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SOME AGRICULTURAL AND QUALITY PROPERTIES OF ULUBAG ECOTYPE LINES OF WILD ORCHARDGRASS (*Dactylis glomerata* L.)

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ABSTRACT

Research was conducted in Erzurum ecologic conditions. Eight lines of Ulubag ecotype that were selected in the previous selection process and 1 control cultivar were used in this research. Lines used in the research were compared to each other and the control variety. Fresh hay yield, dried hay yield, crude protein content and yield, plant nutritional elements, ADF and NDF rates, and seed yield traits were investigated in this research. In Ulubag ecotypes, 6 lines in fresh hay yield and dried hay yield, 1 line in crude protein content, 4 lines in crude protein yield, 1 line in P content, 1 line in Mg content, 7 lines in K content, 1 line in Ca content and 4 lines in seed yield gave better result than control. On the other hand, ADF rates in 4 lines were lower than control variety. However, NDF rates in all lines were better than the control variety. It is concluded that lines 3, 9, 14, and 18 in Ulubag ecotype can be used for new variety development, in terms of hay yield and quality.

Key words: Agronomy, crude protein, selection.

INTRODUCTION

Orchardgrass (*Dactylis glomerata* L.) is a bunch-type, tall-growing, cool-season perennial grass. It is one of the most productive cool-season grasses, tolerant to shade, fairly drought resistant with moderate winter hardiness (Serin and Tan, 1998). It is a very important species in pasture lands in the regions where temperate and humid climatic characteristics are prevalent. This species does not form a dense pasture structure and develops in the form of a bunch; therefore, it has a branching, deeper root formation system. This species can compete with weeds and other grassy species in the regions it is adapted to. Since it is an early rising species in the spring, it is suitable to be used as early spring meadow pasture (Serin and Tan, 1998).

It was reported in the study carried out by Tosun et al., (1996) with the aim of determining some chemical features of plant materials, crop and seed yield of wild orchard grass under irrigated conditions of Erzurum between 1992 and 1995 that meant fresh hay yield was 413.85g per, hay yield was 120.78g per plant, crude protein rate was 13.38%, crude protein yield was 16.35g plant and seed yield was 24.45g plant.

ADF (Acid Detergent Fibre) is composed of cell membranes including the component of alkali soluble lignin, alkali insoluble lignin, fibre bounded nitrogen, minerals insoluble in cellulose and solvents. ADF is the best way of measuring fibre in plant material (Van Soest et al., 1991). NDF (Neutral Detergent Fibre) is composed of cell membrane elements including hemicelluloses, alkali soluble lignin, alkali insoluble lignin, fibre bound nitrogen and minerals insoluble in cellulose and solvents (Van Soest et al., 1991). Both ADF and NDF are the characteristics used for determination of quality in forages. It was stated in a study aimed to determine the quality and mineral content of forages growing in the Mediterranean region that average rates of crude protein, NDF, nitrogen, potassium, magnesium, sodium, calcium and phosphorus were 13.60%, 48.63%, 2.18%, 3.51%, 0.41%, 1.89%, 0.42% and 0.31% in orchardgrass (Convertini et al., 1999).

MATERIALS AND METHODS

This study was carried out under the ecological conditions of Erzurum. Lines of Ulubag populations determined to be promising and one variety (USA breed as standard) were used to make comparisons in previous studies carried out over the plant materials of orchardgrass taken from eight different locations in Erzurum (Tosun and Sagsoz 1994; Sagsoz et al. 1996; Tosun et al. 1996; Tosun et al., 1997).

The amounts of annual rainfall were close to each other in 2005 (414.1mm) and 2006 (410.4mm) while in 2007 it was higher (433.7mm) than previous two years. Average annual temperature in 2005, 2006 and 2007 was 5.1, 6.4 and 5.5^{o}C, respectively while long term average temperature was 5.7^{o}C. Soil pH in experimental area is 7.45 and reflects light alkali reaction. Structure of soil is sandy, clayish and loamy and poor in organic material (1.37%) (Sagsoz et al., 1996).

Experiment was designed in the complete randomized block design with three replications. Plots were arranged in the length of 6 m and 6 plant lines (with the interval distance of 50 cm). Spring fertilisation was 15kg N da^{-1} and autumn fertilisation was 10kg P_2O_5 da^{-1}. Plots were irrigated and weeds were controlled when needed. Crops from 50 cm inside the upper and lower side of the plot and in one line along the longer plot side were removed from the area as side effect while harvesting the plot. Half of the plot was harvested for hay yield and the other half for seed yield.

Parameters studied in the experiment

Fresh hay yield and hay yield

Green plant material cut from the area in the plot at the beginning of flowering period after removing side effect was weighed without allowing for water loss. Data was converted into kg da^{-1}. 500g samples were taken from the harvested plants in order to estimate the hay yield, and then dried in an oven at 78°C for 24 hours and weighed using a sensitive scale. Dry matter yield was estimated using data obtained by considering green plant matter yield in kg/da.

Crude protein rate and yield

Samples used for the determination of hay yield were weighed by dividing 0.5g parts after grinding and the nitrogen total was estimated according to Kjeldahl method. Crude protein rates of plant material were estimated by multiplying nitrogen rates calculated with coefficient 6.25 (Yeldan, 1984). Crude protein yield was calculated in kg/da by multiplying the hay yield with crude protein rate.

Mineral content analysis of plant samples

Dried plant samples were subjected to fresh decomposition by treating 0.5g of material with nitric perchloride acid. Ratios of Na, K, P, Ca and Mg were determined in the solutions (Kacar, 1972).

Determination of ADF (acid detergent fibre) and NDF (neutral detergent fibre) rates

An analysis method was applied to the 0.8g and 0.9g of grinded plant samples in ANKOM fibre analysing device. Samples were washed off in acetone; stored and dried at 105°C overnight; cooled in desiccators; weighed and ADF and NDF rates were determined (Anonymous, 1995).

Seed yield

Seeds of plants in the other half of the plot area remaining after the harvesting for the determination of plant material were obtained by cutting plants after taking out the side effects. Seeds were weighed and seed yield was estimated in kg da^{-1}.

Statistical analysis of data

Data was analysed using the GLM procedure in the SAS (SAS 1999) program.

RESULTS AND DISCUSSION

Fresh hay yield and hay yield

Differences in genotypes were statistically insignificant for fresh plant hay yield between the first (2006) and second (2007) experimental years and an average was taken. Average fresh hay yield of genotypes was 1094.04 kg da^{-1} and the highest yield in the first year (1260.53 kg da^{-1}) was obtained from line 3. Yield of fresh hay in the second year was higher than the first year in all genotypes and difference between the two years was statistically significant *($P<0.01$)*.

Second year average fresh hay yield was determined to be 2062.68 kg da^{-1}. Line 9 was the highest in two – year average values with 1800.87 kg da^{-1} while the lowest yield was obtained from line 1 with 1301.07 kg da^{-1}. Two – year average yield was 1578.36 kg da^{-1} (Table 1).

Table 1. Fresh and hay yields of orchardgrass genotypes

Genotype	Fresh hay yield (kg da^{-1})			Hay yield (kg da^{-1})		
	2006 year	2007 year	Average	2006 year	2007 year	Average
1	1146.67	1455.47	1301.07	467.73	385.17	426.45
3	1260.53	2176.80	1718.67	515.77	541.80	528.78
6	1100.00	1847.20	1473.60	417.40	498.60	458.00
9	1138.13	2463.60	1800.87	431.10	575.03	503.07
11	1116.80	1924.53	1520.67	416.03	521.03	468.53
14	1077.07	2148.27	1612.67	444.07	571.40	507.73
18	978.13	2505.07	1741.60	350.67	599.10	474.88
19	1064.00	2043.73	1553.87	421.87	524.67	473.27
Control	965.07	1999.47	1482.27	428.57	498.23	463.40
Average	1094.04	2062.68	1578.36	432.58	523.89	478.24

As in fresh hay yield, differences between hay yield in the first and second years and two – year average of genotypes were statistically insignificant while those between the years were very significant *($P<0.01$)*. In the first year, average hay yield of genotypes was 432.58 kg da^{-1} and the highest hay yield was obtained from line 3 (515.77 kg da^{-1}). In the second year, average hay yield was 523.89 kg da^{-1} and line 18 was in the first row (599.10 kg da^{-1}). The two year average hay yield was 478.24 kg da^{-1}. Dry plant material yield of control was below the average with 498.23 kg da^{-1} being in the 8th row (Table 1).

No recorded differences between the ecotypes used in the experiment for plant material yield may indicate that selection studies carried out in future years will be successful. The final (third) stage of selection started previously was evaluated in the scope of the present experimental study. Until the final stage of mentioned selection study, better lines were determined after each selection cycle and pollination was performed among them. Variability existing between the lines was narrowed. The highest two – year average hay yield was determined to be 622.5 kg da^{-1} in a study (Serin, 1991) using orchardgrass as control (USA Breed) under ecological conditions of Erzurum. Results of the present study were slightly lower than the results of the outlined study, which might have resulted from the different years and locations of the studies. As already known, yield is a quantitative character affected largely by environment. Therefore, different amount of rainfall might have affected this parameter.

Crude protein rate and yield

Differences between genotypes for crude protein rate in the first and second years and two – year average were statistically insignificant. However, differences between the years were very significant and *(P<0.01)* and interaction between year x genotype was significant (*P<0.05*). In the first year of study, average crude protein rate of genotypes was 10.58%, line 9 was in the first row with 11.92%. In the second year, average crude protein rate was 13.37% and higher than the first year. Line 3 exhibited the highest rate (15.03%) (Table 2). When considered two year average values, average crude protein rate was 11.98%.

Table 2. Crude protein content and crude protein yield of orchardgrass genotypes.

Genotype	Crude protein content (%)			Crude protein yield (kg da^{-1})		
	2006 year	**2007 year**	**Average**	**2006 year**	**2007 year**	**Average**
1	9.70	14.28	11.99	45.21 **a-c***	54.22	49.72
3	9.87	15.03	12.45	50.81 **a**	81.46	66.14
6	10.39	11.60	10.99	43.07 **a-c**	57.53	50.30
9	11.92	12.89	12.41	51.15 **a**	73.88	62.52
11	10.08	12.39	11.23	41.23 **bc**	63.07	52.15
14	10.76	13.56	12.16	47.55 **ab**	77.98	62.77
18	10.57	14.69	12.63	36.44 **c**	87.16	61.80
19	10.22	12.66	11.44	42.58 **a-c**	65.89	54.23
K	11.72	13.26	12.49	49.33 **ab**	66.44	57.88
Average	10.58	13.37	11.98	45.26	69.74	57.50
LSD				**9.08**		

*Differences were significant in the same column with a different letter (p<0.05).

Even though the differences between genotypes for crude protein yield were significant in the first year *(P<0.05)*, they were insignificant in the second year and the two year average. Average crude protein yield in the first year was 45.26 kg da^{-1} and the highest value was 51.15 kg da^{-1} in line 9. Crude protein yield in the second year was higher than the first year and differences between the years were significant *(P<0.01).* In the second year, the average crude protein yield was 69.74 kg da^{-1}. Line 18 exhibited the highest yield with 87.16 kg da^{-1}. When considered the two year average crude protein yield average of all genotypes was calculated to be 57.50 kg da^{-1}, line 3 exhibited the highest crude protein yield (66.14 kg da^{-1}) and control was in the fifth row with 57.88 kg da^{-1} (Table 2).

The crude protein rate was 13.38% in a study by Tosun et al. (1996) on orchard grass under irrigated conditions of Erzurum while ranging from 10.10 to 13.60% in other studies (Gordon et al., 1962; Reid et al., 1967; Aydin, 1994; Schoner and Pfeffer, 1996).

Mineral content of plant samples

The difference between genotypes for P (phosphorous) content in the first year was significant *(P<0.05)* and average P content was 0.229%. The highest P rate was in line 19 (0.263%). The rate of P in the second year (0.327%) was higher than the first year and the annual difference was significant *(P<0.01).* The difference between genotypes in the second year was insignificant and the highest P rate was in line 19 with 0.367%. The second year average P rate was 0.327%.

When considering, the two year average, differences between genotypes for P rate were significant *(P<0.05).* Average P rate was 0.278% and line 19 was in the first row (0.315%) (Table 3).

Table 3. Phosphor and magnesium percentages of orchardgrass genotypes.

Genotype	P (%)			Mg (%)		
	2006 year	**2007 year**	**Average**	**2006 year**	**2007 year**	**Average**
1	0.260 **ab***	0.323	0.292 **ab***	0.117	0.107	0.112
3	0.193 **bc**	0.353	0.273 **ab**	0.133	0.110	0.122
6	0.133 **c**	0.310	0.222 **c**	0.127	0.113	0.120
9	0.233 **ab**	0.310	0.272 **ab**	0.143	0.110	0.127
11	0.250 **ab**	0.273	0.262 **bc**	0.123	0.110	0.117
14	0.220 **ab**	0.347	0.283 **ab**	0.127	0.103	0.115
18	0.243 **ab**	0.337	0.290 **ab**	0.120	0.107	0.113
19	0.263 **a**	0.367	0.315 **a**	0.120	0.107	0.113
Control	0.260 **ab**	0.323	0.292 **ab**	0.143	0.107	0.125
Average	0.229	0.327	0.278	0.128	0.108	0.118
LSD	**0.067**		**0.048**			

*Differences were significant in the same column with a different letter (p<0.05).

Differences between genotypes for Mg (magnesium) rate in the first and second years and the two years average was statistically insignificant, however; those between the years are significant *(P<0.01)*. Average Mg rate was 0.108% in the second year. From the two year average, the average Mg rate of genotypes in the study was determined to be 0.118%, Line 9 exhibited the highest rate (0.127%) (Table 3).

The difference between K (potassium) rates of genotypes in the first year were significant *(P<0.05)*. Average potassium rates in the first year were 2.109%. The second year average K rate (0.337%) was lower than the first year and the difference between the years was significant *(P<0.01)*. When considering the average values, the difference between the K rates of genotypes was significant *(P<0.05)*. In addition, interaction between year x genotype was also significant *(P<0.05)*. Significant differences between genotypes and extremely significant differences the between years caused the interaction between the years x genotypes to be significant (Table 4).

Table 4. Potassium and calcium percentages of orchardgrass genotypes.

Genotype	K (%)			Ca (%)		
	2006 year	**2007 year**	**Average**	**2006 year**	**2007 year**	**Average**
1	2.217 **b***	0.327	1.272 **b***	0.193	0.107 **c****	0.150
3	2.043 **b**	0.357	1.200 **b**	0.137	0.107 **c**	0.122
6	2.027 **b**	0.350	1.188 **b**	0.213	0.217 **ab**	0.215
9	2.177 **b**	0.333	1.255 **b**	0.317	0.077 **c**	0.197
11	1.820 **b**	0.340	1.080 **b**	0.093	0.173 **b**	0.133
14	2.650 **a**	0.313	1.482 **a**	0.143	0.097 **c**	0.120
18	2.050 **b**	0.350	1.200 **b**	0.097	0.097 **c**	0.097
19	2.073 **b**	0.343	1.208 **b**	0.123	0.183 **ab**	0.153
K	1.920 **b**	0.323	1.122 **b**	0.160	0.240 **a**	0.200
Average	2.109	0.337	1.223	0.164	0.144	0.154
LSD	**0.412**		**0.209**		**0.060**	

*Differences were significant in the same column with a different letter (p<0.05).
**Differences were very significant in the same column with a different letter (p<0.01).

Differences between the genotypes for Ca (calcium) rates were insignificant in the first year and the two year average, but highly significant in the second year *(P<0.01)*. The average Ca rate in the first year was 0.164% and line 9 exhibited the highest rate 0.317%. The second year average Ca rate was 0.144%. Control was in the first row for Ca rate (0.240%) while for the two year average line 6 was in the first row (0.215%) (Table 4).

The rates of K, Ca and Mg were found as 2.59 to 2.84%, 0.36 to 0.64% and 0.17 to 0.26% in some studies on orchardgrass (Copponet, 1964; Whitehead, 1966). In another study, Convertini et al., (1999) reported that orchardgrass had the contents of K, Mg, Ca and P in the rates of 3.51%, 0.41%, 0.42% and 0.31% respectively. Results in the present study were slightly lower than the values mentioned above. This situation is believed to be caused by both genotypes and different environmental conditions of the plants. In this respect, Cherney and Cherney (2005) reported that K fertilisation increases K rate in forage plants while reducing the content of P, Ca, Mg and Na.

ADF and NDF rates of plant samples

The first year average of ADF was 36.02% and the control had the highest rate with 37.11% while line 9 showed the lowest rate (34.68%). In the second year, the average ADF rate was 35.53% and lower than the first year, but their difference was not significant. In the second year, line 14 had the highest ADF rate (37.75%). The two year average ADF rate was 35.78% and the control was in the fifth row for the average ADF (35.76%) (Table 5).

Table 5. ADF and NDF percentages of orchardgrass genotypes.

Genotype	ADF (%)			NDF (%)		
	2006 year	2007 year	Average	2006 year	2007 year	Average
1	36.96	35.22	36.09	63.96	58.74	61.35
3	35.89	35.50	35.70	62.32	57.25	59.79
6	36.04	36.08	36.06	63.20	60.72	61.96
9	34.68	35.75	35.22	61.80	60.95	61.38
11	34.90	34.53	34.72	62.91	59.34	61.12
14	36.15	37.75	36.95	62.42	61.28	61.85
18	35.90	33.76	34.83	61.89	58.59	60.24
19	36.59	36.78	36.69	61.64	60.53	61.08
K	37.11	34.42	35.76	62.58	56.55	59.56
Average	36.02	35.53	35.78	62.53	59.33	60.93

The differences between the first and second years and the average NDF rates of genotypes were statistically insignificant, while those between years were extremely significant *($P<0.01$)*. Average NDF rate of genotypes in the first year was 62.53% and the highest NDF rate were obtained from line 1 (63.96%). Line 14 were in the first row (61.28%), in the second year for NDF, while the second year's average NDF was 59.33%. When considering the two year average data, line 6 exhibited the highest NDF rate (61.96%) and the lowest rate was obtained from the control (59.56%). Average NDF of the two years was 60.93 % (Table 5).

In the study of Holden et al. (2000) on orchardgrass, ADF and NDF rates were 28.3 and 48.3% respectively in the first year while in the second year they were 30.2% and 52.8%. Cherney and Cherney (2005) reported that NDF rates were between 61.0 and 65.0% in orchardgrass. Results of previous studies are parallel with those found in the present study. It is desirable for forage crops to have low ADF and NDF rates since these substances cause digestion difficulties and thus lowering food quality. From this point of view, it is an expected and desired situation in the present study that ADF and NDF rates of genotypes used are not different significantly from control, and content of ADF in some genotypes is lower than control.

Seed yield

Seed yield differences between genotypes were significant in the first year *($P<0.05$)* while insignificant in the second year and for the averages. However, differences between the years were significant *($P<0.01$)* and interaction between year and genotype were also significant *($P<0.05$)*. The average seed yield in the first year was 43.19 kg da^{-1} and the highest yield was obtained from line 14 with 55.40 kg da^{-1}. The average seed yield in the second year was lower than the first year (30.71 kg da^{-1}). For the average seed yield, line 18 was in the first row (39.14 kg da^{-1}). When considering the two year average seed yield, it was seen that the average of all genotypes was 36.95 kg da-1 and line 14 revealed the highest yield with 41.37 kg da-1 (Table 6).

Table 6. Seed yield of orchardgrass genotypes.

Genotype		Seed yield (kg da^{-1})		
		2006 year	2007 year	Average
1		47.37 **a-c***	23.03	35.20
3		33.30 **d**	32.47	32.88
6		37.57 **cd**	30.64	34.10
9		37.57 **cd**	38.30	37.93
11		40.53 **b-d**	29.63	35.08
14		55.40 **a**	27.34	41.37
18		41.13 **b-d**	39.14	40.14
19		50.37 **ab**	25.73	38.05
K		45.43 **a-c**	30.10	37.77
Average		43.19	30.71	36.95
LSD	**11.1**			

*Differences were significant in the same column with a different letter (p<0.05).

Four of the genotypes were superior to control variety for seed yield. Seed yield of year was considerably lower than the first second year. The average monthly temperature of March (9.1°C) was higher in 2007 (second year), than 2006 (1.2°C) and long term (-2.8°C). Metabolic activity in plants may start depending on this situation. The sudden decrease in average temperature in April to 1.4 °C (which was 7.2°C in 2006 and 5.3°C long term average) might have caused damage at the points where metabolic activity started. Therefore, it is thought that the number of plant stems decreased. It was observed that the number of bunched stems decreased. This situation may be the reason for the decrease in seed yield in the second year.

The highest seed yield was obtained to be 24.6 kg da^{-1} in the study of Serin et al. (1994) conducted under the ecological conditions of Erzurum. It was stated in another study by Gokkus et al. (1994) that average seed yield was 27.0 kg da^{-1}. Seed yield obtained in the present study is higher than that found in other studies under the ecological conditions of Erzurum. It is a desired situation in plant production to have high seed yields as well as high hay yields. From this point of view, it can be said that lines taken in selection experiment are promising.

In conclusion lines obtained from the last stage of selection program were evaluated in the present study that was aimed to develop a new cultivar using selection in Ulubag ecotype of orchardgrass native in Erzurum province. The main aim of the selection programme is to develop variety from the lines with higher quality plant material and yield (compared to control variety). It was determined that lines 3, 9, 14 and 18 belonging to Ulubag ecotype and used in experiment can be used to develop new varieties.

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