *Türkiye III. Pasture and Forage Congress*. 402–407.

Tükel, T., and R. Hatipoğlu (1994). Researches on the morphological, biological and agricultural characteristics of the orchardgrass (*Dactylis glomerata* L.) plant in the Çukurova region. *Field Crops Congress, Volume III, Proceedings of Meadow Pasture and Forage Crops*, 25-29 April 1994 (İzmir) 44-47 p.

Tuna, M., D. K. Khadka, M. K. Shrestha, K. Arumuganathan and A. Golan-Goldhirsh (2004). Characterization of natural orchardgrass (*Dactylis glomerata* L.) populations of the Thrace Region of Türkiye based on ploidy and DNA polymorphisms. Euphytica. *135*(1): 39–46. doi:10.1023/b:euph.0000009537.08697.4e

Uysal, P., M. Uzun, M. M. Ozgoz, A. Yazici, K. Terzioglu, E. Aksakal, S. E. Dumlu, S. Cakal and K. Haliloğlu (2015). Morphological and seed yield characteristics of orchardgrass ecotypes of Eastern Anatolia Region. Ekin Journal of Crop Breed. Genetics. *1*(2): 78–83.

Xie, W. G., X. F. Lu, X. Q. Zhang, L. K. Huang and L. Cheng (2012). Genetic variation and comparison of orchardgrass (*Dactylis glomerata* L.) cultivars and wild accessions as revealed by SSR markers. Genetics and Molecular Res.., *11*(1): 425–433. doi:10.4238/2012.February.24.1

Yan, D., X. Zhao, Y. Cheng, X. Ma, L. Huang and X. Zhang (2016). Phylogenetic and diversity analysis of dactylis glomerata subspecies using ssr and it-isj markers. Molecules. *21*(11): 1459. doi1:0.3390/molecules21111459

Zahid, M. I. (1996). Cocksfoot *(Dactylis glomerata L.)* seed production: a thesis presented in partial fulfilment of the requirements for the degree of Master of Agricultural Science at Massey University. Massey University.

Zhang, C., M. Sun, X. Zhang, S. Chen, G. Nie, Y. Peng, L. Huang and X. Ma (2018). AFLP-based genetic diversity of wild orchardgrass germplasm collections from Central Asia and Western China, and the relation to environmental factors. Plos One. 13(4): 1-16. doi:10.1371/journal.pone.0195273

Zhang, C., J. Zhang, Y. Fan, M. Sun, W. Wu, W. Zhao, X. Xiaopeng Yang, L. Huang, Y. Peng, X. Ma, X. Zhang (2017). Genetic Structure and Eco-Geographical Differentiation of Wild Sheep Fescue (*Festuca ovina* L.) in Xinjiang, Northwest China. Molecules. 22(8):1316. doi:10.3390/molecules22081316

Zhouri, L., R. Kallida, N. Shaimi, P. Barre, F.Volaire, F. Gaboun, A. Douaik and M. Fakiri (2017). Characterization of cocksfoot *(Dactylis glomerata L.)* population for growth traits and

summer dormancy. J. Materials and Environmental Sciences 8.12 (2017): 4378-4384. doi:10.26872/jmes.2017.8.12.461

Zhouri, L., R. Kallida, N. Shaimi, P. Barre, F. Volaire, F. Gaboun and M. Fakiri (2019). Evaluation of cocksfoot (*Dactylis glomerata* L.) population for drought survival and behavior. Saudi J. Bio. Sci., *26*(1): 49–56. doi:10.1016/j.sjbs.2016.12.002

Zirak, R., A. Soleimani, M. Zeinolabedini, H. Hatami Maleki and A. Kheiri (2019). Morphological and AFLP-Based Genetic Diversity Assessment of Elaeagnus angustifolia L. Plant Genetic Researches. 5 (2): 41-54. doi:10.29252/pgr.5.2.41.