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COLLECTION, CONSERVATION AND EVALUATION FOR FORAGE YIELD OF ALFALFA LANDRACES GROWN IN EAST ANATOLIA

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ABSTRACT

This study was conducted to collect, evaluate and conserve alfalfa landraces grown in Van province, East Anatolia in 2009-2011. Ten counties were visited and 66 alfalfa landraces were collected. The seed samples were sent to Aegean Agricultural Research Institute for long term conservation. With other 4 populations collected from university campus, a total of 70 alfalfa accessions with seven standards (controls) were grown in an augmented trial design with 5 replicates. Cultivar Elci had the highest green and dry matter yields. There was a great variability between landraces in terms of the characters recorded. Green, dry matter and crude protein yields of landraces were in the range of 24.67-103.21 t ha^{-1}, 6.04-24.26 t ha^{-1}, and 1.07-4.96 t ha^{-1}, respectively. Landraces collected from Ercis and Gevas appeared to have high green and dry matter yields.

Keywords: Conservation, collection, evaluation, landraces, *Medicago sativa*, yield

INTRODUCTION

Biodiversity and plant genetic resources have been a popular worldwide issue for a long time. Turkey is located in an area which is included within the two gene centers by Vavilov (Harris, 1990). The country has different ecological conditions and there are diversity of plant species in the natural flora. It is also a part of one of the oldest domestication centers Near East, having some micro gene centers for some forage plants such as alfalfa, sainfoin, clovers and vetches. It was also reported that the Near East is an important center of origin for some productive and persistent forage species evolved under more intensive grazing pressure than species in other areas (Harlan, 1951 and 1983).

The main cultivated forage species in Turkey are alfalfa, sainfoin and common vetch. As Qualset et al. (1987) defined, landraces are the most variable populations of cultivated plants and heterogeneous mixture of genotypes. The landraces are being still cultivated in some regions, especially in East Anatolia. They have been grown for a very long time, and after being naturally or consciously selected in their habitats for many years for desirable characteristics, they are now useful genetic resources. The landraces must be collected and conserved for the present day scientists or the future.

Alfalfa (*Medicago sativa* L.) has greater forage quality than nearly all other forage crops. It has got high green and dry matter yield with considerably high protein and vitamin content (Açıkgoz, 1991; Barnes et al., 1995; Sabancı, 2009). It is widely grown in Turkey as in most part of the world. The main agricultural activity in East Anatolia is animal husbandry. The area of forage crops covers 36 % of total agricultural area (Sabancı et al., 2010). This ratio is more than 50 % in Van and Hakkari provinces. Alfalfa hay production is about 2.2 million tonnes in the region that is more than half of the total production in Turkey.

Lots of researches were conducted for forage crops in East Anatolia and in the other parts of the country, but those studies generally ignored the conservation of forage genetic resources. The objectives of this project were to collect alfalfa landraces grown in Van province, to assess their agricultural potentials, and to conserve them in a gene bank.

MATERIAL AND METHOD

Fourty five villages of ten counties were visited in Van province in 2007 and 2008, and seeds of sixty-six alfalfa landraces were collected. After trashing and cleaning, half of the seed of each sample was sent to the Aegean Agricultural Research Institute for long term conservation.

Seven standard varieties were used namely Elci, Bilensoy, Alsancak, Kalender, Planet, MA 324 and Kayseri. The standards and landraces were sown in an augmented design on 3rd of April 2009. Four populations collected from university campus were included to fix the number of accessions necessary for the experimental design. The standards were planted in each of five

replicates. Fourteen local varieties were placed separately in each replicate, with the plots comprised of 4 rows, 3 m length and 30 cm row spacing. Fertilizers were applied by calculating 4 kg da^{-1} nitrogen (N) and 8 kg da^{-1} phosphorus (P_2O_5) in the first year, and 8 kg da^{-1} phosphorus in the second and third years. Cutting was performed without recording in the first year, and alfalfa landraces were cut three times in consecutive two years. Irrigation was applied when necessary before cuttings and once after each cut. The dates of cutting at 10 % flowering stage were 18th June, 22nd July and 25th August in 2010; 5th June, 10th July and 15th August in 2011. Total yield of three cuts were used in evaluation.

The characters recorded were green, dry matter and protein yields. Statistical analysis was carried out by using TARIST program. Analysis of variance was performed over standard varieties and replicates to find out the experimental error. The varieties grown in any replicate once were compared by using this error. Means of landraces were fixed in consideration with the deviation of the replicates in which they were placed from overall mean (Federer and Raghavarao, 1975: Açıkgoz et al., 2004).

The climate of the region located in the east of Anatolia has semiarid conditions with the average long term precipitation of 382.3 mm, the annual mean temperature was 9.32 ^{0}C and relative humidity was and 57.7 %. For two consecutive years of experiment, 2010 and 2011; annual rainfalls were 377.4 and 516.9 mm, mean temperatures were 10.37 and 9.45 ^{0}C and relative humidity were 53.5 and 56.6%, respectively.

Soil characteristics of the experimental area were sandy silt, slightly alkaline (pH=8.45), calcareous (13.2-17.9 %), low organic matter (1.81 %), suitable salt content (0.021 %), adequate potassium and low phosphorus content.

RESULTS AND DISCUSSION

Green yield

The green yields of standard varieties and landraces over years are listed in Table 1. Tables are fixed in a compacted form excluding the resembling ones. Green yield was higher in the second year (53.56 t ha^{-1}) than the first (46.27 t ha^{-1}) but the difference was not statistically significant. Because alfalfa is a perennial crop, it is possible to have more yields in consecutive years than previous ones in the first 2-3 years. Keskin et al. (2009) presented a similar result that alfalfa varieties had high yields in the second year. As Kır and Soya (2008) mentioned, alfalfa yield is low in the establishment year and it increases in the following year and reaches the maximum yield in the third year. They obtained high green yields in the third year of their experiment consisting of five different cultivars. Radovic et al. (2009) expressed similar results, in their experiment with seventeen alfalfa varieties, average of green yield (82.52 t ha^{-1}) in the third year was higher than in the second year (75.17 t ha^{-1}).

Table 1. Green yields of alfalfa standards and landraces (t ha^{-1})

No/Site	2010	2011	Mean	No/Site	2010	2011	Mean
1/Elçi‡	53.25	63.20	58.23	35/Erciş	73.12	86.24*	79.68*
2/Kalender	47.42	57.30	52.36	36/Çatak	63.85	75.10	69.48
3/Alsancak	43.82	52.54	48.18	38/Çatak	55.50	65.50	60.50
4/Planet	39.21	44.64	41.93	40/Çatak	63.24	77.61	70.43
5/Bilensoy	49.43	54.97	52.20	41/Çatak	64.38	74.38	69.38
6/Kayseri	48.20	52.42	50.31	42/Çatak	60.37	72.87	66.62
7/MA 324	42.53	49.86	46.19	45/Gevaş	56.07	65.82	60.95
Mean	46.27	53.56	49.92	46/Gevaş	79.25*	94.25*	86.75*
16/Başkale	54.75	66.00	60.38	47/Gevaş	63.25	78.25	70.75*
18/Başkale	53.13	66.26	59.70	48/Gevaş	56.07	66.44	61.26
24/Erciş	88.83*	103.21*	96.02*	49/Gevaş	55.37	63.49	59.43
25/Erciş	55.00	95.00*	75.00*	51/Saray	53.75	71.25	62.50
26/Erciş	54.15	63.78	58.97	52/Saray	62.60	81.35*	71.98*
32/Erciş	64.24	79.86	72.05	53/Saray	53.60	74.20	63.90
33/Erciş	73.87	87.62*	80.75*	69/Pop. 3	25.98	27.23	26.61
34/Erciş	76.37*	93.24*	84.81*	70/Pop. 4	24.67	27.79	26.23
Mean	46.37	55.98	51.17	LSD	12.44	12.98	6.19

‡: Standards significantly different at p<0,05

*: Significantly different from standards at p<0,05

Year x standard interaction effect was not significant, but there were significant differences between the standard varieties. Average green yield over standards and years was 49.92 t ha^{-1}. The highest yielding variety was cultivar Elci in the first year with 53.25 t ha^{-1}, and in the second with 63.20 t ha^{-1}. Cultivar Planet had the lowest yields in both years. The average yields over years were 58.23, 52.36 and 52.20 t ha^{-1} for cultivars Elci, Kalender and Bilensoy, respectively. The highest yielding cultivar Elci improved for mainly south eastern of Turkey was also

found highly productive in different ecological conditions (Eğinlioğlu et al., 1996; Altınok and Karakaya, 2002). Cultivar Kayseri also had green yield more than 50 tons per hectare. Cultivars Kayseri and Bilensoy have high performances under Central and East Anatolian conditions. Elci and Bilensoy had high average green yields in Van conditions (Keskin et al., 2009).

Green yields were higher than the results of Yılmaz et al. (1996) who recorded a mean yield of 36.58 t ha^{-1} for the same location. This yield is relatively low because the experiment was conducted without irrigation with two cuts each in the second and third years. Alfalfa yield is very high under suitable conditions. It is expressed that green yield could be more than 100 tones per hectare with seven cuts in coastal area (Eğinlioğlu et al., 1996).

Significant differences occurred between alfalfa landraces, green yields changed from 24.67 to 103.21 t ha^{-1}. Five landraces from Ercis, two from Gevas and one from Saray owned significantly superior yields over the standards related to the fixed values.

Our findings confirmed the statement of Şengül (2007) who conducted an experiment with 27 alfalfa landraces collected from Van Lake province. He pointed out significant differences between landraces for most seedling characters including fresh and dry matter yield. Another set of landraces from Van was investigated for some traits, and significant differences were determined for yield per plant and for the other characters (Şengül, 2003).

In consideration with all studies cited and the results of present research, it is clarified that there was a great variation between landraces and standard varieties for green yield.

Dry matter content and yield

Differences for dry matter content between years were not significant. Overall average dry matter content was 24.16 %, being a little higher in the second year than the first (Table 2). Standard varieties had similar average dry matter contents changing from 22.80 % for cultivar Kalender to 25.04 % for cultivar Bilensoy.

Table 2. Dry matter contents and yields of alfalfa standards and landraces.

Dry matter content (%)				**Dry matter yield (t ha^{-1})**			
No/Site	2010	2011	Mean	No/Site	2010ǂ	2011	Mean
Bilensoy	23.23	26.84	25.04	Elciǂ	12.02	15.13	13.58
MA 324	24.52	25.25	24.89	Kayseri	11.42	13.23	13.32
Kayseri	23.82	25.44	24.63	Bilensoy	11.47	14.78	13.13
Planet	23.37	25.08	24.22	Kalender	10.36	13.51	11.94
Alsancak	22.86	25.01	23.94	Alsancak	9.90	12.90	11.40
Elci	22.88	24.27	23.57	MA 324	10.27	12.38	11.33
Kalender	21.94	23.66	22.80	Planet	9.09	11.05	10.07
Mean	23.23	25.08	24.16	Mean	10.65	13.28	11.97
69/Pop. 3	27.95	30.50	29.23*	24/Erciş	19.10*	23.73*	21.42*
68/Pop. 2	26.64	31.65	29.15*	46/Gevaş	17.86*	24.26*	21.06*
63/Ahlat	26.40	29.15	27.78	34/Erciş	18.50*	22.33*	20.42*
62/Gürpınar	25.18	30.35	27.77	33/Erciş	16.21*	21.07*	18.64*
57/Gürpınar	25.56	29.30	27.43	32/Erciş	15.35	21.48*	18.42*
Pop. 1	25.56	28.90	27.23	35/Erciş	15.89*	20.65*	18.27*
59/Gürpınar	25.09	28.90	27.00	25/Erciş	14.07	22.32*	18.20*
53/Saray	24.35	29.55	26.95*	52/Saray	14.64	21.51*	18.08*
2/Ozalp	24.25	29.00	26.63*	53/Saray	13.05	21.92*	17.49*
66/Merkez	24.99	27.55	26.27	40/Çatak	13.95	19.75*	16.85*
27/Erciş	23.64	27.90	25.77*	36/Çatak	14.32	17.91	16.12
9/Çaldıran	24.05	27.10	25.58	47/Gevaş	13.71	17.48	15.60
32/Erciş	23.89	26.90	25.40*	49/Gevaş	13.43	17.45	15.44
29/Erciş	23.23	26.60	24.92*	68/Pop. 2	13.31	17.19*	15.25*
23/Erciş	19.36	20.80	20.08	70/Pop. 4	6.04	6.53	6.29
Mean	22.87	25.24	24.06	Mean	10.53	13.90	12.21
LSD	2.28	2.75	1.23	LSD	2.674	3.550	1.531

ǂ: Years/Standards significantly different at p<0,05
*: Significantly different from standards at p<0,05

Aka and Avcıoğlu (2003) found dry matter contents of alfalfa varieties between 22.52 and 24.57 %., and they observed 23.65 % for cultivar Elci, that is almost identical (23.57 %) obtained in the present study. Soya et al. (2005) also reported similar results in Aegean conditions. As they indicated, dry matter content is a trait which is not affected greatly from ecological changes. The values found by Mohammed (2007) who studied on forage yield of alfalfa varieties under Ankara and Konya conditions confirm this approach. The average dry matter content of

different varieties including Kayseri and Bilensoy was 25 % in this research.

Dry matter contents of alfalfa landraces ranged between 19.36 and 26.40 % in 2010 and 20.80-30.35 in 2011. The highest average values were 29.23 and 29.15 %, belonged to the population number 3 and 2 collected from university campus. Five ecotypes had significantly higher dry matter contents than the standard varieties, three of them from Ercis, one from Ozalp and one from Saray.

Significant differences for dry matter yield were observed between years and also standard varieties. Average yield over standards and replicates were 10.65 t ha^{-1} in 2010 and 13.28 t ha^{-1} in 2011. As for green yield, the following 2-3 years are more productive for dry matter than previous ones for perennial forage crops. Altınok and Karakaya (2002) obtained 6.51 t ha^{-1} in the first year, 12.97 t ha^{-1} and 12.26 t ha^{-1} in consecutive years. There are some other researches that confirm this approach (Keskin et al., 2009; Radovic et al., 2009).

Cultivar Elci was the highest standard with 13.58 t ha^{-1} dry matter yield. The lowest yield came out for cv Planet having 10.07 t ha^{-1}. Those values are higher than the results of an experiment conducted by Yılmaz et al. (1996) who found out dry matter yields of alfalfa varieties changing from 7.66 to 11.43 t ha^{-1} in the same province. This difference is acceptable because the yield is the total of two cuts in contrast to four cuts of present experiment. Increase in number of cuts causes increase in total yield. Eğinlioğlu et al. (1996) reported high dry matter yields of seven cuts ranging between 18.84-25.65 t ha^{-1} in the second year of their experiment. An experiment in Samsun dry conditions gave the lower dry matter yields between 2.04-2.91 t ha^{-1} with only one cut (Aydın et al., 1994).

Dry matter yields of landraces changed from 6.04 to 24.26 t ha^{-1} with an overall mean of 12.21 t ha^{-1} (Table 2). There is a wide range of variability between landraces grown in Van conditions. Similar variation was assessed by Şengül and Tahtacioglu (1996) who obtained dry matter yields of 9.82-17.96 t ha^{-1} from a trial conducted in Erzurum. There are some other researches in which dry matter yields were in the range of the results of this study (Aka and Avcıoğlu, 2003; Soya et al., 2005; Aydemir et al., 2011).

The highest yielding landraces were collected from Ercis and Gevas. Ten landraces provided significantly higher yields than the top standard variety Elci, six of them were Ercis ecotypes, one from each Gevas and Catak and two from Saray. The majority of landraces collected from different counties of Van was found out as having lower yields than the standards. According to the data given by Şengül (1995), alfalfa local ecotypes gathered around Van had slighter and thinner stems and lower yields than Kayseri variety.

Crude protein content and yield

Year x standard interaction was significant, cultivar Kalender had the highest crude protein content (19.49 %) in 2010, but it was at the bottom (17.43 %) in 2011 (Table 3). Cultivar Alsancak gave adversely similar results being higher in the second year than the first. There were not significant differences between years and standards. The average crude protein contents of standard varieties changed between 17.22 % for cv MA 324 and 18.46 % for cv Kalender.

The results of various researches emphasize that protein content is a trait which is not affected from different ecological conditions. Yücel et al. (2011) found out crude protein contents in Çukurova conditions being very close to the present study. The contents they reported were 18.40 % for cv Kalender, 17,90 % for cv Elci and 18,50 % for cv Bilensoy. Karadağ et al. (2011) obtained almost identical protein content for cv Bilensoy in Tokat ecology.

There was a great variability between landraces for crude protein content. Comparisons were done by using fixed values of landraces which are not presented. The overall mean value was 17.74 %. The crude protein contents varied from 14.96 % to 21.43 % between landraces, seventeen of them differed significantly from standard varieties.

Significant differences occurred between years for crude protein yield (Table 3). It was higher in the second year than in the first. The differences between standards and interactions were not significant. The highest and the lowest protein yields were 2.34 and 1.79 t ha^{-1}, obtained from Elci and Planet, respectively. The average protein yields of other varieties were in a range of 1.96 and 2.29 t ha^{-1}. Overall mean crude protein yield was 2.12 t ha^{-1}, a little higher than the average crude protein yield reported by Şengül and Tahtacıoğlu (1996).

The results are similar to those expressed by Aydın et al. (1994), but some previous studies have presented conflicted results. Soya et al. (2005) achieved crude protein yield changing from 3.18 to 3.78 t ha^{-1}, Eğinlioğlu et al. (1996) obtained high yields ranging 3.07-4.35 t ha^{-1}. The different results should be attributed to the ecological differences, and the number of cuttings. The trials concerned were conducted in Aegean region where cutting number may reach up to seven or eight.

Significant differences for crude protein yield were observed between landraces grown in Van province. Yields varied between 1.06 and 4.96 t ha^{-1}. In consideration with the average fixed values, not presented, eleven landraces had significantly higher yields than the standards. Those landraces were collected from Ercis, Catak, Gevas and Saray.

Table 3. Crude protein contents and yields of alfalfa standards and landraces.

Crude protein content (%)				Crude protein yield (t ha^{-1})			
No/Site	**2010**	**2011**	**Mean**	**No/Site**	**2010ǂ**	**2011**	**Mean**
Kalender	19.49	17.43	18.46	Elci	2.03	2.65	2.34
Kayseri	17.65	18.58	18.11	Bilensoy	2.00	2.58	2.29
Alsancak	17.35	18.46	17.91	Kayseri	2.01	2.46	2.23
Planet	17.40	18.04	17.72	Kalender	2.04	2.37	2.21
Bilensoy	17.49	17.48	17.49	Alsancak	1.71	2.35	2.03
Elciǂǂ	16.92	17.55	17.24	MA 324	1.73	2.19	1.96
MA 324	16.79	17.64	17.22	Planet	1.59	1.99	1.79
Mean	17.59	17.88	17.73	Mean*	1.87	2.37	2.12
24/Erciş	21.70*	20.89*	21.30*	24/Erciş	4.15*	4.96*	4.55*
37/Çatak	20.83	21.43*	21.13*	34/Erciş	3.71*	4.56*	4.14*
22/Muradiye	20.13	21.43*	20.78*	46/Gevaş	3.16*	4.47*	3.81*
23/Erciş	19.86	20.68*	20.27*	35/Erciş	3.24*	4.11*	3.67*
34/Erciş	20.04	20.43	20.24*	33/Erciş	2.87*	4.05*	3.46*
35/Erciş	20.39	19.89	20.14*	25/Erciş	2.41	4.21*	3.31*
4/Merkez	19.25	20.68	19.97*	52/Saray	2.63*	3.75*	3.19*
26/Erciş	20.13	19.60	19.87*	32/Erciş	2.63	3.64*	3.14*
28/Erciş	18.99	20.68*	19.84*	36/Çatak	2.69	3.48	3.09*
11/Çaldıran	19.43	19.68	19.56*	47/Gevaş	2.65*	3.44	3.05*
47/Gevaş	19.34	19.68	19.51*	53/Saray	2.17	3.72*	2.94*
20/Muradiye	19.51	19.43	19.47*	40/Çatak	2.41	3.33	2.87
12/Çaldıran	19.43	19.43	19.43*	42/Çatak	2.22	3.13	2.67
19/Muradiye	20.13	18.68	19.41*	27/Erciş	2.05	3.16	2.60
6/Merkez	18.64	19.68	19.16*	16/Başkale	2.12	3.01	2.56
36/Çatak	18.81	19.43	19.12	38/Çatak	2.26	2.82	2.54
3/Ozalp	18.81	19.24	19.03*	39/Çatak	2.20	2.78	2.49
10/Çaldıran	18.73	19.32	19.03*	68/Pop. 2	2.13	2.82	2.48*
67/Pop. 1	14.96	15.86	15.41	70/Pop. 4	1.06	1.07	1.07
Mean	17.94	18.25	18.10	Mean	1.89	2.54	2.22
LSD	1.147	1.490	0.648	LSD	0.45	0.65	0.27

ǂǂ: Year x standard interaction significant at p<0,05 (LSD=1.295)

ǂ: Years significantly different at p<0.05

*: Significantly different from standards at p<0,05

CONCLUSION

This research conducted in the eastern Anatolia ecological conditions showed that there were significant differences related to green and protein yields among alfalfa landraces grown in the region. The study has confirmed that the differences among standard varieties were significant for green and dry matter yields, but those were not for crude protein yield. Standard variety Elci had higher forage yields than the others, cultivars Kayseri and Bilensoy also had high yields. Landraces collected from Ercis and Gevas presented the highest forage and protein yields. Taking into account the results, it is possible to conclude that these alfalfa ecotypes are promising material for further breeding studies.

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