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Research article/Araştırma makalesi

Variations within and among populations depending on some leaf characteristics of oriental beech (*Fagus orientalis* Lipsky)

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Abstract

At the beginning of the tree breeding programs, it is started over investigations of genetic variations. Thanks to the genetic variation investigations it is proved how does the scape of variations among populations and trees in populations change according to the variations like altitude, distance from sea and rain.

Oriental beech is a very important tree species in the forestry. It is aimed in this study to determine variations on the seedling which are grown from seeds picked from 11 different Oriental beech populations (Sinop-Merkez, Sinop-Ayancık, Samsun-Kunduz, Samsun-Karapınar, Karabük-Yenice, Düzce-Çiçekli, Trabzon-Maçka, Trabzon-Çaykara, Giresun-Kulakkaya, Ordu-Akkuş and Kahramanmaraş-Andırın) in terms of leaf width, leaf length, leaf area, leaf vein angle and leaf moisture. By making these measurements on the seedlings belong to the all populations, variations among populations connected to these characteristics are determined. Besides, measurements on tree basis was done by using 6000 leaves in 6 populations, ten trees from per populations, 10 seedlings from per tree, 10 leaves from per seedlings and differences within populations were determined by looking these characteristics.

As a result of the variance analysis which is done connected with leaf width, length, area and leaf vein angle it was determined that there are statistical differences among populations for all these characteristics. As a consequence of the variance analysis belong to the leaf measure, significance level is over 0.05. According to this result it is determined that 11 populations became homogenous depending leaf moisture. All the characters except for leaf moisture showed differences within 6 separate populations. Although populations are homogenous in terms of leaf moisture it is understood that trees within populations showed variations for these characters. According to the hierarchical cluster analysis Sinop-Merkez, Sinop-Ayancık and Karabük-Yenice populations are at the same group in terms of all leaf characters and other populations created other group.

Key words: Oriental beech, leaf length, leaf area, leaf moisture, variation, origin

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Doğu kayınında (*Fagus orientalis* Lipsky) bazı yaprak karakterlerine ait populasyonlar arası ve içi varyasyonlar

Özet

Islah (tree breeding) programlarının başlangıcında tür içi genetik çeşitlilik (varyasyon) araştırmaları üzerinde durulmaktadır. Genetik çeşitlilik araştırmaları sayesinde, çeşitliliğin populasyonlar arası ve populasyon içi ağaçlar arası kapsamı, bunun rakım, denizden uzaklık, yağış gibi değişkenlere göre nasıl değişim gösterdiği ortaya konulmaktadır.

Doğu Kayını ülkemiz ormancılığında önemli bir ağaç türüdür. Bu çalışmada, 11 farklı doğu kayını popülasyonundan (Sinop-Merkez, Sinop-Ayancık, Samsun-Kunduz, Samsun-Karapınar, Karabük-Yenice, Düzce-Çiçekli, Trabzon-Maçka, Trabzon-Çaykara, Giresun-Kulakkaya, Ordu-Akkuş ve Kahramanmaraş-Andırın) toplanan tohumlardan yetiştirilen 2+0 yaşındaki fidanlarda yaprak eni, yaprak boyu, yaprak alanı, yaprak damar açısı ve yaprak nemi bakımından meydana gelen varyasyonları belirlemek amaçlanmıştır. Bu ölçümler tüm populasyonlara ait

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fidanlarda yapılarak, bu özelliklere bağlı, populasyonlar arası varyasyonlar ortaya konulmuştur. Ayrıca, 6 populasyonda, her populasyondan 10 ağaç, her ağaçtan 10 fidan ve her fidandan 10 yaprakta olmak üzere toplam 6000 yaprak kullanılarak ağaç bazında ölçümler yapılmış ve bu özelliklere bağlı olarak populasyon içi farklılıklar belirlenmiştir.

Yaprak eni, yaprak boyu, yaprak alanı ve yaprak damar açısına ilişkin olarak gerçekleştirilen varyans analizi sonucunda bu karakterlerin hepsi için populasyonlar arasında istatistiksel olarak farklılıklar olduğu belirlenmiştir. Yaprak nemine ait varyans analizi sonucunda ise önem düzeyi 0.05'ten büyük çıkmıştır. Bu sonuca göre çalışılan 11 populasyonun, yaprak nemine bağlı olarak homojen bir yapı gösterdikleri belirlenmiştir. 6 populasyonun her birinin kendi içerisinde ise yaprak nemi dışındaki tüm karakterlerin farklılık gösterdiği belirlenmiştir. Yaprak nemi bakımından populasyonlar homojen bir yapı gösterse de, populasyonlar içerisindeki ağaçlar ise bu karakter bakımından varyasyonlar gösterdiği anlaşılmıştır.

Hiyerarşik kümeleme analizi sonucu oluşan gruplandırmaya göre; ölçülen tüm yaprak karakterleri bakımından Sinop-Merkez, Sinop-Ayancık ve Karabük-Yenice populasyonları aynı grup içerisinde yer almış olup diğer populasyonlar ise diğer grubu meydana getirmiştir.

Anahtar kelimeler: Doğu Kayını, yaprak eni, yaprak boyu, yaprak alanı, varyasyon, orijin

1. Introduction

In forests of our country have 54 % conifer forests and 46 % deciduous forests. Beech represented by 10 species in the Northern Hemisphere is one of the most important types of deciduous forests. There are two types including Oriental beech (*Fagus orientalis* Lipsky.) and European beech (*Fagus sylvatica* L.) in Turkey. Oriental beech has a wider spread than the other type. Oriental beech in our country is spreading in 1.961.660 ha area, including 1.621.257 ha forest in normal structure and 340.403 ha forest in discontinuous structure (Anonymous, 2014; Ertekin et.al., 2015).

As is known, afforestation efforts are expensive and long-term investments. It is required to use seeds and seedling which have superior genetic qualities in order to guarantee the future of these investments. To determine the genetic quality of the seedlings, it is essential to know the genetic variation of the trees in the population (Yahyaoğlu and Genç, 2007). Today, it can be made in a more sensitive manner origin certification by genetic variation researches. Thus, it can be possible to do afforestation efforts through actual origins and without causing genetic contamination. Results obtained from this study are intended to contribute to the realization of these matters.

Each population, in order to adapt to different environmental conditions which are effective in its region, is considered genetically unique (Işık and Yıldırım, 1990). Therefore, use of other biological information together with population genetic principles in management of these populations is even more important (Namkoong, 1989).

It is expressed that the best way to determine the genetic variation for a species will be by comparison of populations in different habitats (Chmura, 2002). Species which are spread very wide areas have very much geographical variation and local races in the same time (Işık, 1981; Zobel and Talbert 1984; Kaya, 1990). Broken geographical structure, changing climate and soil characteristics over short distances of Turkey have encouraged the formation of local races even short distances in forest tree populations (Işık, 1988; Kaya 1989). Due to the showing spread in such a geographic region of oriental beech, it may has genetically variations.

In this study, it is aimed to investigate of variations in populations in natural distribution areas in our country for oriental beech (*Fagus orientalis* Lipsky.), one of main tree species in our country, depending on some morphological characters belong to leaf.

2. Materials and methods

In this study, as the study material has been selected 11 natural oriental beech populations that represented the natural range of oriental beech in Turkey. Leaves belong to seedlings that grown by seeds collected from a total of 225 trees including average of 20 pieces from each of these populations have been used.

2.1. Determination of sample populations

In accordance with to the research objectives, 11 oriental beech populations, which are able to represent Turkey, have been selected. Accordingly, it has been made measurements on leaves of seedlings that grown by seeds collected from Sinop-Merkez, Sinop-Ayancık, Samsun-Kunduz, Samsun-Karapınar, Karabük-Yenice, Düzce-Çiçekli, Trabzon-Maçka, Trabzon-Çaykara, Giresun-Kulakkaya, Ordu-Akkuş and Kahramanmaraş-Andırın populations. Some informations related to sites of populations collected seed material have been given in Table 1, and the geographical location of the populations have been given in Figure 1.

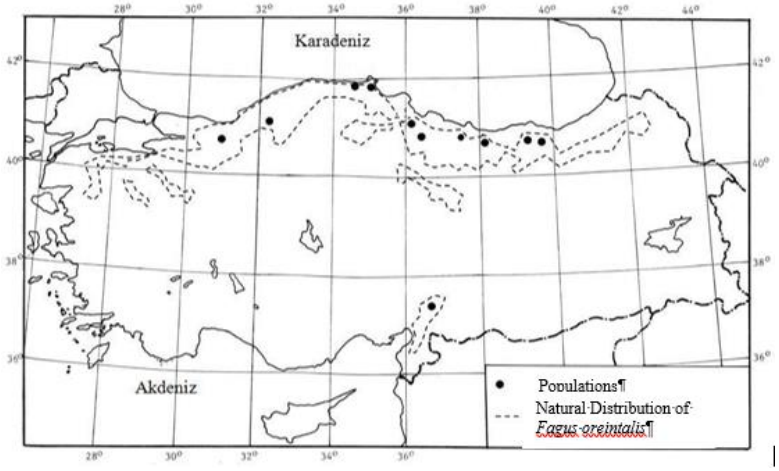

Figure 1. The geographical location of the populations collected seed material

Table 1. Information on the sample plots

Pop No	Name of Population	Tree Number (N)	*East Longitude	*North Latitude	Altitude	Aspect Groups
1	Sinop Merkez	21	646426-645002	4530786-4531627	90-140	N, NW, E, S, SW
2	Sinop Ayancık	26	644126-647212	4633190-4635389	605-745	N, NE, NW, E, S, SW
3	Samsun Kunduz	20	666533-665881	4559311-4559075	1300-1390	N, NE, NW
4	Samsun Karapınar	20	685470-685433	4549004-4549406	1250-1360	N, NE
5	Karabük Yenice	20	452653-457710	4566618-4576555	610-1100	N, NE, NW, E, S, SW
6	Trabzon Maçka	19	536104-537264	4502315-4502863	1510-1650	N, NE, NW, E, SW, W
7	Trabzon Çaykara	18	602433-603016	4504412-4506099	920-1485	NE, E, S, SW, SE, W
8	Giresun Kulakkaya	18	442625-452537	4503642-4504163	455-1460	N, NE, W, S
9	Ordu Akkuş	23	331483-331845	4519805-4520234	1200-1315	N, NE, NW, ES, SE, SW
10	Düzce Çiçekli	20	853080-855918	4507317-4508900	1310-1405	N, NE, NW
11	K.Maraş Andırın	20	269188-272115	4175208-4185518	1395-1740	N, NE, NW, E, SE, W

* The coordinates of the sample plots have been taken by the UTM coordinates system.

2.2. Measurements related to leaf

Leaf width, leaf length, leaf area, leaf vein angle and leaf moisture values have been measured in 2+0 years-old oriental beech seedlings. Variations among populations have been revealed with measurements made in seedlings belong to all populations in terms of these features. Also, measurements on the basis of tree have been performed using a total of 6,000 leaves, included 10 trees from each population, 10 seedlings from each tree and 10 leaves from each seedlings, in Düzce-Çiçekli, Trabzon-Maçka, Trabzon-Çaykara, Giresun-Kulakkaya, Ordu-Akkuş and Kahramanmaraş-Andırın populations. And, differences within population have been determined depending on these features.

Leaf vein angle has been obtained by measuring 3 different parts included bottom, middle and upper parts of leaf in each leaf.

Measurements related leaves were performed using the ImageJ (Image Analysis Software) program. This program were used in various scientific studies carried out to examine the variation in leaf (Bayramzadeh et al., 2008)

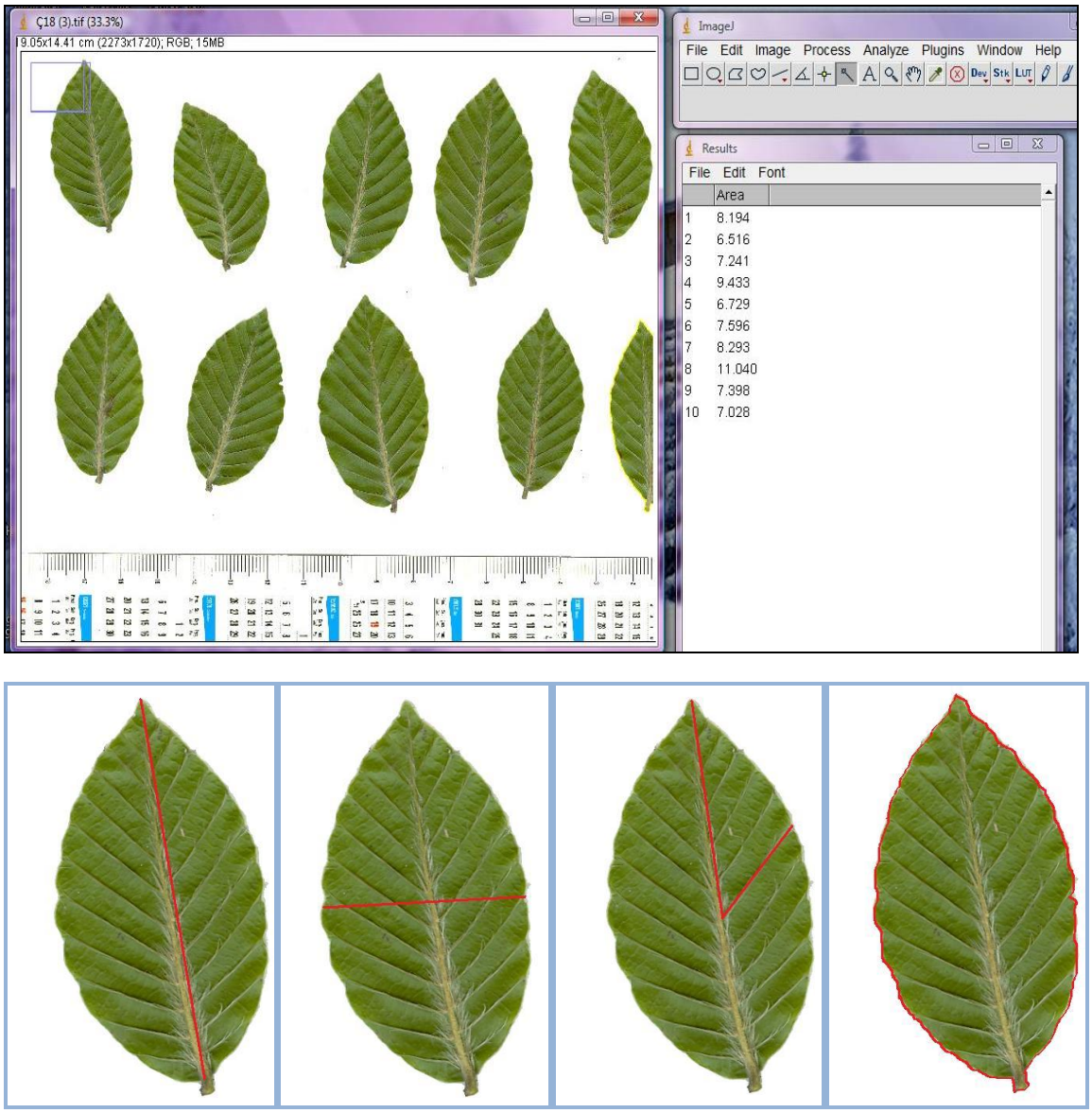

Figure 2. Measurement of leaf length, leaf width, leaf vein angle and leaf area using ImageJ (Image Analysis Software) software.

2.3. Data analysis

Data were analyzed using the SPSS 20.0 statistical program. The analyses conducted included ANOVA, Duncan's Test and Cluster.

3. Results

Leaf width, leaf length, leaf area, leaf vein angle and leaf moisture have been measured by using leaf samples obtained from seedlings belong to populations under study.

The average leaf width, leaf length, leaf area, leaf vein angle and leaf moisture values for all populations have been given with standard deviations in Table 2.

Analysis of variance has been performed to determine whether the differences in terms of measured these characters belong to leaf among populations. Duncan test has been conducted to determine groups. And then, the results have been given in Table 2. As can be seen from the table, as a result of analysis of variance carried out related to leaf width, leaf length, leaf area and leaf vein angle has been determined that there are differences as statistically for all these characters. Significance level is greater than 0.05 as a result of analysis of variance performed related to leaf moisture. According to this result, it can be said that 11 populations under study show a homogeneous structure in terms of leaf moisture.

Table 2. The results of the analysis of variance and Duncan test concerning leaf width, leaf length, leaf area, leaf vein angle and leaf moisture values among populations

Pop.	Avg. Leaf Width (cm)	Avg. Leaf Length (cm)	Avg. Leaf Area (cm^2)	Avg. L. Vein Angle (Degree)	Avg. L. Moisture (%)
Sinop	3.45±0.51 f	5.70±0.72e	13.61±3.47 e	44.92±9.36 a	67.20±7.45
S.Ayancık	3.23±0.52 d	5.36±0.88de	12.20±3.89 e	47.60±8.58 bc	67.60±6.96
Kunduz	2.51±0.54 ab	4.32±0.88 a	7.69± 3.30 ab	47.60±10.06bc	68.60±5.74
Karapınar	2.59±0.33 ab	4.67±0.56 b	8.50±1.90 bc	43.96±9.57 a	68.50±7.44
Yenice	2.93±1.10 c	5.35±2.01de	12.22±9.65 e	46.48±9.22 b	68.60±6.55
Maçka	2.88±0.65 c	5.15±1.02cd	10.63±4.55 d	48.24±4.05 d	64.80±5.77
Çaykara	2.72±0.61 bc	4.84±0.98 bc	9.78±4.02 cd	47.18±5.40 bc	64.04±6.69
Kulakkaya	2.72±0.64 bc	4.84±1.06 bc	9.34±4.43 cd	47.88±5.80 d	65.90±4.50
Akkuş	2.84±0.62 c	4.99±1.03bcd	10.10±4.33 d	47.10±5.80 bc	63.76±10.4
Çiçekli	2.34±0.60 a	4.07±0.89 a	7.05±3.04 a	46.11±4.41 a	66.95±8.08
Andırın	2.41±0.61 a	3.99±1.05 a	7.38±3.66 ab	45.15±5.84 a	66.04±5.77
Avg.	2.66±0.66	4.66±1.10	9.08±4.31	46.55±5.82	66.30±1.85
Anova	F:70.250 P: 0.000**	F:122.814 P: 0.000**	F:78.669 P: 0.000**	F:44.144 P: 0.000**	F:1.697 P: 0.133

** There is difference as statistically. Significance level *P<0.01*

As a result of Duncan test conducted to determine different groups have formed in terms of leaf length. When we examine to composed groups, Sinop-Merkez population has had the highest values in terms of leaf width, leaf length and leaf area. Additionally, Düzce-Çiçekli population and K.Maraş-Andırın population have had the lowest values in terms of these characters. Sinop-Merkez population, having the highest value, has formed alone a group in terms of leaf width and leaf length. Sinop-Merkez population has taken place in the same group with Sinop-Ayancık and Karabük-Yenice populations in terms of leaf area. Düzce-Çiçekli population, having the lowest value, has formed alone a group in terms of leaf area. Düzce-Çiçekli population has taken place in the same group with K.Maraş-Andırın population in terms of leaf width and, has taken place in the same group with K.Maraş-Andırın and Samsun-Kunduz populations in terms of leaf length. When we look at Duncan test results, populations forming other groups show a similar ranking according to measured characters. Unlike the previous groupings, Sinop-Merkez population has taken place in the same group with Düzce-Çiçekli, K.Maraş-Andırın and Samsun-Karapınar populations in terms of leaf vein angle. Trabzon-Maçka population, which has the largest vein angle, has formed alone a group in terms of leaf vein angle.

Graphical distribution of populations, in terms of leaf width, leaf length, leaf area, leaf vein angle and leaf moisture values, has been given in Figure 3 and Figure 4.

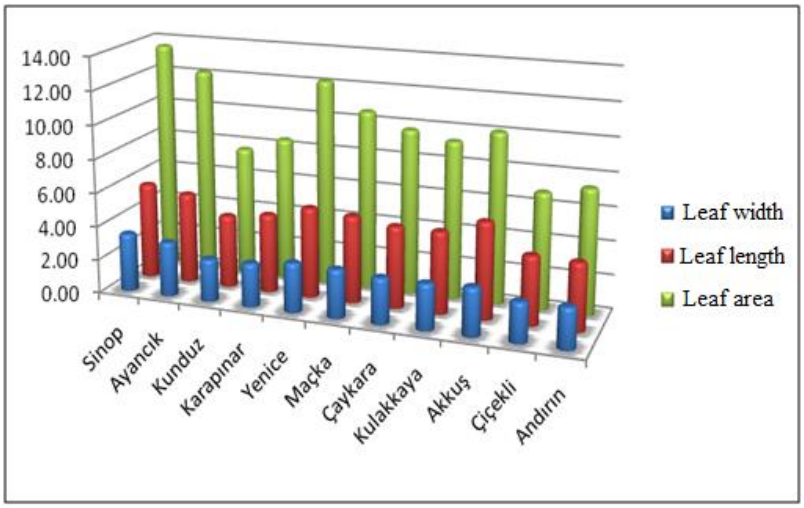

Figure 3. According to populations, leaf width (cm), leaf length (cm) and leaf area (cm^2)

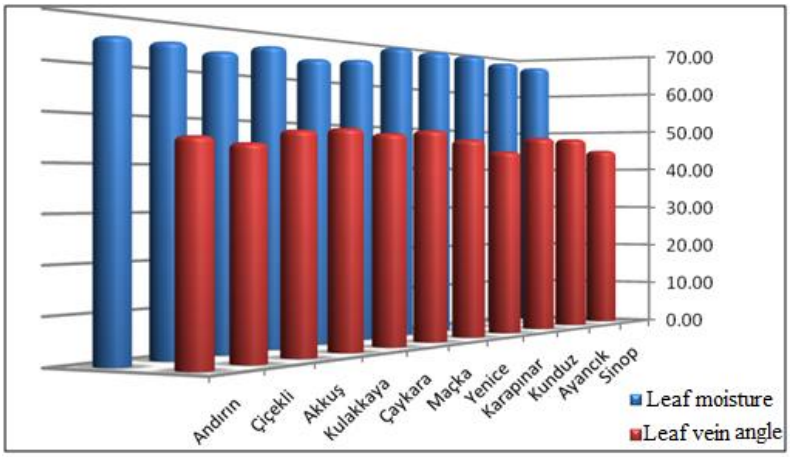

Figure 4. According to populations, leaf moisture (g) and leaf vein angle (degree)

As can be seen from Figure 3, leaf width, leaf length and leaf area show a parallel change according to populations. Leaf vein angle is not in the same direction with these features. According to conducted correlation analysis, leaf vein angle has not showed a significant correlation with other leaf characteristics. This situation supports the results obtained. It has been determined that leaf moisture has taken very close values one another, and has not exhibited a statistically change according to population.

It has been tested by analysis of variance to determine whether difference with regard to measured leaf characteristics within populations. Whether 6 populations, in terms of the average leaf width, leaf length, leaf area, leaf vein angle and leaf moisture, show a variation, and average values for these populations have been given with standard deviations in Table 3. The results of analysis of variance and averages leaf width, leaf length, leaf area, leaf vein angle and leaf moisture values belong to seedlings that grown by seeds obtained from populations have been given in Table 3. As can be seen from table, the result of analysis of variance conducted in terms of leaf moisture, it has been determined that Trabzon-Maçka and Ordu-Akkuş populations have exhibited differ within themselves with % 95 confidence level, and Giresun-Kulakkaya and Kahramanmaraş-Andırın populations have exhibited differ within themselves with % 99 confidence level. It has been determined that Trabzon-Çaykara and Düzce-Çiçekli populations have not displayed variation within population in terms of this character. Each population has had smaller than significance level of 0.01 in terms of leaf width, leaf length, leaf area and leaf vein angle characters. According to this result, it has been determined that each population has exhibited differ within themselves related to these characters.

A statistical analysis has been made with hierarchical cluster analysis as using leaf width, leaf length, leaf area, leaf vein angle and leaf moisture values in order to determine how populations involved in graphically a grouping. And then, the significance of this groupings has been tested by discriminant analysis.

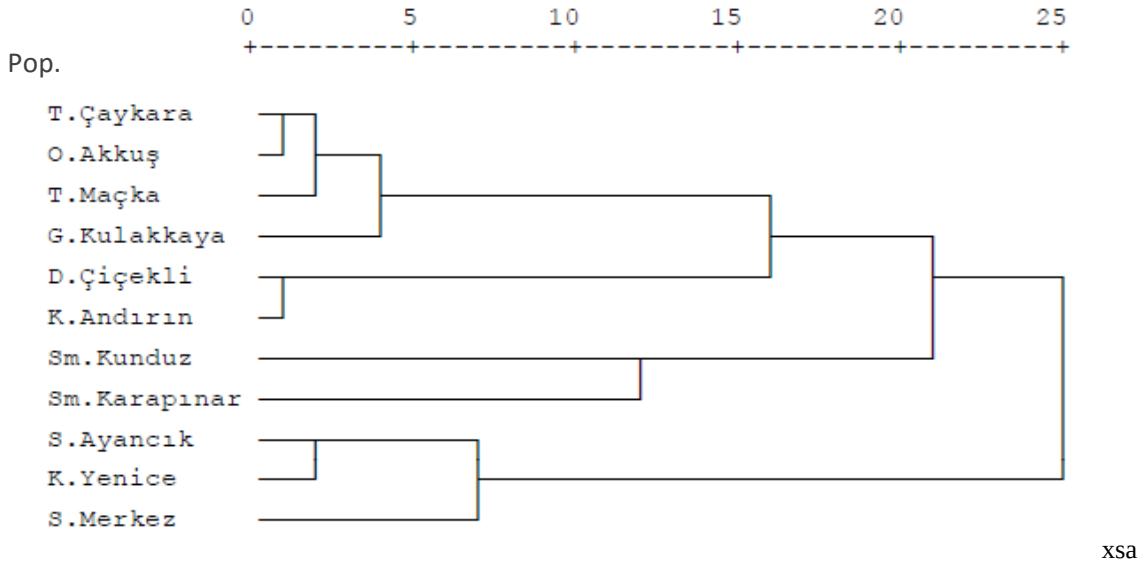

Figure 5. Dendogram obtained with Cluster analysis related to leaf width, leaf length, leaf area, leaf vein angle and leaf moisture

Table 3. The results of the analysis of variance and averages concerning leaf width, leaf length, leaf area, leaf vein angle and leaf moisture values within populations

Tree	Trabzon-Maçka					Trabzon-Çaykara					Giresun-Kulakkaya				
No	LW (cm)	LL (cm)	LA(cm^2)	LVA (˚)	LM(%)	LW (cm)	LL (cm)	LA(cm^2)	LVA (˚)	LM(%)	LW (cm)	LL (cm)	LA(cm^2)	LVA (˚)	LM(%)
1	3.14±0.75	5.38±1.23	12.41±5.73	49.10±3.8	62.88±4.5	2.56±0.55	4.62±0.82	8.73±3.27	46.93±4.5	59.74±4.0	2.22±0.43	4.03±0.83	6.29±2.38	46.20±5.8	68.81±3.8
2	3.00±0.48	5.45±0.79	11.54±3.43	47.60±3.4	65.61±10.1	2.87±0.54	4.93±0.83	10.30±3.63	46.69±5.2	68.55±2.1	3.12±0.84	5.49±1.26	12.06±6.69	48.33±6.5	67.50±3.6
3	3.15±0.79	5.58±1.24	12.66±6.14	48.24±4.2	63.82±3.6	2.66±0.46	4.52±0.74	8.91±3.02	49.35±4.3	66.33±3.6	2.91±0.54	5.04±0.87	10.21±3.72	47.95±5.4	65.88±2.7
4	3.09±0.58	5.44±0.91	11.63±3.93	48.32±3.5	67.86±4.2	2.67±0.63	4.89±0.81	9.67±3.86	45.40±6.3	63.31±2.2	2.90±0.50	4.92±0.81	9.92±3.25	47.01±4.8	62.05±2.5
5	2.53±0.50	4.68±0.82	8.32±3.13	47.79±4.0	62.83±2.6	2.77±0.57	5.18±1.06	10.66±4.05	47.30±4.9	63.21±1.7	2.67±0.50	4.75±0.90	8.87±3.28	47.41±5.0	64.59±3.2
6	3.02±0.69	5.18±1.09	11.44±4.88	48.03±4.3	63.73±8.2	3.12±0.58	5.46±0.84	12.56±4.31	48.18±4.4	64.33±1.3	2.67±0.66	4.96±1.07	9.24±4.90	48.21±7.0	63.05±3.2
7	2.48±0.47	4.57±0.83	7.94±2.92	47.75±3.8	66.14±2.3	2.82±0.60	4.99±1.07	10.52±4.26	45.84±6.5	64.39±2.5	2.24±0.45	4.08±0.68	6.47±2.31	48.91±6.1	64.05±2.6
8	2.73±0.57	4.99±0.95	9.70±3.98	46.95±4.4	62.85±2.9	2.48±0.58	4.41±0.88	8.27±3.50	47.08±6.1	67.13±2.6	3.02±0.47	5.44±0.89	11.55±3.45	48.98±4.4	71.27±5.6
9	2.80±0.58	5.13±0.86	10.30±3.72	48.85±3.7	69.37±7.8	2.86±0.61	5.07±0.90	10.45±3.85	46.81±4.7	59.64±7.7	2.56±0.69	4.88±0.78	8.17±3.02	47.11±6.4	65.72±4.8
10	2.87±0.60	5.10±0.81	10.43±3.92	49.77±4.2	63.21±2.7	2.47±0.60	4.39±1.06	8.15±3.78	47.73±5.3	63.12±9.1	2.98±0.66	5.14±0.53	9.99±5.91	48.87±5.0	63.14±3.6
Avg.	2.88±0.65	5.15±1.02	10.63±4.55	48.24±4.1	64.80±5.7	2.72±0.61	4.84±0.98	9.78±4.02	47.18±5.4	64.04±6.6	2.72±0.44	4.84±1.06	9.34±4.43	47.88±5.8	65.90±4.5
F	15.709	11.713	13.852	4.148	1.698	11.279	12.965	11.212	4.038	1.815	35.988	34.638	10.575	2.741	7.672
S	<0.00	<0.00	<0.00	<0.00	<0.101	<0.00	<0.00	<0.00	<0.00	0.067	<0.001	<0.001	<0.001	<0.008	<0.008
Tree	Ordu-Akkuş					Düzce-Çiçekli					Kahramanmaraş-Andırın				
No	LW (cm)	LL (cm)	LA(cm^2)	LVA (˚)	LM(%)	LW (cm)	LL (cm)	LA(cm^2)	LVA (˚)	LM(%)	LW (cm)	LL (cm)	LA(cm^2)	LVA (˚)	LM(%)
1	2.93±0.60	5.10±1.00	10.82±4.84	49.43±4.7	68.42±2.2	4.56±1.00	2.53±0.59	8.15±3.47	44.97±4.2	69.30±3.4	1.86±0.43	3.26±0.78	4.57±1.94	43.81±5.6	67.53±1.8
2	2.40±0.58	4.16±0.83	7.30±3.12	48.18±5.4	63.45±4.3	4.06±0.71	2.20±0.45	6.16±2.24	43.24±3.6	63.67±1.9	2.27±0.68	3.40±0.99	6.11±3.36	46.11±5.2	62.59±5.1
3	3.19±0.68	5.52±1.10	12.65±5.19	51.81±5.5	64.68±1.6	3.39±0.87	2.00±0.55	5.08±2.67	44.83±3.7	57.64±16.8	2.35±0.47	3.74±0.85	6.73±2.80	45.77±6.5	65.13±2.6
4	2.83±0.61	4.83±0.89	9.73±4.11	45.00±5.5	62.25±2.5	4.10±0.61	2.37±0.43	6.87±2.21	41.98±4.3	62.30±2.2	2.16±0.54	3.86±0.88	6.26±2.94	43.69±4.1	67.30±2.4
5	2.68±0.57	4.68±0.99	9.00±3.46	45.65±5.3	58.81±8.8	3.86±0.78	2.31±0.54	6.53±2.99	43.88±4.7	65.24±2.4	2.41±0.63	4.31±1.54	8.15±4.78	41.55±5.7	68.35±3.7
6	3.27±0.50	6.07±1.12	14.06±4.57	44.38±5.4	67.18±1.6	3.91±0.87	2.10±0.46	5.93±2.52	45.48±4.0	65.94±1.7	2.52±0.58	4.03±0.83	7.67±3.61	47.88±5.6	63.70±2.5
7	2.71±0.49	4.74±0.76	9.02±3.09	48.97±4.9	73.35±13.5	4.28±1.18	2.78±0.92	8.32±4.15	43.20±3.6	65.01±6.5	2.25±0.44	3.65±0.69	6.25±2.27	43.13±4.4	61.66±6.9
8	2.76±0.58	4.91±0.88	9.36±3.93	46.33±5.2	61.65±2.0	3.85±0.90	2.42±0.67	6.87±3.25	45.21±5.5	65.74±4.1	2.93±0.59	4.58±0.77	10.06±3.49	44.46±5.8	66.12±3.4
9	2.62±0.48	4.73±0.84	8.57±3.04	46.00±5.7	60.44±2.4	4.45±0.53	2.52±0.35	7.84±1.96	43.63±4.1	64.32±3.3	2.61±0.57	4.64±1.02	9.01±3.95	46.53±5.8	69.50±3.0
10	3.00±0.49	5.31±0.70	11.01±3.14	47.70±5.9	62.49±2.6	3.86±0.67	2.28±0.44	6.36±2.29	43.67±3.9	64.79±2.4	2.53±0.53	4.29±0.84	8.03±3.03	47.81±4.9	68.56±1.7
Avg.	2.84±0.62	4.99±1.03	10.10±4.33	47.10±5.8	63.76±10.4	4.07±0.89	2.34±0.60	7.05±3.42	46.11±4.9	66.95±1.5	2.41±0.61	3.99±1.05	7.38±3.66	45.15±5.8	66.04±4.35
F	21.735	33.207	26.414	20.731	2.485	13.851	13.270	22.636	7.721	1.171	24.523	23.477	21.421	13.830	5.298
S	<0.00	<0.00	<0.00	<0.00	<0.018	<0.001	<0.001	<0.001	<0.001	0.321	<0.00	<0.00	<0.00	<0.00	<0.00

As a result of hierarchical cluster analysis, 2 groups have formed in terms of grouping. Sinop-Merkez, Sinop-Ayancık and Karabük-Yenice populations have taken place in the same group in terms of measured all leaf characters, and other populations have created the other group. Formation of two different groups can statistically significant, but according to results of cluster analysis given in Figure 5, 9 different groups can form in terms of leaf characteristics. Distribution on the map of this 9 different groups formed has been given in Figure 6. As can be seen from Figure 6, Düzce-Çiçekli and K.Maraş-Andırın populations have taken place in the same group, another group have been formed by Trabzon-Çaykara and Ordu-Akkuş populations. And remaining 7 groups have been created by other populations.

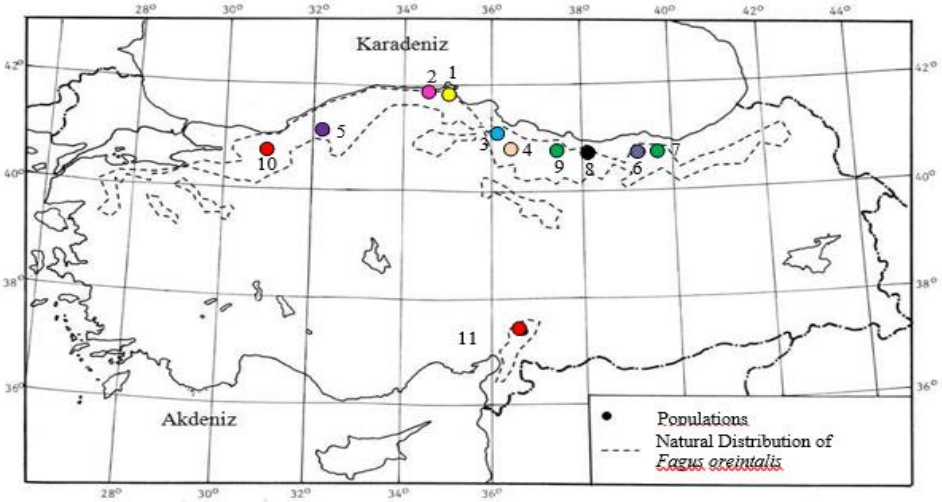

Figure 6. Distribution on the map of groups formed by cluster analysis in terms of leaf width, leaf length, leaf area, leaf vein angle and leaf moisture

4. Conclusions and discussion

In this study, variations within and among populations have been tried to put forward by measuring leaf width, leaf length, leaf area, leaf vein angle and leaf moisture in oriental beech seedlings. Result of the study, it has been determined that leaf width ranged from 2.36 cm to 3.45 cm, leaf length ranged from 3.99 cm to 5.70 cm and leaf area ranged from 6.87 cm^2 to 13.61 cm^2, leaf vein angle ranged from 43.96 degrees to 48.24 degrees. It has been determined that leaf moisture having values close to each other ranged from % 63.76 to % 68.60.

Variations related to leaf morphology depending on populations has been investigated in another study carried out in *Fagus sylvatica* Lipsky and *Fagus orientalis* L. Result of study carried out by sampling trees in different ages, it has been determined that average of leaf width, leaf length and leaf area respectively 5.16 cm, 8.84 cm and 34.2 cm^2 in Fagus sylvatica Lipsky, 4.91 cm, 7.73 cm and 28.8 cm^2 in *Fagus orientalis* L. Variations in terms of measured traits have been detected in both species. This finding has shown a harmony with results obtained in our study. Another study carried out in *Fagus grandifolia* Ehrh., it has been indicated that leaf width ranged from 2.5 cm to 7.5 cm and leaf length ranged from 6 cm to 15 cm (Robert and John, 2004). This result obtained in terms of leaf length in *Fagus grandifolia* Ehrh. has similarity with result obtained in oriental beech.

Sinop-Merkez population has the highest averages in terms of leaf width, leaf length and leaf area. In a study carried out related to production of oriental beech seedlings, it has been reported that total leaf surface is an important factor for growth and it affects positively growth (Tengiz, 1986).

There are numerous studies about variations determined depend on morphological and genetic characteristics of leaf. 13 years old seedlings that grown from seeds collected from 7 different populations have been used in order to investigate morphological and physiological variations related to leaf in *Fagus crenata*. It has been determined that there are significant differences in terms of some traits such as vein elements, the number of veins in mm^2, average vein area, transpiration rate, leaf area, leaf thickness, leaf dry weight among origins in study. In addition, it has been revealed that meaningful relationships between morphological and physiological properties related to leaf in the study (Bayramzadeh et al., 2008). Variations belong to leaf have determined in other studies made for the same species. And it has been reported that this difference originates from differences in the origins. Additionally, it has been indicated that maximum photosynthesis rate has a positive correlation with leaf thickness (Hiura et al., 1996; Koike, and Maruyama, 1998).

Hiura et al. (1996), in their study made for *Fagus crenata*, have indicated that variations related to leaves of seedlings, obtained from different origins and planted in the same field, result from genetic variation of seed resources. These findings have shown a consistence with findings obtained from our study. Accordingly, for leaf lengths depending on determination of variations within and among populations can be said that closely related with growth and development of seedlings.

Suggestions

An efficient tree breeding program is aimed that knowing of genetic structures of existing forest trees in nature. For this aim, it is firstly necessary to determination of geographical variations. And then, it is required that detection of genetic structure. Thus, superior and different individuals are protected for future use. On the other hand, with seed and seedling material obtained from these, it is intended to be used in afforestation efforts by going to mass production.

Determination of variations of species should be made as soon as possible to achieve mentioned objective. For this reason, for species should be done measures on some qualitative and quantitative characters. Recently, isoenzyme, DNA, etc. methods has been used in determination of genetic structure together with developing technology. However, such studies cannot be made without laboratory facilities. And they are expensive studies and require attention.

In this study, determination of variation within and among populations of oriental beech, has been carried out based on the measurement of morphological characters of leaves. Result of study, for oriental beech having optimal distribution among 700-1800 m altitudes, both in optimal distribution areas and outside these areas for natural populations, it has been revealed that show variations within and among populations.

For selected populations in this study, it has been determined that variation within populations is greater than among populations. Therefore, source of variation should be sought within populations rather than among populations. For this objective, populations having variation should be examined in detail with DNA, isoenzyme etc. on the basis of individual. And so, the main source of variation should be identified and continuity should be ensured.

Sinop-Ayancık population and especially Sinop-Merkez population remain outside the optimal natural range in terms of altitude for oriental beech and they have had clearly variations. For this reason, conservation of genetic resources is important in terms of the continuity of variation, and therefore the preservation of biodiversity. The continuation of genetic variation should be provided ensuring protection of existing populations.

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