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Biodiversity in morphological properties and nutritional values of forage grass species

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Abstract: *This study was conducted under humid and warm climatic conditions in 19 Ondokuz Mayis University, Kurupelit campus area (1300 ha) during March and July in 2004. The study aimed to evaluate the forage grass species, which have been protected for over 30 years, and to observe the biological diversity by determining their morphological characters and forage qualities. Some morphological characters and chemical properties of 20 grass species were examined. Statistically significant differences were determined regarding all morphological characters and chemical properties within species and individual species. In examined grass species, number of tiller per plant and main stem length ranged from 5.5 to 40.5 and 39.38 to 96.18 cm, respectively. Root crown diameter, dry matter of root, dry forage weight changed between 6.24 and 21.60 mm, 0.27 and 20.33 g plant*$^{-1}$*, 0.80 and 46.76 g plant*$^{-1}$*, respectively. Protein content of the samples varied from 4.37 to 9.42%. Trace elements content of the samples such as Ca (0.08-0.79%), Mg (0.06-0.17%) and K (0.76-3.03%) were also determined. Potassium contents of dry grass forages were excessively high, however their phosphor contents were generally insufficient, calcium and magnesium contents were fairly insufficient and K / Ca+Mg ratios were over the critic value (2.20) except for two species. In general, Fe, Zn and Mn in dry grass forage samples were found adequate.*

Key words: *Biodiversity, Grasses, Mineral content, Morphological characters, Turkey*
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Introduction

The grasses (Poaceae) are the forth largest family of flowering plants, with some 11000 species. They are worldwide in distribution and main components of most rangeland and grassland ecosystems (Saarela, 2005). They can be highly adapted to different conditions. In addition, grass species can cover ground owing to fibrous roots and their dense growing potential. This character of grass species keeps soil wet and promotes infiltration. Ultimately, they help decrease soil erosion (USEPA, 1996; Jaukauskas and Jaukauskiene, 2003; USDA – NRCS, 2006; Sanderson *et al*., 2007; Misir *et al.,* 2007; Hacisalihoglu, 2007). Grasses grown in many different environments which can be threatened by concentrated overland flow, for instance after surface fire or overgrazing. When the above ground biomass has disappeared, only roots can offer resistance to concentrated flow erosion (Baets *et al*., 2006; Sanderson *et al*., 2007). On the other hand, the well tillered grasses with large leaves, thick root crown, and high biomass can offer better soil cover and are resistant to grazing. Therefore, they protect soil and water (Acar and Ayan, 2004). The contribution of grass species to herbivores, natural environment and ecosystem cannot be deniable (Boody *et al*., 2005; Ferris, 2007).

Turkey is a rich country in terms of species, ecotype, genetic diversity and genetic resources (Davis, 1970). Present geographic differences, hosting many civilizations during the history and its role as a bridge between Asia and Europe contribute to the genetic wealth of Turkey (Kislalioglu and Berkes, 1992; Ozgen *et al*.,1995; Acar *et al*., 2001). Samsun – Amasya – Tokat are sub-centers of diversity for many plant species, especially forages (Davis, 1970; Davis, 1985; Dokuzoglu, 1990). Maintenance of this genetic diversity is extremely important because erosion has occurred due to various reasons.

The University Kurupelit campus area (1300 ha) is a significant genetic resource with different topographic structures (Ayan *et al*., 2006). For example, the altitude is between 0-500 m and it has various soil types, and particularly forest area occupies western part of the campus area including bushy plant vegetation, meadow, rangeland, valleys and hillsides (Ozen and Kilinc, 1996; Acar *et al*., 2001).

Nutritional quality of native plants directly affects grazing performance of the livestock. Poor animal growth and reproductive problems are common even when forage supply is adequate, and can directly be related to mineral deficiencies in soil which may cause low mineral concentrations in forages (McDowell, 1997). Mineral concentrations in both soils and plants affect mineral status of grazing livestock (Towers and Clark, 1983).

A wide variation is observed among the species regarding mineral concentrations (Acar *et al*., 2001; Minson, 1990; Gomide, 1978). Mineral composition of forage plants can be affected by soil-plant factors, growth stage, and sections of plants, climate, and fertilizer application, including pH, drainage, irrigation, soil structure and interaction among minerals (El Shatnawi *et al*., 2004; Minson, 1990; Gomide, 1978). Despite being abundant in soil, phosphorus is the major plant growth-limiting nutrient after nitrogen. Phosphorus in soils is present in insoluble form complexed with cations like iron, aluminium and calcium (Kang *et al.,* 2008). Other element sulphure, an essential element for all living plants, is taken up by plant in the form of sulphate from the soil through roots (Tanvir Ali *et al.,* 2008).

Overall, this experiment intended to observe biodiversity on naturally growing grass species in the campus area, which is very important for genetic resources. Other objective of the research was to find out morphological characters and nutritive values of grass samples. The relations of some morphological characters and soil and water conservation were also the aim of the study.

Materials and Methods

This study was conducted between March and July in 2004 in 19 Ondokuz Mayis University Kurupelit campus, located 41°21´N latitude, 36°15´ E longitude. According to Davis's square system, A6 square system was used in the research (Davis, 1970). Irregular topography covering 1300 ha has between 0 - 500 m altitude, various soil types such as sandy-clay and silty clay in the coastal area, greypodzolic and brown soil on hillsides, different plant communities such as forest, meadow, rangeland, bushy plant vegetation (Pamir and Erentoz, 1974).

Soil pH was 6.85 and organic matter ratio, Ca and Mg contents were 2.94, 0.53 and 0.77%, respectively. K content was 431.2 g kg^{-1}, phosphorus content 12.25 g kg^{-1}, Fe, Zn and Mn contents were 24.77, 1.58 and 37.02 ppm, respectively.

Annual mean temperature was 14.2°C, total annual precipitation was 670 mm, particularly regular, and the number of frost days was 18 during study period. Twenty grass forage species were collected from the campus every three days at flowering stage between March and July, 2004. Some properties of each grass sample such as number of tiller, main stem length, main stem diameter, flag leaf width and length, second leaf width and length (second leaf above top soil) root crown diameter, dry weight of root and stem were examined. Classification of the plants was done according to Davis (1970) and herbariums were used for classification in the archive of laboratory of Biological Science Department in Ondokuz Mayis University. Morphological characters of plants were evaluated according to criteria which were determined by Ministry of Agriculture (Anonymous, 2001).

Collected samples taken from each plant were dried to constant weight at 65°C in a stove. After cooling and weighing, the samples were ground for crude protein, crude ash and mineral content analyses. Crude protein content was calculated by multiplying Kjeldahl nitrogen concentration by the factor 6.25 (Kacar, 1984); crude ash content was determined by ashing at 550°C for 6 hr (AOAC, 1990); mineral content (Ca, K, Mg, Mn, Fe and Zn) of samples was also calculated using atomic spectrophotometer after digesting the samples with $HClO_4$:HNO_3 (1:4) (Kacar, 1984). Phosphorus and sulphur were measured using spectrophotometer at 430 nm wavelength. Each sample was analyzed in duplicate.

The data obtained from the study to determine the morphological characters and chemical properties of grass species growing naturally were evaluated by SPSS-10 in completely randomized plot design (One-way Anova). Differences among the treatments were tested according to Duncan's multiple range test.

Furthermore, the means of morphological characters were evaluating considering confidence limits ($p \leq 0.05$). Confidence limits were calculated by multiplying standard error and table values (Tosun, 1998).

Results and Discussion

Morphological characters: Morphological characters of 20 grass species which were observed in the experiment area are presented in Table 1.

Many factors such as growing conditions, nutrients, humidity, light, temperature, plant density affect the morphological characters of plants (Acar *et al.*, 2001). It is too hard to know how much variation was influenced by their genetic constitutions because of the inequality in the growth conditions. However obtained data might be useful for the evaluation of species.

Tiller number of species changed between 40.5 (*Bromus hordaceus*) and 5.5 (*Lagurus ovatus*). Although most of the grass species had high number of tiller, it was observed that *Bromus hordeaceus* (40.5), *Dactylis glomerata* (33.8) species showed higher tillerring than the other species do. Main stem lengths of the species varied from 96.18 (*K. cristata*) to 39.38 (*P. trivialis*) cm. The highest main stem length was measured in *Koelaria cristata* Pers. (96.18 cm), *Holcus lanatus* (86.40 cm) and *Avena fatua* subsp. *fatua* (85.60 cm). *Avena fatua* subsp. *fatua*, performing weedy character and growing in the cereal areas, had the thickest main stem diameter (3.69 cm), while *Phleum exaratum* had the thinnest (0.96 cm) main stem diameter (Table 1).

Lagurus ovatus had the highest flag leaf length and width (12.09 and 0.78 cm), *Hordeum nodosum* had the longest inferior leaf (21.37 cm), *Holcus lanatus* had the longest leaf width (0.80 cm). Root crown diameters of the species were between 21.60 (*A. fatua* subsp. *fatua*) and 6.30 (*A*. *myosuroides*) mm. *Avena fatua* subsp. *fatua, Dactylis glomerata* and *Hordeum nodosum* had the highest root crown diameter (21.60, 20.38 and 18.57 mm). *Dactylis glomerata*, a perennial and valuable grass forage crop, had the highest root weight (20.33 g $plant^{-1}$), the lowest value was found in *Bromus erectus* (0.27 g $plant^{-1}$). However, the highest dry weight (46.76 g $plant^{-1}$) was determined in *Avena fatua* subsp. *fatua* which is an annual grass performing a higher growth rate, higher length and thicker stem (Table 1).

Calculated high confidence limit values regarding main stem length (for example, confidence limit values of *L. ovatus* and *P.*

Table - 1: Morphological characters and confidence limits of grass species collected from Ondokuz Mayis University campus Turkey

Plant species	Number of tiller**	Main stem length (cm)*	Main stem diameter (cm)**	Flag leaf width (cm)**	Flag leaf length (cm)**	Second leaf width (cm)**	Second leaf length (cm)**	Root crown diameter (mm)**	Dry weight of root (g $plant^{-1}$)**	Dry forage weight (g $plant^{-1}$)**
Lolium perenne L.	31.0^{b} ± 10.32	58.6^{e-h} ± 8.42	1.98^{b-e} ± 0.18	0.58^{b-d} ± 0.10	9.95^{a-c} ± 1.91	0.56^{b-f} ± 0.07	12.04^{c-g} ± 2.85	12.27^{d-h} ± 4.45	4.90^{de} ± 0.86	14.90^{d} ± 2.43
Festuca rubra L.	13.5^{c-f} ± 3.44	76.6^{b-d} ± 10.85	1.12^{de} ± 0.26	0.29^{gh} ± 0.06	11.21^{ab} ± 4.00	0.28^{i} ± 0.05	9.13^{d-g} ± 1.84	6.57^{h} ± 0.96	4.3^{de} ± 0.83	5.83^{f-h} ± 1.01
Hordeum nodosum L.	10.5^{d-f} ± 4.90	84.49^{a-c} ± 11.52	2.73^{ab} ± 0.60	0.58^{b-d} ± 0.1	8.50^{b-e} ± 1.32	0.71^{ab} ± 0.1	21.37^{a} ± 4.28	18.57^{a-c} ± 5.98	4.05^{de} ± 1.32	7.76^{e-g} ± 1.88
Hordeum murinum L.	16.8^{c-f} ± 7.94	51.9^{g-j} ± 10.58	1.55^{c-e} ± 0.20	0.54^{b-e} ± 0.12	6.20^{d-f} ± 1.67	0.39^{f-i} ± 0.05	8.66^{e-g} ± 1.73	10.70^{d-h} ± 3.30	4.64^{de} ± 2.56	0.80^{h} ± 0.70
Koeleria cristata (L.) Pers.	12.0^{c-f} ± 4.70	96.18^{a} ± 11.03	2.00^{b-d} ± 0.55	0.30^{gh} ± 0.04	5.67^{ef} ± 1.46	0.50^{c-h} ± 0.26	9.11^{d-g} ± 3.42	9.60^{d-h} ± 4.11	7.92^{c} ± 1.32	20.65^{c} ± 3.17
Holcus lanatus L.	14.0^{c-f} ± 3.36	86.40^{ab} ± 5.76	2.07^{b-e} ± 0.12	0.60^{b-d} ± 0.06	6.20^{d-f} ± 0.94	0.8^{a} ± 0.05	12.6^{c-f} ± 1.65	6.60^{h} ± 1.29	4.85^{de} ± 0.81	10.00^{d-f} ± 1.65
Cynosorus cristatus L.	13.4^{c-f} ± 4.64	54.60^{f-j} ± 8.15	1.07^{de} ± 0.13	0.23^{h} ± 0.06	9.31^{a-c} ± 1.92	0.29^{i} ± 0.05	9.48^{d-g} ± 1.78	9.06^{e-h} ± 1.49	3.22^{d-f} ± 1.33	4.70^{f-h} ± 1.51
Phleum exaratum Griseb.	17.6^{c-e} ± 4.09	64.70^{d-g} ± 2.47	0.96^{e} ± 0.10	0.22^{h} ± 0.03	2.19^{g} ± 0.34	0.35^{g-1} ± 0.05	10.02^{d-g} ± 1.26	13.06^{c-f} ± 4.21	4.75^{de} ± 0.85	6.88^{f-h} ± 1.11
Lagurus ovatus L.	5.5^{f} ± 2.98	56.20^{f-h} ± 22.61	1.43^{c-e} ± 0.36	0.78^{a} ± 0.16	12.09^{a} ± 3.07	0.53^{b-g} ± 0.10	11.15^{c-g} ± 3.29	6.24^{h} ± 2.95	2.70^{e-g} ± 1.90	5.07^{f-h} ± 3.64
Bromus erectus Huds.	12.1^{c-f} ± 5.24	49.30^{g-j} ± 9.90	1.02^{de} ± 5.53	0.31^{f-h} ± 0.01	8.98^{b-d} ± 2.91	0.35^{g-i} ± 0.08	7.94^{g} ± 2.25	6.75^{g-h} ± 2.76	0.27^{g} ± 0.90	1.85^{gh} ± 0.73
Bromus tectorum L.	21.3^{c} ± 7.19	69.30^{c-f} ± 12.61	2.30^{bc} ± 0.90	0.48^{c-e} ± 0.09	10.56^{a-c} ± 1.49	0.62^{b-d} ± 0.15	10.12^{d-g} ± 2.53	14.41^{c-e} ± 3.29	13.03^{b} ± 1.11	32.91^{b} ± 9.68
Bromus squarrosus L.	7.0^{ef} ± 3.32	72.9^{b-e} ± 13.68	2.78^{ab} ± 0.49	0.39^{e-g} ± 0.07	10.42^{a-c} ± 1.73	0.67^{a-c} ± 0.15	13.3^{cd} ± 2.47	6.45^{h} ± 3.35	4.18^{de} ± 1.13	9.26^{d-f} ± 2.25
Bromus hordeaceus L.	40.5^{a} ± 17.97	59.11^{f-h} ± 1.91	1.64^{c-e} ± 0.31	0.29^{gh} ± 0.06	9.63^{a-c} ± 1.81	0.42^{e-i} ± 0.15	12.28^{c-g} ± 2.29	17.59^{b-d} ± 4.95	5.93^{c-d} ± 0.92	13.35^{de} ± 1.68
Brachypodium pinnatum L.	20.9^{cd} ± 5.57	74.6^{b-d} ± 4.67	1.47^{c-e} ± 0.43	0.25^{gh} ± 0.11	6.16^{d-f} ± 1.24	0.34^{h-i} ± 0.11	15.22^{bc} ± 3.78	12.82^{c-g} ± 4.24	0.76^{fg} ± 0.39	4.84^{f-h} ± 1.18
Avena fatua L.subsp. *fatua*	14.6^{c-f} ± 7.17	85.60^{ab} ± 15.80	3.69^{a} ± 3.37	0.62^{bc} ± 0.26	9.07^{a-d} ± 3.71	0.71^{ab} ± 0.26	19.94^{a} ± 6.16	21.60^{a} ± 10.58	12.12^{b} ± 4.10	46.76^{a} ±15.74
Phalaris tuberosa L.	9.90^{ef} ± 5.65	62.10^{d-h} ± 19.30	3.45^{a} ± 2.28	0.49^{c-e} ± 0.08	10.84^{ab} ± 2.29	0.64^{a-d} ± 0.15	18.12^{ab} ± 4.79	11.57^{d-h} ± 4.94	4.48^{de} ± 1.73	3.64^{f-h} ± 1.03
Alopecurus myosuroides Huds.	10.0^{ef} ± 3.82	46.3^{h-j} ± 8.03	1.58^{c-e} ± 0.67	0.67^{ab} ± 0.13	8.10^{b-e} ± 2.31	0.59^{b-e} ± 0.13	13.12^{cd} ± 2.23	6.30^{h} ± 3.11	2.69^{e-g} ± 0.44	6.37^{f-h} ± 1.28
Poa angustifolia L.	13.5^{c-f} ± 6.28	65.05^{d-g} ± 7.96	1.55^{c-e} ± 0.48	0.40^{e-g} ± 0.08	6.20^{d-f} ± 1.16	0.48^{d-h} ± 0.09	9.46^{d-g} ± 1.70	7.72^{f-h} ± 2.88	4.42^{de} ± 1.74	7.46^{-h} ± 2.56
Poa trivialis L.	7.2^{ef} ± 3.07	39.38^{j} ± 4.75	1.37^{c-e} ± 0.25	0.47^{c-e} ± 0.12	4.94^{f} ± 1.52	0.60^{b-e} ± 0.12	8.51^{fg} ± 1.05	7.89^{f-h} ± 0.84	3.20^{d-f} ± 0.79	4.43^{f-h} ± 1.38
Dactylis glomerata L.	33.8^{ab} ± 12.18	69.15^{c-f} ± 3.56	3.00^{ab} ± 0.98	0.45^{d-f} ± 0.06	7.61^{c-f} ± 1.56	0.53^{b-g} ± 0.06	13.05^{c-e} ± 2.89	20.38^{ab} ± 8.88	20.33^{a} ± 4.77	25.99^{c} ± 3.64

** Data with same letter are not significantly different ($p \leq 0.01$) and * ($p \leq 0.05$)

Table - 2: Chemical properties of grass species collected from Ondokuz Mayis University campus Turkey

Plant species	Crude protein (%)	Crude ash (%)	Ca (%)	Mg (%)	K (%)	K/Ca+Mg ratio	P (%)	Ca / P ratio	N / S ratio	Fe (ppm)	Zn (ppm)	Mn (ppm)
Lolium perenne L.	6.90^{i}	8.21^{m}	0.51^{c}	0.12^{bd}	2.66^{c}	4.21^{i}	0.22^{bd}	2.32^{d}	3.25^{h}	233.2^{l}	23.2^{e}	38.9^{m}
Festuca rubra L.	5.45^{n}	9.0^{k}	0.46^{d}	0.08^{eg}	0.77^{m}	1.44^{o}	0.14^{fg}	3.29^{b}	2.64^{j}	539.8^{b}	23.8^{e}	60.4^{j}
Hordeum nodosum L.	9.21^{b}	9.99^{d}	0.09^{k}	0.09^{dg}	1.34^{g}	7.42^{b}	0.24^{ac}	0.38^{l}	2.73^{i}	193.5^{n}	9.9^{m}	38.6^{m}
Hordeum murinum L.	6.11^{k}	7.43^{r}	0.34^{fg}	0.06^{g}	0.99^{k}	2.47^{m}	0.15^{eg}	2.27^{d}	4.08^{d}	484.5^{d}	9.5^{mn}	45.7^{i}
Koeler1a cristata (L.) Pers.	4.37^{r}	13.16^{a}	0.79^{a}	0.13^{bc}	0.89^{l}	0.98^{p}	0.15^{eg}	5.27^{a}	3.33^{g}	769.6^{a}	12.6^{l}	195.3^{b}
Holcus lanatus L.	5.85^{i}	9.47^{g}	0.11^{jk}	0.08^{eg}	1.12^{hj}	6.04^{e}	0.21^{ce}	0.52^{k}	1.22^{p}	138.2^{p}	8.4^{op}	87.7^{f}
Cynosorus cristatus L.	5.35^{o}	9.34^{h}	0.29^{gh}	0.14^{ab}	0.98^{k}	2.28^{n}	0.14^{fg}	2.07^{e}	2.25^{k}	216.7^{m}	30.3^{b}	224.2^{a}
Phleum exaratum Griseb.	5.41^{n}	7.85^{o}	0.15^{jk}	0.12^{bd}	0.81^{m}	3.05^{l}	0.13^{g}	1.15^{h}	2.11^{l}	240.9^{j}	18.7^{h}	124.5^{c}
Lagurus ovatus L.	6.06^{k}	7.66^{p}	0.08^{k}	0.17^{a}	0.76^{m}	3.06^{l}	0.28^{ab}	0.29^{m}	1.83^{n}	110.0^{r}	15.3^{k}	31.5^{n}
Bromus erectus Huds.	8.86^{c}	9.27^{i}	0.12^{jk}	0.11^{be}	1.07^{i}	4.50^{g}	0.24^{ac}	0.50^{k}	4.06^{d}	251.7^{1}	7.8^{p}	64.9^{i}
Bromus tectorum L.	4.58^{p}	7.36^{s}	0.11^{jk}	0.14^{ab}	1.14^{h}	4.48^{gh}	0.17^{dg}	0.65^{j}	1.70^{o}	330.2^{g}	14.8^{k}	76.1^{g}
Bromus squarrosus L.	7.42^{f}	8.49^{l}	0.16^{j}	0.10^{cf}	1.98^{e}	7.56^{a}	0.30^{a}	0.53^{k}	2.16^{l}	337.9^{f}	17.1^{i}	51.7^{k}
Bromus hordeaceus L.	8.53^{d}	9.65^{f}	0.34^{fg}	0.09^{dg}	1.34^{g}	3.16^{k}	0.22^{bd}	1.55^{g}	3.25^{h}	474.8^{e}	16.1^{j}	67.9^{h}
Brachypodium pinnatum L.	7.89^{e}	8.07^{n}	0.25^{h}	0.07^{fg}	1.34^{g}	4.10^{j}	0.25^{ac}	1.00^{h}	3.51^{f}	188.6^{o}	26.7^{d}	33.7^{n}
Avena fatua L.subsp. *fatua*	6.11^{k}	9.39^{h}	0.38^{ef}	0.08^{eg}	2.06^{d}	4.41^{h}	0.25^{ac}	1.52^{g}	3.91^{e}	192.5^{n}	21.4^{f}	65.6^{i}
Phalaris tuberosa L.	7.27^{g}	9.01^{k}	0.56^{b}	0.11^{be}	3.03^{a}	4.55^{g}	0.23^{bd}	2.44^{c}	2.01^{m}	237.1^{k}	26.2^{d}	95.2^{e}
Alopecurus myosuroides Huds.	6.76^{j}	11.14^{b}	0.41^{e}	0.10^{cf}	1.16^{h}	2.26^{n}	0.25^{ac}	1.64^{f}	5.14^{a}	326.4^{h}	29.3^{e}	74.9^{g}
Poa angustifolia L.	5.56^{m}	9.17^{j}	0.15^{j}	0.09^{dg}	1.51^{f}	6.21^{d}	0.14^{fg}	1.07^{h}	1.65^{o}	194.4^{n}	8.9^{no}	43.5^{l}
Poa trivialis L.	7.02^{h}	9.84^{e}	0.09^{k}	0.07^{fg}	0.94^{kl}	5.83^{f}	0.11^{g}	0.82^{i}	4.68^{b}	248.8^{i}	20.1^{g}	53.9^{k}
Dactylis glomerata L.	9.42^{a}	10.99^{c}	0.33^{fg}	0.14^{ab}	2.97^{b}	6.37^{c}	0.20^{cf}	1.65^{f}	4.43^{c}	520.4^{c}	41.5^{a}	100.9^{d}

* Data with same letter are not significantly different ($p \leq 0.01$), P = Phosphorous, S = Sulphur, Ca / P = Calcium / Phosphorus

tuberosa were 22.61 and 19.30 cm respectively), number of tiller (*B. hordaceus* 10.58, *D. glomerata* 12.18, *L. perenne* 10.32), root crown diameter (*A. fatua* subsp. *fatua* 10.58, *D. glomerata* 12.18), dry weight of root (*D. glomerata* 4.77, *A. fatua* subsp. *fatua* 4.10), dry forage weight (*A. fatua* subsp. *fatua*, *B. tectorum*, *D. glomerata, L. ovatus* and *L. perenne* 15.74, 9.68, 3.64, 3.64 and 2.43, respectively) showed that high variation exists among plants belonging to the same species (Table 1). Even though some part of the variation was caused by environmental conditions, these species may be important genetic sources for breeding studies regarding soil and water preservation and forage production (Ozgen *et al*., 1995; Sanderson *et al*., 2007).

Chemical properties: Chemical properties of the native grass species in the experiment area are presented in Table 2. There are highly significant differences among the grass species in terms of all chemical properties.

Crude protein (CP) contents of the species ranged from 4.37 (*K. cristata)* to 9.42% in *Dactylis glomerata*. Crude protein contents of 8 species were over 7% which is at critic level (Espinoza *et al*., 1991); the value of one species was close to 7%, and for the values was below 7% (Table 2). Crude protein contents in these grass species growing under natural conditions without any agricultural management were slightly below the expected value. Plant age and environmental conditions may affect the nutritive value of grasses (El Shatnawi *et al*., 2004). Thus, Tuna *et al.* (2004) reported that the protein contents of some grasses were between 3.85-7.80%.

El Shatnawi and Al-Qurran (2003) also reported that protein content of *Hordeum murinum* decreased to 2.9% at maturity stage.

Crude ash ratios including total minerals of the plant tissues ranged from 7.36 (*Bromus tectorum*) to 13.16% in *K. cristata*. Fe, Ca and Mn contents of *K. cristata*, having the highest crude ash ratio, were higher comparing the other species (Table 2). Crude ash ratios (13.16%) of the species were higher than the data reported by Tuna *et al.* (2004) (4.17-7.44%).

Ca contents of grass species were found out between 0.79 in *K. cristata* and 0.08% in *L. ovatus*. Ca contents in forages are recommended at least 3.1 g kg^{-1} for beef cattle (NRC, 1996) and 0.3% for ruminants (Tajeda *et al*., 1985). Ca contents of 9 grass species were below the recommended values (Table 2). Low Ca content of species might be explained in two ways: these grass species may genetically have low Ca content (Kidambi *et al*., 1989; Rayburn, 1997), or these native grass species might grow in Ca-poor soils.

Mg contents of grass species were between 0.06% in *Hordeum murinum* and 0.17 % in *L. ovatus* (Table 2). Mg contents of all species were below the recommended value suggested by Tajeda *et al*. (1985), whereas Mg contents of 9 grass species were lower than the value recommended by the NRC (1985). This situation may be due to low Mg contents of the soil. Acar *et al*. (2001) reported that Mg contents of some grass species grown in the same soils were also lower than recommended values.

K contents were between 3.03% in *P. tuberosa* and 0.76% in *L. ovatus*. K contents of all grass species samples were over the value (6.5 g kg^{-1}) recommended by NRC (1985) for cattle. K contents of all species were also higher than 0.8% recommended by Tajeda *et al*. (1985) except for *L. ovatus* and *F. rubra* (Table 2). The fact that grass species have generally high K content (Minson, 1990) and high available K contents of soils might have caused high K contents of grass species. But it should also be considered that high K content may cause Mg deficiency (Laredo *et al*., 1986).

K/ Ca+Mg ratios of grass species changed between 7.56 in *B. squarrosus* and 0.98 in *K. cristata*. It is recommended that K/ Ca+Mg ratio of forages should be below 2.20 (Mayland and Grunes, 1979; Kidambi *et al*., 1989). K/ Ca+Mg ratios of all species except *F. rubra* L. and *K. cristata* (L.) Pers. were over 2.20 (Table 2). The K/ Ca+Mg ratios over 2.20 may cause grass tetany, especially in cool seasons (Kemp and t'Hart, 1957; Mayland and Grunes, 1974). Higher K contents and lower Ca and Mg contents of examined grass species samples increased the K/ Ca+Mg ratios over 2.20 (Table 2).

Phosphorus contents of the grass species were between 0.11% (*Poa trivialis*) and 0.30% (*Bromus squarrosus*) (Table 2). It is reported that forages for cattle should contain P between 0.17 and 0.39% (NRC, 1996) and forages for sheep should have P between 0.16-0.38% (NRC, 1985). P contents of the 7 grass species studied in this study were insufficient for cattle and sheep, rest of them were between the recommended limits (Table 2).

Calcium / phosphorus ratios of grass species were between 0.29 (*Lagurus ovatus*) and 5.27 (*Koelearia cristata* Pers. (Table 2). When Ca / P ratio is over 2.00, milk fever may be observed in animals and effectiveness of forage-animal product transformation may decrease (Jacobson *et al*., 1972; Reid and Jung, 1974). It was determined that Calcium / phosphorus ratios of 6 grass species were higher than 2.00, one was close to 2.00 and rest (14) of the other species' ratios were less than 2.00 (Table 2).

Nitrogen / sulphur ratios of the samples were between 1.22 (*Holcus lanatus*.) and 5.14 (*Alopecurus myosuroides* subsp. *myosuroides*) (Table 2). It was revealed that the most suitable N / S ratios of livestock forages were 11/1 for sheep and 15/1 for cattle (Kincaid, 1988). N/S ratios of all grass species were higher than recommended value (Table 2). Plants might not have taken sufficient nitrogen as they were collected from the unfertilized natural areas. High S content might affect the Cu, Zn and Se availability for sheep (Suttle, 1974).

Fe contents of grass samples were between 110.0 ppm in *L. ovatus* and 769.6 ppm in *K. cristata* (Table 2). Fe contents of all grass species were higher than the recommended value (50 ppm) for forages. Fe contents of the soils in the study were high. It was also determined previously that all legume species had high Fe contents in a research which was conducted with legumes collected from the same area (Acar *et al*., 2001). The results of the present study were in consistence with the results of Loue (1986) and Boila *et al*. (1985), who reported that Fe contents of native plants were higher than Fe contents of the plants which were grown in the cultivated areas. It was also reported that Fe deficiency had not been observed in grazing ruminants consumed forages in adequate amounts (McDowell *et al*., 1984). But, Becker *et al*. (1965) reported that Fe deficiency had been observed in the ruminants grazing on sandy soils.

Zn contents of collected samples were between 7.8 ppm in *B. erectus* and 41.5 ppm in *D. glomerata* (Table 2). Recommended values of forages are between 10 ppm (Danbara *et al*., 1985) and 50 ppm (Periguad, 1970; Lamand, 1975) for ruminants; 30 ppm (NRC, 1996) for cattle. Zn contents of the grass species were over the value recommended by Danbara *et al*. (1985), while they were lower than the values recommended by Periguad (1970), Lamand (1975). Zn contents were similar to the findings of Kidambi *et al*. (1989), Khan *et al*. (2004).

Mn contents of grass samples ranged between 31.5 ppm in *L. ovatus* and 224.2 ppm in *C. cristatus* (Table 2). While Mn contents of most of the samples were over or close to the critic value (40 mg kg^{-1}) recommended by McDowell *et al*. (1984), the values of a few samples were lower than the critic value (50 ppm) recommended by Periguad (1970), Lamand (1975). Excessive Mn contents might cause appetite decreases in animals (Danbara *et al*., 1985).

It was concluded from the present study that diversity between and within species were quite high. These plants may be important genetic resources for improved varieties.

Most of the grass species were superior in terms of their morphological characters. Such as number of tiller, main stem length, leaf sizes, dry root and forage weight. They can be useful for breeding studies which could be used for pasture - forage plant, and the purpose of soil and water preservation. Furthermore, while P contents of the examined grass species were high, crude protein, Ca and Mg contents of the grass species were insufficient and there were important instabilities in K/Ca+Mg and Ca/P ratios. Thus, the data on morphological characters and mineral matter contents of plants growing in these areas give background information on the effects of these plants on the livestock which may be highly useful for further research work in the area.

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