An investigation on improved source population for the alfalfa (*Medicago sativa* L.) breeding

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Received: 09-04-2018 Accepted: 29-08-2018 DOI: 10.18805/LR-420

**ABSTRACT**

The aim of the research was to determine the forage yield and quality of thirty alfalfa (*Medicago sativa* L.) genotypes. Plots were established in 2014 in Isparta, Turkey, in a randomized complete block design with 3 replicates. Five cuttings were done during the 2015, 2016 and 2017. The dry matter yield (DMY), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL) and relative feed value (RFV) were determined. According to the three years average results, significant differences were determined for all parameters. Alfalfa genotypes viz., Cay-1, Cay-2, Keciborlu-1 and Keciborlu-3 were selected for alfalfa breeding program due to their superior yield and quality features.

**Key words:** Alfalfa, Breeding, *Medicago sativa* L., Relative feed value, Yield.

**INTRODUCTION**

Since Turkey government released the forage crops development plan for livestock in 2002, the planting area of forage crops in Turkey reached 1.80 million hectares by the end of 2017 (TUIK, 2017). The highest increase in sowing area has been occurred in alfalfa (*Medicago sativa* L.) which has high nutritional value, important ecological functions, and is widely grown in Mediterranean areas. The alfalfa has high yield, high protein content and high digestibility. It is reputed by researchers as the ‘queen of forages’ (Dale et al., 2012). Alfalfa originated in Vavilov’s Near Eastern Center Asia Minor, Transcaucasia, Iran and Turkistan. The wild alfalfa and related perennial species are found throughout Eurasia and as far north as Siberia (Abbasi et al., 2007). There are more than 60 species of the genus *Medicago* all over the world and half of them grow in Anatolia. The primary center for the genus is in the Caucasus, north-western Iran and north-eastern Turkey (Ivanov, 1977). Alfalfa is a cross pollinated, polyploidy, perennial grown primarily for a vegetative product. This means that alfalfa is a heterozygous, continually segregating population in which every plant is genetically different (Hou and Wang, 2014). A lot of breeding aims for alfalfa are similar to those in other crops like increasing yield, enhancing nutritive value and improving tolerance to abiotic and biotic stresses are all important (Li and Brummer, 2012).

The objective of this study was to determine the forage yield and quality parameters of alfalfa genotypes collected from Lake Region of Turkey and to identify a source population for the alfalfa breeding program.

**MATERIALS AND METHODS**

The research was conducted during the 2014-2017 growing seasons in Isparta Province (37°45’ N, 30°33’ E; elevation 1035 m), located in the Mediterranean region of Turkey. The soil texture was clay loam, the organic matter was 1.5%, the lime was 7.2%, the total salt was 0.36%, the exchangeable K was 119 mg kg\(^{-1}\), the extractable P was 3.8 mg kg\(^{-1}\), and the pH of a soil-saturated extract was 7.8. Average temperature and total precipitation were 12.5°C and 483 mm in 2015; 13.1°C and 450 mm in 2016; 12.9°C and 532 mm in 2017; 12.2 °C and 564 mm in long year (1928-2014) averages, respectively.

Total 30 alfalfa (*Medicago sativa* L.) genotypes as the experimental material were developed from TUBITAK 110O257 project (Albayrak et al., 2014).

Each plot was of 5 rows, each 2 m in length. The row spacing was 20 cm. The seeding rates were 20 kg ha\(^{-1}\). The plots were fertilized in establishment year using DAP (18% N and 46% P) at 100 kg ha\(^{-1}\). The plots were irrigated once after each harvest.

The plots were harvested on 12 May, 20 June, 21 July, 19 August, and 2 September of 2015, on 28 May, 30 Jun, 29 July, 28 August, and 28 September of 2016, and on 25 May, 28 June, 27 July, 29 August, and 3 October of 2017. The harvest time was based on the 10% flowering stage of...
alfalfa. The plots were not harvested in the year of establishment. After the harvest, samples were dried at 70 °C for 48 h, and weighed. The crude protein (CP) content was calculated by multiplying the Kjeldahl nitrogen concentration by 6.25 (Kacar and Inal, 2008). The acid detergent fiber (ADF), neutral detergent fiber (NDF) and the acid detergent lignin (ADL) contents were determined according to methods from Ankom Technology (Komarek, 1993). The relative feed value (RFV) was estimated according to the following equation adapted from Albayrak and Turk (2013): RFV = [120 / NDF] × [88.9 – (0.779 × ADF)] × [0.775].

The trial was conducted in a randomized complete block design with 3 replications. A split plot design was used for unified analysis of the 3 years (Table 1). The statistical analysis of the yield and quality data was performed using the SAS general linear model procedure (SAS Institute, 1998). The means were compared using Duncan’s test at the 0.05 probability level.

RESULTS AND DISCUSSION

Cay-1 (25400 kg ha⁻¹), Keciborlu-1 (24428 kg ha⁻¹), Cay-2 (24323 kg ha⁻¹) and Keciborlu-3 (24058 kg ha⁻¹) alfalfa genotypes had significantly the high three-year average dry matter yields. The average of dry matter yield of other genotypes ranged from 21911 to 11910 kg ha⁻¹ (Table 2). Alfalfa dry matter yields in different researches were determined at the range of 4590-26000 kg ha⁻¹ (Albayrak and Turk, 2013; Jafarian et al., 2015; Ahmad et al., 2017; Avci et al., 2018). It can be said that the interaction of many factors (climate, soil structure, fertilization, irrigation possibilities, cutting time, cutting height, number of cuttings, ecological conditions as well as kinds of varieties) in alfalfa cultivation may be the reason for these differences in dry matter yield (Gokalp et al., 2017).

When three-year average crude protein contents of alfalfa genotypes were examined, Keciborlu-3, Cay-2, Sandikli-1, Huyuk-1, Keciborlu-1, Yenisar-2, Sandikli-2, Cay-1, Suhut-3, Aksehir-1, Cay-3 and Aksehir-2 alfalfa genotypes (21.24, 21.19, 21.08, 21.00, 20.92, 20.66, 20.66, 20.61, 20.38, 19.96, 19.90 and 19.88 %) had higher crude protein contents than the other alfalfa genotypes. Alfalfa is the cheapest crude protein source for animals, and the protein content of the plant is directly related to the developmental period (Radovic et al., 2009). According to the results of previous studies, the crude protein ratio of alfalfa were determined as: 20.99% (AL-Ghumaiz, 2012), 19.70 % (Malushi et al., 2017), 40.5-5.0% (Sulc et al., 2017), 6.21% (Boziskovic et al., 2014), 4.62-7.32% (Kertikova et al., 2014), 7.1-7.8% (Yari et al., 2014) and 7.36% (Dale et al., 2012). Our findings are generally similar to those of the above mentioned researchers. Nevertheless, it should be kept in mind that the varieties and ecological factors as well as the changes in the harvest time, were effective factors in the change of the crude protein content of alfalfa (Rimi et al., 2012).

Among genotypes, Cay-2 (7.41%), Yalvac-3 (7.37%), Sandikli-2 (7.33%), Yesilova-1 (7.46%), Keciborlu3 (7.48%), G.Dost-1 (7.49%), Bucak-3 (7.65%) and Sandikli-1 (7.68%) genotypes had less ADL content compared with the other alfalfa genotypes (between 8.54-7.83 %). Lignin ensures strength to plants and allows the plant vascular system to transport water in the plant without leakage (Webb et al., 1996). Along with that lignin increased with advanced maturity in alfalfa. However lignin was indigestible and reduced fiber digestibility in ruminants (Undersander et al., 2009). ADL contents were determined in previous studies as 7.4 % (Malushi et al., 2017), 4.0-5.0% (Sulc et al., 2017), 6.21% (Boziskovic et al., 2014), 4.62-7.32% (Kertikova et al., 2014), 7.1-7.8% (Yari et al., 2014) and 7.36% (Dale et al., 2012). Our findings indicated that ADL contents of alfalfa genotypes were within reasonable limits.

Table 1: Results of analysis of variance and mean squares of the traits determined.

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>DMY</th>
<th>CP</th>
<th>ADL</th>
<th>ADF</th>
<th>NDF</th>
<th>RFV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block (B)</td>
<td>2</td>
<td>1898730**</td>
<td>4.432</td>
<td>0.186</td>
<td>0.725</td>
<td>7.659</td>
<td>70.141</td>
</tr>
<tr>
<td>Genotype (G)</td>
<td>29</td>
<td>13684170**</td>
<td>21.14**</td>
<td>1.319**</td>
<td>12.348**</td>
<td>7.231**</td>
<td>156.38**</td>
</tr>
<tr>
<td>Error 1</td>
<td>58</td>
<td>220810</td>
<td>2.16</td>
<td>0.172</td>
<td>1.720</td>
<td>2.663</td>
<td>32.46</td>
</tr>
<tr>
<td>Year (Y)</td>
<td>2</td>
<td>13956540**</td>
<td>93.35**</td>
<td>2.242**</td>
<td>244.59**</td>
<td>413.82**</td>
<td>8610.54**</td>
</tr>
<tr>
<td>G x Y</td>
<td>58</td>
<td>391740**</td>
<td>0.377</td>
<td>0.052</td>
<td>0.975</td>
<td>0.497</td>
<td>12.096</td>
</tr>
<tr>
<td>Error 2</td>
<td>120</td>
<td>168140</td>
<td>1.711</td>
<td>0.198</td>
<td>2.064</td>
<td>1.783</td>
<td>23.538</td>
</tr>
</tbody>
</table>

df = degrees of freedom *P < 0.05 and **P < 0.01.
genotypes (between 44.72-43.62%). ADF contents were determined 26.70-39.50% and NDF contents were 34.58-58.70% depending on different ecological regions and varieties in alfalfa (Jafraarian et al., 2015; Jian et al., 2015; Kavut and Avcıoglu, 2015; Yuek and Avcıoglu, 2016; Ahmad et al., 2016; Min, 2016; Malushi et al., 2017). Changes in harvest time with varieties and ecological factors have been shown to be effective on the ratio of ADF and NDF (Rimi et al., 2015; Jian et al., 2015; Yuek and Avcıoglu, 2015; Yuek and Avcıoglu, 2016; Ahmad et al., 2016; Min, 2016; Malushi et al., 2017). In this study, RFV of all the alfalfa genotypes were determined between 144.86-130.24 in good group in terms of quality. RFV rates together. Therefore, the ADF and NDF ratios must be low for the RFV to be high. Putman,(2010) reported that forages with an RFV of over 180, 150-180, 125-150, 100-120, and less than 100 were categorized as supreme, premium, good, fair and utility, respectively. In the present study, RFV of all the alfalfa genotypes were determined for yield and quality characteristics. Genotypes Cay-1, Cay-2, Keciborlu-1 and Keciborlu-3, were selected for high dry matter yield crude protein content and relative feed value in order to be used in the alfalfa breeding program.

CONCLUSION

In this study, thirty alfalfa genotypes were determined for yield and quality characteristics. Genotypes Cay-1, Cay-2, Keciborlu-1 and Keciborlu-3, were selected for high dry matter yield crude protein content and relative feed value in order to be used in the alfalfa breeding program.

ACKNOWLEDGMENT

This research was financially supported by TUBITAK (Turkish Scientific and Technological Research Council, project no. 214O066).
REFERENCES


