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Investigation for the Determination of White Clover (*Trifolium repens* L.) Cultivars That Can Be Grown in Southeastern Anatolia Region of Turkey

Mehmet Basbag, Ismail Gul and Veysel Saruhan
Department of Field Crops, Faculty of Agriculture, Dicle University, Diyarbakir, Turkey

Abstract: In the present study, some agronomic characteristics were investigated on 9 white clover cultivars obtained from various resources, between 1999 and 2001, under irrigated conditions in Southeastern Anatolia Region of Turkey. The average values of the three years for the white clover showed that the green herbage yield varied from 17713 to 28490 kg ha^{-1}; dry herbage yield from 4501 to 7574 kg ha^{-1}; plant height from 9.88 to 14.56 cm and their protein percentage from 16.52 to 19.00%. Tahora produced the highest green and dry herbage yield and plant height among all the cultivars and this was followed by cultivars Merwi and Kersey. The lowest green and dry herbage yields were obtained from D-269 and Milka cultivars. The protein content of the cultivars did not show any significant differences. However, Huia cultivar had the highest protein percentage (19.0%).

Key words: White clover, *Trifolium repens*, herbage yield, plant height, crude protein

INTRODUCTION

Forage crops cultivation to meet the roughage and compound feeds requirements of the Turkey's animal husbandry has not developed due to lack of economical, technical and some of cultural insufficiency. According to the last data obtained, cultivated area of the barley, corn, common vetch, alfalfa, rye, millets and canary-grass is 4, 750, 000 ha and the production is 19, 125, 070 ton (Anonymous, 2001a).

Clover cultivars are the legume forage crops that take place in second rank after alfalfa production in the World. While the clover cultivars are harvested 2,213,021 ha area in the world and average world forage yield 377,511 hg ha^{-1} and production is 83,543,900 mt, there is no clover production in Turkey (Anonymous, 2004).

Of all the grassland of our country, 11% is found in the Southestern Anatolian Region. However, because it is overgrazed and used unconsciously like other grassland areas in the country, it is damaged and has low yield potential. The percentage of forage crop growing area within total field crop is 0.3%. The region has an important potential for stock farming, with about 4, 084, 270 sheep, 1, 452, 350 goats and 678, 830 cows (Anonymous, 2001a). In order to cover increasing needs for roughage in the region, it is necessary to improve the existing grasslands and to grow forage crops.

Clover and the other forage crops has a high potential as the main crops in crop rotation and the places where the animal production is dominant after implementing of the GAP Project. Six percent alfalfa and 10% of the other forage crops are considered to be grown in the progressing irrigated area, based in the cropping pattern study. White clovers provide high yielding and good quality roughage and protect soil against erosion by entering crop rotations and by taking place in mixtures with other perennial forage grasses.

Nowadays, there are many white clover cultivars which are adapted to the various climatically conditions through the World. In order to develop the animal production in the region, different white clover cultivars must be investigated for the yield and adaptation.

As a result of adaptation studies on white clover cultivars different findings were obtained earlier.

Saglamtimur *et al.* (1986) obtained 4000-8000 kg ha^{-1} dry herbage yield from white clover cultivars in Cukurova Region. Rhodes *et al.* (1989) obtained the dry herbage yield of the white clover cultivars between 880-1020 kg/da in England. Tukel *et al.* (1992) obtained 10790-42830 kg ha^{-1} green herbage yield, 2710-8640 kg ha^{-1} dry herbage yield and 17.6-22.0 cm plant height in the study conducted with 6 white clover cultivars under irrigated condition in Harran Plain.

Annicchiarico (1993) obtained the dry matter yield of the white clover cultivars between 11500-14500 kg ha^{-1} in Southern Lombardy in Italy. Ayres and Poppi (1993) pointed out that the crude protein content more than 250 g kg^{-1} in the dry matter. Silbir *et al.* (1994) obtained 33060-70430 kg ha^{-1} green herbage yield, 7970-13020 kg ha^{-1} dry herbage yield and 20.6-23.3 cm plant height on the 3 white clover cultivars in Harran Plain. Aygun *et al.* (1998) obtained 7084-10473 kg ha^{-1} dry

Corresponding Author: Mehmet Basbag, Department of Field Crops, Faculty of Agriculture, Dicle University, Diyarbakir, Turkey Tel: 90-412 248 85 09/90-412 248 81 53

herbage yield as the highest dry herbage yield from Merwi and Kersey white clover cultivars irrigated conditions in Erzurum.

In this investigation, some important agronomical characteristics and herbage yield of 9 white clover cultivars obtained from different organisations within the country and abroad were examined to identify the suitable white clover cultivars for the ecological conditions of the Southeastern Anatolia Region of Turkey.

MATERIALS AND METHODS

In this investigation, 9 white clover cultivars are used. Among these white clover cultivars; Kopu, Huia, Tahora and Kersey were obtained from Margot Forde Forage Germplasm Centre (New Zealand), Mervi and Blanca were obtained from East Anatolian Agricultural Research Institute (Erzurum), D-269 was obtained from Southeastern Anatolia Agricultural Research Institute (Diyarbakir), Milka was obtained from Cimteknik Seed Company (Ankara), Ak Ucgul cultivar was obtained Unal Seed Company (Istanbul).

This research has been carried out in the Department of Field Crops of the Faculty of Agriculture at Dicle University in Diyarbakir. The altitude of the research location is 660 m and it is located on 37°54' N and 40°14' E, altitude 660 m).

Generally, Mediterranean and East Anatolian continental climate are effective in this region. In The Southeastern Anatolia of Turkey, the average annual temperature is 15.8, rainfall is 481.6 mm and the average relative humidity is about 53.8%. The average temperature can reach 30°C in July and August. The lowest average temperature can be 7°C in December and January. The earliest frost in the region is usually at the end of October and the last frost around end of April. Most rain falls in winter and there is almost no rainfall from July to September.

Weather conditions during the years when the research was carried out, are given in Fig. 1 and 2 (Anonymous, 2001b). The total rainfall in 1999 and 2000 (260.2 and 382.8 mm) (Fig. 2) was lower than the

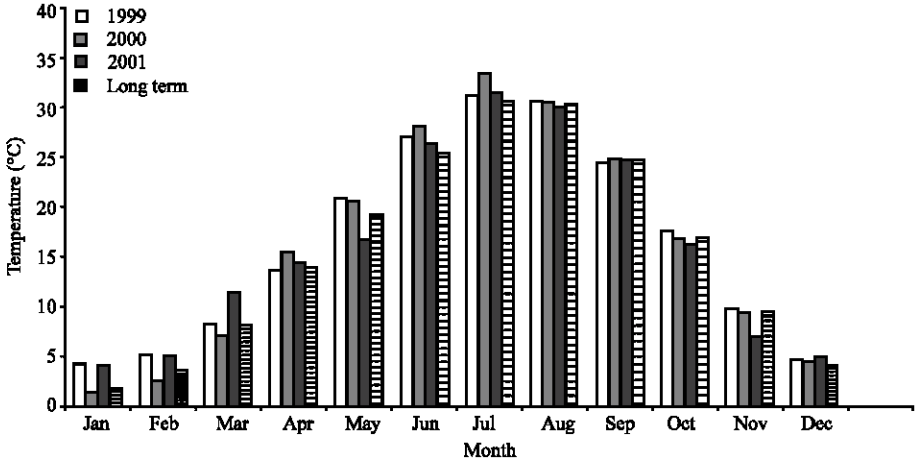

Fig. 1: Average air temperatures (°C) in the research area

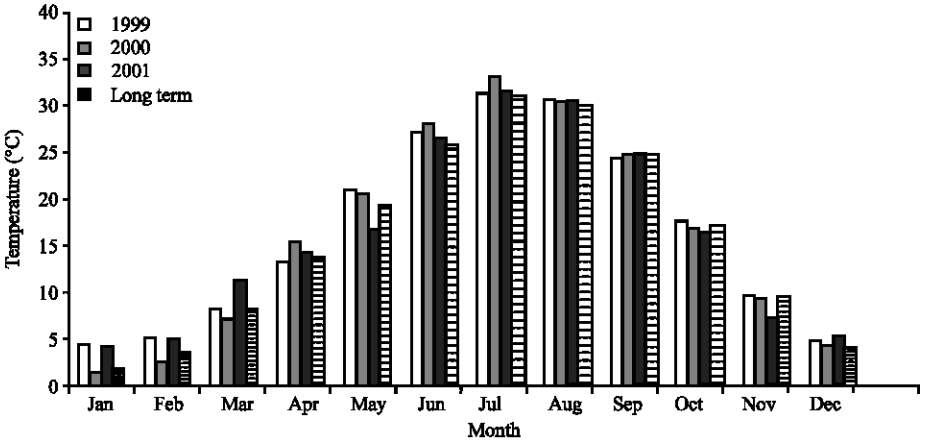

Fig. 2: Average amount of rainfal (mm) in the research area

average, while the total rainfall for 2001 (605.2 mm) was higher than normal. There was no important difference in average temperature between the years of the experiments and the long-term average.

The soils of the experimental area were thinly structured alluvial material or limestone. The soil is low in organic material and phosphorus and has adequate calcium and high clay content (49-67%) in the 0-150 cm profile. Also, the salt rate is suitable for cultivating plants and the water permeability of the soil is good (Anonymous, 1997).

This experiment was carried out on the research area of the Faculty of Agriculture at Dicle University and the experimental design was Completely Randomised Block with 4 replications.

Seed was sown by hand at 5 kg ha^{-1} in six-row plots, with rows 20 cm apart and 5 m long. Sowing took place on 12 May 1999. The experimental area was fertilized with 4 kg nitrogen (N) and 10.2 kg P_2O_5 before planting.

The trial was irrigated by sprinkler. The irrigating intervals were between 7-12 days and irrigation period was 8 h on average 7.86 mm h^{-1}. In addition to rainfall, 1250 mm water was applied to the trial annually. The highest rate of the water consumption occurred in July and August.

According to Hughes *et al.* (1966), cuttings were made at the full bloom period of cultivars. Before cutting, the mean plant height was obtained from randomly selected 10 plants by averaging the distance from soil level to the highest point at the top.

The dry herbage percentage was determined by randomly taking 0.5 kg green herbage from each plot and drying it in the greenhouse.

For the protein analysis, the herbage samples (with stalks and leaves) which were taken from each plot through the year, were grounded and at the end of the season and mixed equally and the sample taken from this mixture was used for protein analysis. The crude protein percentage was determined with Leco FP-528 protein analyser.

Analysis of variance was done by using a MSTAT-C statistic program and differences were compared by LSD tests.

RESULTS AND DISCUSSION

Green herbage yield: The differences between the cultivars with respect to the green herbage yield were found significant for each two years and average of these years. All white clover cultivars that were examined in a season total green herbage yield in first year is low, but, in second and third years were obtained similar (Table 1).

The average green herbage yield were 6510 kg ha^{-1} in 1999, 28915 kg ha^{-1} in 2000, 29241 kg ha^{-1} in 2001 and the 3-years average value was 21697 kg ha^{-1}. The reason why the first year's yield was low is due to the root growth and the short growing period in the first year.

Table 1: Average green herbage yields (kg ha^{-1}) of different cultivars of white clover and statistical groups

Cultivars	1999	2000	2001	Average
Ak Uçgul	6534bc	25838bc	24905	19092de
Milka	4360c	24368c	24487	17738e
Kopu	6267bc	27818bc	24754	19613cd
Huia	4237c	21267c	28273	17926de
Tahora	9415a	39461a	36595	28490a
Kersey	6825abc	31845abc	35020	24563abc
Mervi	7189ab	37235ab	33551	25992ab
Blanca	6418bc	29631abc	32560	22870bcd
D-269	7344ab	22773c	23021	17713e
Average	6510	28915	29241	21555
LSD (5%)	2704	11480	NS	5034
CV (%)	29.25	27.22	24.02	28.69

Means shown with the same letter in the same column are not significantly different at 0.05 probability level. NS, Non Significant

The green herbage yields varied from 4237 to 9415 kg ha^{-1} in 1999. While the highest green herbage yields were obtained from Tahora, D-269, Mervi and Kersey cultivars, respectively; the lowest yield values were obtained from Huia and Milka cultivars.

The green herbage yields varied from 21267 to 39461 kg ha^{-1} in 2000. While the highest green herbage yields were obtained from Tahora, Mervi, Kersey and Blanca, the lowest yield values were obtained from Huia, D-269 and Milka.

The green herbage yields varied from 23021 to 36595 kg ha^{-1} in 2001. While the highest green herbage yields were obtained from Tahora and Blanca, the lowest yield values were obtained from D-269 and Milka.

According to the average values of the three years, the green herbage yields varied from 17713 to 28490 kg ha^{-1}. While the highest green herbage yields were obtained from Tahora, Mervi and Kersey, the lowest yield values were obtained from D-269 and Milka (Table 1).

Present findings related to green herbage yield of the white clovers were in agreement with Tukel *et al.* (1992), but they were lower than Silbir *et al.* (1994) and higher than Rhodes *et al.* (1989). This difference was possibly due to the different cultivars and different ecological conditions from their study.

Dry herbage yield: According to the results of Table 2 the differences between the cultivars with respect to the dry herbage yield were not found significant for second year; these differences were found significant first year, third year and according to the average of these years.

The average dry herbage yield were 1908 kg ha^{-1} in 1999, 8262 kg ha^{-1} in 2000, 6621 kg ha^{-1} in 2001 and the three years average value was 5598 kg ha^{-1}. The reason why the first year's yield was low is due to the root growth and the short growing period in the first year.

Table 2: The average dry herbage yields (kg ha^{-1}) of different cultivars of white clover and statistical groups

Cultivars	1999	2000	2001	Average
Ak Ucgul	1898abc	7398	5766bcd	5021cd
Milka	1227c	6851	5427cd	4501d
Kopu	1810bc	8263	5365cd	5146cd
Huia	1236c	6633	6120bcd	4663d
Tahora	2662a	11321	8740a	7608a
Kersey	2126ab	8503	8206ab	6278abc
Mervi	2287ab	10113	7525abc	6642ab
Blanca	1818bc	7878	7481abc	5726bcd
D-269	2127ab	7399	4857d	4794d
Average	1908	8262	6621	5598
LSD (5%)	832.4	NS	2549	1374
CV (%)	29.86	27.53	26.38	30.16

Means shown with the same letter in the same column are not significantly different at 0.05 probability level. NS, Non Significant

The dry herbage yields varied from 1227 to 2662 kg ha^{-1} in 1999. While the highest dry herbage yield were obtained from Tahora, Mervi, D-269 and Kersey cultivars, respectively; the lowest yield values were obtained from Milka and Huia cultivars. The dry herbage yields varied from 6633 to 11321 kg ha^{-1} in 2000. While the highest dry herbage yields were obtained from Tahora, the lowest yield values were obtained from Huia.

The dry herbage yields varied from 4857 to 8740 kg ha^{-1} in 2001. While the highest dry herbage yields were obtained from Tahora, Kersey, Mervi and Blanca, the lowest yield values were obtained from D-269.

According to the average values of the three years, the dry herbage yields varied from 4501 to 7608 kg ha^{-1}. While the highest green herbage yields were obtained from Tahora, Mervi and Kersey, the lowest yield values were obtained from Milka, Huia and D-269 (Table 2).

Present findings related to dry herbage yield of the white clovers were in agreement with Tukel *et al.* (1992), Rhodes *et al.* (1989), Silbir *et al.* (1994), Aygun *et al.* (1998) and Saglamtimur *et al.* (1986).

Plant height: There were significant differences among white clover cultivars with respect to plant height for each year and average of the 3 years.

The average plant heights were 10.77 cm in 1999, 14.32 cm in 2000, 11.47 cm in 2001 and the 3 years average value was 12.19 cm. The plant heights varied from 7.62 to 14.09 cm in 1999. While the highest plant heights were obtained from Tahora and Kersey, the lowest yield values were obtained from Huia.

The plant heights varied from 11.58 to 17.06 cm in 2000. While the highest plant heights were obtained from D-269, Tahora and Kersey, the lowest yield values were obtained from Huia and Milka (Table 3).

The plant heights varied from 9.27 to 14.08 cm in 2001. While the highest plant heights were obtained from Kersey, Tahora, Mervi and Blanca, the lowest yield values were obtained from Milka.

Table 3: The average plant height (cm) of different cultivars of white clover and statistical groups

Cultivars	1999	2000	2001	Average
Ak Ucgul	10.22de	14.13cde	10.15bc	11.50de
Milka	8.15fg	12.21f	9.27c	9.88f
Kopu	9.34ef	12.95ef	10.21bc	10.84ef
Huia	7.62g	11.58f	10.71bc	9.97f
Tahora	14.09a	16.29ab	13.30ab	14.56a
Kersey	13.12ab	15.63abc	14.08a	14.28ab
Mervi	11.66bcd	15.16bcd	13.25ab	13.36abc
Blanca	10.78cde	13.86de	11.88abc	12.18cd
D-269	11.92bc	17.06a	10.41bc	13.22bc
Average	10.77	14.32	11.47	12.20
LSD (5%)	1.696	1.538	3.204	1.267
CV (%)	10.61	7.35	11.47	12.77

Means shown with the same letter in the same column are not significantly different at 0.05 probability level. NS, Non Significant

Table 4: The average crude protein (%) of different cultivars of white clover and statistical groups

Cultivars	1999	2000	2001	Average
Ak Ucgul	17.48	16.49d	15.58	16.52
Milka	19.97	17.76bcd	16.11	17.95
Kopu	18.87	19.69a	16.52	18.36
Huia	21.51	18.71abc	16.76	19.00
Tahora	19.08	18.50abc	16.49	18.02
Kersey	19.40	17.55bcd	15.71	17.55
Mervi	21.14	16.94cd	16.19	18.09
Blanca	20.12	19.17ab	16.54	18.61
D-269	19.22	17.22cd	15.74	17.39
Average	19.64	18.00	16.18	17.94
LSD (5%)	NS	1.784	NS	NS
CV (%)	14.57	6.79	8.44	10.94

Means shown with the same letter in the same column are not significantly different at 0.05 probability level. NS, Non Significant

According to the average values of the three years, the plant heights varied from 9.88 cm to 14.56 cm. While the highest plant heights were obtained from Tahora, Kersey and Mervi, the lowest values were obtained from Milka and Huia (Table 3).

Our findings related to plant heights of the white clovers were lower than Tukel *et al.* (1992) and Silbir *et al.* (1994). This difference was possibly due to the different cultivars and different ecological conditions from their studies.

Crude protein: There was a significant difference among white clover cultivars with respect to the crude protein percentage in the second year. However, there were no differences for the 1st, 3rd years' rates and the 3 year's average values (Table 4).

The crude protein percentages were found as 19.64% in 1999, 18.00% in 2000 and 16.18% in 2001 and as 17.94% according to the average of the three years.

The crude protein percentage varied from 17.48 to 21.51% in 1999, while the highest crude protein percentage was obtained from Huia, the lowest yield values were obtained from Ak Ucgul.

The crude protein percentage varied from 16.49 to 19.69% in 2000, while the highest crude protein percentage were obtained from Kopu, Blanca, Huia and Tahora, the lowest values were obtained from Ak Uçgul.

The crude protein percentage varied from 15.78 to 16.76% in 2001, while the highest crude protein percentage was obtained from Huia, the lowest values were obtained from Ak Ucgul.

According to the average values of the three year, the crude protein percentage varied from 16.52 to 19.00%. While the highest crude protein percentage was obtained from Huia, the lowest value was also obtained from Ak Ucgul.

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