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Determination of Some Characteristics of Tall Fescue (*Festuca arundinaceae* Schreb.) Populations Collected from Natural Flora and Selection of Grass Type Genotypes

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A R T I C L E I N F O

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A B S T R A C T

The aim of this study was to determine the identification criteria (phenological, morphological and some agricultural) and select the ones suitable for turfgrass. Agricultural studies in Black Sea Agricultural Research Institute Ambarköprü Station were carried out. Identification studies was done according to IBPGR with 900 genotypes in 2015 and 2016. Some parameters determined in the study as follows. Average plant height 65–177 cm, main stem thickness 2.0–6.1 mm, internode length 11–53 cm, flag leaf length 10–42 cm, flag leaf width 3–14 mm, days to heading 208–246, lodging ratio 1.5–5.0 (1=erect; 5= prostrate), tillering potential 9–330, spring growth 1.5–5.0 (1- early; 5- late), herbage forage yield 101–2330 g/plant. End of the morphological and technological measuring and observations, 49 genotypes were selected for turfgrass with using relative rating method. According to the analysis, the genotypes were first divided into two main groups. It was determined that the genotypes FA 06-07, FA 31-02, FA 09-08 and FA 05-13 in the first group were collected from Samsun and Tokat locations, and all of the genotypes in the second group were collected from the Tokat location.

1. Introduction

Today, while the population is decreasing due to migration from rural areas to cities, it is increasing in cities. As cities grow geographically and humanly, natural areas disappear and people's need and longing for green spaces increases. Rapid population growth, migration and unplanned urbanization, social, economic, political and cultural conditions cause the deterioration of the physical environment of the people living in the city and a decrease in the quality of life (Kır et al., 2010; Özköse, 2012; Alay, 2020).

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In cities where green areas are sufficient, the quality of life and productivity of individuals are also high. Therefore, a great deal of importance is given to green areas in the establishment of cities. Today, green areas are needed in many sports and playgrounds such as parks, gardens, football-golf fields, horse races, as well as on railway sides, airports, around buildings, hospitals and schools. (Kuşvuran, 2009; Özköse, 2012).

Turfgrass areas, in addition to their aesthetic contribution to urban spaces, create a green cover that allows them to play and rest. They absorb sunlight during the day and affect the environment positively by not giving back the radiation they collect during the night. By absorbing the dust in the air, they eliminate the dust problem. They also consume carbon dioxide in the atmosphere as they are a natural oxygen producer. Green areas also remove other atmospheric pollutants such as ozone, sulfur dioxide, nitrogen dioxide, ammonia, carbon monoxide, volatile organic compounds and lead (Stier et al., 2013). They ensure that rain and snow waters are transformed into groundwater on a regular basis. They lose water by transpiration, thereby reducing the ambient temperature up to 5 ˚C. By forming approximately 4000 shoots in an area of 1 m^2, they function like an air conditioner due to their energy absorption properties (Uzun, 1992; Avcıoğlu, 1997; Oral and Açıkgöz, 1998, Nick et al., 2016).

Although our country has a great genetic potential in terms of grass breeding, all purchased grass species are varieties obtained from breeding studies of foreign countries. These varieties cannot show the desired characteristics in our country's conditions (such as climate, soil, resistance to diseases and pests) and the plant life is short. This situation necessitates more fertilization, irrigation and other maintenance works in lawn areas and requires the facility to be renewed in a short time (Özköse, 2012; Alay, 2020). Thus, the construction and maintenance costs of lawn fields increase significantly. We need to breed new varieties by using the grass plants found in our natural flora and use our potential to produce grass seeds. Developing a domestic grass variety will not only contribute to meeting the seed needs of our country, but also contribute to meeting the grass needs of countries with similar ecologies and improving export opportunities. Scientific studies on this subject will gain momentum and the number of trained people, information and resources will increase.

This study was carried out to determine the morphological and agricultural characteristics of tall fescue (*Festuca arundinaceae* Schreb.) populations collected from the natural flora of the Central Black Sea Region and to select genotypes that could be turf type.

2. Materials and Methods

2.1. General characteristics of the research area

The research was carried out in Samsun Black Sea Agricultural Research Institute, Çarşamba Ambarköprü trial station (41°29' 11 N - 36° 401 06 E) between 2014-2016. Its height above sea level is 17 meters.

2.2. Soil and climate characteristics of the research area

The pH value of the soil of the research area is 7.35, and it is slightly alkaline, clay loam, organic matter is medium, phosphorus is very low, lime is medium, salt free and potassium is insufficient.

The average temperature of the province of Samsun 1980-2016 for many years is 15.0 °C and the total precipitation is 992.4 mm. According to the long-term average, the highest temperature value was 24.9 °C in August, and the lowest temperature value was 6.5 °C in January. The highest total precipitation was in January with 154.4 mm and the lowest precipitation was in July with 22.8 mm. When the average temperature and total precipitation values for many years are examined, it is seen that the dry period begins in late June and continues until mid-October (Table 1).

When the climate data of the years of the experiment were compared, the lowest monthly total precipitation was in April with 16.8 mm in the first year of the experiment, in November with 18.5 mm in the second year and in July with 31.5 mm in the third year. In March 2014, the total precipitation amount in March, April and May, when the seedlings were planted and the cool season plants made a significant part of their development, was lower than the average of 2015-2016 and many years. While the average relative humidity for many years was 77.2%, this value was 78.5% in 2014, 79.0% in 2015 and 78.1% in 2016 (Table 1).

Within the scope of TAGEM /TA/00/11/01/009 and "Black Sea Region Forage Crops Research Project", seeds of a total of 64 populations, 9 from Samsun, 53 from Tokat and 2 from Sinop, were collected. While collecting, features such as collection place, latitude, longitude, altitude were recorded, and the seeds were taken from different places at a distance of at least 1 km.

Table 1. The average temperature, average relative humidity and total precipitation values of the county of Çarşamba, 2014, 2015 and 2016 and the long-term average (U.Y.O.) (1980-2016) (Anon., 2018)

Location	Çarşamba											
	Total Precipitation (mm)				Average Temperature (ºC)				Average Relative Humidity (%)			
Months	Long-Term Average	2014	2015	2016	Long-Term Average	2014	2015	2016	Long-Term Average	2014	2015	2016
January	154.4	-	128.5	199.9	6.5	-	6.9	6.3	69.8	-	68.8	100.0
February	52.2	-	103.0	37.4	8.7	-	8.0	10.9	71.9	-	76.0	70.3
March	81.5	41.5	112.9	103.8	9.6	9.8	8.6	10.3	77.1	77.3	81.4	73.2
April	68.5	16.8	106.0	50.6	12.1	12.2	10.7	14.4	76.8	75.2	74.8	75.6
May	100.2	48.6	20.4	267.7	16.6	16.8	16.7	16.7	80.2	79.5	79.3	79.6
June	103.7	115.4	106.8	33.6	21.2	20.5	20.7	22.2	78.4	79.6	82.2	77.0
July	22.8	46.4	29.5	31.5	23.8	23.9	23.0	23.9	76.5	78.4	80.4	76.3
August	69.7	95.8	179.6	37.4	24.9	24.7	24.6	25.2	79.9	79.8	80.7	78.9
September	59.1	101.2	42.5	108.1	21.1	20.4	22.4	20.0	80.5	81.6	86.8	76.4
October	69.6	103.9	76.0	38.9	15.6	15.8	16.6	14.9	84.7	86.9	90.3	83.4
November	73.1	116.2	18.5	79.6	11.8	10.4	13.0	11.2	75.0	71.6	72.0	71.2
December	137.7	93.8	125.6	162.8	8.2	10.0	7.4	4.9	75.3	75.3	74.8	75.7
Mean	**82.7**	**77.9**	**87.4**	**95.9**	**15.0**	**16.4**	**14.9**	**15.1**	**77.2**	**78.5**	**79.0**	**78.1**
Total	**992.4**	**779.6**	**1049.3**	**1151.3**	–	--	–	–	–	--	–	–

Seeds belonging to the populations were sown in one row on the land of the Black Sea Agricultural Research Institute, Ambarköprü trial station in October 2013. Sowing was done manually in rows of 5 m in length. From these rows, 20 randomly selected genotypes (per plant) for each population were planted in the observation garden with 20 plants (genotypes) from each population in March 2014. Considering the soil analysis results, fertilization was made at the stage of planting the seedlings in the field at 5 kg N (nitrogen) and 8 kg P (phosphorus) per decare. In the years of 2015 and 2016 of the experiment, a total of 10 kg of nitrogen fertilization, 5 kg per decare in the early spring and 5 kg after the first cutting, was applied. In general, irrigation was not done in the experiment. It has been sprayed twice a year against Melolontha ssp. with the drug whose active ingredient is Lambda-cyhalothrin. Weed control was done when necessary. The total number of plants in the experiment was 1280, and later on, some genotypes were damaged by (*Melolontha* ssp.) and lost during mechanization studies. For this reason, observations and measurements were made in 900 genotypes. In 2015, the cutting was done on May 6, and in 2016, on May 15. In both years, the second cutting was not done because the plants showed little development after cutting. Cleaning was carried out at the end of October in the establishment year, 2015 and 2016 years.

In this study, turf type genotypes were determined according to the weighted scaling method among 900 genotypes, with agricultural and morphological identification lasting two years, excluding the establishment year. The averages of two-year data were used to determine the superior tall fescue genotypes, which are candidates for turf type. The minimum (by subtracting the extreme ones) and the maximum (by subtracting the extreme ones) values were obtained from the values obtained. The difference between the maximum and minimum values is divided by 3, and the result is added to the minimum value and added to the maximum values to form 3 groups. Average values were obtained by multiplying the scale score of the genotypes with the feature of being a turf type and the % importance level. Genotypes above the mean were selected (Gebeyahou et al, 1982; Yazgan, 1989; İslam and Deligöz, 2012). Descriptive statistics of the data of each feature obtained from this study were made. At the end of the calculations, the minimum and maximum value, mean, standard deviation and coefficient of variation results were obtained. Since the data obtained will only show the characteristics of the group to which it is related, “mean±standard deviation” is given together (Özbek and Keskin, 2007).

3. Results and Discussion

3.1. Spring growth (1-5)

When the average of 2015 and 2016 in terms of spring growth is examined, the lowest group value was 1 (early), the highest group value was 5 (late), and the average group value was 3 (medium). It was determined that 140 of the genotypes were early, 697 of them were medium and 63 of them were late. The standard deviation value determined between genotypes was calculated as 3±0.84. Looking at the average of both years, it is seen that the standard deviation is low. This shows that the variation between the observation values given to the genotypes in terms of spring growth is close. The coefficient of variation was calculated as 30.7% on average (Table 2). This shows that the variability between genotypes is high. This is an expected result since the studied populations were collected from nature.

If tall fescue is grown for forage grass, it gives more green grass and comes to grazing maturity early, if it is grown for turf grass, it stays green for a longer time and provides the expected benefits as green area. Late maturing genotypes were selected for turf type.

Arslan and Orak (2011) reported the spring growth rate of of tall fescue with turf type grass characteristics and some species as 3 (1-5) in Tekirdağ coastal belt. Also, Alagöz and Türk (2017) reported the spring growth rate of 1.7-4.3 (1-5) in five turf grass crops (*Lolium perenne* L., *Poa pratensis*, *Festuca arundinacea*, Festuca rubra var. rubra, Festuca rubra var. commutata) in Isparta ecological conditions. Moreover, Varoğlu (2010) reported the spring growth of *Festuca arundinacea* as 3.5 (1-5) in its mixtures with pure stand and *Lolium perenne* in İzmir conditions, while Varoğlu et al. (2015) reported that the spring growth of tall fescue (*Festuca arundinaceae*) and red fescue (*Festuca rubra*) varieties in Bornova conditions between 2-4 (1-5). In another study, Erdoğan and Sürmen (2019), spring growth of *Festuca rubra var. rubra* in Aydın conditions was measured as 4.5 (1-5) while *Festuca rubra var. commutata*'s was 2.0 (1-5) and *Festuca arundinacea*'s spring growth was 2.5 (1-5). In addition, Özkan and Avcıoğlu (2013) determined the spring growth rate in Mediterranean conditions between 1.38-3.32 (1-5) in the mixtures of *Festuca arundinacea* with pure stand and *Lolium perenne*, while Eraşık and Soya (2014) were reported as 2.57 (1-5), and Balekoğlu (2015) reported as 6.52 (1-9) in Mediterranean conditions.

These results are in general agreement with our study. Spring growth is closely related to the climate. How long the winter season lasts, the severity and duration of the cold, the snow cover, the number of days when the temperature is below zero, the number of hot days, etc. factors directly affect spring growth. In addition, the genetic diversity of tall fescue turf type genotypes is also important.

Table 2. Frequency distribution and descriptive statistics values of spring growth of tall fescue genotypes

Observation Value		Mean	
	Group Value (1-5)	Number	%
1-2*	1 (early)	140	15.56
3*	3 (medium)	697	77.44
4-5*	5 (late)	63	7.00
Minimum		1	
Maximum		5	
Average		3	
Standard Deviation		3±0.84	
Coefficient of Variation (CV) (%)		30.7	

*1-Too fast growth *2-Fast growth *3-Moderate growth * 4-Slow growth *5-Too slow growth DK- Coefficient of Variatio

3.2. Tillering potential (number/genotype)

When the average of the years 2015 and 2016 was analyzed in terms of tilling potential, the minimum number of tillering was 9 (less-infrequent), the maximum number of tillering was 330 (frequent-high), the mean of genotypes was 84.87 (near medium), and the standard deviation value was 84.87±51.6. Looking at the average of both years, it is seen that the standard deviation is high. This shows that genotypes have wide variation in terms of tillering potential. It was determined that 551 genotypes were in the 1st (less-rare) group, 276 were in the moderate and 73 were in the 5th (frequent-high) group. The coefficient of variation was calculated as 60.7% on average (Table 3). This shows that the variability between genotypes is high. Grass density can be measured by counting the amount of stems or leaves per unit area. However, it can be determined more easily and accurately by stem counting.

It is desirable that the density (tillering potential) value, which expresses the number of shoots per unit area, is high in grass areas. Therefore, over tillering is important in terms of suppressing foreign plants, completely covering the area and creating a good green plant (Beart, 1973; Avcıoğlu, 1997). Genotypes that have over tillering potential were selected for turf purposes.

Varoğlu (2010) found tillering potential of some species (*Festuca rubra* (Engina, Franklin, Pernille), *Festuca arundunaceae* (Eldorado, Finelawn, Apache), *Poa pratensis* (Enprima, Geronimo, Connni)) used in green areas and to be 4.3 (1=seldom, 5=dense), while Özkan and Avcıoğlu (2013) reported between 3.67-4.56 (1-5) for *Festuca arundinacea*, *Lolium perenne*, *Festuca rubra var. rubra*, *Festuca rubra var. commutata*, *Festuca ovina* and *Poa pratensis* in Mediterranean conditions. Also, Eraşık and Soya (2014), reported as 4.61 (1-5) in Mediterranean conditions. On the other hand, Balekoğlu (2015) investigated the tillering potential of some *Festuca arundinacea* cultivars (Eldorado, Millenium, Rebel Pro, Regiment-2, Tahoe, Tomat, Turbo RZ) in Mediterranean conditions on a scale of 1-9 (1=rare, 9=frequent), and reported it as 7.36. Whihe Erdoğan ve Sürmen (2019), stated the tillering potential in tall fescue as 3.25 (1-5) in Aydın province conditions, Varoğlu et al., (2015), found it between 2.8-4.8 (1= sparse, 5= dense) of *Lolium* sp., *Poa* sp., *Festuca* sp. turf type grass crops, in Bornova conditions. Saygın and Ayan (2019) found that the number of tillering varies between 3.5-5 (1-5) in pure stand tall fescue sowing, in which a total of 6 cuttings were made and 4 sowing rates were applied (30, 40, 50 and 60 g/m^2) in Samsun – Çarşamba conditions. Okkaoğlu (2006), who measures tillering condition as a number instead of a scale, reported 104.60 in İzmir conditions, while Ayan et al. (2011) reported it as 17-220 in Samsun-Çarşamba conditions.

There is a general similarity between the results of this study and the results of other researchers. In tall fescue turf type genotypes, besides the genetic differences of plants in terms of tillering number, environmental factors (climate, soil moisture, etc.) such as cutting tool type, cutting height, cutting frequency, amount of nutrients in the soil, light exposure of the bottom parts of the plant, plant age and development also are factors affecting.

Table 3. Frequency distribution and descriptive statistics values of tillering potential of tall fescue genotypes

Observation/Measurement Value (number/genotype)		Mean	
	Group Value (1-5)	**Number**	**%**
[5-85]	1 (seldom)	551	61.22
[86-165]	3 (moderate)	276	30.67
165<	5 (dense)	73	8.11
Minimum		9	
Maximum		330	
Average		84.87	
Standard Deviation		84.87±51.6	
Coefficient of Variation (CV) (%)		60.7	

3.3. Lodging ratio (1-5)

When the average of the years 2015 and 2016 is examined in terms of lodging ratio, the lowest group value was 1 (erect), the highest group value was 5 (prostrate) and the average group value was 2.23 (semi-erect). It was determined that 448 genotypes were in the 1st (erect) group, 403 were in the 3rd (moderate) group and 49 were in the 5th (prostrate) group. The standard deviation value determined between genotypes was calculated as 2.23±0.89. Looking at the average of both years, it is seen that the standard deviation is very high. This shows that the genotypes have high variation. The coefficient of variation was calculated as an average of 52% (Table 4). As a result of the scoring, 49 genotypes can be evaluated as turf type, which develops erect, semi-erect, covers the soil surface better and gets 50 score (highest) in terms of lodging ratio.

Lodging ratio in tall fescue and some species in some species, while Ayan et al. (2011) were determined as 1-3 in *Festuca arundinacea* Schreb., *Festuca ovina* L., *Festuca pratensis* Huds., *Festuca rubra* L., *Festuca drymeja* Koch., *Festuca amethystina* L., *Festuca woronowii* Hackel. and *Festuca lazistanica subsp. giresunica* Alex. in Samsun conditions, Özköse (2012) was determined that it varies between 1-8 (1=erect, 9=prostrate) in Ankara conditions.

In our study, the growth pattern of genotypes varied between 1 and 5. There is a general similarity between the study and the results of the researchers. The differences may be caused by many factors such as the type of plants, genetic structure, temperature, soil and air humidity, nitrogen fertilization.

Table 4 Frequency distribution and descriptive statistical values of tall fescue genotypes of lodging ratio

Observation Value	Group Value (1-5)	Mean Number	Mean %
1*	1 (erect)	448	49.78
2-3*	3 (semi-erect)	403	44.78
4-5*	5 (prostrate)	49	5.44
Minimum		1	
Maximum		5	
Average		2.23	
Standard Deviation		2.23±0.89	
Coefficient of Variation (CV) (%)		52	
*1- Erect *2- Semi-erect *3- Moderate *4- Semi-prostrate *5- Prostrate			

3.4. Days to heading

When the average of the years 2015 and 2016 in terms of days to heading is examined, the lowest number of days was 207, the highest number of days was 242 and the average number of days was 232. 163 genotypes were in the 1st (early) group, 672 were in the 3rd (medium) group and 65 were in the 5th (late) group. The standard deviation value determined between genotypes was calculated as 232±11.2. Looking at the average of both years, it is seen that the standard deviation is high. This shows that the genotypes are somewhat far from each other in terms of days to heading. The coefficient of variation was calculated as an average of 5.6% (Table 5). This shows that the variability between genotypes is high. This result is an expected result since the studied populations are collected from nature.

Early stem elongation and flowering are undesirable in turf grass (Açıkgöz, 1994). Controlling the entry of turf type grasses into the booting stage means controlling the quality of the grass. Because when the turf grass enter the seed creation period, the desired continuous uniform green cover is disrupted due to the stem elongation (Avcıoğlu, 1997). As stated by the researchers, 65 genotypes, which were determined grass having late maturity in terms of the number of days of stem elongation, can be considered as grass type.

The number of days of stem elongation in tall fescue genotypes varied between 207 and 242, as the average of two years. Since the reactions of plants to the common effects of photoperiod and temperature factors are different, there are significant differences in terms of maturation time between genotypes in the species (Tosun, 1973). Grass plants are generally long day plants and can flowering in very wide photoperiods (Açıkgöz, 1994; Avcıoğlu, 1997).

Oliveira and Charmet (1989) found the between 6 May and 7 June in 50 perennial ryegrass population collected from North West Spain, while while Romani et al (2002) found 52 genotypes of perennial ryegrass (*Lolium perenne*) collected from different regions of Italy reported the heading date between 5 and 25 May. Also, Mirjalili and Bennet (2006), in their study in Iran, reported the average heading date of 11 perennial ryegrass lines to be 6 May. Shipway et al (2010) reported that in the UK conditions, when there is 50% stem elongation in grass species or varieties, it is determined as the stem elongation date; for example, if it happened after 20 days from 1 May, it expressed as REE20 (Relative Ear Emergence). They are divided into three groups as early, medium and late, since the duration of stem elongation differs in tall fescue, and they report that each group covers a period of 12 days or more. They report that the heading dates of the perennial ryegrass varieties they are working on vary between 18 May and 29 June. Sokolovic et al. (2011) recorded the heading dates of populations collected from different parts of the country between 13-20 May for perennial ryegrass breeding suitable for Serbian conditions.

The number of days of stem elongation or dates values obtained from this study are generally in agreement with the results of other researchers. Differences may be caused by many environmental factors such as climate and soil characteristics, as well as genetic and variety differences in the materials used.

Table 5. Frequency distribution and descriptive statistics values for the number of days to heading of tall fescue genotypes

Observation/Measurement Value (day)		Mean	
	Group Value (1-5)	Number	%
[206-220]	1 (early)	163	18.11
[221-232]	3 (medium)	672	74.67
232<	5 (late)	65	7.22
Minimum		207	
Maximum		242	
Average		232	
Standard Deviation		232±11.2	
Coefficient of Variation (CV) (%)		5.6	

3.5. Plant height (cm)

When the average plant height of 2015 and 2016 is examined, the lowest plant height was 65 cm, the highest plant height was 184 cm and the average plant height was 129.5 cm. It was determined that 114 of the genotypes were in the 1st (long) group, 703 in the 3rd (medium) group and 83 in the 5th (short) group. The standard deviation value determined between genotypes was calculated as 129.5±17.42. Looking at the average of both years, it is seen that the standard deviation is high. This shows that the variation between genotypes in terms of plant height is high. The coefficient of variation was calculated as 18.5% on average (Table 6). This shows that the variability between genotypes is high. Since the studied populations are populations collected from nature, this result is expected. 83 short-grown genotypes can be evaluated with 50 points (the highest) as turf type grass in terms of plant height.

Table 6. Frequency distribution and descriptive statistics values of plant height of tall fescue genotypes

Observation/Measurement Value (cm)		Mean	
	Group Value (1-5)	Number	%
136<	1 (long)	114	12.67
[95-136]	3 (medium)	703	78.11
[51-94]	5 (short)	83	9.22
Minimum		65	
Maximum		184	
Average		129.5	
Standard Deviation		129.5±17.42	
Coefficient of Variation (CV) (%)		18.5	

Desired plant height varies according to the purpose of growing in tall fescue. Tall fescue plants to be used as turf grass should be short in length, slowly developing after the cutting, narrower leaf blade width, etc. features are required. In this study, the average plant height of two years varied between 65-184 cm.

Watkins and Meyer (2004) measured the plant height of *Festuca arundinaceae* between 71.7-104 cm in American conditions, while Edward (1993) reported it as 122 cm. Also, Dzyubenko and Dzyubenko (2011), stated it between 100-160 cm in Russian conditions. While Gençkan (1983) found the plant height of Festuca arundinaceae between 30-200 cm in İzmir conditions, Davis (1985) reported that he measured the plant height between 30-150 cm in Turkey conditions, just two years later. Öztan and Okatan (1985) found the plant height of *Festuca arundinaceae* to be between 100-150 cm in the climatic conditions of Trabzon province located in the humid Black Sea Region, while Ayan and Acar (2009) measured it between 120-150 cm in Samsun conditions, and again Ayan et al., (2011) reported that they found it between 63-170 cm in Samsun conditions. Moreover, Serin and Tan (1998) reported that the plant height of tall fescue varies between 100-150 cm in Erzurum cold climate conditions. Başer and Kaplan (2015) reported that the plant height of tall fescue varies between 69.1-97.3 cm Kayseri conditions, while Kaya and Avcı (2019) reported that they determined it as 20-95 cm Konya conditions in the continental climate.

Although there is a general similarity in terms of plant height, there are some differences as well. These differences may be caused by environmental and genetic factors.

3.6. Main stem thickness

When the average of the years 2015 and 2016 is analyzed in terms of main stem thickness, the lowest main stem thickness was 1.9 mm, the highest main stem thickness was 6.1 mm and the average main stem thickness was 3.1 mm. It was determined that 235 of the genotypes were in the 1st (thick) group, 538 in the 3rd (medium) group and 127 in the 5th (thin) group. The standard deviation value determined between genotypes was calculated as 3.1±0.64. Looking at the average of both years, it is seen that the standard deviation is high. This shows that the variation between genotypes is high in terms of main stem thickness. The coefficient of variation was calculated as an average of 23.7% (Table 7). This shows that the variability between genotypes is high. Since the studied populations are populations collected from nature, this result is expected. 127 genotypes with 50 points (highest) in terms of main stem thickness can be evaluated.

Desired main stem thickness varies according to the purpose of cultivation. There is a close relationship between main stem thickness and yield-yield components in tall fescue. There is a very important relationship between plant height and main stem thickness in tall fescue plant. As the main stem thickness increases, the plant height also increases (Ayan et al., 2011). It is desirable that the main stem of tall fescue plant to be used as turf type is thin, the herbage yield is low and it develops slowly.

Table 7. Frequency distribution and descriptive statistics values of main stem thickness of tall fescue genotypes

Observation/Measurement Value (mm)		Mean	
	Group Value (1-5)	Number	%
3.8<	1 (thick)	235	26.11
[2.8-3.8]	3 (medium)	538	59.78
[1.7-2.7]	5 (thin)	127	14.11
Minimum		1.9	
Maximum		6.1	
Average		3.1	
Standard Deviation		3.1±0.64	
Coefficient of Variation (CV) (%)		23.7	

In this study, main stem thickness in tall fescue genotypes varied between 1.9–6.1 mm. The main stem thickness was found as 2.29 mm by Yazgan et al. (1992), while it was reported as 2.66 mm by Ekiz et al. (1995) in Ankara conditions. While Arslan and Orak (2011) were stated as 2.10 mm of stem thickness in Tekirdağ coastal belt, Ayan et al. (2011) were reported between 2.22-6.77 mm in Samsun conditions.

Although there is a general similarity between the main stem thickness determined in the research and the results of the researchers mentioned above, there are also differences with some of them. Among the reasons for this; It may also be caused by the genetic structure of the studied genotypes, such as the different climate and soil conditions of the research location.

3.7. Internode length

In terms of internode length, the lowest internode length was 11 cm, the highest internode length was 53 cm, and the average internode length was 25.25 cm, according to the average of 2015 and 2016. It was determined that 154 of the genotypes were in the 1st (long) group, 720 in the 3rd (middle) group and 26 in the 5th (short) group. The standard deviation value determined between genotypes was calculated as 25.25±4.81. Looking at the average of both years, it is seen that the standard deviation is high. This shows that the variation between genotypes is high in terms of internode length. The coefficient of variation was calculated as 19.9% on average (Table 8). This shows that the variability between genotypes is high. Since the studied populations are populations collected from nature, this result is expected. The above 26 genotypes with 50 points (the highest) in terms of internode length were selected. Internode length plays an important role in determining the height of the plant in tall fescue. It is not a desirable situation because turf type tall fescue plant to be used in the green area is tall in height, has a high herbage yield and grows rapidly, as it will require more care (irrigation, mowing, fertilization) both in terms of aesthetics. The large number of genotypes (900 genotypes) used in this study and the fact that these genotypes were collected from different ecological regions and altitudes may cause a wide variation in internode length.

In this study, it was determined that the internode length varies between 11 and 53 cm in tall fescue genotypes. While Watkins and Meyer (2004) found the internode length between 13.1-20.9 cm in American conditions, Okkaoğlu (2006) stated as 13.3 cm in İzmir conditions, and Ayan et al. (2011) reported between 3.2-37 cm in Samsun conditions.

Although there is a general similarity between the research conducted and the results of the researchers mentioned above, there are differences. These differences are due to the differences in the research location, climate and soil conditions, and the genotypes studied.

Table 8. Frequency distribution and descriptive statistics values of internode length of tall fescue genotypes

Observation/Measurement Value (cm)		Mean	
	Group Value (1-5)	Number	%
36<	1 (long)	154	17.11
[22-36]	3 (medium)	720	80.00
[6-21]	5 (short)	26	2.89
Minimum		11	
Maximum		53	
Average		25.25	
Standard Deviation		25.25±4.81	
Coefficient of Variation (CV) (%)		19.9	

3.8. Flag leaf length (cm)

When the average of the years 2015 and 2016 is examined in terms of flag leaf length, the lowest flag leaf length is 10 cm, the highest flag leaf length is 42 cm, and the average flag leaf length is 19.94 cm. It was determined that 443 genotypes were in the 1st (long) group, 383 in the 3rd (middle) group and 74 in the 5th (short) group. The standard deviation value determined between genotypes was calculated as 19.94±5.06. Looking at the average of both years, it is seen that the standard deviation is high. This shows that the variation between genotypes is high in terms of flag leaf length. The coefficient of variation was calculated as an average of 25.5% (Table 9). This shows that the variability between genotypes is high. Since the studied populations are populations collected from nature, this result is expected.

Many researchers have reported that flag leaf length of tall fescue (*Festuca arundinacea* Schreb.) varies between 4-61 cm in different ecologies (Gençkan, 1983; Davis, 1965-1985; Öztan and Okatan, 1985; Edward, 1993; Serin and Tan, 1998; Hannaway et al., 1999; Okkaoğlu, 2006; Salman et al., 2008; Ayan and Acar, 2009; Dzyubenko and Dzyubenko, 2011; Kaya and Avcı, 2019). The flag leaf length values (10-42 cm) determined in this study are among the values obtained in the studies.

Although there is a general similarity between the research conducted and the results of the researchers mentioned above, it also differs with some others. The reasons for this may be due to the different research location, climate, soil conditions and genotypes.

Table 9. Frequency distribution and descriptive statistics values of flag leaf length of tall fescue genotypes

		Mean	
Observation/Measurement Value (cm)	**Group Vlaue (1-5)**	**Number**	**%**
29<	1 (long)	443	49.22
[18-29]	3 (medium)	383	42.56
[6-17]	5 (short)	74	8.22
Minimum		10	
Maximum		42	
Average		19.94	
Standard Deviation		19.94±5.06	
Coefficient of Variation (CV) (%)		25.5	

3.9. Flag leaf width (mm)

When the average of the years 2015 and 2016 in terms of flag leaf width is examined, the lowest flag leaf width was 3 mm, the highest flag leaf width was 14 mm and the average flag leaf width was 8.06 mm. It was determined that 764 of the genotypes were in the 1st (very rough) group, 86 in the 3rd (rough) group and 50 in the 5th (moderate) group. The standard deviation value determined between genotypes was calculated as 8.06±2.89. Looking at the average of both years, it is seen that the standard deviation is high. This shows that the variation between genotypes is high in terms of flag leaf width. The coefficient of variation was calculated as 35.5% on average (Table 10). This shows that the variability between genotypes is high. Since the studied populations are populations collected from nature, this result is expected.

If the leaf width is less than 1 mm, it is described as very fine, between 1-2 mm as fine, between 2-3 mm as moderate, between 3-4 mm as rough and if larger than 4 mm as very rough. It is ideal for grass plants to have a flag leaf width between 1.5-3 mm (Beard 1973; Avcıoğlu 1997).

In order to determine the turf type grass characteristics in tall fescue, Edward (1993) reported that the flag leaf width changed between 0.3-1.27 mm in American conditions, while Hannaway et al. (1999) reported that it changed between 3-12 mm in American conditions. Also, Davis (1985) calculated the width of the flag leaf in tall fescue as 5-10 mm in the natural flora of Turkey. While Okkaoğlu (2006) reported the flag leaf width as 6.75 mm in tall fescue in İzmir conditions, Varoğlu (2010) reported it as 3.6 mm in the same conditions. Again in the same province, Salman and Avcıoğlu (2008) reported that they calculated the flag leaf width between 2-6 mm in Lolium perenne and *Festuca arundinacea*. While Avcıoğlu (1997) reported the flag leaf width between 5.2-6.2 mm (very rough) in Bornova conditions, Uyaroğlu (1999) reported it as 4.77 mm (very rough) in the same conditions. While Alagöz and Türk (2017) found the flag leaf width in tall fescue to be 3.28 mm in Isparta conditions, it was reported by Kılıç and Türk (2017) that it changed between 3.1-3.4 mm, Starlet, Debussy and Rebel cultivars in the same province in the same year. On the other hand, Karaca and Akgün (2005) measured it in LoliumxFestuca hybrids between 5-8.5 mm in the same conditions. While Erdoğan and Sürmen (2019) found it in tall fescue to be 4.08 mm in humid Aydın climatic conditions, Arslan and Acar (2019) reported that it was 3.3 mm (rough) in humid Samsun conditions. In the continental climate conditions, while Ekiz et al. (1995) measured it in tall fescue as 6.58 mm in Ankara, Kaya and Avcı (2019) measured it between 0.6-10 mm in Konya, and Yılmaz and Avcıoğlu (2000) measured it as 4.71 mm (very rough) in Tokat and Demiroğlu et al (2011) reported that 2.9-4.4 mm in İzmir conditions.

Edward (1993) reported the flag leaf width between 0.3-1.27 mm in order to determine the grass area characteristics in tall fescue, while Hannaway et al. (1999) reported that they found it between 3-12 mm in American conditions. Davis (1985), in the natural flora of Turkey, measured the flag leaf width between 5-10 mm in tall fescue. While Avcıoğlu (1997) measured the flag leaf width between 5.2-6.2 mm in Bornova conditions as very rough, Uyaroğlu (1999) found it as 4.77 mm in Bornova conditions as very rough. In continental climate, Yılmaz and Avcıoğlu (2000) reported the flag leaf width as 4.71 mm (very rough) in Tokat conditions, Kaya and Avcı (2019) reported it as 0.6-10 mm in Konya conditions, and Ekiz et al. (1995) stated it as 6.58 mm in Ankara conditions. Moreover, Alagöz and Türk (2017) calculated the flag leaf width of tall fescue as 3.28 mm in Isparta conditions. While Karaca and Akgün (2005) found the flag leaf width of 5-8.5 mm in LoliumxFestuca hybrids in Isparta conditions, Kılıç and Türk (2017) reported it as 3.1-3.4 mm in Starlet, Debussy and Rebel cultivars in same conditions. In Izmir climate conditions, Okkaoğlu (2006) reported the flag leaf width of tall fescue to be 6.75 mm, while Salman and Avcıoğlu (2008) calculated it to be 2–6 mm in Lolium perenne and *Festuca arundinacea*, and Varoğlu (2010) found it 3.6 mm in same climatic conditions. While Erdoğan and Sürmen (2019) calculated it to be 4.08 mm in Aydın conditions, Arslan and Acar (2019) found it to be 3.3 mm (rough texture) in Samsun conditions.

In this study, it was determined that flag leaf width varies between 3-14 mm or between 1-5 group values in tall fescue genotypes. Although there is a general similarity between the flag leaf width found in the study and the results of the researchers mentioned above, there are also differences with some of them. The reasons for the differences may be due to the different genotypes in terms of research location, climate and soil conditions, cultural practices, cutting height, fertilization, variety and species.

Table 10. Frequency distribution and descriptive statistics values of flag leaf width of tall fescue genotypes

Observation/Measurement Value (mm)		**Mean**	
	Group Value (1-5)	**Number**	**%**
4<	1 (very rough)	764	84.89
4	3 (rough)	86	9.44
3	5 (moderate)	50	5.67
Mimimum		3	
Maximum		14	
Average		8.06	
Standard Deviation		8.06±2.89	
Coefficient of Variation (CV) (%)		35.5	

3.10. Herbage yield (g/genotype)

When the average of the years 2015 and 2016 in terms of herbage yield is examined, the lowest herbage yield was 101 g, the highest herbage yield was 2330 g and the average herbage yield was 629.1 g. In terms of herbage yield it was determined that 267 of the genotypes were in the 1st (high) group, 337 in the 3rd (medium) group and 296 in the 5th (low) group. The standard deviation between genotypes was calculated as 629.1±370.7. Looking at the average of both years, it is seen that the standard deviation is high. This shows that the variation between genotypes in terms of herbage yield is very high. The coefficient of variation was calculated as 57.8% on average (Table 11). As can be seen from the variation limits, the variability between genotypes is very high. Since the studied populations are populations collected from nature, this result is expected. It is important for the turf type grass to stay green as long as possible, to be short, to have low herbage yield and to grow slowly, both in terms of aesthetics and the sustainability of the grass. In the study, herbage yield in tall fescue genotypes varied between 101-2330 g/genotype.

Many factors such as genotype, climate, season, soil moisture, cutting tool, cutting height, cutting frequency affect the herbage yield (Beart, 1973; Avcıoğlu, 1997).

Avcıoğlu et al. (1999) calculated the herbage yield per plant as 24.6 g in Kentucky bluegrass in İzmir conditions. Yılmaz and Avcıoğlu (2000), found the average herbage yield values as 1932.6-2486.5 kg/da, 2277.1 kg/da, 4107.6-4410.7 kg/da, 1684.1-2054.6 kg/da, 2148.4-2326.8 kg/da, 1859.5-2196.6 kg/da and 5053.5 kg/da of creeping bentgrass (*Agrostis stolonifera* L.), bent grass (*Agrostis capillaris*), perennial ryegrass (*Lolium perenne*), kentucky bluegrass (*Poa pratensis*), creeping red fescue (*Festuca rubra var. rubra*), chewings fescue (*Festuca rubra var. commutata*) and tall fescue (*Festuca arundinaceae* Schreb.) in Tokat conditions, respectively. Moreover, Okkaoğlu (2006) reported that herbage yields per plant were found as 953 g for smooth brome (*Bromus inermis*), as 925 g for intermediate wheatgrass (*Elymus hispidus*), as 617 g for reed canary grass (*Phalaris arundinacea*), as 585 g for tall fescue (*Festuca arundinacea* Schreb.), as 453.50 g for orchard grass (*Dactylis glomerata*), as 379.5 g for tall meadow oat (*Arrhenatherum elatius*), and as 197 g for perennial ryegrass (*Lolium perenne*) in İzmir conditions. Also, Kuşvuran (2009) reported that he measured herbage yield values between 153.2-651.4 g/m^2 in tall fescue and bent grass species in Çukurova conditions. Saygın and Ayan (2019), in their study conducted in Samsun – Çarşamba conditions (in pure stand tall fescue), determined the herbage yield between 281-460 g at 30 g/m^2 sowing rate, between 218-670 g at 40 g/m^2 sowing rate, between 248-525 g 50 g/m^2 sowing rate, and between 258-1071 g 60 g/m^2.

While the data obtained from the study and the results reported by some researchers overlap, there are differences with some of them. The herbage yield values obtained from some non-overlapping researchers are yield values per decare, m^2. There is a general similarity with the others, although the plant variety and species are different.

Table 3.11. Frequency distribution and descriptive statistical values of herbage yield of tall fescue genotypes

Observation/Measurement Value (g/genotip)		**Mean**	
	Group Value (1-5)	**Number**	**%**
[100-400]	5 (low)	296	32.89
[401-800]	3 (medium)	337	37.44
800<	1 (high)	267	29.67
Minimum		101	
Maximum		2330	
Average		629.1	
Standard Deviation		629.1±370.7	
Coefficient of Variation (CV) (%)		57.8	

3.11. Genotypes selected as turf type and their characteristics

Among 900 genotypes, 49 turf type genotypes were selected by weighted scaling method and 49 selected genotypes were subjected to cluster analysis. According to the results of the analysis, 5 groups were formed.

1. GROUP (FA 26-10, FA 29-07, FA 49-02, FA 23-17, FA33-12, FA26-02, FA28-08, FA21-07, FA11-12, FA24-03, FA25-03, FA27-01, FA28-20,

FA22-01, FA36-09, FA20-02, FA20-07, FA23-02, FA07-03, FA28-13, FA34-14, FA44-17)

2. GROUP (FA06-07, FA31-02, FA09-08, FA05-13)

3. GROUP (FA43-14, FA37-15, FA09-13, FA25-15, FA36-12, FA58-10)

4. GROUP (FA11-15)

5. GROUP (FA22-18, FA24-08, FA49-16, FA09-19, FA23-16, FA28-03, FA32-06, FA37-02, FA31-19, FA36-13, FA32-14, FA32-17, FA37-12, FA35-19, FA07-13, FA24-18) it has been found. Only FA11-15 genotype was included in the fourth group. According to the analysis, it was determined that FA 26-10 in the 1st group and FA 06-07 in the 2nd group had the farthest degree of relationship in terms of relationship level. FA 26-10 in group 1 and FA 43-14 in group 3, FA 26-10 in group 1 and FA 11-15 in group 4, FA 26-10 in group 1 and FA 22-18 in group 5, respectively are first four genotypes far from each other, as can be seen from the dendogram in Figure 1. It was determined that FA 32-06 in the 3rd group and FA 37-02 in the 5th group had the closest relationship degree in terms of relationship level. FA 32-14 in group 5, FA 32-17 in group 5, FA 20-07 in group 1, FA23-02 in group 1, FA 25-03 in group 1 and FA 27-01 in group 1, respectively are the first four genotypes close to each other, as can be seen from the dendogram in Figure 1. Looking at Figure 1, we can see that the genotypes were first divided into two main groups (1 and 2). Group 1 includes FA 06-07, FA 31-02, FA 09-08 and FA 05-13. These genotypes have the same lodging ratio, spring growth and internode length (except FA 05-13) while also having similar number of days to heading, herbage yield, main stem thickness and flag leaf length (except FA 05-13). These genotypes were collected from Samsun and Tokat locations. The large group 2 is the group with the most differentiation and is clearly divided into two groups as 2a and 2b. Group 2a is less than group 2b in terms of genotype number and includes FA 43-14, FA 37-15, FA 09-13, FA 25-15, FA 36-12, FA 58-10 genotypes. All of these genotypes were collected from Tokat location. These genotypes have the same lodging ratio and spring growth. Group 2b is the group with the most sub-branching and all genotypes were collected from the Tokat location (except FA 07-13 and FA 07-03). Of these genotypes, FA11-15 alone differed from other groups in terms of lodging ratio.

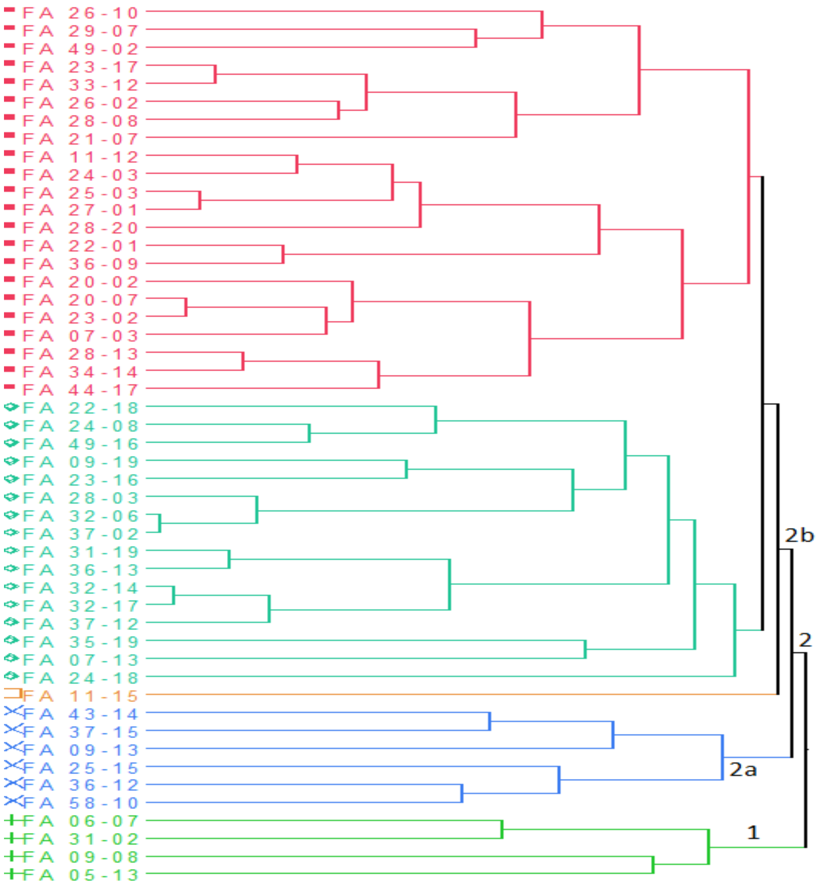

Figure 1. Grouped version of 49 selected grass genotypes

4. Conclusion

According to the analysis, it was determined that FA 26-10 in the 1st group and FA 06-07 in the 2nd group had the farthest relationship degree in terms of relationship level. FA 26-10 in group 1 and FA 43-14 in group 3, FA 26-10 in group 1 and FA 11-15 in group 4, FA 26-10 in group 1 and FA 22-18 in group 5, respectively are the first four genotypes far from each other. It was determined that FA 32-06 in the 3th group and FA 37-02 in the 5th group had the closest relationship degree in terms of relationship level. FA 32-14 in group 5, FA 32-17 in group 5, FA 20-07 in group 1, FA23-02 in group 1, FA 25-03 in group 1 and FA 27-01 in group 1, respectively are the first four genotypes close to each other, as can be seen from the dendogram in Figure 1.

Among 900 genotypes collected from Samsun, Sinop and Tokat provinces, 49 turf type genotypes with broad genetic pool were selected according to their morphological and agricultural characteristics. This genetic material, whose basic data are known, will make a significant contribution to the breeding studies that will be carried out later.

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