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Research article/Araştırma makalesi

Determination of plant characteristics on perennial ryegrass (*Lolium perenne*) genotypes selected from natural pastures

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Abstract

The aim of this study was to determine morphogical and physiological characteristics in *Lolium perenne* genotypes, gathered from pastures of Trabzon, Rize, Erzincan and Erzurum provinces in 2001-2002 years. Total 32 gathered *Lolium perenne* genotypes (31 collected ans 1 control) were grown in Erzurum climatic conditions. Plant characters, plant height, flower length, flower number, kernel length, kernel weight, branch number, stand, leaf number, flowering time, maturation date, thousand kernel weight, germination speed, germination power, leaf length, leaf width, stem thickness and spike length were taken. Result revealed that genotypes 1430, 1516, 1652, 1535, 1785, 1636, 1526 and 1541 were determined as promising genotypes and they should be placed in breeding programs. Considering plant height as indicator character in kernel and hay yield flower number, flowering and maturity times and germination power were determined as efficient characters in genotype selection in *Lolium perenne* breeding. More detailed studies are needed in genotype selection of breeding programs.

Key words: *Lolium perenne*, collection, morphogical, physiological, characterization.

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Doğal meralardan toplanan çok yıllık çim (*Lolium perenne*) genotiplerinde bitkisel özelliklerinin belirlenmesi

Özet

Bu çalışmanın amacı 2001 -2002 yıllarında Trabzon, Rize, Erzincan ve Erzurum bölgelerinde meralardan toplanan *Lolium perenne* (çok yıllık çim/ingiliz çimi) genotiplerinde morfolojik ve fizyolojik karakterlerin belirlenmesine çalışılmıştır. 31 adet toplanan 1 adet kontrol olmak üzere toplam 32 *Lolium perenne* genotipinde Erzurum iklim şartlarında bitki boyu, çiçek boyu, çiçek sayısı, tohum boyu, tohum eni, yandal sayısı, bitkinin duruşu, yaprak sayısı, çiçeklenme gün sayısı,tohum olgunlaştırma tarihi, bin tane ağırlığı, çimlenme hızı, çimlenme gücü, yaprak boyu, yaprak eni, sap kalınlığı ve başak boyu gibi bitki karakterleri belirlenmiştir. Sonuçlar göstermiştir ki; 1430, 1516, 1652, 1535, 1785, 1636, 1526 ve1541 nolu genotiplerin ileri ıslah programlarına aktarılması gerektiği ortaya konulmuştur. Bitki boyu indicator olarak esas alındığında tohum, verim, çiçek sayısı, çiçeklenme ve tohum olgunlaştırma tarihi ve çimlenme hızı *Lolium perenne* genotiplerinin seçiminde etkili karakterler olarak belirlenmiştir. Islah programlarında genotiplerin seçimi için daha fazla çalışmalara ihtiyaç vardır.

Anahtar kelimeler: *Lolium perenne*,toplama, morfolojik, fizyolojik, karakterizasyon.

1. Introduction

Having eight species in Gremineae family, *Lolium perenne* is one of the important genus. With two important ryegrass species, italian ryegrass (*Lolium multiflorum* Lam.) and perennial (*Lolium perenne*). *Lolium perenne* (çok yıllık çim/ingiliz çimi) is perennial plant and is native plant in temperate/cold regions in the world (Sağlamtimur et al., 1989;

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Soya et al., 1997; Avcıoğlu et al., 1999). Having hairless and bunch appearance, it is a high yielding crop for grazing/hay when growing environment is favorable (Şehirali, 1997). *Lolium perenne* is known as the first cultivated plant among forage crops(Schoth, 1963), and it is well adapted to Europe, Southern Asia coastal and southern areas of America; ryegrass could easily produce not only kernel yield but hay yield if it is grown favorable climatic conditions, especially sufficient amount rainfall/irrigation (Tokluoğlu, 1979; Sağlamtimur et al., 1989; Şehirali, 1997; Soya et al., 1997). *Lolium perenne* is one of the common forage grasses cultivated in all parts of Turkey The cultivation of *Lolium perenne* is not stable. Such essential property of *Lolium perenne* is its ability to give stable and high hay yield if given with adequate water and nutrients (Balbay, 2008). The amount of yield commonly depends upon genetic performance in *Lolium perenne* (Johnson, at al., 2002). Flowering and maturation times plays important role in kernel and hay yield, besides in stress tolerance and differences on flowering and maturation times in ryegrasses significantly depends on climatic conditions (Sağlamtimur et al., 1989; Şehirali, 1997; Gilliland et al., 2000). Literatures stressed that flowering and maturation times varied 130-150 days (Tomov, 1972; Andinç, 1985) and 180-220 days, respescively (Andinç, 1985; Aygün et al, 2007a; Aygün et al, 2007b). Moreover, flower number in spike and flower length are important criteria and they were considered in a number of studies (Gilliland et al., 2000; Darvishi, 2009) and flower number in spike and flower length were varied as 14-65 and 0.2-1.8 mm, respectively (Elçi and Açıkgöz, 1976; Gilliland et al., 2000; Karaca and Akgün, 2005). Vagnerova et al. (1984) well described the effect of climate on characterictics of *Dactylis glomerata* L. genotypes. He concluded that climatic variations and genotypic differences determines genotypic disparities, similarities in early developmental stage are increasingly differentiated in later stages.

High yielding genotypes can be improved by monitoring efficient plant characters leading promising breeding new varieties. The main aim of plant breeding is to develop and produce novel superior genotypes. Essentially, only this by this method new variety of crops, having higher yield, resistant to pests and disease can be grown. Hence, plant breeding can be defined as a science as well as art of improving genetic make-up of plants in relation to their economic use. Moreover, classification and grouping genotypes based on common features will serve evaluation of genotypes to be selected in breeding programs; will help to increase their usefulness. Determination of relationship between plant characters will allow filling gap of information sequences of genotype evolution either simple or complex types of genotypes. The aim of this study was to determine morphogical and physiological characteristics in *Lolium perenne* genotypes, gathered from pastures of Trabzon, Rize, Erzincan and Erzurum provinces.

Determination of similarities/dissimilarities in *Lolium perenne* genotypes and characters were made by cluster analysis. Besides, by taking into consideration plant height as a determiner criterion in selection of pasture or hay yield types, our aim included to determine the effect of criteria on plant height by regression analysis, and creating suitable model to classify L. perenne genotypes.

2. Materials and methods

This study was carried out in 2001 and 2002 years. *Lolium perenne* genotypes were gathered from Erzurum, Erzincan, Trabzon and Rize provinces and were sown Pasinler experimental station of Eastern Anatolia Research Institute in Erzurum climatic conditions in 2001. Data were taken in genotypes in 2002. Gathering area of genotypes is shown in Figure 1.

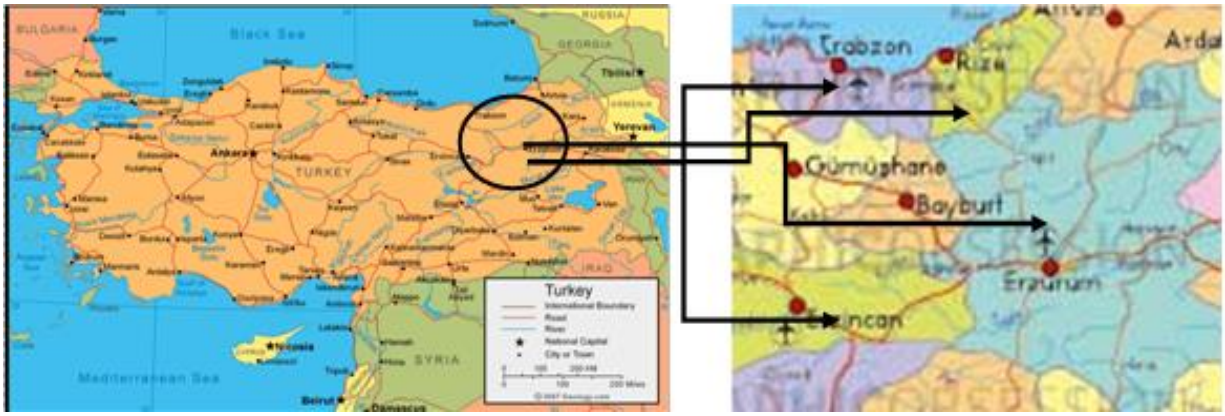

Figure 1. Gathering area of genotypes of *Lolium perenne*
Şekil 1. *Lolium perenne* için toplama alanları

Climate in the collecting area has been classified as arid climate with cold winter and hot summer in Erzincan and Erzurum provinces; humid climate moderate winter and summer. Mean, minimum and maximum temperature, relative humidity and total amount of rainfal during April-August growing season of 2000 and 2001 years, and long term years are shown in Table 1.

Genotypes gathered and planted in 2000; data of plant characters were taken in 2002. 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 %). Total 32 gathered L. perenne genotypes (31 collected ans 1 control) were grown in one-row plots of 1 m in length and 4 m spacing between the rows. Plant characters, plant height, flower length, flower number, kernel length, kernel weight, branch number, Stand, leaf number, flowering time, maturation date, thousand kernel weight, germination speed, germination power, leaf length, leaf width, stem thickness and spike length were taken according to methods of (Tosun 1973), (Tokluoğlu 1979), (Açıkgöz 1982), (Sağsöz 1974). Data of plant characters in the study were evaluated by statistical procedures; the simple correlation, multiple linear regression and cluster analysis

3. Results

Meteorological data of Trabzon, Rize, Erzurum and Erzincan provinces are seen (Table 1). The precipitations in 2000, 2001 and long years in Trabzon and Rize provinces were 239.0 mm, 263,4 mm and 250.1 mm; 636,5 mm 723,3 mm and 634,7 mm, respectively. Besides lower rainfalls occurred in Erzincan and Erzurum provinces in 2000, 2001 and long years (105,7 mm, 153.2 mm and for Erzincan; 95.3 mm, 68.7 mm and 216 mm, respectively) than Trabzon and Rize provinces. This phenomenon gave better opportunity to observe properties and performances of *Lolium perenne* genotypes It was stressed that selection success is strongly related to magnitude of variations of plant characters in

Table 1. Meteorological data of the Erzurum, Erzincan, Trabzon and Rize provinces
Tablo 1. Erzurum, Erzincan, Trabzon and Rize illerine ait meteorolojik beriler

	Provinces	Years	Months					Total or Average
			April	May	June	July	August	
Precipitation (mm)	**Erzincan**	**2000**	39.5	26.1	14.1	18.1	7.9	105.7
		2001	55.2	80.0	8.7	1.9	7.4	153.2
		Long Years	50.0	56.2	30.9	7.7	5.4	150.4
	Erzurum	**2000**	34.9	42.0	9.7	4.0	4.7	95.3
		2001	68.7	7.3	36.6	9.2	226.7	68.7
		Long Years	56.0	75.0	42.3	27.7	15.6	216.8
	Trabzon	**2000**	55.7	39.1	48.4	3.4	92.4	239
		2001	80.3	61.1	44.3	32.7	45.0	263.4
		Long Years	54.8	54.6	56.4	41.2	42.9	250.1
	Rize	**2000**	56.1	97.4	149.9	36.7	296.4	636.5
		2001	127.2	126.5	136.1	92.7	240.8	723.3
		Long Years	91.3	101.2	131.2	131.4	179.4	634.7
		Years	**Months**					**Total or Average**
			April	**May**	**June**	**July**	**August**	
Temperature (°C)	**Erzincan**	**2000**	7.4	9.8	15.5	22.3	19.3	14.9
		2001	7.2	9.3	15.4	20.6	19.9	14.5
		Long Years	11.1	15.9	20.6	25.0	24.8	19.5
	Erzurum	**2000**	5.4	12.6	15.8	19.5	20.6	14.8
		2001	5.6	10.1	15.3	18.7	20.4	14.0
		Long Years	5.2	10.4	14.9	19.4	19.5	13.9
	Trabzon	**2000**	15.5	16.0	20.3	24.4	23.4	19.9
		2001	12.0	15.6	20.5	25.5	26.0	19.9
		Long Years	12.3	16.3	20.7	24.2	24.3	19.5
	Rize	**2000**	15.0	16.0	20.2	24.2	23.8	19.8
		2001	12.2	15.5	20.1	25.3	25.6	19.7
		Long Years	11.9	16.3	20.6	24.0	24.3	19.4
		Years	**Months**					**Total or Average**
			April	**May**	**June**	**July**	**August**	
Humidity (%)	**Erzincan**	**2000**	65.8	65.4	53.0	53.9	56.2	58.9
		2001	60.1	58.0	58.4	52.0	57.3	57.2
		Long Years	62.4	60.8	56.6	52.1	54.3	57.2
	Erzurum	**2000**	65.4	61.3	48.1	46.2	44.1	53.0
		2001	53.4	55.8	57.0	53.0	53.6	54.6
		Long Years	65.8	60.9	55.3	48.6	45.9	55.3
	Trabzon	**2000**	80.2	79.0	73.9	75.0	72.0	76.0
		2001	74.3	76.6	75.0	72.7	73.1	74.3
		Long Years	74.5	78.0	75.9	75.1	76.1	75.9
	Rize	**2000**	83.5	79.1	75.2	77.4	77.2	78.5
		2001	73.5	76.9	76.0	75.1	75.4	75.4
		Long Years	76.6	77.9	77.5	78.7	80.0	78.1

Regional Meteorology Stations of Erzurum, Erzincan, Trabzon and Rize; Erzurum, Erzincan, Trabzon ve Rize Meteoroloji Bölge Müdürlükleri

accessions/genotypes gathered from locations having different altitudes and climate conditions. Similar results were taken in temperatures and humidity. It is clear that Rize and Trabzon provinces are located in coastal region of Black Sea; moderate climate prevails in both provinces; whereas having harder climatic conditions in Erzincan and Erzurum provinces placing in Eastern Anatolia with continental climatic conditions. Meteorological data of Trabzon, Rize, Erzurum and Erzincan provinces are seen (Table 1). The precipitations in 2000, 2001 and long years in Trabzon and Rize provinces were 239.0 mm, 263,4 mm and 250.1 mm; 636,5 mm 723,3 mm and 634,7 mm, respectively. Besides lower rainfalls occurred in Erzincan and Erzurum provinces in 2000, 2001 and long years (105,7 mm, 153.2 mm and for Erzincan; 95.3 mm, 68.7 mm and 216 mm, respectively) than Trabzon and Rize provinces. This phenomenon gave better opportunity to observe properties and performances of *Lolium perenne* genotypes It was stressed that selection success is strongly related to magnitude of variations of plant characters in accessions/genotypes gathered from locations having different altitudes and climate conditions. Similar results were taken in temperatures and humidity. It is clear that Rize and Trabzon provinces are located in coastal region of Black Sea; moderate climate prevails in both provinces; whereas having harder climatic conditions in Erzincan and Erzurum provinces placing in Eastern Anatolia with continental climatic conditions.

Lolium perenne, well responds to water and this gives well advantage to crop to show better performance (Sağlamtimur et al., 1989; Gilliland et al., 2000; Açıkgöz, 2001), and similar to this data of plant characters in *Lolium perenne* gathered from Rize and Trabzon provinces were higher than that of Erzurum and Erzincan provinces. Both characters in Rize and Trabzon provinces are so higher than Erzurum and Erzincan provinces. Table 2 shows minimum, maximum and mean values of characters.

Table 2. Minimum, maximum and mean values of characters *Lolium perenne*
Tablo2. Minimum, maksimum ve ortalama *Lolium perenne*'ye ait ortalam değerler

Characters	Min.	Max.	Mean	Characters	Min.	Max.	Mean
Flower Length	0.3	2	1.93±0.36	**Flowering Time**	148	151	149.8±1.48
Flower Number	15	89	23.3±12.41	**Maturation Time**	196	217	203.8±3.71
Kernel Length	0.0	1.4	0.73±0.31	**Thousand Kernel Weight**	0.2	5.6	1.7±0.98
Kernel Width	0.1	1.2	0.23±0.27	**Germination Speed**	0.0	82.3	30.93±21.60
Plant Height	22.5	91	55.9±15.90	**Germination Power**	0.5	94.2	60.80±27.99
Branch Number	1.0	5.0	2.5±1.16	**Leaf Length**	3.2	83	16.46±15.14
Stand	1.0	2.0	1.56±0.50	**Leaf Width**	0.1	5.5	0.58±0.91
Leaf Number	3	29	8.59±6.61	**Stem Thickness**	0.1	2.8	0.43±0.61
Spike Length	6.5	23.7	15.34±4.88				

Ranges in flower length flower number, kernel length and kernel width were found as 0,3 – 2 mm, 15-89, 0.0- 1,4 mm, and 0.1-1.2 mm, respectively. The most of genotypes (29 genotypes 90.62%) showed up 0,15-1,03 mm interval in stem thickness. Genotypes had 22.5-91.0 cm plant height 1.0-5.0 brunch number 1.0-2.0 Stand and 3.0-29.0 leaf numbers a minimum and maximum valves spike length, flowering time, maturity time, thousand kernel weight and germination speed in genotypes were observed as 6.5-23.7 mm,148-151 days, 196-217 days, 0.2-5.6 gr and 0.0-82.3 %, respectively. On the other hand, germination power, leaf length, leaf width and steam thickness were observed as 0.5-94.2 %, 3.2-83.0 mm, 0.1-5.5 mm and 0.1-2.8 mm, respectively. This wide range of characters reveals that big variation occurred in genotypes (1996; Avcıoğlu et al., 1999; Balbay, 2008) stressed that increase in variations genotypes enhances selection successes and development of novel promising genotypes and this situation is very important in fodder crop breeding (Avcı et al., 1996; Gilliland et al., 2000; Açıkgöz, 2001). Frequency distribution of genotypes for characters is given in Table 3.

Most of genotypes in flower length appeared about (27 genotypes 40.6 -43.7 %) in 0.73-1.57mm interval and this interval was 39.6-73.8 cm (21.8-37.5 %, 29 genotypes) in plant height. The highest values belonged to 3-10 mm in leaf number (68.7 %, 22 genotypes). Germination speed and power are important characters measuring germinability of genotypes; besides due to high rates of dormancy, dead seed high germination ability plays important role establishment of pastures, green areas etc.(Tokluoğlu, 1979; Sağlamtimur et al., 1989; Soya et al., 1997; Avcıoğlu et al., 1999; Salman and Avcıoğlu, 2000; Darvishi. 2009). Germination speed and power appeared heavily in 0.0-41.1 (35.4 % 22 genotypes) and 48.0-94.2 % (48.0-94.2 % 22 genotypes) respectively.

Leaf structure and number are part of crops (Avcıoğlu et al., 1999; Alonso, 2004; Okkaoğlu, 2006; Darvishi, 2009). Spike characteristics forms kernel number, kernel yield (Sağlamtimur et al., 1989; Avcıoğlu et al., 1999; Darvishi, 2009) leaf length and width become intense in 3.2-23.1 mm (90.6 %, 29 genotypes)

Table 3. Frequency distribution of genotypes for characters in *Lolium perenne*
Tablo 3. *Lolium perenne*'de genotipik karakterlerin frekans dağılımları

Flower Length			**Plant Height**			**Leaf Number**		
Freq.Interval	**Plnt.Num.**	**%**	**Freq.Interval**	**Plnt.Num.**	**%**	**Freq.Interval**	**Plnt.Num.**	**%**
0.30 – 0.72	2	6.2	22.5 – 39.62	7	21.8	3.0 – 10	22	68.7
0.73 – 1.15	13	40.6	39.63 – 56.75	10	21.2	11 - 16	7	21.8
1.16 – 1.57	14	43.7	56.76 – 73.87	12	37.5	17 - 23	1	3.1
1.58 – 2.0	3	9.37	73.88 – 91.0	3	9.3	24 - 29	2	6.2
Germination Speed			**Germination Power**			**Leaf Length**		
Freq.Interval	**Plnt.Num.**	**%**	**Freq.Interval**	**Plnt.Num.**	**%**	**Freq.Interval**	**Plnt.Num.**	**%**
0.0 - 20.57	11	35.4	0.5 – 23.92	5	15.6	3.2 – 23.15	29	90.6
20.6 – 41.15	11	35.4	24.0 – 47.35	5	15.6	24.0 – 43.1	1	3.1
42.0 - 61.72	5	16.1	48.0 – 70.77	8	25.0	44.0 – 63.0	1	3.1
62.0 - 82.3	4	12.9	71.0 – 94.2	14	43.7	64.0 - 83.0	1	3.1
Spike Length			**Kernel Length**			**Kernel Width**		
Freq.Interval	**Plnt.Num.**	**%**	**Freq.Interval**	**Plnt.Num.**	**%**	**Freq.Interval**	**Plnt.Num.**	**%**
6.5 – 10.8	4	12.5	0.0 – 0.46	6	19.3	0.10 – 0.65	30	93.7
10.9 –15.1	14	43.75	0.47 – 0.93	15	48.3	0.66 – 1.2	2	6.2
15.2 – 19.4	7	21.87	0.94 – 1.40	10	32.2	-	-	-
19.5 – 23.7	7	21.87	-	-	-	-	-	-
Branch Number			**Maturation Time**			**Thousand Kernel Weight**		
Freq.Interval	**Plnt.Num.**	**%**	**Freq.Interval**	**Plnt.Num.**	**%**	**Freq.Interval**	**Plnt.Num.**	**%**
1 – 2.3	16	50.0	196 -203	26	81.2	0.2 – 2.0	24	75
2.4 – 3.6	12	37.5	204 - 210	4	12.5	2.1 – 3.8	7	21.8
3.7 – 5.0	4	12.5	211 - 217	2	6.2	3.9 – 5.6	1	3.1
Flower Number			**Stand**			**Flowering Time**		
Freq.Interval	**Plnt.Num.**	**%**	**Freq.Interval**	**Plnt.Num.**	**%**	**Freq.Interval**	**Plnt.Num.**	**%**
15 - 52	31	96.87	1	14	43.7	148 - 149	12	37.5
53 - 89	1	3.12	2	18	56.2	150 - 151	20	62.5
Leaf Width						**Stem Thickness**		
Freq.Interval	**Plnt.Num.**	**%**				**Freq.Interval**	**Plnt.Num.**	**%**
0.12 – 2.81	31	96.87				0.15 –1.03	29	90.62
2.81- 5.5	1	3.12				1.04 – 1.91	1	3.12
-	-	-				1.92 – 2.8	2	6.25

and 0.1-2.8 mm (96.8 %, 31 genotypes), respectively. Spike length in genotypes was mostly seen in 10.9-15.1 mm (43.7 %, 14 genotypes). Kernel length and width and thousand kernel weight consisted of 0.0-0.93 mm (19.3-43.3 %, 21 genotypes), 0.1-0.6 mm (93.7 %, 30 genotypes), and 0.2-2 gr, 75.0 %, 24 genotypes), respectively. Highest genotype numbers in brunch number and flower number were observed in 1.0-3.6 interval (37.5-50.0 %, 28 genotypes) and 15.0-52.0 interval (96.8 %, 31 genotypes). Equal distribution was seen in Stand (43.7%, 14 genotypes in 1 and 56.2%, 18 genotypes in 2). Flowering and maturity determines kernel and hay yield; increase and decrease in duration causes changes amount of yield (Darvishi, 2009). The highest plant intervals in flowering and maturity times occurred as 150-151 days (62.5 %, 20 genotypes) and 196-203 days (81.2 %, 26 genotypes) respectively. Breeding programs monitor development of genotypes successive crop production depends upon effectiveness of fundamentally breeding methodology (Sağlamtimur et al., 1989; Tükel and Hatipoglu, 1994; Avcıoğlu et al., 1999). Besides, effective breeding program is only carried out when forcible characteristics are used in programs (Sağlamtimur et al., 1989; Tükel and Hatipoglu, 1994; Avcıoğlu et al., 1999). Properties of plant characters, their efficiencies and relationship between characters should be determined and highlighted of effective breeding programs (Darvishi, 2009) Table 4 shows significant relationship between characters in *Lolium perenne* genotypes.

Even though relationship between flower length and Stand plant high and flower number leaf number and branch number germination speed and germination power stem thickness and leaf width were found as significant at 1%; significant and negative relationship (P<0.01) were determined in germination power and stem thickness. Besides relationship between flower length and leaf width stem thickness and kernel width, leaf length and plant height germination power and thousand kernel weight flower length and spike height habits and kernel length were found as significant and positive (P<0.05). Significant and negative relationship (P<0.01) appeared in plant height and Stand, germination power and steam thickness.

Table 4. Shows significant relationship between characters in *Lolium perenne*
Tablo 4. *Lolium perenne*'de karakterler arasındaki önemli ilişkiler

Relationship Between Characters	**Correlation Value (%)**		**Relationship Between Characters**	**Correlation Value (%)**	
Flower Length- Stand	0.474**		Flowering Time-Plant Height	-0.374*	
Plant Height-Flower Number	0.460**		Leaf Length-Plant Height	0.365*	
Plant Height-Stand	-0.488**		Spike Length-Plant Height	0.414*	
Leaf Number-Branch Number	0.576**		Leaf Length-Stand	-0.382*	
Germination Power-Germination Speed	0.706**		Germination Power-Thousand Kernel Weight	0.401*	
Stem Thickness-Leaf Width	0.715**		Leaf Width-Thousand Kernel Weight	-0.394*	
Germination Power-Stem Thickness	-0.449**		Flower Length-Spike length	0.441*	
Flower Length-Leaf Width	0.410*		Germination Power-Flower Number	-0.360*	
Stem Thickness-Kernel Width	0.358*		Stand-Kernel Length	0.377*	

Mean while relationship between flowering time and plant height leaf length and habits, leaf width and thousand kernel weight, germination power and flower number were determined as negative and significant at % 5. Similar to these results, (Balbay, 2008) stressed that plant height, thousand kernel weight germination power and flowering time are important characters in forage crops breeding. Especially flowering time and plant height thousand kernel weight are play important role in new genotype development (Ekiz et al., 1995; Tükel and Hatipoglu, 1994), and especially plant height in monitors amount of hay yield in *Lolium perenne* (Bilir, 2001). Cluster analysis is one of the best methods to classify genotypes/characters in breeding programs (Şehirali, 1997). Cluster analyses were made to classify genotypes in Figure 2 and plant components in Figure 3.

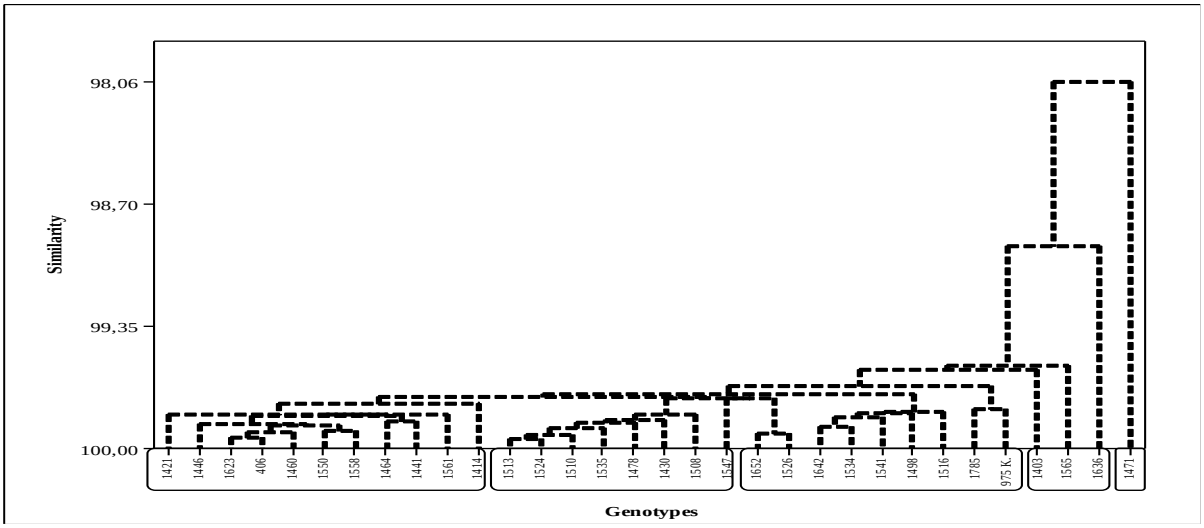

Figure 2. Cluster analysis of *Lolium perenne* genotypes
Şekil 2. *Lolium perenne* genotiplerine ait cluster analizi

Cluster analysis classified genotypes in five groups. Genotype 1471 drove separate group alone. While genotypes 1403, 1565 and 1636 participated some group, genotypes 1652, 1526, 1642, 1534, 1531, 1498, 1516, 1785 and 975 (control) joined in some group and they could safely be selected as superior genotypes. Moreover, genotypes 1421, 1446, 1623, 406, 1460, 1550, 1558, 1464, 1441, 1541 and 1414 created one group, last group had genotypes 1513, 1524, 1510, 1535, 1478, 1430, 1508 and 1547. Biplot analysis of plant characters are given in Figure 3.

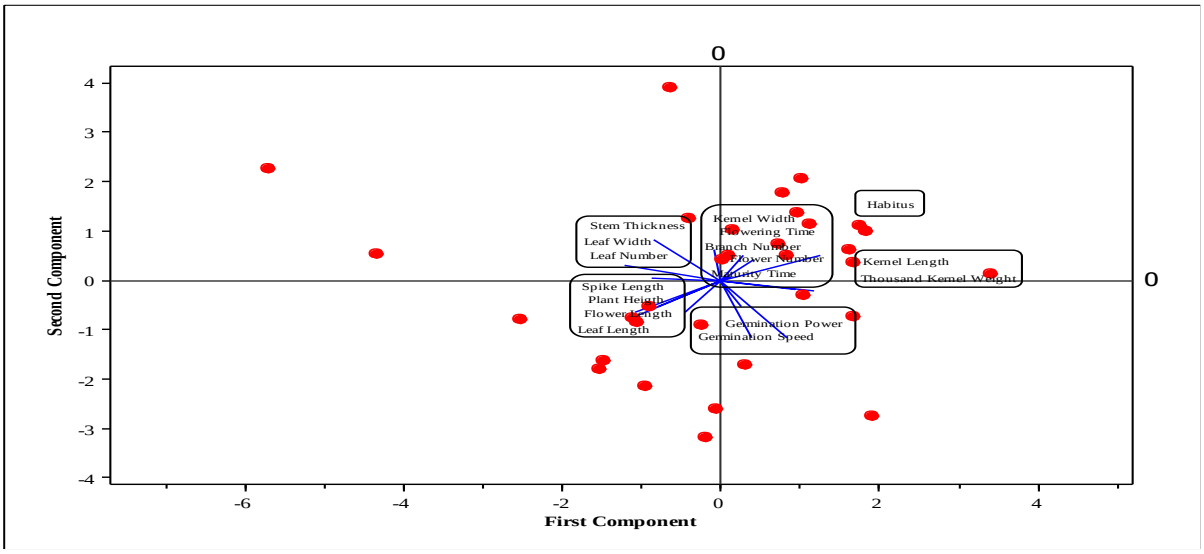

Figure 3. Biplot analysis of plant characters in *Lolium perenne*
Şekil 3. *Lolium perenne*'de bitki karakterlerine ait biplot analizi

Biplot analysis revealed that plant characters classified in six groups. When Stand was alone, kernel length and thousand kernel weight, flowering time, branch number, flower number and maturity time joined same group; germination speed and power constituted of some group. Stem thickness, leaf width and leaf number occurred in same group; lest group comprised spike length, plant height flower length and leaf length. It could be said that genotypes could well grouped by using characters having different variation. One the some way better selection and classification of genotypes is possible if characters with big with different variations are used (Açıkgöz, 1982; Gilliland et al., 2000; Darvishi, 2009; Tamura and Yonemaru, 2010). Elçi and Açıkgöz (1976), Şehirali (1997), Gül (2006) and, Balbay (2008) revealed that important characters should be used for better genotypes selection characters. Selection purpose first then particular and effective selection characters should be determined and used in forage crops.

Table 5. Total regression and multiple regression analyses of plant characters in *Lolium perenne*
Tablo 5. *Lolium perenne*'de bitki karakterlerine ait toplam ve çoklu regresyon analizi

Source	**Degree of Freedom**	**Means of Square**	**F_{value}**
Regression	16	411.17	4.89**
$Error_{residual}$	15	84.14	
Total	31		
1.) Plant Height = 769 + 14,0 x Flower Length + 0,696 x Flower Number + 3,23 x Kernel Length + 21,6 x Kernel Width - 3,32 x Branch Number - 7,87 x Stand + 0,315 x Leaf Number - 2,73 x Flowering Time - 1,71 x Maturity Time - 1,42 x Thousand Kernel Weight + 0,057 x Germination Speed + 0,281 x Germination Power - 0,050 x Leaf Length - 0,31x Leaf Width + 7,20 x Stem Thickness + 0,212 x Spike Length			
Predictor	**Coefficient**	**T_{value}**	**P**
Flower Length	14,02	1,39	0,185
Flower Number	0,1687	4,12	0,001
Kernel Length	3,231	0,40	0,693
Kernel Weight	21,59	11,63	0,048
Branch Number	-3,317	2,312	0,172
Stand	-7,875	-1,25	0,231
Leaf Number	0,3151	0,95	0,359
Flowering Time	-2,731	-2,15	0,048
Maturation Time	-1,7092	-2,19	0,045
Thousand Kernel Weight	-1,422	-0,53	0,605
Germination Speed	0,0566	0,37	0,720
Germination Power	0,2806	1,94	0,042
Leaf Length	-0,0502	-0,35	0,731
Leaf Width	-0,313	-0,06	0,956
Stem Thickness	7,195	0,87	0,399
Spike Length	0,2122	0,35	0,731
R^2(%)= 83,9			
2.) If(plant height<20;"1";if(and(plant height>=20; plant height<40);"2";if(and(plant height>=40; plant height<60); "3";if(and (plant height>=60; plant height<80);"4" if(plant height>=80;"5";"")))))			

Determination of more efficient characteristics promotes the magnitude of successes (Şehirali, 1997). Regression analysis including total and multiple regression models is useful tool in determination of effectiveness of characters (Olgun and Aygün, 2011). Table 5 shows total regression and multiple regression analysis assigning the effect of plant characters in plant height that was accepted as dependent factor versus the other independent characters.

Total regression analysis revealed that the effect of plant characters on plant height accepted as a determiner criterion in selection of pasture or hay yield types in *Lolium perenne* is significant at 1 %. mentioned that plant growth genotypic performance could surely be evaluated by seasonal changes in plant height or dry matter accumulation affecting photosynthetic efficiency, leaf/kernel characteristics and therefore hay yield. Accepting plant height as dependent character

Plant Height = 769 + 14,0 x Flower Length + 0,696 x Flower Number + 3,23 x Kernel Length + 21,6 x Kernel Width - 3,32 x Branch Number - 7,87 x Stand + 0,315 x Leaf Number - 2,73 x Flowering Time - 1,71 x Maturity, Time - 1,42 x Thousand Kernel Weight + 0,057 x Germination Speed + 0,281 x Germination Power - 0,050 x Leaf Length - 0,31x Leaf Width + 7,20 x Stem Thickness + 0,212 x Spike Length **(1)**

Multiple regression analysis cleared that the effect of flower number on plant height was significant at 1 %; whereas kernel width, flowering time, maturity time and germination power had significant effect ($p<0.05$) on plant height. Similar to our findings, (Bilir, 2001; Balbay 2008; Darvishi, 2009) concluded that flower and kernel characteristics are milestones of hay yield. Especially flowering and maturity time are important (Gül, 2006), it should be taken into consideration that duration flowering and maturity time are determined by climatic factors particularly temperature (Avcıoğlu and Gül, 1997).

Early or late flowering and maturity times can decrease target yield so moderate early flowering and maturity time could be more efficient on target yield under continental climatic conditions (Salman and Avcıoğlu, (2000). Besides flower number and germination power are efficient characters monitoring kernel and plant development (Önder and Avcı, 2000). It could be inferred that plant height is logical term as signify indicator representing plant development (Tükel and Hatipoglu, 1994). It is left half finished when a study isn't modeled and necessary forecasting isn't made; modeling of results/studies could give safe information of about studies (Olgun and Aygün, 2011). Plant height was grouped by using this formula below.

If(plant height<20;"1";if(and(plant height>=20; plant height<40);"2";if(and(plant height>=40; plant height<60); "3";if(and (plant height>=60; plant height<80);"4" if(plant height>=80;"5";"")))))) **(2)**

In this formula, *Lolium perenne* genotypes were grouped and are shown in Table 6. Plant height was separated in five groups. Genotype 1421 appeared group 1, besides genotypes 1430, 1516, 1652, 1785, 1535, 1636, 1526, and 1541 were showed similar properties with control genotype 975 and placed in group 5. Genotypes having short plant height almost < 50-60 cm could be selected as meadow crop, however taller ones almost > 60 cm plant height could be leaded for hay yield (Avcıoğlu and Gül, 19979. Our results showed that genotypes 1421, 1446, 1623, 1464, 1550, 1471, 406, 1513, 1547, 1642, 1510, 1565, 1534, 1508 and 1460 placed in short or moderate plant height (group 1, 2 and 3) and seemed more suitable to meadow establishment or improvement. Meanwhile genotypes 1478, 1403, 1414, 1498, 1524, 1430, 1524, 1430, 1516, 1652, 1785, 1535, 1636, 1526, 1541 and 975 as taller genotypes constituted of group 4 and 5; are appropriate to hay yield

So, *Lolium perenne* is important crop not only in kernel yield but hay yield and it is one of the main crop meadow/forage crops (Sağlamtimur et al., 1989; Şehirali, 1997). Population in continental climate can expend in leaf, steam and kernel characteristics less rapidly than coastal climates (Yazgan et al., 1992; Salman and Avcıoğlu, 2000) differences in plant characters in *Lolium perenne* appear to be dependent on water availability and temperature. İt is therefore important that big variation plays important role success of breeding programs in forage crops (Şehirali, 1997; Salman and Avcıoğlu, 2000). Determination of plant characteristics showing significant variation will expand occurrence of novel genotypes.

Result revealed that genotypes 1430, 1516, 1652, 1535, 1785, 1636, 1526 and 1541 were determined as promising genotypes and they should be placed in breeding programs in Erzurum ecological conditions as continental and high altitude climatic conditions having hard cold winter, cool and short summer. Besides considering plant height as indicator character in kernel and hay yield flower number, flowering and maturity times and germination power were determined as efficient characters in genotype selection in *Lolium perenne* breeding. More detailed studies are needed in genotype selection of breeding programs.

Table 6. Grouping of *Lolium perenne* genotypes

Access No	Flower Length	Flower Number	Kernel Length	Kernel Weight	Plant Height	Branch Number	Stand	Leaf Number	Flowering Time	Maturation Time	Thousand Kernel Weight	Germination Speed	Germination Power	Leaf Length	Leaf Width	Stem Thickness	Spike Length	Group
1421	0,8	20	0,4	0,1	23	3	2	5	151	203	1	24	36	4	0,3	0,2	11	1
1446	0,7	18	1,0	0,1	39	2	2	5	151	203	2	32	45	13	0,2	0,2	10	2
1623	1.12	15	0.6	0.1	37	3	2	4	151	203	2	18	48	3	0.1	1.1	13	2
1464	1.50	16	0.5	1.2	37	2	1	3	151	217	2	10	22	14	0.3	0.2	11	2
1550	0.9	24	0.4	0.1	32	3	2	5	151	203	2	25	65	8	0.4	0.2	13	2
1471	1.3	89	0.6	0.1	91	1	1	3	151	203	1	0	1	19	0.7	0.4	21	2
1558	0.9	18	1.0	0.2	35	3	2	16	151	203	2	27	70	14	0.3	0.4	12	2
1561	1.22	25	0.5	0.1	47	3	2	10	148	203	1	2	18	14	0.3	0.2	16	2
1441	1.1	16	1.0	0.3	46	1	2	8	151	203	2	15	28	6	0.3	0.2	12	3
406	1.1	18	0.6	0.1	44	3	1	5	151	203	2	22	56	9	0.4	0.2	14	3
1513	1.1	20	1.2	0.4	62	5	2	4	151	203	2	28	87	9	0.4	0.5	11	3
1547	0.8	24	0.5	0.1	53	3	1	16	151	203	1	42	66	9	0.4	0.3	10	3
1642	1.2	24	0.4	0.1	60	3	2	8	151	204	2	82	94	15	0.4	0.3	23	3
1510	0.8	24	1.1	0.4	54	2	2	13	148	203	6	18	85	8	0.2	0.3	7	3
1565	0.9	26	1.2	0.3	53	2	2	6	148	203	2	29	59	42	0.4	0.3	12	3
1534	1.3	20	1.4	0.4	53	2	2	4	148	217	2	76	93	8	0.3	0.2	19	3
1508	1.4	25	0.8	0.2	60	4	2	25	151	203	3	15	68	15	0.5	0.3	14	3
1460	1.4	20	1.2	0.2	37	2	2	4	151	203	2	12	41	6	0.2	0.2	21	3
1478	1.4	21	0.5	0.1	59	2	1	4	151	203	2	18	76	15	0.4	0.3	23	4
1403	1.3	23	0.4	0.3	55	5	1	29	151	203	1	36	82	44	0.5	0.4	19	4
1414	2.0	26	0.5	0.1	63	3	1	10	148	204	1	13	33	15	0.6	0.3	24	4
1498	1.1	25	1.1	0.2	48	3	2	5	148	203	2	55	88	7	0.4	0.3	12	4
1524	0.9	16	1.2	0.3	54	1	2	7	151	203	2	23	82	7	0.4	0.2	11	4
1430	1.4	23	0.5	0.1	71	3	1	19	151	203	2	24	80	22	0.5	0.3	19	5
1516	1.5	23	0.5	0.1	68	1	1	4	151	203	2	64	91	21	0.5	0.3	17	5
1652	1.5	24	0.7	0.2	80	2	1	4	148	203	1	45	78	15	1.0	0.4	14	5
1785	1.9	22	0.6	0.1	68	1	1	4	151	203	0	12	10	22	5.5	2.8	12	5
1535	0.9	20	0.4	0.1	72	1	1	5	148	203	2	24	87	19	0.5	0.2	8	5
1636	1.3	17	1.2	0.3	72	2	1	4	148	204	3	42	93	83	0.5	0.3	18	5
1526	1.45	22	0.6	0.1	72	1	1	6	148	203	1	43	68	16	0.4	0.3	19	5
1541	1.7	19	0.7	0.1	73	3	2	15	148	205	2	79	83	12	0.7	0.2	22	5
975 Cont.	0.3	23	0.7	1.2	77	5	2	15	148	196	2	6	14	16	0.7	2.6	22	5

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