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Morphological and seed yield characteristics of orchardgrass ecotypes of Eastern Anatolia Region

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ABSTRACT

Present research was carried out to assess the genetic diversity in orchardgrass ecotypes of Eastern Anatolia region and to determine the genotypes available for breeding. Morphological and seed yield characteristics of 25 orchardgrass ecotypes, collected from natural vegetations of Ağrı, Ardahan, Artvin, Bayburt, Bingöl, Erzurum, Kars and Muş provinces of the region, were determined. After germination, the orchardgrass seedlings were transferred to the experimental field area of Eastern Anatolia Agricultural Research Institute in early spring of 2010. The 10 plants of each ecotype were investigated regarding plant height, number of nodes, node spacing, leaf length, leaf width, length of panicle axis, seed yield parameters of orchardgrass *(Dactylis glomerata* L.) in 2011-2012. Of all investigated parameters, seed yield (g) and plant height (cm) exhibited a greatest variation. Based on the Principal Components Analysis, orchardgrass genotypes were divided into 3 principal groups. Specified parameters were able to explain 72,666% of current variation. The first component representing 34,611% of total variation was composed of leaf length and leaf width; the second component representing 21,101% of total variation was plant height, and third component representing 16,953% of total variation was number of nodes.

Keywords: orchardgrass, Eastern Anatolia, morphological biodiversity

Introduction

Turkey exhibits characteristics of a small continent with regard to biological diversity since there are three different bio-climates and three bio-geographical regions (Europe-Siberia, Mediterranean and Iran-Turan) in Turkey (Aytepe and Varol, 2007; Anonymous, 2007).

Cultivation of several common field and forage crops has successfully been performed under field conditions in Turkey, which has various soil, climate and cropping patterns. However, very few forage crops are actually cultivated in Turkey and it is hard to improve forage crop cultivation. Therefore, in addition to current ones, new species and genotypes should be included in forage crop cultivation (Canbolat and Karaman 2009).

Natural pastures are significant genetic resources in development of new plant species and such lands constitute almost one-fifth of country surface area. Eastern Anatolia Region has about 35% of total pasture lands of the country and pastures of the region constitute gene source of various plants used in pasture and meadows of the country. Despite the significantly rich natural flora, plant species and diversity of the region, especially with regard to forage crops, a number of economically valuable plant species, such

as orchardgrass (*Dactylis glomerata* L.), have not been identified in detail. Orchardgrass is a long-life, perennial cool season bunchgrass adapted to cool regions of the world. It is highly adaptive to various environmental conditions and has well re-grow characteristics. Orchardgrass is widespread in most European countries, Northern and southern American countries, Australia, New Zealand and Asia. It yields proper mixtures for dry hay, silage and pasture. It is usually used with alfalfa (*Medicago sativa* L.) or red clover (*Trifolium pratense* L.) for dry hay and with white clover (*Trifolium repens* L.) for pastures (Sanada *et. al*., 2010).

There are limited studies on orchardgrass (*Dactylis glomerata* L.) populations which are very common over pasture and meadows of Turkey (Tuna et al*.,* 2004). Such a rich genetic diversity has not sufficiently been valued and commercial species have not been developed yet.

Genetic resource preservation and plant breeding programs mainly depend on the use of current genetic diversity to a large extend (Ahmad et al., 2008). There are several methods in genetic analysis of breeding lines and population germplasm. These methods include pedigree data, morphological data, agronomic performance data, biochemical data and recently the molecular data (Mohammadi and Prasanna, 2003). Determination of genetic diversity via morphological data is among the traditional methods (Tuna et al., 2004**)**.

Determination of agronomic and morphological characteristics of high yielding orchardgrass genotypes well-adapted to the regional conditions and determination of genetic diversity based on these characteristics are of significant issues in utilization of current population into breeding programs.

Objectives of present study were to determine the morphological, phenological and agronomic characteristics of orchardgrass ecotypes collected from Eastern Anatolia Region to determine current diversity and to select available genotypes for the use in advanced breeding programs.

Materials and methods

Materials

A total of 25 orchardgrass (*Dactylis glomerata* L.) ecotypes, collected from natural pastures of Ağrı, Ardahan, Artvin, Bayburt, Bingöl, Erzurum, Kars and Muş Provinces of Eastern Anatolia Region of Turkey, constituted the plant material of this study. Experiments were carried out in Pasinler experimental station of Eastern Anatolia Agricultural Research Institute during the years 2010-2012. The information on orchardgrass ecotypes used as material is provided in Table 1.

Methods

Orchardgrass seeds, obtained from single plants in different years were sown into the pots in early spring of 2010. The seedlings with certain level of growth were transplanted into field area providing 10 seedlings per row with 50 cm x 50 cm spacing. The observations were obtained from 10 seedlings of each ecotype during the years 2011 and 2012. The genotypes yielded two cuts under ecological conditions of Erzurum. Morphological and phonological characteristics were determined at the first cut. Total fresh and dry hay yield were taken as the total of two cuts. Plant height, number of nodes, node spacing, leaf length, leaf width, length of panicle axis parameters of orchardgrass (*Dactylis glomerata* L.) were investigated.

The methods and principals given for orchardgrass (*Dactylis glomerata* L.) in the "Technical Directives for Agricultural Experiments" issued by the General Directorate of Seed Registration and Certification Center of Ministry of Food, Agriculture and Livestock of Turkey were used (Anonymous, 2001) and observations were made on 10 plants of each ecotype.

Data analysis

All data were standardized before the principal components and cluster analyses. Standardization was conducted to eliminate the unit effect and carried out through dividing entire data by standard deviation and subtracting from the mean value. The descriptive statistical analysis was carry out using SPSS (IBM-SPSS statistic for windows version 20.0). Statgraphics Centurion XV (Statpoint Inc 2006) was used for principal components analysis.

Moreover, Numerical Taxonomy Multivariate Analysis System (NTSYS-pc version 2.1 software) was used to generate dendrogram (Rohlf, 2000). Euclidian distances were calculated by using standardized data to determine the differences among genotypes. Couple methods were tried to generate clusters and EUCLID distances with the highest cophenetic correlation coefficient (r = 0.77453) and UPGMA method were used as the cluster method.

Results and discussion

Descriptive statistics

The statistics value defined for investigated ecotypes are given in Table 2. While the highest variation with 51.8% was observed in number of seed yield, it was followed by total fresh leaf length with 27.3%, then length of panicle axis with 26,7%. Plant height yielded the lowest variation (9.9%) among the parameters examined.

In general, the population used in the present study exhibited a wide range of variation which can be considered as an advantage since it provides opportunity in multipurpose breeding studies.

Leaf lengths of ecotypes varied between 7.0-26 cm. Various observations were reported between 14.99- 27.40 cm, 7.0–20.5 cm and 2.00 - 36.00 cm in respective order by Tosun and Sağsöz (1994), Aygün et al (2009) and Ayan et al (2010).

Similarly, Aygün et al (2009), Tosun and Sağsöz (1994) and Ayan et al (2010) reported different leaf widths varying between 5- 11 mm, 5.18-7.19 mm and 2.7-10 mm, respectively. Leaf widths varied between 7-10 mm in the present study.

Although plant heights varied between 70-111 cm in this study, in previous studies it varied between 74.7-101.47 cm (Tosun and Sağsöz, 1994), 59.8-64.5 cm (Mika et al., 2002), 49.1- 95 cm (Aygün et al., 2009) and 63.00 -160.00 cm (Ayan et al., 2010).

Number of nodes varied between 3-5 per plant. This parameter was determined between 2.7-4.0 nodes/plant by Tosun and Sağsöz (1994) and between 3-6 nodes/plant by Ayan et al. (2010). Field experiments were found to be in harmony with them but the value reported by Tosun and Sağsöz (1994) for greenhouse conditions were found to be lower than field experiments.

Node spacing in present study was found to be between 15-27 cm. Ayan et al. (2010) investigated the same parameter on the seeds collected from natural floras of Ordu, Samsun and Sinop Provinces and reported between 1.50-29.30 cm.

Length of panicle axis of investigated ecotypes varied between 8-23 cm. Mika et al. (2002) reported the lengths of seed head axis of ecotypes that varied between 10.5-10.3 cm.

Principal components analysis

Principal components analysis revealed that 3 components had Eigen values greater than 1 (Table 3). The factors with Eigen values greater than 1 were taken into consideration to determine the number of factors (Kaiser 1960). An Eigen value greater than 1 indicates that weighted values of the relevant principal component are reliable (Mohammadi and Prasanna 2003). Scree test, developed by Cattell (1966), is another graphical method to determine number of factors. According to scree test, 3 principal components had a value greater than 1 (Table 3). The factor groups and corresponding PC axis values based on scree test and principal components analysis carried out on investigated orchardgrass ecotypes are presented in Table 3 and Figure 1.

Principal components represented 72.66% of total variation observed in orchardgrass ecotypes (Table 3). While determining number of principal components, it is reported that it should be in number to explain at least 67% of total variation (Karaağaç and Balkaya 2010). Considering all these criteria, number of principal components was determined to be 3 (Table 3).

With regard to parameters investigated in principal component analysis, the observations with the highest component weight values had a large interval. Analyses revealed that the first principal component, representing 34.61% of total variation, was composed of length of leaf, leaf width, the second principal component, representing 21,10% of total variation, was the plant height; third principal component, representing 16.95% of total variation, was due to node numbers

Cluster analysis

UPGMA dendrogram (Figure 2) was drawn and evaluated as four groups to present the relationships among ecotypes. Cluster analysis is usually used for grouping the collected germplasm. Groups can be formed either randomly or in a way to maximize genetic distance (Tuna et al., 2004).

Orchardgrass ecotypes were divided into 4 groups based on cluster analysis. The ecotypes 1,3,4,5,6,7, 8,9,11,12,13,14,16,17,18,19,22 and 23 were placed into the first group and they had the highest mean node spacing (21.6 cm) and the lowest mean leaf length (15.3 cm). The ecotypes of 10, 15 and 21 were placed into the second group and these ecotypes had the highest plant height (21.7 cm) and panicle length axis (19.3 cm) as well as with the lowest distance of internodes (17 cm) and number of nodes (3.3 cm). The third group consisted of 20 and 24 ecotypes with highest mean values of plant height (106.5cm) and seed yield (51.03 g). In fourth group a sole ecotype (2) was found with mean lowest values of plant height (70 cm) and seed yield (15.23 g).

Conclusion

Genetic diversity assessment of collected materials and selection of plants available for breeding programs were the main objectives of this study. Experimental results revealed a large variation among collected ecotypes. This may be considered as an advantage since it provides opportunity in multipurpose breeding studies. Determination of genetic diversity of these materials with large variations and grouping them accordingly may help in decision making process of breeding line selection phase.

In general, the plants collected in present study exhibited a broad range of variation. Regarding seed

yield prominent ecotypes were determined and they were transferred to the breeders in the institute for detailed analysis while studies will continue on other ecotypes.

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Table 1. List of orchardgrass (Dactylis glomerata L.) ecotypes used in this study

Plant number	Origin	Plant number	Origin	Plant number	Origin
1	Erzurum	10	Erzurum	19	Artvin
2	Ardahan	11	Bingöl	20	Erzurum
3	Ağrı	12	Artvin	21	Kars
4	Muş	13	Erzurum	22	Bayburt
5	Erzurum	14	Bayburt	23	Ardahan
6	Kars	15	Erzurum	24	Erzurum
7	Bingöl	16	Muş	25	Ardahan
8	Erzurum	17	Ağrı		
9	Bingöl	18	Erzurum		

Table 2. Descriptive Statics value for investigated ecotypes

	Minimum	Maximum	Mean	Std. Deviation	Variance	% CV
Plant height (cm)	70	111	91.16	9.012	81.223	9.9
Number of nodes (nodes/plant)	3	5	3.44	0.583	0.340	16.9
Length of panicle axis (cm)	8	23	12.76	3.407	11.607	26.7
node spacing (cm)	15	27	20.68	3.772	14.227	18.2
Leaf length (cm)	7	26	16.44	4.491	20.173	27.3
Leaf width (cm)	0.7	1.0	0.804	0.0978	0.010	12.2
Seed yield (g)	12.90	93.55	34.6332	17.931	321.529	51.8

Figure 1. Screen plot of principal component analysis of investigated parameters

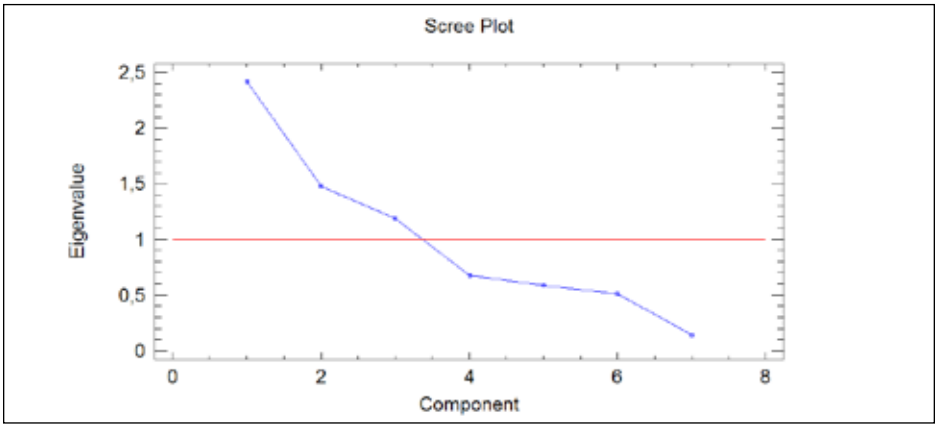
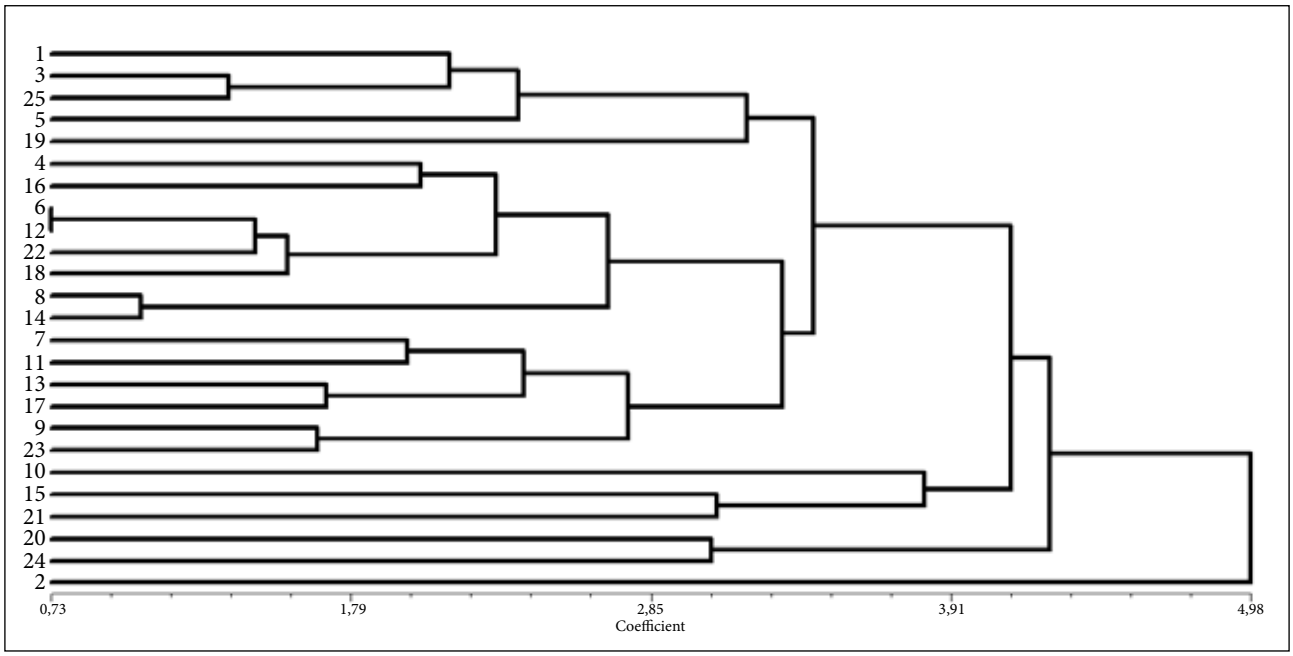


Table 3. Principal components and factors groups based on principal component analyses investigated in orchardgrass ecotypes

	1	**2**	**3**
Eigen value	2.42279	1.47707	1.18674
Proportion of variance %	34.611	21.101	16.953
Cumulative variance, %	34.611	55.712	**72.666**
Observation	1	2	3
Plant height (cm)	0.0394297	**0.666219**	-0.120285
Number of nodes (nodes/plant)	-0.0371103	-0.211208	**-0.820891**
Length of panicle axis (cm)	0.414892	-0.0962776	0.460501
node spacing (cm)	-0.36789	0.369574	0.0548325
Leaf length (cm)	**0.559125**	0.0957526	-0.0136107
Leaf width (cm)	**0.570966**	-0.0794078	-0.271273
Seed yield (g)	0.225759	**0.591789**	-0.151084

Figure 2. UPGMA dendrogram of orchardgrass ecotypes



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