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Determination of Genetic Variation Between Populations of *Abies nordmanniana* subsp. *bornmulleriana* Mattf According to some Seed Characteristics

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1. Introduction

The success of any sustainable reforestation program, among other things, hinges on a continuous supply of high quality seeds for the production of the desired quantity of seedlings in nurseries or for successful stand establishment by direct sowing out in the field. What is seed quality then? Seed quality is defined as "a measure of characters or attributes that will determine the performance of seeds when sown or stored" (Hampton 2002). It is a multiple concept encompassing the physical, physiological, genetic, pathological and entomological attributes that affect seed lot performance (Basu, 1995).

Several factors affect the production of high quality seeds, such as insect infestation (El Atta 1993, Dajoz 2000, Bates et al. 2000, 2001), pollination failure and post-zygotic degeneration (Owens et al. 1990, El-Kassaby et al. 1993), infection by seed borne pathogens (Pritam and Singh 1997), environmental conditions during seed development (Gutterman 2000) as well as the genetic constitution (Bazzaz et al. 2000).

Genetic diversity is the richness of the hereditary information in the gene pole of one species. High level of inter-species genetic diversity is an assurance for adaptation to changing environmental conditions, an indication for adaptation potential of the species and an important part of the ecosystem stability. Also genetic diversity is a raw material for tree improvement studies. As such, most of the researches about the genetic diversity are in high priority in forest trees improvement programs (Şevik et al., 2010a, 2010b).

Genetic variation is the fundamental component, which ensures survival and thus the stability of forest ecosystems as its quantity and quality determines the potential of population to adapt the changing in environmental condition. This is particularly important with changing population and climatic condition and when the long-term stability of forest ecosystems is increasingly threatened by environmental stress. Thus, a genetic characterization of natural forest resources is the first step necessary for a better understanding of genetic resources for implementation of insitu and exsitu conservation activities (Şevik, 2010; Turna et al., 2006; Şevik et al. 2010a).

Up to now, in Turkey, studies about genetic diversity of the main forest trees have been concentrated on pine species, neglecting other main forest tree species. Turkish fir is among the one of the neglected species.

Turkish fir (*Abies nordmannianan* subsp. *bornmülleriana*) has a special importance for Turkey because of its increasing economic value in marketplace and decorative characteristic in landscape architecture. Furthermore, being an endemic species for Turkey, very decorative species, for this reason the species is the most widely preferred Noel tree in the world (Şevik et al, 2011). Turkish fir is distributed from Kızılırmak River to Mount Uludağ in Western Blacksea region, particularly in Ayancık, Ilgaz Mountains, Bolu Seben Mountains, Boyabat-Göktepe forests, Abant and Mount Uludağ. Stands of fir species occupy roughly 600.000 ha at Turkey (Anonymous, 2006).

The objectives of this study were to investigate the Genetic diversity among Turkish fir populations in Turkey, and determine the extent of between population variation, using 13 different morphological characters.

2. Materials and methods

Seed collection and sowing: Open pollinated seed materials from seventeen different natural populations of Turkish fir collected from Western Black Sea Region. Locations and description of the studied population are indicated in Fig. 1 and Table 1 in this study.

Fig. 1. Locations of the populations

Seed and seedling morphological variables studied and data collection: In this study, width, thickness, length and weight of seeds, carpel width, length and weight, carpel scape width and length, wings width and length were determined from total 303 sample trees. All length and width were measured with digital micro-compass (0,01 mm) from 10 samples for each sample tree. All weight was measured with digital weighing machine (0,001 gr).

Statistical Analyses: Data were subjected to multi-way analysis of variance, Duncan test and Hierarchical Cluster analysis with SPSS statistical package program. Relationships between 13 related characters were tested using correlation analyses.

Pop. No	Population Name	City	Number of Sample Trees	Altitude (m)	Longitude (E)	Latitude (N)
1	Bafra1	Samsun	10	828	35°21'18"	41°34'01"
2	Bafra2	Samsun	10	1012	35°21'33"	41°33'28"
3	İskilip1	Amasya	20	1673	33°46'11"	41°22'36"
4	İskilip2	Amasya	20	1852	34°13'34"	40°49'01"
5	Türkeli	Sinop	13	1348	34°16'15"	41°44'58"
6	Ilgaz1	Kastamonu	20	1430	33°49'17"	41°09'27"
7	Ilgaz2	Kastamonu	20	1624	33°49'11"	41°08'60"
8	Ilgaz3	Kastamonu	20	1995	33°50'58"	41°07'47"
9	Ballıdağ1	Kastamonu	20	1056	33°29'02"	41°37'11"
10	Ballıdağ2	Kastamonu	20	1374	33°25'29"	41°34'12"
11	Ballıdağ3	Kastamonu	20	1640	33°22'37"	41°31'58"
12	Samatlar	Kastamonu	20	1497	33°15'32"	41°22'06"
13	Eflani	Karabük	20	1102	32°51'45"	41°29'02"
14	Aladağ	Bolu	10	968	31°37'15"	40°40'21"
15	Kıbrıscık2	Bolu	20	1499	32°00'42"	40°25'46"
16	Kıbrıscık1	Bolu	20	1791	32°02'22"	41°28'43"
17	Göynük	Bolu	20	1270	30°41'27"	40°30'08"

Table 1. Description of the studied populations in Turkey

Moreover, collected data was determined with Penrose formule. Data were standardized before the calculations and the morphological distance among populations were estimated as;

$$Z_{i,k} = \frac{(X_{i,k} - \bar{x})^2}{S_k}$$

Where $Z_{i,k}$ is standardized values of the k^{th} characteristics of the i^{th} population, $X_{i,k}$ is original average of the k^{th} characteristics of the i^{th} populations for the k^{th} characteristics and S_k is the standard deviation of the studied populations for the k^{th} characteristics (Şevik, 2005, 2010).

$$D_{i,j} = \sum_{k=1}^{p} \frac{(\mu_{ki} - \mu_{kj})^2}{p.V_k}$$

Where, D_{tj} is the morphological distance between the i^{th}, population and the j^{th} populations, n is the number of studied characteristics, μ_{kj} is the standardized values of the k^{th} of the I^{th} population, μ_{kj} is the standardized values of the k^{th} characteristics of the j^{th} population, V_k is the variance of standardized averages of the k^{th} characteristics (Yahyaoğlu et al, 2001) was applied by standardized values in SPSS statistical package program (Şevik, 2010).

3. Results

The analysis of variance showed that there were significant differences among populations at 0.01 for seed width and 0.001 for other characters. Mean values and multiple comparisons of studied morphological characters shown in Tables 2.

Population Name	Carpel Length (mm)		Scale Length (mm)		Carpel width (mm)		Scale width (mm)	
Bafra1	33.31±0.81	a	25.21±0.82	ab	28.70±1.01	abcd	**4.87±0.14**	**a**
Bafra2	33.32±0.98	a	**24.70±0.92**	**a**	**27.63±1.12**	**a**	5.12±0.21	abc
İskilip1	36.41±0.68	cdef	27.36±0.61	bcde	31.01±0.71	cde	5.08±0.11	abc
İskilip2	36.18±0.85	cdef	26.50±0.63	abcde	31.07±0.90	de	5.00±0.12	ab
Türkeli	**33.54±0.87**	**a**	25.69±0.5	abc	27.86±0.85	a	5.29±0.14	abcd
Ilgaz1	33.71±0.78	ab	25.33±0.66	ab	28.39±0.60	ab	5.18±0.13	abc
Ilgaz2	36.39±0.95	cdef	27.83±0.67	cde	29.87±0.82	abcde	5.41±0.12	bcd
Ilgaz3	34.86±0.64	abcd	26.95±0.65	bcde	28.47±0.82	abc	5.10±0.12	abc
Ballıdağ1	36.99±0.73	ef	**28.69±0.62**	**e**	**32.17±0.69**	**e**	**5.71±0.16**	**d**
Ballıdağ2	36.56±0.55	cdef	28.06±0.66	de	31.53±0.69	e	5.50±0.11	cd
Ballıdağ3	36.30±0.56	cdef	27.73±0.53	cde	30.87±0.61	bcde	5.65±0.12	d
Samatlar	36.06±0.52	bcdef	27.77±0.52	cde	31.56±0.68	e	5.67±0.12	d
Eflani	34.04±0.53	abc	26.34±0.58	abcd	29.97±0.63	abcde	5.18±0.12	abc
Aladağ	**37.43±0.84**	**f**	28.21±1.12	de	32.07±0.66	e	5.53±0.15	cd
Kıbrıscık2	34.12±0.76	abc	25.79±0.69	abc	30.86±0.64	bcde	5.29±0.17	abcd
Kıbrıscık1	36.65±0.70	def	27.93±0.58	cde	31.93±0.72	e	5.45±0.15	bcd
Göynük	36.11±0.70	bcdef	28.15±0.68	de	30.67±0.72	bcde	5.45±0.11	bcd
Av.	35.41±0.72		26.96±0.65		30.27±0.74		5.32±0.13	
F	3,194***		3,007***		3,420***		3.42***	

Table 2. Mean values of studied morphological characters and results of Duncan test.

According to Table 2, Population of Kıbrıscık2 is in the first homogeny group according to all characters and population of Ilgaz1 is too except wing length. These populations showed lowest performance for thirteen characters. Populations of Aladağ, Ballıdağ1 and Ballıdağ2 showed highest performance. Aladağ population (except wing width), Ballıdağ1 and Ballıdağ2 populations (except carpel scape width) are in the last homogeny group according to Duncan test. These populations showed the highest performance almost for all characters. The mean values and standard deviation of morphological characters by populations are shown in Table 2 (Şevik, 2010).

Average carpel length is 35,41 mm, carpel width is 30,27 mm, scale length is 26,96 mm and scale width is 5,32 mm. According to results of variance; carpel length 12,4%, carpel width

16,4%, scale length 16,2%, scale width 17,2% change of minimum values to maximum values. Maximum values of scale length (28,69 mm), carpel width (32,17 mm) and scale with (5,71 mm) determined to population of Ballıdağ1. Minimum values of scale length (24,7 mm) and carpel width (27,63 mm) determined to Population of Bafra2. Minimum scale width is 4,87 mm (Bafra1), minimum carpel length is 33,54 mm (Türkeli). Maximum carpel length is 37,43 mm determined to population of Aladağ.

Popul. Name	Carpel Scape Length (mm)		Carpel Scape Width (mm)		Carpel Weight (mg)		Wing Length (mm)		Wing Width (mm)	
Bafra1	4.79±0.12	bcdef	1.61±0.07	cdef	275.64±20.03	ab	15.31±0.47	bc	**14.04±0.51**	**a**
Bafra2	**4.17±0.12**	**a**	1.41±0.09	ab	**245.60±22.69**	**a**	14.74±0.91	ab	14.05±0.66	a
İskilip1	4.86±0.11	def	**1.75±0.06**	**f**	353.41±14.83	de	16.97±0.50	cde	15.85±0.42	c
İskilip2	4.96±0.13	def	1.70±0.05	ef	**358.38±20.35**	**e**	17.37±0.59	def	**16.40±0.39**	**c**
Türkeli	4.72±0.12	bcdef	1.62±0.05	cdef	273.34±18.87	ab	**13.27±0.58**	**a**	14.45±0.49	ab
Ilgaz1	4.41±0.11	ab	1.41±0.04	ab	252.23±11.26	a	16.25±0.43	bcde	14.47±0.30	ab
Ilgaz2	4.89±0.14	def	1.58±0.04	bcdef	299.35±16.62	abcd	16.97±0.64	cde	15.98±0.46	c
Ilgaz3	4.43±0.07	abc	1.51±0.06	abcd	251.07±12.66	a	16.31±0.55	bcde	15.64±0.30	bc
Ballıdağ1	4.74±0.12	bcdef	1.54±0.05	abcde	330.65±14.27	cde	17.60±0.46	def	15.75±0.32	c
Ballıdağ2	**5.13±0.12**	**f**	1.54±0.04	abcde	339.47±11.48	cde	17.65±0.52	def	15.81±0.26	c
Ballıdağ3	4.58±0.12	bcd	1.62±0.05	cdef	299.12±12.54	abcd	16.56±0.41	cde	15.20±0.31	abc
Samatlar	4.84±0.15	cdef	1.51±0.04	abcd	325.96±17.56	bcde	17.09±0.46	cdef	15.38±0.32	bc
Eflani	4.64±0.10	bcde	**1.40±0.05**	**a**	286.68±12.46	abc	16.00±0.46	bcd	15.10±0.36	abc
Aladağ	4.94±0.24	def	1.68±0.07	def	315.50±19.19	bcde	18.06±0.66	ef	15.63±0.49	bc
Kıbrıscık2	5.07±0.10	ef	1.49±0.05	abc	272.18±14.67	ab	17.60±0.54	def	14.39±0.40	ab
Kıbrıscık1	4.99±0.09	def	1.59±0.04	cdef	352.06±16.43	de	**18.90±0.52**	**f**	15.82±0.34	c
Göynük	4.90±0.12	def	1.54±0.06	abcde	347.25±19.36	de	17.26±0.61	def	16.17±0.36	c
Av.	4.77±0.12		1.56±0.05		304.58±15.79		16.7±0.54		15.3±0.38	
F	3,808***		3,604***		5,675***		4,703***		3,376***	

Table 2. (Continue). Mean values of studied morphological characters and results of Duncan test.

Average carpel scape length is 4,77 mm, carpel width is 1,56 mm, carpel weight is 304,58 mg, wing length is 16,7 mm, wing width is 15,3 mm. According to results of variance; scale scape length 14,4%, scale scape width 25%, carpel weight 45,9%, wing length 42,4%, wing width 15,2% change of minimum values to maximum values.

According to the table, population of Bafra1 had shown minimum values of carpel scape length (4,17 mm) and carpel weight (245,60 mg). Iskilip1 had shown Maximum values of carpel weight (358,38 mg) and wing width (16,4 mm). Minimum values; wing width is 14,04 mm (Bafra1), carpel scape width is 1,4 mm (Eflani) and wing length is 13,27 mm (Türkeli).

Maximum values; wing length is 18,9 mm (Kıbrıscık1), carpel scape width is 1,75 mm (Iskilip1) and carpel scape length is 5,13 mm (Ballıdağ2).

The mean values and standard deviation of morphological characters by populations are shown in Table 2 (Şevik, 2010).

Population Name	Seed Length (mm)		Seed Width (mm)		Seed Thickness (mm)		Seed Weight (mg)	
Bafra1	11.00±0.34	ab	5.74±0.11	abc	3.97±0.09	ab	81.58±5.41	abcde
Bafra2	10.84±0.39	a	5.78±0.12	abcd	3.82±0.14	a	85.84±7.66	abcde
İskilip1	11.63±0.28	abcd	6.12±0.13	de	3.92±0.08	ab	84.55±4.38	abcde
İskilip2	11.46±0.22	abc	5.93±0.12	abcd	3.90±0.07	ab	72.94±4.29	ab
Türkeli	11.44±0.18	abc	5.95±0.14	abcd	3.94±0.10	ab	79.97±4.85	abc
Ilgaz1	**10.83±0.23**	**a**	5.65±0.12	ab	**3.73±0.08**	**a**	74.71±3.73	ab
Ilgaz2	12.01±0.28	cdef	5.86±0.12	abcd	4.03±0.08	ab	95.57±4.60	defg
Ilgaz3	11.48±0.16	abc	5.65±0.07	ab	3.77±0.06	a	80.41±3.05	abcd
Ballıdağ1	12.46±0.21	ef	6.07±0.09	cde	4.22±0.09	ab	103.29±4.53	fg
Ballıdağ2	**12.57±0.17**	**f**	6.05±0.08	cde	4.33±0.08	b	**109.11±3.82**	**g**
Ballıdağ3	12.36±0.22	def	5.85±0.09	abcd	4.05±0.07	ab	94.71±3.90	cdefg
Samatlar	11.77±0.25	bcde	5.85±0.08	abcd	3.83±0.09	a	91.68±4.66	cdef
Eflani	11.16±0.24	ab	**6.36±0.12**	**e**	3.90±0.07	ab	87.96±4.29	bcde
Aladağ	11.99±0.26	cdef	5.99±0.12	bcd	4.07±0.14	ab	95.42±7.44	defg
Kıbrıscık2	11.06±0.19	ab	**5.61±0.08**	**a**	3.77±0.05	a	**71.72±2.78**	**a**
Kıbrıscık1	11.67±0.25	bcde	5.76±0.13	abcd	**4.34±0.43**	**b**	83.27±4.59	abcde
Göynük	12.15±0.24	cdef	5.96±0.08	abcd	3.93±0.1	ab	96.80±4.65	efg
Av.	11.64±0.23		5.89±0.1		3.97±0.1		81.58±4.05	
F	5,123***		3,451***		1,789**		5,942***	

Table 2. (Continue). Mean values of studied morphological characters and results of Duncan test.

Average values of seed length (11,64 mm), seed width (5,89 mm), seed thickness (3,97) and seed weight (81,58 mg) are shown in the table. According to the table minimum seed length (10,83 mm) and seed thickness (3,73 mm) values are determined to population of Ilgaz1, minimum seed width (5,61 mm) and seed weight (71,72 mg) values are determined to population of Kıbrıscık2. Maximum values of seed length is 12,57 mm (Ballıdağ2), seed width is 6,36 mm (Eflani), seed thickness is 4,34 mm (Kıbrıscık1) and seed weight is 109,11 mg (Ballıdağ2).

On the cluster dendrogram constructed on the basis of Euclidean distances with the use of the nearest neighbourhood method for 13 quantitative morphological traits, two distinct

groups can be noticed: the first is İskilip1, İskilip2, Ballıdağ2, Göynük, Samatlar, Aladağ, Kıbrıscık1 and the others. The second group cans distinct two groups, Ilgaz1 and others. According to these results, it can be said that there are three main groups (Figure 2 and 3).

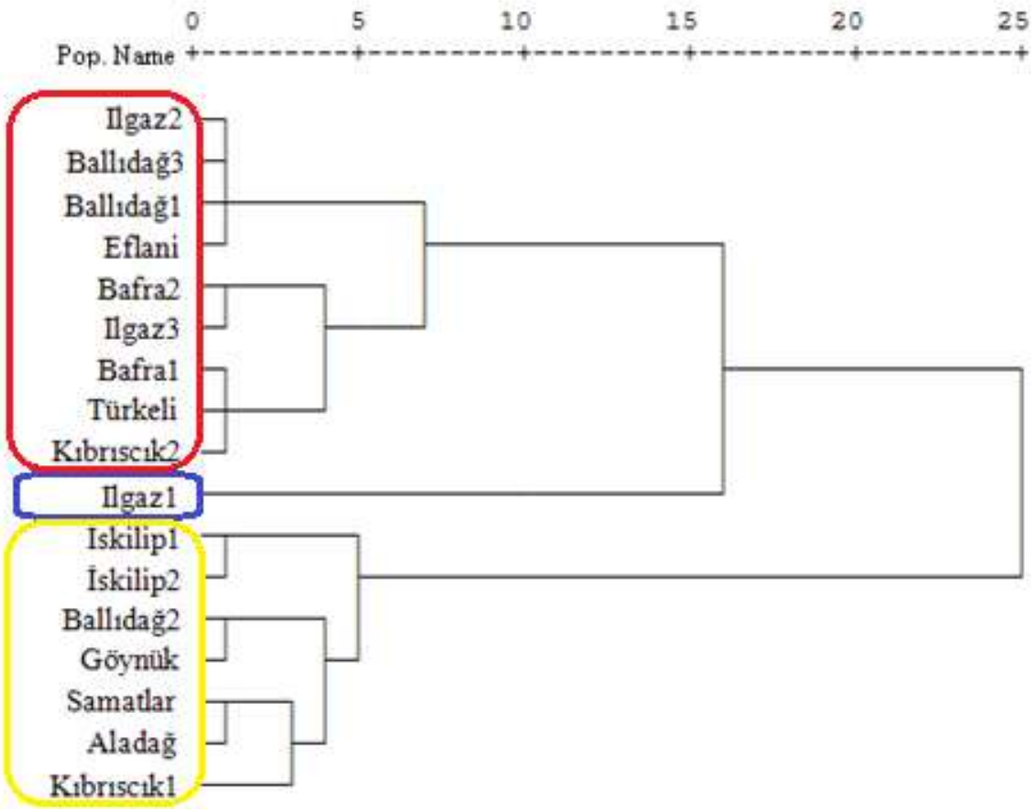

Fig. 2. Dendrogram of 17 population of Turkish fir based on 13 morphological traits.

According to results of cluster analysis, red color is the first group, blue color is the second group and the yellow color is the third group in the figure 3 (Şevik, 2010).

Some populations are geographically and genetically close to each other like, Bafra1 and Bafra2, Ilgaz2 and Ilgaz3, İskilip1 and İskilip2 populations. Some of them are geographically close to each other even though genetically different from each other. For example Ballıdağ1 and Ballıdağ2, İskilip1 and İskilip2 populations. On the contrary, some populations are genetically close to each other even though geographically different from each other. For example Bafra1 and Kıbrıscık2, İskilip1 and Göynük populations (Figure 2 and 3).

The highest 16 values calculated between Ilgaz1 and the other populations. Maximum 5 values are between the populations of Ilgaz1 and Eflani (10,3635), Kıbrıscık1 (9,9517), Ilgaz3 (9,2148), Türkeli and Ilgaz2 (8,4679). Minimum 5 values are 0,3029 (Bafra1 and Samatlar), 0,4078 (Bafra1 and Göynük), 0,4107 (Ballıdağ3 and Samatlar), 0,4673 (Bafra1 and Ilgaz2) and 0,5038 (Kıbrıscık2 and Göynük).

Results of correlation analyses are shown in Table 4. According to Table 4 there were positive significant correlation was found between all characters except carpel scape width and seed length, seed thickness, seed weight. The correlation between carpel scape length

and carpel scape width is significant at the 0.05 level, other all correlations are significant at the 0.01 level (Table 4).

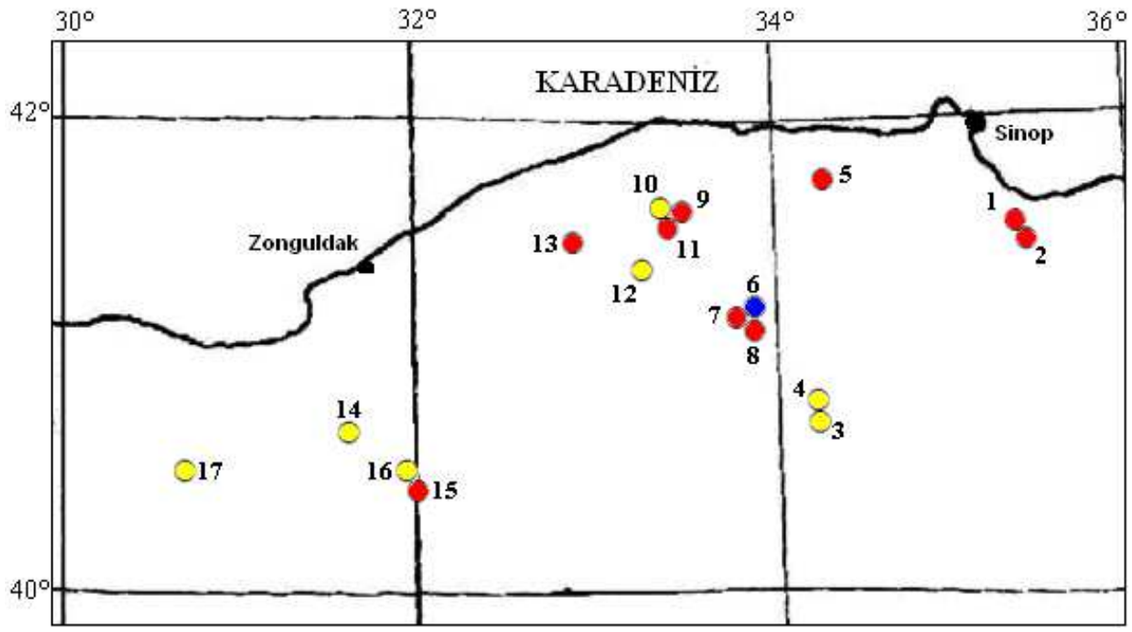

Fig. 3. Geographic positions of populations and results of cluster analysis

Morphological distance and grouping according to Penrose formula are shown that Table 3.

Pop. No	1	2	3	4	5	6	7	8
2	1.0171							
3	0.8408	1.0587						
4	0.8715	1.2715	0.6238					
5	1.1440	1.4252	1.5351	1.5285				
6	**7.1725**	**5.7758**	**7.4618**	**7.2740**	**8.8849**			
7	**0.4673**	1.5966	1.3288	1.3045	1.6894	**8.4679**		
8	0.9812	1.4185	0.8796	0.8711	1.7620	**9.2148**	1.0019	
9	0.9410	1.2547	0.7509	1.0335	1.6805	**7.2567**	0.6187	1.0099
10	1.8281	2.0630	2.8355	2.1007	2.7878	**4.6134**	1.6283	1.9982
11	0.6217	2.0264	1.5577	1.8446	2.3340	**8.0759**	0.5578	1.3256
12	**0.3029**	1.3819	1.1421	1.2455	1.5132	**8.0839**	0.7395	0.6935
13	1.5400	2.5653	0.8524	1.9061	1.9414	**10.3635**	1.3006	1.2208
14	0.5383	0.8897	1.0649	1.2452	1.0398	**5.2708**	0.9439	1.5747
15	0.9053	1.1575	1.1795	0.8243	1.1764	**7.5639**	0.5617	0.5652
16	1.3048	2.1365	1.3576	1.6116	1.1450	**9.9517**	1.1685	0.7097
17	**0.4078**	1.0211	1.0387	0.8375	1.4796	**7.0460**	0.5381	0.7332

Table 3. Morphological distance among populations according to Penrose Formula

Pop. No	9	10	11	12	13	14	15	16
10	1.9756							
11	1.1810	1.7470						
12	1.2355	1.8239	**0.4107**					
13	0.8475	3.3882	1.4892	1.5608				
14	0.8184	1.3315	0.8540	0.7276	1.7854			
15	0.5766	0.9610	1.2016	0.9795	1.3299	0.9168		
16	1.3074	2.0367	1.4842	1.1814	0.7464	1.6195	0.6667	
17	1.0942	1.2490	1.0541	0.6694	1.6872	1.0009	**0.5038**	1.1633

Table 3. (Continue). Morphological distance among populations according to Penrose Formula

	CL	SL	CW	SW	CSL	CSW	CWe	WL	WW	SeL	SeW	SeT
SL	**0.81****											
CW	0.69**	0.55**										
SW	0.51**	0.51**	0.60**									
CSL	0.38**	0.30**	0.49**	0.29**								
CSW	0.27**	0.29**	**0.19****	0.20**	**0.14***							
CWe	**0.78****	0.70**	0.71**	0.45**	0.48**	0.38**						
WL	0.60**	0.47**	**0.80****	0.43**	0.38**	**0.18****	0.63**					
WW	0.77**	0.69**	0.58**	0.35**	0.30**	0.28**	0.71**	0.63**				
SeL	0.62**	0.57**	0.57**	0.41**	0.39**	0.09^{ns}	0.54**	0.41**	0.55**			
SeW	0.39**	0.41**	0.40**	0.21**	0.22**	0.20**	0.43**	0.27**	0.51**	0.46**		
SeT	0.32**	0.31**	0.34**	0.30**	0.25**	0.04^{ns}	0.30**	0.28**	0.28**	0.44**	0.28**	
SeWe	0.64**	0.62**	0.56**	0.42**	0.38**	0.06^{ns}	0.58**	0.44**	0.60**	0.77**	0.55**	0.45**

ns: Non significant, **: significant at the 0.01 level, *: significant at the 0.05 level.

Table 4. Pearson correlation coefficients among 13 morphological characters

According to results of correlation analysis the highest relations are between the carpel length and seed length (0,81), carpel width and wing length (0,80) and carpel length and carpel weight (0,78). The minimum values are determined between carpel scape width and carpel scape length (0,14), wing length (0,18) and carpel width (0,19).

4. Discussion

According to results of the cluster analysis and variance analysis, Ilgaz1 population is very different to other populations. It could be because of its longitude and different ecological and genetical material condition. Results of the cluster analysis (Figure 2) were well accordance with morphological distances. For instance, morphological distances of Ilgaz1 were the highest than the others. Similarly population of Ilgaz1 is very different to other populations according to cluster analysis. These results could be used in preparation of

gene map, seed transfer zones, determination of breeding populations, gene conservation areas, geographic variation and resulting of provenance trials of the species in short period. Preparation of forest gene maps and determination of seed transfer zones and geographical variation by morphological distance were also suggested by Yahyaoğlu et al 2001.

Genetic variation can be determined with morphological characters (Güney, 2009; Kulaç et. al., 2010; Şevik, 2010), isosymes analysis (Bilgen and Kaya, 2007; Turna, 2003) and DNA markers (Clark et. al., 2000; Goldstein, 1995). Many researchers use these methods for determination to genetic variation on *Abies* species; Messaoud et all. (2007) *Abies balsamea,* Okada et all., (1973) *Abies sachalinensis,* Parker et all. (1981) *Abies balsamea* and *Abies lasiocarpa,* Kolotelo (1998) *Abies amabilis*, *Abies grandis* and *Abies lasiocarpa* e.c.

Shea (1990) reported that the variation among the populations is small (1,3%) but significant in *Abies Lasiocarpa*. Sorensen and Franklin (1977) reported that, year effect including interactions with places and trees in places made up an estimated 45 % of the variance in seed weight and 25% of the variance in cotyledon number. Among population genetic variance was much lower than within population variance, ranging from 6.6 to 6.8% for drought resistance traits to 7.8–14.0% for bud-break dates and a maximum of 10.0–17.9% for height growth traits to *Abies alba*. Therefore, genetic variance was predominantly within population (Sagnard et al, 2002).

The average genetic distance for all pair-wise comparisons between the ten populations of *Abies alba* in Italy was 0.014 (Parducci and Szmidt, 1997). 7,3% of the total genetic variation was due to differences among populations for gymnosperms (Hamrick et. al., 1992) and 10% for eigth Abies species (Shea and Furnier 2002). 13.3% of the total diversity is distributed among populations in *Abies alba* (Vendramin et al. 1999). Great variation was observed in the heterozygosity among the population studied and ranged from 0.010 *(A. pinsapo)* to 0.328 *(A. cephalonica).* The inter population genetic diversity was about 26% of the total genetic diversity. The average coefficient of gene differentiation (Gst) was 0.255, which means that approximately 26% of the total diversity of the Mediterranean firs exist among the populations. In particular, the geographical Area III (Turkey) has scored the highest value of Gst (25.8%), (Scaltsoyianne, 1999).

The proportion of genetic diversity among the populations of *Abies sachalinensis* is 1,5 % (El-Kassaby, 1992), populations of *Abies mariesii* is 2,6 % (Suyama et al. 1992) and populations of *Abies cephalonica* is 4.8% (Fady and Conkle 1993).

Conte (2004) reported that ANOVA analysis of *Abies nebrodensis* indicated that most of genetic variation resides within subsets (84%). More than 10% of the total genetic diversity was due to differences among populations of *Abies nebrodensis* (Vicario et, al., 1995).

Total percentage of genetic variation present in the population explained by interplot or among subpopulation differences is 0,35% of *Abies fraseri*. Thus, more than 99% of the genetic variation is due to within plot (i.e. tree to tree) variation (Diebel and Feret 1991). Most of the genetic diversity lies within populations to *Abies cephalonica* (Fady and Conkle 1993). Less than 10% of the total observed variation appeared among populations of *Abies cephalonica* (Hamrick, 1989) and the variation among the populations is 11% in *Abies alba* (Vicario et al. 1995). Vendramin et al. (1999) reported that 13.3% of the total diversity is distributed among populations in *Abies alba.* On average, the genetic diversity among populations of *Abies* species has been found to be 6,3 % (Hamrick et al. 1992).

The high within-population genetic diversity and low among-population differentiation observed in conifers have been attributed to common lifehistory traits, such as longevity and extensive gene flow (Hamrick et al., 1992; Streiff et al., 1998). The biogeographic history of a species should also contribute significantly to current patterns of genetic variation (Planter et al. 2000).

Despite the comparatively low levels of allozyme variation and the small genetic distances between populations, geographical differentiation among silver fir populations at different spatial scales could be demonstrated with markers (Konnert and Bergmann 1995). A large difference in cone legth, seed germination and seed weight was observed among the sites and among mother trees to *Abies sachalinensis* in Japan (Okada, 1973).

Contrary other Abies species, there are not enough study for Turkish fir. For this, it can be suggested that all populations, especially Ilgaz1 population, be considered for a gene conservation program. Also, future studies are necessary to provide deeper insights in to the subject. It may be concluded from the present study that studied characteristic were the important factors on morphological distance among populations. Ecological and geographical differentiation is important factors which influence the breeding and sampling strategies of tree crops. It is also essential to consider the relationship between population structure in natural and domesticated populations (Chalmers et al. 1992; Şevik, 2010; Şevik et al. 2011b). Results of this study could be taken into consideration in silvicultural purpose (afforestation, artificial regeneration) and breeding strategies (i.e. determination of breeding populations, gene conservation areas, seed transfer zones, seed sources and geographic variation, resulting of provenance trial; establishment of seed orchard) of this species.

Generally, our results show that large genetic diversity exist in Turkish fir to explain its great ecological plasticity and evolutionary. This results of study showed that the populations are not homogeneous with regard to the morphological characteristics. Populations consist of the trees having more or less different characteristics. The reason of the fact that the grouping and differences existed among the studied population in terms of the morphological characters may explain that there were different origins or varieties forming the Turkish fir stands. Variation in most of these characteristics appeared to be related altitude, divergent gene and genotype frequencies.

As is known, the morphological and physiological characteristics of forest trees are inherited. These features, with the growing effects of climate and environmental conditions can vary very little. As an example; needle length, the number of needles, cones, seed and leaf characteristics, branching characters as show some morphological features. In fact, many researchers in determining the genetic diversity of forest trees, one or a few of the uses of these characters. (Matziris, 1989; Cregg, 1994; Matziris, 1984; Komar, 2000; Fan ve Grossnickle, 1999; Lamhamedi, 2000; Matziris, 1997; John, 1948; Schmidtling et. al., 2005; Kathleen and Furnier 2002; Erkan, 2008; Bilir, 2002; Tylek ve Walczyk 2002, Güney et al., 2011, Kulaç et al. 2011a, 2011b; Turna and Güney, 2009; Turna, 2003, 2004). Seed size, parameters in terms of quality seeds is the most widely used classification also reflects the morphological diversity of values within and between populations. (Güney, 2009). Seeds in the trees, cones and cone elements, least affected by environmental conditions and thus genetic structure of the tree is considered the beginning of the elements that represent the most healthy way. Therefore especially in studies of genetic diversity of seeds, cones, and cones from the studies of the elements has a special place because it results is quite healthy (Turna et al., 2009).

Erkuloğlu (1993) reported that average weight of *Abies bornmulleriana* Mattf. Seeds from Bolu are 57,13 mg. Okada et al., (1973) *Abies sachalinensis* Masters in their study, in Japan, studied on 7 population and thousand grain weight of seed on the basis of population varied between 9.3 g to 12.3 g have identified. Also Skrzyszewska and Chlanda (2009) *Abies alba* Mill. thousand grain weight of seed on the basis of population, have found varied between 38.92 g and 53.27 grams. Edwards (1982), Fowells (1965)'to refer to *Abies lasiocarpa* var. *arizonica* (Merriam) Lemra. subalpine fir, compared to other types of seeds, the seeds of its much larger that represents about 70%. Kolotelo (1998) *Abies amabilis* seed weight (Dougl.) Forbes has changed between 25 mg and 55.6 mg and is the average of 34.5 mg, also *Abies grandis* Lindl. varied between 17.5 mg and 27.6 mg and average is 21.7 mg and *Abies lasiocarpa* (Hook.) Nutt. average of 7.2 mg to 18.5 mg and 12 mg of states that have changed. According to these results, the seeds of Uludag Fir, *Abies alba* Mill., *Abies amabilis* (Dougl.) Forbes, be said to be heavier than the seeds of *Abies lasiocarpa* (Hook.) Nutt. and *Abies grandis* Lindl. Also Sorensen and Franklin (1977) *Abies Procera* Rehd. state that the seed weight varied between 33 mg and 102.6 mg. In our study, the average seed weight ranged between 71.72 mg and 109.11 mg, the average was determined to be 81.58 mg. Gökmen (1970), indicates that *Abies nordmanniana* Mattf. seeds is 1 cm in length. According to these results, seeds of Uludag Fir with *Abies Procera* Rehd. seeds appear to be close to each other in weight. Franklin (1974) *Abies Procera* Rehd. carpel averaging 2.5 x 3 cm in size, seeds indicates that the average size of 12 x 6 mm. Macvean (2007) *Abies guatemalensis* Rehder indicates seed length about 8-10 mm and wings about 15 mm long.

Nowadays; because of its increasing economical value in market and decorative characteristic in landscape architecture, Turkish fir (*Abies nordmanniana* subsp. *bornmulleriana* Mattf.) is taking more importance. In addition to this being an endemic species of Turkey and widely preferred Noel tree in the world. Turkish fir is one of the most important trees to Christmas tree and for these there are very much studies on this species (Frampton and McKinley, 1999; Frampton et al. 2009; Talgø et. al., 2009; Newton et al., 2009; Hart et al., 2009; Langdren et al., 2008; Frampton and Işık, 2008; Talgø and Stensvand, 2008).

In this study, the genetic diversity of Turkish fir determined with respect to the some morphological characteristics. In this sense construction of genetic diversity, basic morphological characteristics, geographical variations and the morphological differences between tree species in the optimal and extreme distribution area of Turkish fir was determined.

Until now a few studies have been conducted about Turkish fir (Kaya et al., 2008; Şimşek, 1991; Velioğlu, 1999; Kaya and Raynal, 2000; Nielsen and Chastagner, 2005). But there is no comprehensive study to disclose the spatial distribution of Turkish fir and provide background information for future studies. In the near future; the studies done with the morphological characters about genetical variations are should also be analysed with DNA markers and isosymes analysis.

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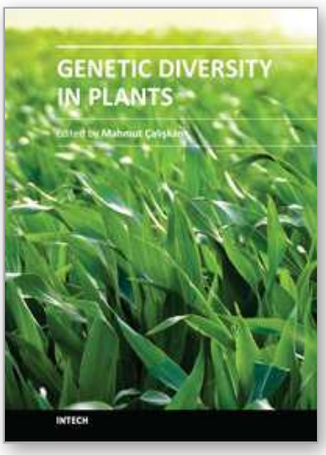

Genetic Diversity in Plants

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Genetic diversity is of fundamental importance in the continuity of a species as it provides the necessary adaptation to the prevailing biotic and abiotic environmental conditions, and enables change in the genetic composition to cope with changes in the environment. Genetic Diversity in Plants presents chapters revealing the magnitude of genetic variation existing in plant populations. The increasing availability of PCR-based molecular markers allows the detailed analyses and evaluation of genetic diversity in plants and also, the detection of genes influencing economically important traits. The purpose of the book is to provide a glimpse into the dynamic process of genetic variation by presenting the thoughts of scientists who are engaged in the generation of new ideas and techniques employed for the assessment of genetic diversity, often from very different perspectives. The book should prove useful to students, researchers, and experts in the area of conservation biology, genetic diversity, and molecular biology.

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