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*Full Length Research Paper*

# Yields and qualities of some red clover (*Trifolium pratense L.*) genotypes in crop improvement systems as livestock feed

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**The objective of this study was to compare twenty-five genotypes of red clover (*Trifolium pratense* L.) in terms of yield (in 2000 - 2004) and quality performance (in 2000 - 2001) for animal feeding. The genotypes were evaluated for dry matter yield (DMY), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), digestible dry matter (DDM), dry matter intake (DMI), relative feed value (RFV), total digestible nutrients (TDN), net energy-lactation (NEl), net energy-maintenance (NEm) and net energy-gain (NEg) content. There were significant differences in DMY (P < 0.01), CP, ADF, NDF, DDM, DMI, RFV (P < 0.05), TDN, NEl, NEm and NEg (P < 0.01) amongst the genotypes. The Rajah cultivar had the highest DMY (13629 kg ha$^{-1}$) amongst the genotypes according to five year results. While the highest CP (15.94%), NDF (50.59%), DDM (68.68%), TDN (66.50%), NEl (0.70 Mcal/1b), NEm (0.76 Mcal/1b) and NEg (0.44 Mcal/1b) were determined in the L-818 line, the lowest ADF (25.96%) was also found in the L-818 line. The highest DMI (3.16%) was observed in the Hamua cultivar. The highest RFV was determined in the Tohum Islah ecotype (156), the Hamua (155), the Orbit (154) cultivars and the L-812 (154) line. Our results showed that there were large variations in terms of yield and quality performances amongst the red clover genotypes for animal feeding. The Rajah, L-832 (selected from wild forms) and Pawera had the highest yields amongst the genotypes. The L-818, L-812 lines (selected from wild forms), Tohum Islah ecotype, Lucrun and Redwent cultivars were superior in terms of forage quality properties (low in ADF and NDF and high CP, DDM, DMI, RFV, TDN, NEl, NEm, NEg) than the other red clover genotypes.**

**Key words:** Red clover, genotypes, dry matter yield, crude protein, nutritive value.

## INTRODUCTION

Animal breeding and obtaining high levels of production via healthy feeding are important for regions that deal with stockbreeding. Stockbreeding is the most important occupation on highlands of Turkey. Despite obtaining animals which are at high levels of production as a result of artificial insemination studies in these regions, there are still some problems in meeting the forage requirements of these animals. Therefore, forage crops that have high levels of production should be improved so that animals can be fed adequately and healthily during long winters.

The possibility to accurately predict the nutritive value of forage crops is a prerequisite for designing rations and directing forage crops breeding (Kruse et al., 2008). Nutrient deficiencies in low quality roughages affect microbial growth and fermentation in the rumen and result in an overall low animal productivity (Assefa and Ledin, 2001). Quality forage promotes good health and better performance (Harris, 1992). Therefore, choosing superior yield and quality forage genotypes is very important for animal health as well as high milk and meat production.

Nutritive values of forage crops can be changed amongst cultivars, ecotypes and genotypes within a plant species for animal nutrition. Differences in quality properties of forage crops within a species have been shown by Job (1996) in eight red clover cultivars, Broderick et al.

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(2004) in 113 red clover entries, Yolcu et al. (2008a) in 12 lucerne cultivars and Yolcu et al. (2009) in 25 red clover genotypes.

Crude protein, acid detergent fiber, neutral detergent fiber, relative feed value and total digestible nutrients are important criteria for determining hay quality (Yolcu et al., 2008b) in animal feeding. Therefore, CP and NDF (Assefa and Ledin, 2001); CP, ADF and NDF (Malhi et al. 2005; Calobro et al., 2007); CP, ADF, NDF, DDM and RFV (Lekgari et al., 2006); CP, ADF, NDF, DDM, DMI, RFV, TDN and NEI (Lithourgidis et al., 2006) were examined as quality criteria in many studies.

The aim of this study was to choose superior genotypes (in DMY, CP, ADF, NDF, DDM, DMI, RFV, TDN, NEl, NEm, NEg) in animal feeding amongst 25 red clover genotypes under field conditions.

## MATERIALS AND METHODS

### Site characteristics

This experiment was carried out in the experimental field of The East Anatolia Agricultural Research Institute, in Pasinler, Erzurum (39° 55' N, 42° 61' E) in 2000, 2001, 2002, 2003 and 2004. The study area was situated at an altitude of 1853 m above sea level in Eastern Turkey.

The soil characters of the experiment area are loam and clay-loam. The organic matter content of the soil is low (1.79%). The pH level of the plot area was 7.1, and P and K levels of the area were in 69.3 kg $P_2O_5$ $ha^{-1}$ and 2066 kg $K_2O$ $ha^{-1}$. The mean annual temperature, the total precipitation and the relative humidity for the region are 4.2°C, 400.9 mm and 64.3%, respectively. Generally, while May has the highest mean precipitation (71.9 mm), August has the lowest precipitation (17.5 mm). The winters are very cold and long. Generally snow in Pasinler remains approximately for 120 - 140 days a year. Climatic dates of research years and long terms averages are reported in Table 1.

### Field experiment

The study was designed in a factorial arrangement of a randomized complete block design with four replications. The Tohum Islah ecotype (the most common ecotype), Rotra (tetraploid), Piemontese, Hamua, Xiashao, Lucrun, Pawera (tetraploid), Colenso, Redwent, Lakeland, Orbit, Rajah cultivars of red clover (*Trifolium pratense* L.) used in experiments have origins from USA, Germany, Italy, New Zealand, China, Germany, New Zealand, New Zealand, Australia, USA, USA, Denmark, respectively. L-68, L-77, L-79, L-81, L-509, L-584, L-777, L-812, L-818, L-832, L-1881, L-1920 and L-1922 lines of red clover used in the experiment selected from native flora except L-584 which has origins from FAO.

The red clover genotypes were sown in April of 2000. Dry matter yield data were collected from 2000, 2001, 2002, 2003 and 2004, although other dates were collected from 2000 and 2001. That is, dates of CP, ADF, NDF, DDM, DMI, RFV, TDN, Nel, Nem and Neg were determined in the result of analyze or calculate in 2000 and 2001 year samples. Dry matter yields as mean of five years and CP, ADF, NDF, DDM, DMI, RFV, TDN, Nel, Nem and Neg as mean of two years were given in the results.

The sizes of the plots were 6.0 m long by 1.5 m wide, with 30 cm of row spacing. Individual plots were 1.5 x 6.0 = 9.0 $m^2$ in size. Plots were fertilized with 40 kg N $ha^{-1}$ as ammonium sulphate $(NH_4)_2SO_4$ only in the first year then phosphorus was applied as triple superphosphate until the phosphorus quantity of the soil reached 150 kg $ha^{-1}$ $P_2O_5$ every year (Çomaklı, 1991; Serin and Tan, 2001). After the humidity period, red clover plots were irrigated until it reached field capacity when available useful water in the soil decreased down to 50%, with intervals of 8 -10 days practically (Çomaklı, 1991). 2.25 $m^2$ parts of each plot were harvested for yield during 50% flowering stage once in 2000 and three times in 2001, 2002, 2003 and twice in 2004. After the fresh hay samples were oven-dried at 70°C for 48 h, dry matter yields of the genotypes were determined.

### Quality measurements

500 g fresh yield samples were taken from each plot for analysis. The samples were washed to remove soil using deionised water. The fresh hay samples were oven-dried at 70°C for 48 h and were ground to pass 1 mm. The Kjeldahl method (Bremner, 1996) and a Vapodest 10 Rapid Kjeldahl Distillation Unit (Gerhardt, Konigswinter, Germany) were used to determine total N of the genotypes. Crude protein (CP) content of the genotypes was calculated by multiplying N contents by a coefficient of 6.25 (Frank, 1975). Acid detergent fiber (ADF) and neutral detergent fiber (NDF) analyses were determined by Van Soest (1963). Digestibility dry matter (DDM), dry matter intake (DMI), relative feed value (RFV), total digestible nutrients (TDN), net energy-lactation (NEl), net energy-maintenance (NEm) and net energy-gain (NEg) were calculated according to the following equations adapted from common formulas for forages (Schroeder, 1994):

DDM % = 88.9 - (0.779 x ADF %),
DMI % = 120 / NDF
RFV = (DDM % x DMI %) / 1.29
TDN % = 96.35 - (ADF % x 1.15) (adapted equation from Lucerne formulas)
NEl: Mcal/1b = (TDN % x 0.01114) - 0.054
NEm: Mcal/1b = (TDN % x 0.01318) - 0.132
NEg: Mcal/1b = (TDN % x 0.01318) - 0.459

Data were subjected to the analysis of variance using the MSTAT-C procedure and means were separated with Duncan's test for differences amongst the genotypes.

**Table 1.** Climatic dates of the research location in 2000, 2001, 2002, 2003, 2004 years and long-term average (1929 - 2000).

| | Jan. | Feb. | March | April | May | June | July | August | Sep. | Oct. | Nov. | Dec. | Total/Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **Total Precipitation (mm) (Monthly)** | | | | | | | | | | | | |
| 1929 - 2000 | 18.7 | 24.3 | 26.3 | 50.8 | 71.9 | 38.3 | 25.5 | 17.5 | 18.5 | 47.4 | 36.7 | 25.0 | 400.9 |
| 2000 | 18.8 | 7.2 | 61.3 | 35.0 | 42.0 | 9.7 | 4.0 | 4.7 | 40.7 | 42.3 | 1.6 | 23.8 | 291.1 |
| 2001 | 4.9 | 11.9 | 51.1 | 104.9 | 68.7 | 7.3 | 36.6 | 9.0 | 3.8 | 51.2 | 33.2 | 35.1 | 423.9 |
| 2002 | 14.0 | 8.9 | 37.4 | 81.2 | 73.1 | 74.0 | 39.1 | 54.6 | 18.1 | 42.9 | 25.6 | 19.7 | 488.6 |
| 2003 | 17.7 | 30.7 | 32.9 | 81.4 | 29.9 | 45.7 | 18.5 | 5.1 | 19.3 | 90.9 | 36.1 | 16.1 | 424.3 |
| 2004 | 14.3 | 90.0 | 33.7 | 36.0 | 121.7 | 40.7 | 17.9 | 1.3 | 6.0 | 27.4 | 43.6 | 8.2 | 440.8 |
| | **Mean Temparature (°C) (Monthly)** | | | | | | | | | | | | |
| 1929 - 2000 | -9.4 | -9.6 | -3.3 | 4.4 | 9.3 | 13.0 | 17.5 | 17.1 | 12.8 | 6.6 | -1.3 | -7.0 | 4.2 |
| 2000 | -9.7 | -11.3 | -7.6 | 7.4 | 9.8 | 15.5 | 22.2 | 19.3 | 14.4 | 7.0 | 1.2 | -5.9 | 6.0 |
| 2001 | -12.2 | -5.7 | -4.4 | 7.2 | 9.3 | 15.4 | 20.6 | 19.9 | 14.9 | 6.2 | -3.6 | -5.1 | 5.9 |
| 2002 | -16.7 | -8.4 | -1.0 | 4.2 | 9.8 | 14.3 | 18.3 | 16.6 | 13.6 | 8.9 | 1.3 | -12.0 | 4.1 |
| 2003 | -7.7 | -8.2 | -6.6 | 4.4 | 11.6 | 14.5 | 18.9 | 20.0 | 13.8 | 8.8 | -0.7 | -6.6 | 5.2 |
| 2004 | -9.0 | -8.7 | -1.7 | 4.0 | 9.7 | 14.5 | 17.9 | 19.6 | 13.8 | 7.9 | -1.0 | -14.1 | 4.4 |
| | **Mean Relative Humidity (%) (Monthly)** | | | | | | | | | | | | |
| 1929 - 2000 | 76.7 | 76.0 | 74.8 | 65.4 | 61.4 | 57.3 | 51.1 | 47.7 | 50.2 | 61.8 | 72.5 | 76.5 | 64.3 |
| 2000 | 71.2 | 73.6 | 73.4 | 64.8 | 57.9 | 47.8 | 36.7 | 43.4 | 47.4 | 67.2 | 64.2 | 79.5 | 60.6 |
| 2001 | 80.6 | 71.9 | 65.0 | 65.4 | 61.3 | 48.1 | 46.2 | 44.1 | 42.0 | 60.1 | 71.5 | 80.4 | 61.4 |
| 2002 | 72.4 | 74.0 | 71.3 | 64.0 | 55.8 | 57.0 | 53.0 | 53.6 | 52.9 | 61.9 | 69.4 | 73.5 | 63.2 |
| 2003 | 77.6 | 73.3 | 75.8 | 62.2 | 52.0 | 50.6 | 49.3 | 42.7 | 46.3 | 64.1 | 74.5 | 71.3 | 61.6 |
| 2004 | 77.1 | 78.0 | 70.0 | 58.0 | 63.0 | 53.0 | 42.0 | 41.0 | 40.9 | 59.0 | 72.0 | 78.0 | 60.9 |

## RESULTS AND DISCUSSION

### Dry matter yield, crude protein, acid detergent fiber and neutral detergent fiber contents

Dry matter yields of red clover genotypes were signify-cantly different ($p < 0.01$) according to five year results. These values were range from 8741 kg ha$^{-1}$ to 13629 kg ha$^{-1}$. The rajah cultivar had the highest dry matter yields amongst the red clover genotypes (Table 2). This cultivar was followed by L-832 line (12958 kg ha$^{-1}$) and Pawera (12614 kg ha$^{-1}$) cultivar. The lowest dry matter yield was found in orbit (8741 kg ha$^{-1}$) cultivar. Similar yield variation inside a species has been shown by Steyovic et al. (2008) and Bukvic et al. (2008) in red clover cultivars.

Significant differences ($p < 0.05$) were found in crude protein content amongst the genotypes in the two-year results. The highest CP content was found in the L-818 line amongst 25 genotypes. The value was followed by the Xiashao, Lucrun cultivars, L-1881 and L-79 lines, respectively (Table 2). The lowest CP content value was found in the L-777 line amongst the genotypes. Only crude protein content of the L-818 line was higher than those of the red clover commonly used in beef cattle diets issued by NRC (2000) (15.0%). The other values were under crude protein content of the red clover in NRC (2000) (Figure 1). The crude protein contents of the red clover genotypes were also under the values used in dairy cattle diets issued in NRC 2001 (20.8%). These results were shown in Figure 1. The red clover genotypes showed large variations in terms of crude protein content for animal feeding. Similar crude protein variation inside a species has been reported by Lugic et al. (2002) within 12 red clover cultivars, Kallenbach et al. (2002) within three lucerne cultivars and Kamalak et al. (2005) within 14 lucerne varieties.

Differences ($p < 0.05$) in terms of ADF and NDF were also determined amongst the genotypes in the two-year results (Table 2). The lowest ADF contents were found in the L-818 line amongst 25 genotypes. The value was followed by the L-812 line, Tohum Islah ecotype, Lucrun and Redwent cultivars. The highest value in terms of ADF content was determined in the L-79 and L-77 lines amongst 25 genotypes. Acid detergent fiber contents of all other genotypes except L-79, L-77 lines, Pawera and Lakelend cultivars were under acid detergent fiber content of the red clover in NRC 2000 (36.00%) (Figure 2). Similarly, acid detergent fiber contents of all other genotypes except L-832, L-68 and L-1881 lines in addition to the same genotypes were also under the values used in dairy cattle diets issued in NRC 2001 (33.40%). These results were shown in Figure 2. The lowest NDF contents were determined in Hamua, Orbit cultivars and Tohum Islah ecotype. Neutral detergent fiber contents of all other genotypes except of L-818 line, Rajah, Pawera cultivar and L-81 line were under neutral detergent fiber content of the red clover in NRC 2000 (46.30%). Most of the genotypes were also under the values used in dairy cattle diets issued in NRC 2001 (42.90%) (Figure 3).

**Table 2.** Dry matter yield, crude protein, acid detergent fiber and neutral detergent fiber contents of red clover genotypes.

| Cultivars/Lines | DMY*(kg ha$^{-1}$) | CP (%) | ADF (%) | NDF (%) |
|---|---|---|---|---|
| Tohum Islah | 11630 c-g | 13.06 bc | 29.31 ef | 39.61 c |
| Orbit | 8741 i | 13.44 a-c | 30.88 c-e | 39.22 c |
| Rajah | 13629 a | 12.67 bc | 30.84 c-f | 49.26 ab |
| Rotra (Tetraploid) | 12324 b-d | 12.44 bc | 32.03 b-d | 41.23 bc |
| Hamua | 12011 b-e | 12.67 bc | 32.82 a-f | 38.06 c |
| Redwent | 11636 c-g | 13.06 bc | 29.77 d-f | 40.40 bc |
| Xiashao | 11954 b-f | 14.56 ab | 33.20 a-e | 41.82 a-c |
| Piemontese | 12183 b-e | 13.25 bc | 31.38 b-f | 40.64 bc |
| Colenso | 11926 b-f | 13.38 bc | 31.01 b-f | 42.46 a-c |
| Lakeland | 12482 bc | 13.44 a-c | 36.77 a-d | 43.88 a-c |
| Lucrun | 11686 c-g | 14.06 a-c | 29.71 ef | 40.33 bc |
| Pawera (Tetraploid) | 12614 a-c | 12.38 bc | 37.82 a-c | 46.83 a-c |
| L-68 | 11152 e-g | 13.44 a-c | 33.76 a-e | 44.35 a-c |
| L-77 | 12119 b-e | 12.94 bc | 38.05 ab | 44.24 a-c |
| L-79 | 9879 hi | 13.81 a-c | 38.47 a | 43.23 a-c |
| L-81 | 11573 c-g | 12.13 bc | 31.09 b-f | 46.55 a-c |
| L-509 | 10768 gh | 13.25 bc | 30.79 c-f | 42.77 a-c |
| L-584 | 10846 f-h | 13.63 a-c | 31.43 a-f | 42.11 a-c |
| L-777 | 11292 d-g | 12.00 c | 31.56 a-f | 46.04 a-c |
| L-812 | 10684 gh | 12.75 bc | 27.85 e-f | 40.47 bc |
| L-818 | 11156 e-g | 15.94 a | 25.96 e | 50.59 a |
| L-832 | 12958 ab | 13.19 bc | 33.83 a-e | 42.47 a-c |
| L-1881 | 9152 i | 13.94 a-c | 33.41 a-e | 44.53 a-c |
| L-1920 | 12261 b-e | 13.13 bc | 30.80 c-f | 40.56 bc |
| L-1922 | 11144 e-g | 12.50 bc | 31.17 b-f | 42.63 a-c |
| Mean | 11494 | 13.24 | 32.15 | 42.97 |
| Importance | P < 0.01 | P < 0.05 | P < 0.05 | P < 0.05 |
| LSD Value | 1142 | 2.50 | 7.05 | 8.97 |

*Dry matter yields of 2000, 2001and 2002 years were taken from master thesis belong to Ayten Tavlaş.

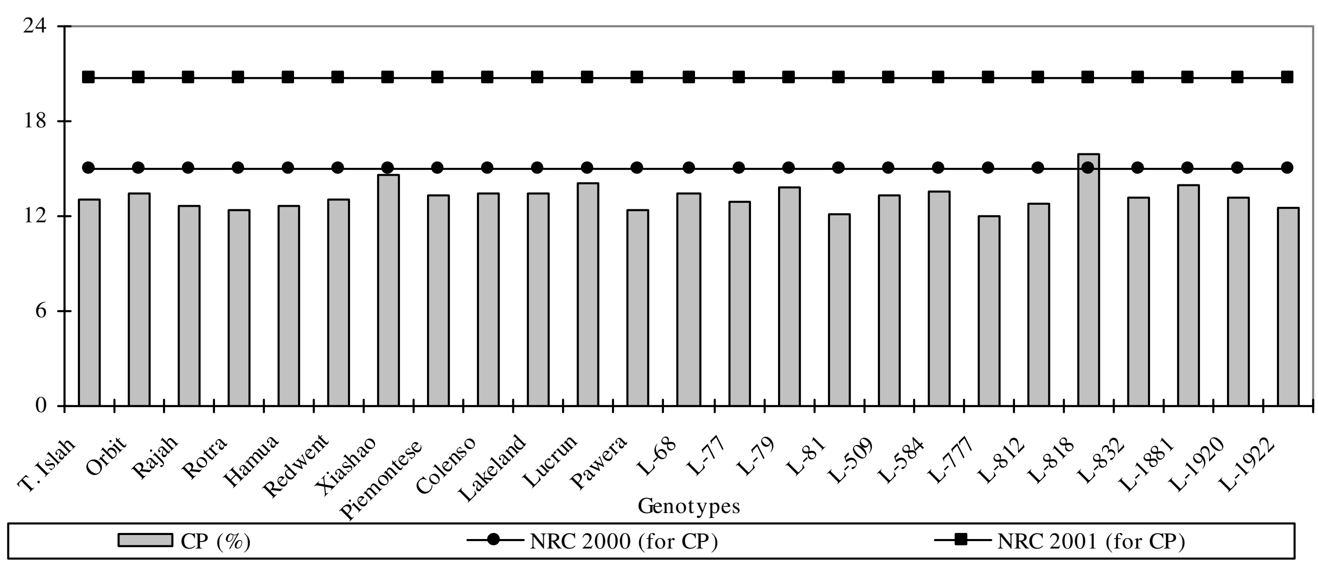


**Figure 1.** Relation between crude protein content of red clover genotypes and values of NRC (2000) and NRC (2001).

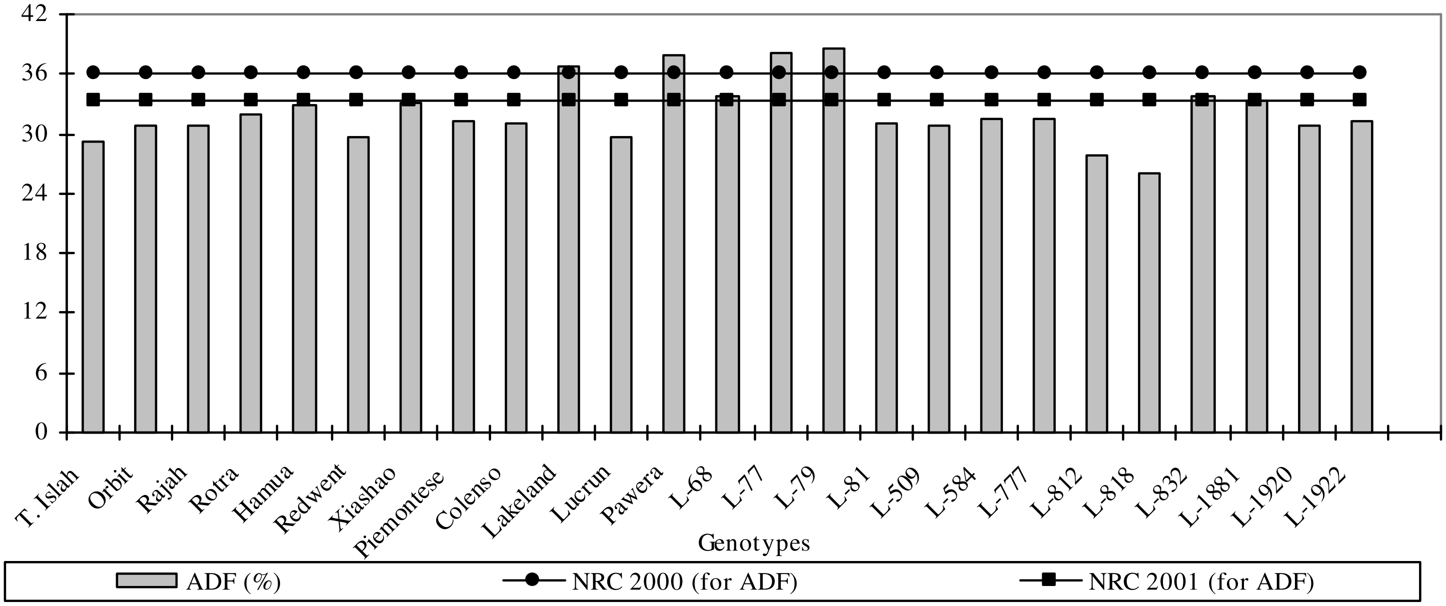


**Figure 2.** Relation between acid detergent fiber of red clover genotypes and values of NRC (2000) and NRC (2001).

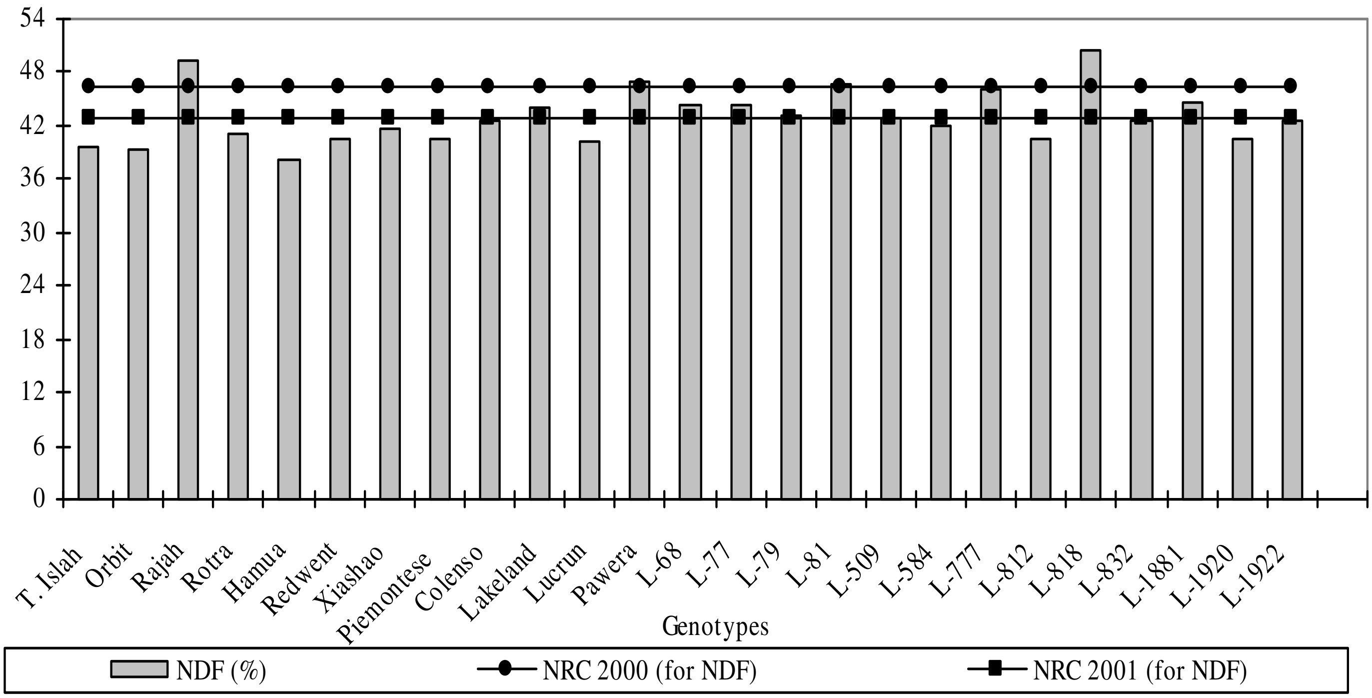


**Figure 3.** Relation between neutral detergent fiber of red clover genotypes and values of NRC (2000) and NRC (2001).

The red clover genotypes showed significant variation in terms of ADF and NDF for animal feeding. Similar findings were determined by Blümmel et al. (2003) within 12 varieties of sorghum stover and Yolcu et al. (2008b) within 12 Lucerne cultivars.

**Digestibility dry matter, dry matter intake contents and relative feed value**

Significant differences ($p < 0.05$) were determined amongst 25 genotypes in terms of DDM, DMI and RFV

**Table 3.** Digestibility dry matter (DDM), dry matter intake (DMI) contents and relative feed value (RFV) of red clover genotypes.

| Cultivars/Lines | DDM (%) | DMI (%) | RFV |
|---|---|---|---|
| Tohum Islah | 66.08 ab | 3.03 ab | 156 a |
| Orbit | 64.85 a-d | 3.06 ab | 154 a |
| Rajah | 64.88 a-c | 2.48 cd | 124 bc |
| Rotra (Tetraploid) | 63.95 a-f | 2.92 a-d | 145 a-c |
| Hamua | 63.34 a-f | 3.16 a | 155 a |
| Redwent | 65.72 a-c | 2.97 a-c | 151 ab |
| Xiashao | 63.04 b-f | 2.94 a-d | 146 a-c |
| Piemontese | 64.46 a-e | 2.96 a-c | 147 a-c |
| Colenso | 64.75 a-e | 2.85 a-d | 143 a-c |
| Lakeland | 60.26 c-f | 2.74 a-d | 128 a-c |
| Lucrun | 65.76 ab | 2.98 a-c | 152 a-b |
| Pawera (Tetraploid) | 59.39 d-f | 2.59 b-d | 119 c |
| L-68 | 62.60 b-f | 2.71 a-d | 132 a-c |
| L-77 | 59.38 e-f | 2.73 a-d | 126 a-c |
| L-79 | 58.94 f | 2.78 a-d | 127 a-c |
| L-81 | 64.69 a-e | 2.58 b-d | 129 a-c |
| L-509 | 64.92 a-c | 2.81 a-d | 141 a-c |
| L-584 | 64.42 a-f | 2.87 a-d | 143 a-c |
| L-777 | 64.32 a-f | 2.61 b-d | 130 a-c |
| L-812 | 67.21 ab | 2.97 a-c | 154 a |
| L-818 | 68.68 a | 2.42 d | 129 a-c |
| L-832 | 62.56 b-f | 2.83 a-d | 137 a-c |
| L-1881 | 62.88 b-f | 2.70 a-d | 132 a-c |
| L-1920 | 64.91 a-c | 2.96 a-c | 149 ab |
| L-1922 | 64.62 a-e | 2.85 a-d | 141 a-c |
| **Mean** | **63.86** | **2.82** | **139.6** |
| Importance | $P < 0.05$ | $P < 0.05$ | $P < 0.05$ |
| LSD Value | 5.50 | 0.54 | 29.7 |

for animal feeding. As a result of differences in ADF contents, DDM contents of the genotypes were also different in two-year results. The highest DDM ratio was found in the L-818 line amongst the genotypes (Table 3). The value was followed by the L-812 line, Tohum Islah ecotype and Lucrun cultivars, respectively. The lowest value in terms of DDM was found in the L-79 line. Because NDF contents of the genotypes were different, DMI ratios were also different. The highest DMI ratio was found in the Hamua cultivar. The value was followed by the Orbit cultivar, Tohum Islah ecotype, Lucrun, Redwent cultivars and the L-812 line. The lowest DMI ratio was the L-818 line (Table 3). While the highest relative feed values were found in the Tohum Islah ecotype, Hamua, Orbit cultivars and L-812 line, the lowest RFV was determined in the Pawera cultivar amongst red clover genotypes (Table 3). As a result of differences determined in DDM and DMI values amongst red clover genotypes, RFV values were also different amongst the genotypes. In similar researches, differences within a species were shown by Lekgari et al. (2006) in RFV and Yolcu et al. (2008b) in DDM, DMI and RFV.

## Total digestible nutrients, net energy lactation, net energy maintenance and net energy gain contents

Differences ($p < 0.01$) in terms of TDN, NEl, NEm and NEg contents were determined amongst the genotypes (Table 4). Total digestible nutrients contents of the genotypes ranged from 52.11%(L-79 line) to 66.50%(L-818 line). The highest total digestible nutrients contents were determined in the L-818, L-812 lines, Tohum Islah ecotype, Lucrun, Redwent cultivars and L-509 line, respectively. The highest NEl, NEm and NEg contents were found in the L-818 and L-812 lines, respectively (Table 4). These values were 0.70, 0.67 Mcal/1b (NEl), 0.76, 0.73 Mcal/1b (NEm) and 0.44, 0.40 Mcal/1b (NEg). The lowest NEl, NEm and NEg contents were determined in the L-79 lines. These values were also 0.52, 0.55, 0.22 Mcal/1b, respectively. In a similar research, Yolcu et al. (2008b) showed differences in TDN, NEl, NEm and NEg

**Table 4.** Total digestible nutrients (TDN), net energy lactation (NEl), net energy maintenance (Nem) and net energy gain (Neg) contents of red clover genotypes.

| Cultivars/Lines | TDN (%) | NEl (Mcal/1b) | NEm (Mcal/1b) | NEg(Mcal/1b) |
|---|---|---|---|---|
| Tohum Islah | 63.15 ab | 0.65 a-c | 0.71 a-c | 0.38 a-c |
| Orbit | 60.84 a-d | 0.63 a-d | 0.68 a-c | 0.35 a-c |
| Rajah | 60.88 a-d | 0.63 a-d | 0.68 a-c | 0.35 a-c |
| Rotra (Tetraploid) | 59.52 a-f | 0.61 b-e | 0.66 b-d | 0.33 b-d |
| Hamua | 58.62 a-f | 0.60 b-f | 0.65 b-e | 0.32 b-e |
| Redwent | 62.12 a-c | 0.65 a-c | 0.70 a-c | 0.37 a-c |
| Xiashao | 58.17 a-f | 0.60 b-f | 0.64 b-f | 0.31 b-f |
| Piemontese | 60.27 a-e | 0.62 a-d | 0.67 a-c | 0.34 a-d |
| Colenso | 60.70 a-e | 0.63 a-d | 0.68 a-c | 0.35 a-c |
| Lakeland | 54.07 c-f | 0.55 d-f | 0.58 d-f | 0.25 d-f |
| Lucrun | 62.19 a-c | 0.65 a-c | 0.70 a-c | 0.37 a-c |
| Pawera (tetraploid) | 52.78 d-f | 0.53 ef | 0.56 ef | 0.23 ef |
| L-68 | 57.53 b-f | 0.59 c-f | 0.63 c-f | 0.30 c-f |
| L-77 | 52.60 ef | 0.53 ef | 0.56 ef | 0.23 ef |
| L-79 | 52.11 f | 0.52 f | 0.55 f | 0.22 f |
| L-81 | 60.61 a-e | 0.63 a-d | 0.67 a-c | 0.35 a-c |
| L-509 | 60.94 a-c | 0.63 a-d | 0.68 a-c | 0.35 a-c |
| L-584 | 60.21 a-f | 0.62 a-d | 0.67 a-c | 0.34 a-d |
| L-777 | 60.06 a-f | 0.62 a-d | 0.67 a-c | 0.34 a-d |
| L-812 | 64.33 ab | 0.67 ab | 0.73 ab | 0.40 ab |
| L-818 | 66.50 a | 0.70 a | 0.76 a | 0.44 a |
| L-832 | 57.46 b-f | 0.59 c-f | 0.63 c-f | 0.30 c-f |
| L-1881 | 57.94 b-f | 0.59 c-f | 0.64 b-f | 0.31 b-f |
| L-1920 | 60.23 a-d | 0.63 a-d | 0.68 a-c | 0.35 a-c |
| L-1922 | 60.52 a-e | 0.63 a-d | 0.67 a-c | 0.35 a-c |
| **Mean** | 59.37 | 0.61 | 0.66 | 0.33 |
| Importance | P < 0.01 | P < 0.01 | P < 0.01 | P < 0.01 |
| LSD Value | 8.16 | 0.081 | 0.093 | 0.099 |

within a species on lucerne cultivars. TDN values of all the genotypes except Lakeland, Pawera cultivars, L-77 and L-79 lines were higher than that of the red clover commonly used in beef cattle diets issued by NRC (2000) (55.00%). The majority of the genotypes were also over the values used in dairy cattle diets issued in NRC (2001) (59.10%) in terms of TDN. These results were shown in Figure 4. The NEl, NEm, NEg contents of the red clover genotypes were lower than those of the red clover commonly used in beef cattle diets (NRC, 2000) and in dairy cattle (NRC, 2001).

To be useful in livestock feeding, forage quality information must be available before feeding (Coleman and Moore, 2003). Quality of forage can be explained with levels of low ADF, NDF but high CP (Kallenbach et al., 2002), RFV and TDN (Anon, 2005). The highest CP, DDM, TDN, NEl, NEm, NEg contents and the lowest ADF were found in the L-818 line (selected from wild form) amongst the red clover genotypes. Relative feed value (RFV) is a widely accepted forage quality index in the marketing of hays in the United States of America (Canbolat et al., 2006). The highest RFV was obtained from, by the Tohum Islah ecotype, Hamua, Orbit cultivar and L-812 line respectively. TDN refers to the nutrients that can be utilized and available for livestock (Lithourgidis et al., 2006). The highest total digestible nutrients were found in the L-818, L-812 lines, Tohum Islah ecotype, Lucrun and Redwent cultivars, respect-tively.

## Conclusion

Over all, significant variation was determined in terms of yield and quality amongst the red clover genotypes. Rajah, L-832 (selected from wild forms) and Pawera had the highest dry matter yields. It may be recom-mended that these materials should be cultivated in regions which are lacking roughages. The L-818, L-812 lines (selected from wild forms), Tohum Islah ecotype, Lucrun and Redwent cultivars had superior quality performance than those of the others amongst the red clover genotypes. It may be recommended that these

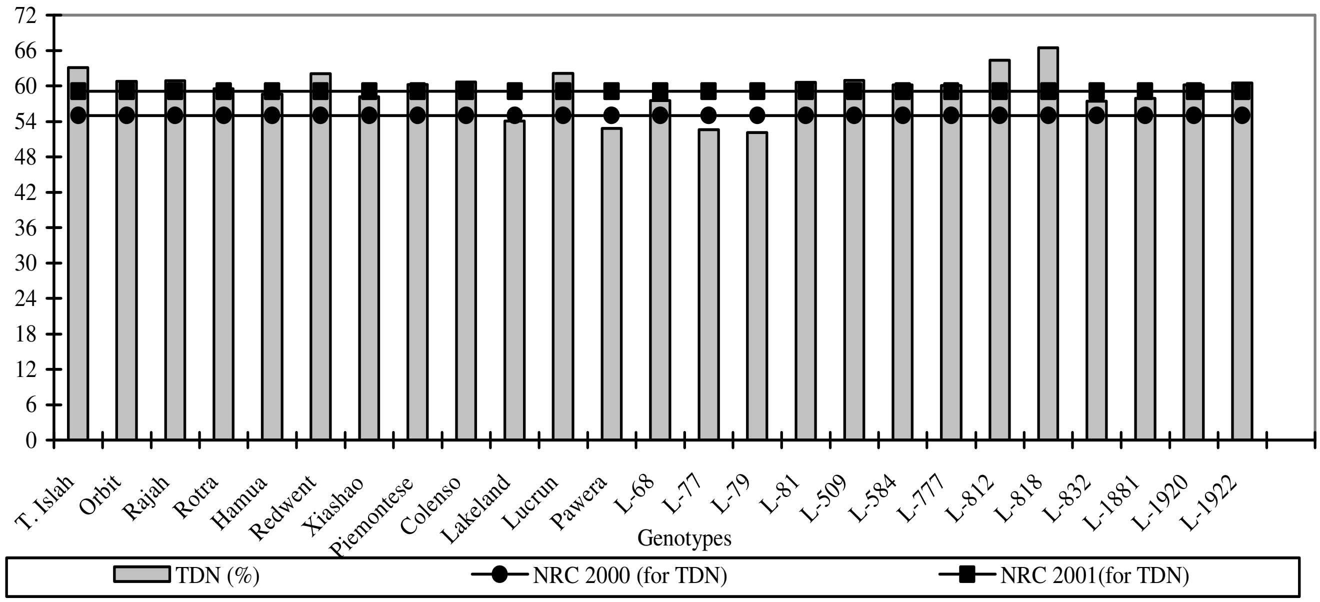


**Figure 4.** Relation between total digestible nutrient of red clover genotypes and values of NRC (2000) and NRC (2001).

these materials should be used in regions which are lacking quality forage. Improvement studies should be carried out using both material groups, if both quality and yield are lacking.

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