Artvin Çoruh Üniversitesi
Orman Fakültesi Dergisi
ISSN:2146-1880, e-ISSN: 2146-698X
Cilt: 15, Sayı:1, Sayfa: 73-84 Nisan 2014

Artvin Coruh University
Journal of Forestry Faculty
ISSN:2146-1880, e-ISSN: 2146-698X
Vol: 15, Issue: 1, Pages: 73-84 April 2014

http://edergi.artvin.edu.tr

Determination of Genotypic Performances of White Clover (*Trifolium repens* L.) Collected from Natural Pastures

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Article Info:
Research article
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ABSTRACT

This study was conducted to fine out morphological and physiological characteristics of white clover genotypes obtained from different location of Eastern Anatolia pastures. Similarities/dissimilarities in white clover genotypes and plant characteristics' by principle components analysis were made. Plant height as a depended variable the effect of criteria on plant height and critic the best model to calcify genotype were made in white clover. As a result, wide variations were determined in not only plant characteristics but also genotypes. This was variation in other word genetic differentiations. Genetic differentiation on genotypes in white clover could help plant selection in white clover breeding present. Study showed that white clover breeding may be based on erect and prostrate plant selection. Plant characteristics and genotypes were classified in five certain groups on plant height.

Keywords: White clover (*Trifolium repens* L.), characterization, principle component analysis, biplot analysis.

Doğal Meralanrdan Toplanan Ak Üçgül (*Trifolium repens* L.) Genotiplerinin Performanslarının Belirlenmesi

ÖZET

Bu çalışmada Doğu Anadolu mera alanlarından toplanan ak üçgül(Trifolium repens L.) genotiplerinin fizyolojik ve morfolojik karakterlerinin incelenmesi amacıyla yapılmıştır. Ak üçgül genotiplerinin benzerlik ve farklılıkları principle component analizi yoluyla yapılmıştır Bitki boyu bağımlı değişken olarak kabul edilerek genotipler değerlendirilmiş, genofipler arasındaki farkı ise en iyi şekilde ortaya koyan model olarak bu model kullanılmıştır. Sonuç olarak sadece bitki özellikleri arasında değil bitki genotipleri arasında da geniş bir varyasyon tespit edilmiştir. Diğer bir deyişle bu farklılık genetik bir varyasyondur. Ak üçgül genotipleri içerisindeki genetik farklılık ıslahta bitki seçiminde yardımcı olacaktır. Bu çalışma bitki ıslahında dik ve yatık bitkilerin seçileceğini göstermiştir. Genotipler bitki karakteristiklerine göre belli başlı beş gurupta toplanmıştır.

Anahtar kelimeler: Al üçgül (*Trifolium repens* L.), karakterizasyon, principle component analizi, biplot analizi

INTRODUCTION

Forage crops are the main activities in not only sources of feed industry but also main part of soil protection and erosion. There is a tremendous gap between forage crops production and need of feed industry. Even though cultivation there for and accordingly production are so far from compensation of production of in sufficient forage crops production (Anon 2013). Natural grassland have been playing important role for animal

husbandry, however they have fallen into the back ground in their productivity, since continuous-heavy grazing made their productivity so low. Nevertheless natural grassland plants are important genetic sources of fodder crops breeding program including legumes, grasses families (Mc Ivor 2005). Eastern Anatolia is the important places for forage crops pasture plants (Anon 2006) characteristics of area is mountains and high altitude, cold winter and hot and drought summer.

White clover as a member of legumes is valuable plants in grassland. On the other hand Eastern Anatolia has been hosted many of forage crops including white clover. Studies revealed that Turkey is characterized by more than 30 (Akpınar at al 2010) zone and having 180 frost days Eastern Anatolia alone covers more than 75 % of total grassland area (Anon 2011). Grassland degradation is one of the important factors reducing crop production (Yili 2006; Zhou 2005; Xie 2006). White clover seems promising crop to cover production (Manga at al 1995; Sağlamtimur at al 1986; Açıkgöz 1991; Elçi 1988). Moreover, establishment of artificial grassland to meet sufficient fodder crop requirement in intensive animal farming seems the better solution (Matches 1992; Ledgard 1989; Harris1989; Bax 1993). Due to its valuable nutritive properties and N fixation ability, white clover could be able to chosen is be able to good crop in production (Ledgard 1989; Ruselle 1992; Matches 1992; and Ryan 1989). White clover under irrigated conditions should good adaptability and performance, and could be suggested to grassland areas in Eastern Anatolia (Aygün 1998). Referred that white clover has strong growth in irrigated conditions but it can be stand drought conditions better due to vigorous development and tolerance to wide range of soils types (Chapman 1983; Taylor 1985). This study was designed to fine out morphological and physiological characteristics of white clover genotypes obtained from different location of Eastern Anatolia pastures. Similarities / dissimilarities in white clover genotypes and plant characteristics' by principle components analysis were made. Plant height as a depended variable the effect of criteria on plant height and critic the best model to calcify genotype were made in white clover.

MATERIALS and METHODS

This study was carried out in years of 1989-1990-1991. White clover genotypes were collected from different places of the eastern Anatolia region. Genotypes were sown in Eastern Anatolia Agriculture Research Institute in Pasinler location of Erzurum. Data of three years were taken in genotypes and data of plant characteristics were analyzed. Study area is classified as arid white cool winter hot summer income maximum, minimum temperatures in the area were.

Genotypes were collected were planted in 2000.and data were taken in 1991. Dominant soil type of planting area were had clay–loamy texture (EC: 1.3 ds.m-2 and pH: 7.6, organic matter 2.1 %, P: 27.5 mg kg-1, K: 143.5 mg kg-1, CaCO3: 120.2 %). White clover genotypes were planted in one raw plant of one meter in and four meters spacing. Plant characters were taken by methods of Tosun (1973), Tokluoğlu (1979), Açıkgöz (1982), Tosun and Yurtman (1973), Sağsöz (1974), Sağsöz (1995), Mc Lean and Ivimery (1941), Weaver and Clement (1938) and Crider (1955).

RESULT and DISCUSSION

White clover shows better response to water and crop yield sharply decrease when it's grown rainfed conditions. Accessions growing in different climatic conditions could show different morphological and physiological characters. Similar to these genotypes in this study showed different genotypic variance inferring that the bigger genotypic variance the better breeding success (Açıkgöz 2001; Baker and Willıams 1987; Taylor 1985; Thomson 1985; Brock 1983; Brougham 1960). Minimum, maximums and mean values of plant characters are given in Table 1.

Table 1. Minimum, maximums and mean values of plant characters.

	Minimum	**Maximum**	**Mean**
Flower Number	30,00	200,00	66,61±30,33
Kernel Length	1,00	2,500	1,31±0,42
Kernel Width	0,50	1,50	0,93±0,23
Plant Height	8,00	56,00	26,32±11,33
Habitus	1,00	3,00	1,58±0,65
Leaf Number	3,00	191,00	30,11±34,59
Days to Flowering	122,00	187,00	155,26±12,13
Days to Ker.Mat.	197,00	226,00	206,28±8,00
Tho.Kernel We	0,06	2,70	0,79±0,51
Germ.Speed	0,00	100,00	48,48±30,44
Germ.Power	0,00	100,00	59,81±30,20
Leaf Length	0,90	4,100	2,03±0,80
Leaf Width	0,60	3,40	1,54±0,54
Stem Thickness	0,10	5,00	1,14±1,08

Table 1 denotes minimum, maximums and means values of plant characters. Flower number was determined in 30 minimum 200 maximum and 66.61±33 mean. Kernel length and width in minimum, maximum mean values were 1, 2.5 and 1.31±0.42; 0.50, 1.50, 0.93±0.23, respectively. Plant height, leaf length and width were determined as 8.0 cm, 0.9 cm and 0.60 cm in minimum, 56 cm 41 cm 3.40 cm in maximum and 26.32±11.33, 2.03±0.80 cm and 1.54±0.54 cm in mean. Habitus and leaf number in minimum, maximum and mean 1.00, 3.00 and 1.58±0.65; 3.00, 191.00 and 30.11±34.59, respectively. Days to flowering and kernel maturation in minimum, maximum and mean were 122.00, 187.00 and 155.26±12.13 days; 197.00, 226.00, 206.28±8.00 days, respectively. Thousand kernels weight, germination speed and power, steam thickness in minimum, maximum and mean were found as 0.06, 2.70 and 0.79±0.51 gr; 0.00, 100.00, 48.48±30.44%; 0.00, 100.00,59.81±30.20; 0.10, 5.00, 1.14±1.08 mean, respectively. Sağlamtimur et al., (1986), Aygün (1998) and Bullitta (1989) pointed out that plant characteristics are important on new variety development in breeding programs. A study related to white clover breeding has long been neglected until recant 20 years and this subject is vital on novel genotype development in Turkey (Açıkgöz 2001; Connolly, 2000; Woodfield, 1994; Hallowell, 1966; Elçi, 2005; Anon., 2008). Relationship between plant characteristics in white clover is shown Table 2.

Table 2. Relationship between plant characteristics in white clover.

	Flower Number	Kernel Length	Kernel Width	Plant Height	Habitus	Leaf Number	Days to Flowering	Days to Ker.Mat	Tho.Kernel Weight	Germ.Speed	Germ.Power	Leaf Length	Leaf Width
Kernel Length	0,081ns												
Kernel Width	0,243 *	0,165*											
Plant Height	0,418**	-0,065ns	0,244*										
Habitus	0,332*	0,123*	0,239*	0,111ns									
Leaf Number	-0,026ns	0,099ns	0,220*	0,158ns	0,333*								
Days to Flowering	-0,123*	-0,175*	0,012ns	-0,185ns	0,331*	0,133ns							
Days to Ker.Mat	-0,050 ns	-0,024ns	0,272**	-0,070ns	0,270*	0,108ns	0,676**						
Tho.Kernel Weight	0,319*	0,303**	0,339**	0,276*	0,060ns	0,119ns	-0,036ns	0,222ns					
Germ.Speed	0,076ns	-0,085ns	-0,139*	0,266**	-0,082ns	-0,086ns	-0,341*	-0,243ns	0,292**				
Germ.Power	0,217*	-0,001ns	-0,119ns	0,320**	0,038ns	-0,036 ns	-0,394**	-0,272*	0,320**	0,939**			
Leaf Length	0,612**	0,077ns	0,232ns	0,652**	0,409**	0,096 ns	0,033ns	0,202ns	0,378**	0,132ns	0,221ns		
Leaf Width	0,547**	-0,146ns	0,096ns	0,710**	0,212ns	-0,144 ns	-0,099ns	0,038ns	0,174ns	0,296*	0,350*	0,742**	
Stem Thickness	0,137*	-0,128ns	0,020ns	0,612**	-0,085ns	-0,093 ns	-0,077ns	0,086ns	0,419**	0,417**	0,377*	0,515**	0,590**

Relationship between kernel weight and flower number, kernel weight and kernel length, plant height with kernel weight, habitus with flower number, habitus with kernel length, habitus with kernel weight, leaf number with kernel weight, leaf number with habitus, days to flowering with habitus, days to kernel maturation with habitus, thousand kernel weight with kernel number, thousand kernel number with plant height, germination power with flower number, leaf with germination speed, steam thickness with germination power were found as positive and significant at 5%. Besides, relationship between plant height with flower number, days to kernel maturation with kernel weight, days to kernel maturation with days to flowering, thousand kernel weight with kernel length, thousand kernel weight with kernel weight, germination speed with plant height, germination speed with thousand kernel weight, germination power with plant height, germination power with thousand kernel weight, germination power with germination speed, leaf length with flower number, leaf length with plant height, leaf length with habitus, leaf length with thousand kernel weight, leaf weight with flower number, leaf weight with plant height, leaf weight with leaf length, leaf weight steam thickness, steam thickness with plant height, steam thickness with thousand kernel weight, steam thickness with germination speed, steam thickness with leaf length were found to be positive and significant at 1%. Relationship between days to flowering with flower number, germination speed with kernel weight, germination speed with days to flowering, germination power with days to maturity were determined are negative and significant at 5%. Aygün (1998) found significant relationship between kernel and leaf characteristics that are significant milestones for selection in white clover. On the other hand, distribution or variations of genotypes in terms of plant characterization between plants characteristics are given Figure 1.

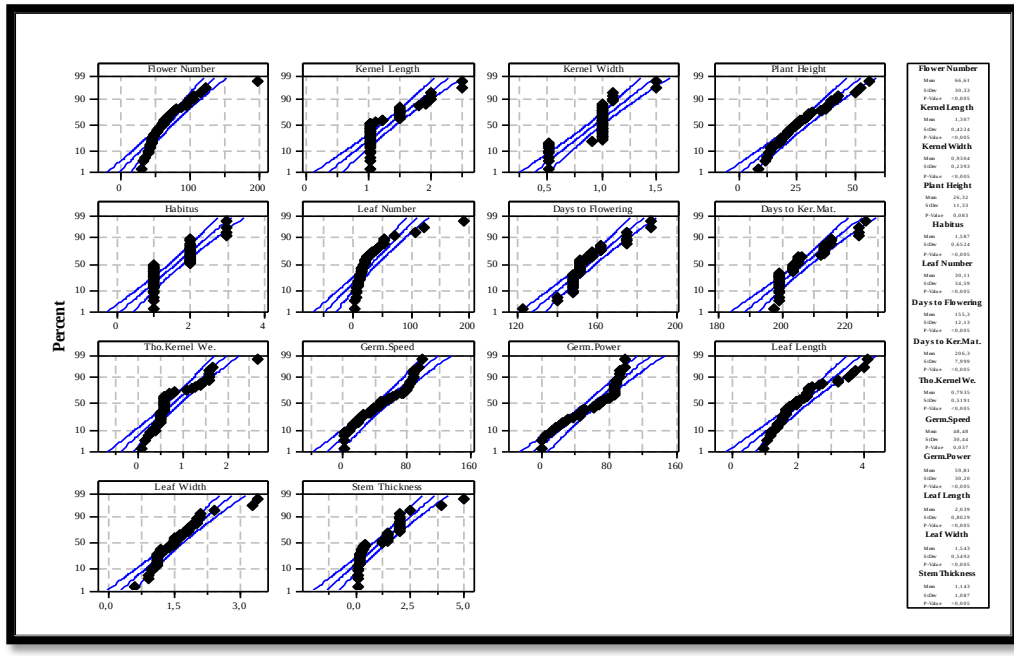

Figure 1. Distribution or variations of genotypes in terms of plant characterization between plants characteristics.

As show in Figure 1, normal distribution were taken from flower number, plant height, leaf number, days to flowering and kernel maturation, thousand kernel weight,

germination speed, germination power, leaf length, leaf weight and steam thickness more variation were seen in kernel length and weight, habitus normal distribution were recorded for plant characteristics in genotypes, this mean that synchronization between genotypes for each plant characteristics show that genotypes deserved to be moved on the next breeding step (Harper 1977; Ahlgren 1950; Gibson 1965; Davies 1967; Barcikowska 1976). In other words synchronization in genotypes for plant characteristics stress that genotypes are about to be candidates for registration. Eigen analysis of correlation matrix and principle component analysis for plant characteristics are shown in Table 2.

Principle component analysis is suitable methods to get smaller number of artificial variables accounting for determining variance new variable. This method also better predictor of similarities or dissimilarities (Marilley 1999; Hebeisen 1997; Deiglmayr 2006; Caradus 1986; Caradus 1992). Table 3 show that describing more than 70%, cumulative percent plant characteristics should be examined in five groups (Eigen value: 1,1254, proportion:0,080,cumulative percent: 76,1%). Genotypes could be grouped for plant height, leaf length and days to flowering, kernel length and leaf length. Similarities/dissimilarities for plant characteristics by biplot analysis are given Figure 2.

Figure 2 show that plant characteristics were classified in five groups. First group constitute of days to flowering and kernel maturation, second group had habitus, kernel weight, leaf number and kernel length. The third group included leaf length, flower number and kernel length. While plant height, kernel weight and steam thickness belonged to group four. The fifty group comprised germination power and germination speed (Table 2). On the other hand, genotypes were classified five groups by dendogram and given in Figure 3.

Table 2. Eigen analysis of correlation matrix and principle component analysis for plant characteristics are white clover.

Eigen value	**4,0372**	**2,6318**	**1,5564**	**1,3088**	**1,1254**	**0,9526**	**0,7277**	**0,5229**
Proportion	0,288	0,188	0,111	0,093	0,080	0,068	0,052	0,037
Cumulative	0,288	0,476	0,588	0,681	0,761	0,829	0,881	0,919
Eigen value	0,3261	0,2653	0,1822	0,1729	0,1505	0,0401		
Proportion	0,023	0,019	0,013	0,012	0,011	0,003		
Cumulative	0,942	0,961	0,974	0,986	0,997	1,000		

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14
Flower Number	0,311	0,137	0,118	-0,393	0,045	-0,321	0,232	0,516	-0,179	-0,117	0,401	0,207	0,185	-0,077
Kernel Length	0,013	0,078	0,598	0,007	-0,220	-0,290	-0,529	-0,328	-0,224	-0,192	0,164	0,001	-0,024	-0,031
Kernel Width	0,119	0,308	0,312	-0,017	-0,250	0,277	0,652	-0,373	0,040	-0,102	0,165	-0,217	-0,018	0,059
Plant Height	0,400	0,036	-0,088	-0,163	-0,047	0,405	-0,130	-0,104	-0,165	-0,457	-0,432	0,332	0,275	-0,050
Habitus	0,122	0,368	0,113	-0,061	0,557	-0,245	-0,003	-0,291	0,535	0,045	-0,104	0,268	0,014	-0,083
Leaf Number	0,017	0,234	0,300	0,152	0,447	0,609	-0,214	0,278	-0,197	0,157	0,219	-0,036	-0,157	-0,012
Days to Flowering	-0,117	0,418	-0,341	0,302	0,129	-0,161	-0,066	0,107	-0,055	-0,645	0,105	-0,318	-0,085	0,083
Days to Ker.Mat.	-0,007	0,444	-0,212	0,411	-0,138	-0,149	0,075	-0,123	-0,442	0,393	-0,037	0,377	0,179	-0,034
Tho.Kernel We.	0,271	0,104	0,305	0,405	-0,331	-0,092	0,038	0,471	0,308	-0,006	-0,372	0,065	-0,283	-0,013
Germ.Speed	0,275	-0,367	0,037	0,385	0,247	-0,104	0,179	-0,120	-0,154	-0,084	0,056	-0,156	0,044	-0,679
Germ.Power	0,311	-0,335	0,117	0,293	0,311	-0,159	0,140	-0,082	-0,165	-0,034	-0,002	0,010	0,085	0,713
Leaf Length	0,402	0,230	-0,070	-0,154	-0,002	-0,082	-0,208	0,028	-0,017	0,340	-0,215	-0,663	0,323	0,016
Leaf Width	0,409	0,039	-0,275	-0,233	-0,006	-0,060	-0,048	-0,189	-0,204	0,091	0,032	0,022	-0,780	0,008
Stem Thickness	0,355	-0,064	-0,267	0,234	-0,268	0,196	-0,263	-0,086	0,421	0,040	0,582	0,119	0,153	0,046

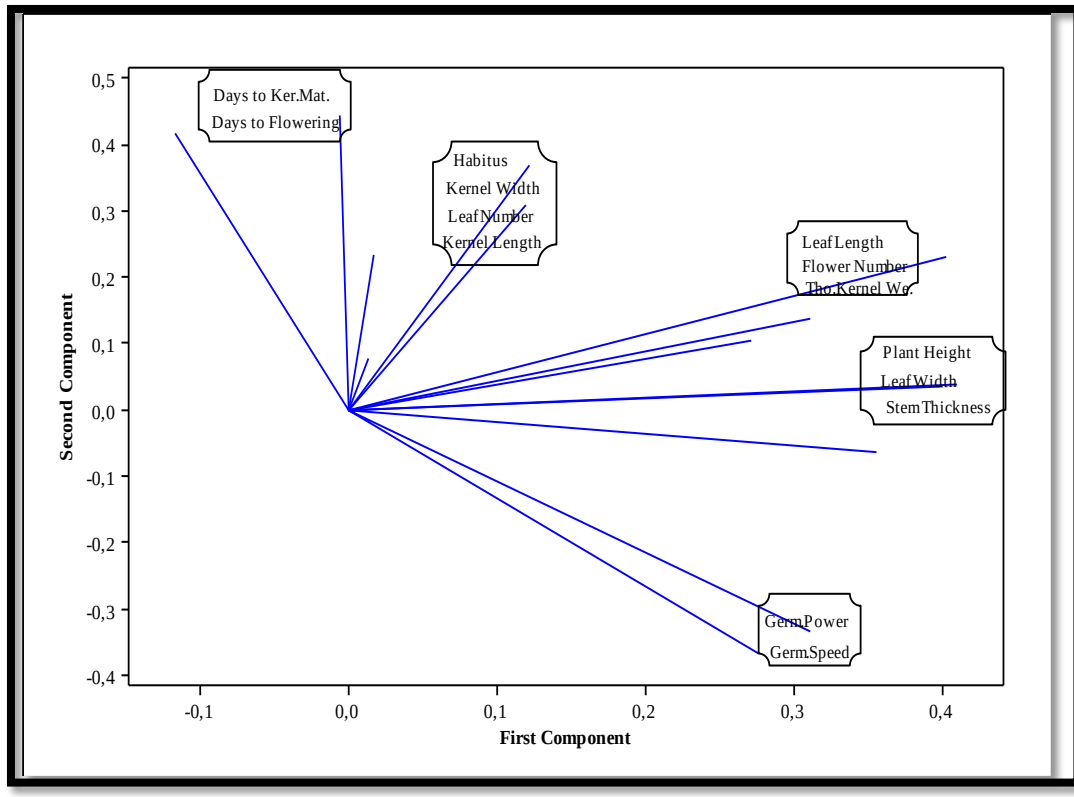

Figure 2. Similarities/dissimilarities for plant characteristics by biplot analysis.

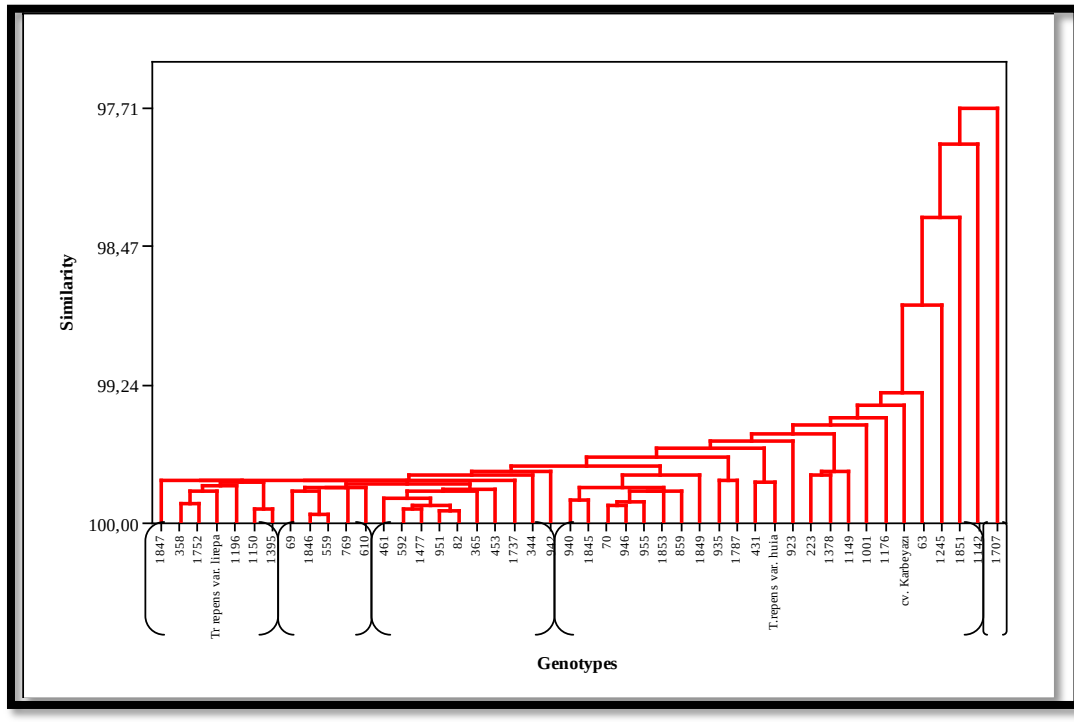

Figure 3. Classifications of genotypes by dendogram.

Figure 3 denotes that, the first group included genotypes, 1395, 1150, 1196, T. repens cv. Lirepa, 1757, 358, and 1847. The second one also included610, 769, 559, 1846, 69. were included in group tree 942, 344, 1737, 453, 365, 82, 951, 1477, 592, 461, group four 1142, 1851, 1245 and 63, T. repens cv. Karbeyazı, 1176, 1001, 1149, 1378, 223, 923, T. repens cv. Huia, 431, 1787, 935, 1849, 859, 1853, 955, 946, 70, 1845, 940. Moreover 1707, The four group was the largest group including 1142, 1851, 1245 and 63, T. repens cv. Karbeyazı, 1176, 1001, 1149, 1378, 223, 923, T. repens cv. Huia, 431, 1787, 935, 1849, 859, 1853, 955, 946, 70, 1845, 940. The last group (group five) drove alone proportion with genotype 1707. Trifolium repens are having generally been evaluated on selected four both erect and prostrate types. The erect genotypes are suitable to hay yield, but the other group prostrate genotypes are appropriate to be grazed (Açıkgöz 2001) Maintained that erect genotypes give more hay yield than prostrate ones. Prostrate genotypes are more resistant to for animal grazing and they could safely place in establishment meadow (Açıkgöz 2001; Baker and Willıams 1987; Taylor 1985; Thomson 1985; Brock 1983; Brougham 1960).

Similarity to this considering plant height as a depended variable multi regression analysis was made to determine the effect of plant characteristics on plant height. Since selection of white clover could mainly be occurred in two groups. First erect plant types, the second group prostrate type (Açıkgöz 2001; Baker and Willıams 1987; Taylor 1985; Cardus at al 2001; Bernard 1972; Bishop 1969; Davies 1970). Multi regression analysis showing the effects of plant characters on plant height was given in Table 3.

Table 3. Multi regression analysis showing the effects of plant characters on plant height.

Analysis of Variance					
Source	DF	SS	MS	F	P
Regression	13	4063,90	312,61	5,86	0,000
Residual Error	32	1707,66	53,36		
Total	45	5771,56			
Predictor	Coef	SE Coef	T	P	
Constant	48,63	35,19	1,38	0,176	
Flower Number	0,00392	0,05689	0,07	0,945	
Kernel Length	-0,531	3,072	-0,17	0,864	
Kernel Width	9,438	5,590	1,69	0,101	
Habitus	-2,520	2,379	-1,06	0,297	
Leaf Number	0,08114	0,03612	2,25	0,032	
Days to Flowering	0,0247	0,1483	0,17	0,869	
Days to Ker.Mat	-0,2716	0,2126	-1,28	0,211	
Tho.Kernel We.	-1,247	3,210	-0,39	0,700	
Germ.Speed	-0,0689	0,1239	-0,56	0,582	
Germ.Power	0,0745	0,1299	0,57	0,570	
Leaf Length	2,944	2,690	1,09	0,282	
Leaf Width	8,633	3,878	2,23	0,033	
Stem Thickness	3,179	1,650	1,93	,063	
S: 7,30510 R^2: 70,4%					

As seen in Table 3, the effect of plants characters on plant height was found to be significant at 1%. Detailed analysis of regression analysis show that the effects of leaf number, leaf weight and steam thickness were determined as significant at 5%. Studies related to white clover revealed that leaf and steam characteristics are important criteria in crop growth (Açıkgöz 2001; Baker and Willıams 1987). Besides

forecasting of plant height could be made regression formula below.

Regression Formula for Forecasting Plant Height
Plant Height: 48,6 + 0,0039 Flower Number - 0,53 Kernel Length + 9,44 Kernel Width - 2,52 Habitus + 0,0811 Leaf Number + 0,025 Days to Flowering - 0,272 Days to Ker.Mat.- 1,25 Tho.Kernel We. - 0,069 Germ.Speed + 0,075 Germ.Power + 2,94 Leaf Length + 8,63 Leaf Width + 3,18 Stem Thickness

As a result, wide variations were determined in not only plant characteristics but also genotypes. This was variation in other word genetic differentiations. Genetic differentiation on genotypes in white clover could help plant selection in white clover breeding present. Study showed that white clover breeding may be based on erect and prostrate plant selection. Plant characteristics and genotypes were classified in five certain groups on plant height. This is an essential attribute not only for classified of plant characteristics but also classifying of genotypes using in breeding program. Beside selection erect genotypes for high yield and prostrate ones for animal grazing will be the right decision in crop selection in white clover breeding. Further studies are needed to determine affective crop selection.

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