Bartın Orman Fakültesi Dergisi
2013, Cilt: 15, Sayı: 1-2
ISSN: 1302-0943
EISSN: 1308-5875

THE FACTORS AFFECTING THE SUCCESS OF NATURAL REGENERATION EFFORTS IN KASTAMONU-ARAÇ REGION'S BLACK PINE (*Pinus nigra* Arnold. subsp. *pallasiana* (Lamb.) Holmboe) STANDS

İlhan YAZGAN[1], *Halil Barış ÖZEL[2]

[1]Forest Engineering, İznik Forest Range District, İznik/Bursa
[2]University of Bartın, Faculty of Forestry, Department of Silviculture, Bartın-TURKEY
***Corresponding author:** halilbarisozel@yahoo.com

ABSTRACT

In this study, where the habitat and the factors affecting the success of natural regeneration efforts performed in different years in Araç region have been investigated has been completed in year 2012.

Within the scope of research, in order to determine the most important factors affecting the success of the black pine natural regeneration efforts, the factor analysis was utilized. As a result of factor analysis, it has been found that physiographic conditions, physical soil properties, organic matter, climate, and outer soil status factors affect the success of regeneration efforts.

Keywords: Black pine, natural regeneration, regeneration success

1. INTRODUCTION

Because of increasing population and the industrialization, the decrease of natural forest resources still continue in 21st century. Especially for satisfying the high amount of demand increase especially for wood raw material, 180 million hectare of natural forests and plantation forests of developing countries have been destroyed between 1980 and 1995 as a result of excessive usage from forest resources. This amount has reached 200 million hectare nowadays (İlter and Ok 2004).

Because of various habitat conditions depending on existence of various climate and physiographic conditions, our country has biologically and economically rich pure and mixed natural forest resources in terms of both of tree species and stand establishments. According to data of year 2004, total forest surface area of our country is 21,188,747 ha. This equals 27.2% of total surface area of our country and is a very important amount. From the qualitative aspect; 50% of our forest resources (10,621,221 ha) is normal bosket and normal coppice forest, and 50% (10,567,526 ha) ruined bosket and coppice forest (Anon. 2006). As can be understood from those data, most of our forest resources have been spoiled as a result of biotic and abiotic factors such as excessive usage, wrong technical interventions, fires, snow, and disaster damages. So their productivity has been decreased. Depending on that decrease in productivity of our natural forest resources, the amount of product obtained from them has gradually decreased year by year. According to recent data, 15-15 million m^3 products can be obtained from forests of our country. This value means an increase of 0.750-0.800 m^3/ha per year. When comparing that value with that of countries such as Romania (2.6 m^3/ha), Greece (2.1 m^3/ha) and old Yugoslavia (2.7 m^3/ha), it is very low (Ürgenç 1998). The significant increase of this rate and consequently the ability to increase the share of forestry industry in our national income can only be possible through successful regeneration (natural and artificial) efforts on our ruined natural forest resources of which the productivity has been decreased, their rehabilitation in terms of quality and quantity, and making unproductive forest areas more productive via forestation efforts. This point takes place in definition of silviculture which is adopted by many scientists as

* Yazışma yapılacak yazar: halilbarisozel@yahoo.com
Makale metni 03.07.2013 tarihinde dergiye ulaşmış, 28.07.2013 tarihinde basım kararı alınmıştır

“planned establishment of new forests and sustainment of (keeping) them with ones existing in nature, and regenerating them and sustaining their existence in best form” (Saatçioğlu 1969; Ata 1995; Odabaşı et al. 2004).

The existence of wide range of species diversity and stand establishments in Turkey depending on various habitat conditions play direct role in determination of techniques to be used in regeneration and keeping efforts to be made, and also in their success. That‘s why; it is very important to determine the regional habitat conditions (climatic, edaphic, and physiographic conditions) and stand properties (stand type, closure, density, layeredness, mixture rate, and etc.) in details in forest area where the silvicultural intervention will be performed (Çepel 1966; Daşdemir 1987; Oliver and Larson 1996; Çolak and Odabaşı 2004). In order to provide that information, the habitat researches and stand structure analyses should be done (Saatçioğlu 1969; Smith et al. 1997; Bachofen and Zingg 2001; Wehrli et al. 2005). Even though the information about habitat conditions and stand properties are very important, they are not enough for the success of regeneration and keeping efforts by themselves. Besides the information obtained from performed researches and stand analyses, also the species to be intervened and the silvicultural requirements of those species should be known (Özel 2007).

The black b-pine populations in our country includes some important criteria such as volume productivity, height increase, diameter increase, wood quality, and seed productivity, and they sustain their existence by adopting themselves to their habitat as a result of natural selection which nature has sustained for hundreds of years. The black pine is one of the leading species spreading all over the world. Besides being the specie objected to many researches in different countries, black pine is also a specie which has engaged botanists’ attention for many years, and there are some debates about its systematic. According to the recently used and valid classification, black pine is distributed into 5 sub-classes (Alptekin 1986; Yaltırık 1988; Ertekin 2006). Those sub-classes and their habitats are given below.

- **a.** *Pinus nigra* Arnold. Subsp. *nigra*: Austrian black pine, (Syn: *Pinus nigra* Arnold var. a*ustriaca* (Hoess.) Badaux.), from Austria to middle Italy, naturally develops in Greece and Yugoslavia.
- **b.** *Pinus nigra* Arnold. Subsp. *larico* (Poiret) Maire: Corsica black pine, (Syn: *Pinus nigra* Arnold var. *corsicana* Suring), exists in Southern Italy, Corsica and Sicilia.
- **c.** *Pinus nigra* Arnold. Subsp. *dalmatica* (Vis.) Franco: Dalmatian black pine, spreads over northwestern coasts and islands of Yugoslavia.
- **d.** *Pinus nigra* Arnold. Subsp. *salzmannii* (Dunal) Franco: Pyrene black pine, (Syn: *Pinus nigra* Arnold var. *cabennensis*), seen in middle and southern Spain and over Pyrene mountains.
- **e.** *Pinus nigra* Arnold. Subsp. *pallasiana* (Lamb.) Holmboe: Anatolian black pine, (Syn: *Pinus nigra* Arnold var. *caramanica*, *Pinus nigra* Arnold var. *pallasiana* Schneid.), spreads over Balkans, Southern Carpathians, Crimean, Turkey, Cyprus, and Syria.

About 30-35 m height, Anatolian black pine is among first class forest trees. They have thick peels, and their old bodies have deep cracks. They have thicker branches than Scotch pine. The resinous gemmas are cylindirical, their tips become sharp suddenly. 8–15 cm length needle-leaves are dark green and hard. As they head through gemma at sucker tips, they create a gap like a pot, and that property of them differs from Scotch pine (Anşin 1994; Ertekin 2006).
Being in second place after Turkish pine in our needle-leaved tree species, black pine is resistant against both drought and winter colds, and its habitat spreads over 3,328,730 ha in our country. The habitat of black pine are Thrace, Northern, Western, Southern and Central Anatolia. They don’t exist in marine climate regions of eastern Black Sea region only. This situation is very important from the aspect of evaluation of habitat requirements of this specie. Black pines create pure forests at 400-1400 m altitudes in Black Sea region, except eastern part. They exist at 1400–1700 m altitudes together with Scotch pines and in smaller surface areas. They create mixed stands in western parts of Black Sea region, especially with abies and oaks. Being leading specie in western Anatolia with its large and pure forests, it dominates in higher altitudes. They spread over valleys through shoulders facing the sea. The specie spreading into the steps at most in Anatolia is black pine. It creates its most valuable stands in Kütahya-Tavşanlı, Dursunbey-Alaçam, Adana-Pos, Kastamonu-Boyabat-Elekdağ, Çorum-Kargı, Tosya and Karabük-Yenice. The most typical property of black pine is to prefer the locations facing against the sea such as south parts in northern and central Anatolia, northern shoulders and narrow valleys in Toros mounts; black pine prefers extreme climate conditions. On the other hand, black pine has wide variation in Anatolia. Despite it grows in hot and dry climates, it is also specie which can resist against winter colds. Black pine is a

half-light tree. This property of them continues to half-shadow tree property under optimum regional conditions. The black pine is very abstinent in terms of soil requirements, and creates taproot. Because of its resistance against drought and frost, rapid growth, valuable wood, and being the specie closest to step, the black pine is the first tree coming to the mind during forestation efforts in our country (Saatçioğlu 1976; Yaltırık 1988; Anşin and Özkan 1993; Ertekin 2006).

In this study, by using the Large Field Cover Method (LFCM), it was aimed to determine the success level of black pine regeneration efforts in Kastamonu-Araç region. Within this context, 5 parts of fields where 1st Forest Sub-District Directorate (affiliated with Araç Forest District Directorates) has conducted natural regeneration efforts in different years (2004, 2005, and 2007) have been chosen as research site. In order to achieve the goal of this research, the determinations and evaluations specified below have been made during 2 years in experiment sites from black pine regeneration fields:

- **a.** The habitat conditions (climatic, edaphic, and physiographic factors) of stands where natural regeneration efforts have been made have been determined,
- **b.** During 2 years of study (2011-2012), the changes in numbers of youth beeches in unit of area (m^2) in regeneration fields and the changes in their development (length and thee root neck diameter (the status of tip and the color of leaves) have been investigated,
- **c.** The effect levels of many factors affecting the success of regeneration effort have been determined via multi-dimensional statistical analyses, and the most important factors affecting the success of regeneration have been stated.

2. MATERIAL - METHOD

2.1 Material

2.1.1 General Introduction of Research Sites

Located within the borders of Araç district of Kastamonu and administratively affiliated with Araç Forest District Directorate, Araç (Central) Forest Sub-District Directorate is located in the E26-a3, E26-a4, F28-b3 and F28-b4 sections of 1/25000 scaled topographic Kastamonu map. Having a rough terrain in general, the Araç Forest Sub-District Directorate's mean altitude is 1150 m, while the lowest point is Brook Aydın and the highest point is Çandarlı hill (Anon. 2011).

From the forest populations, the research site is located in *northwestern euxin* sub-zone of *euxin* forest zone (Mayer and Aksoy 1998). In Araç planning unit, according to the inventory studies completed in 2011, there are totally 12,143 ha forest field. Of this field; 62.6% is normal, and the rest has the characteristic of ruined forest. According to the forestry being implemented, the forest sub-district directorate has been separated into 3 process units. In harmony with that, the distribution of forests in planning unit in terms of area, tree wealth, and increase is shown in Table 1 (Anon. 2011).

Table 1. The status of forests of Araç Forest Sub-District Directorate in terms of area and tree wealth by process units

Process Units	Area (ha)	Total Wealth (m^3)
AA-Process unit of bad habitat fields	2,465.6	458,976
AB-Black pine process unit	8,473.4	2,796,165
AC-Rehabilitation sites process unit	1,204.6	1,345,897
General Total	**12,143.6**	**4,601,038**

Evaluating the forests in Araç region in terms of stand organization, most of forests of sub-district directorate (56.6%) are in mixed-stand organization. In mixed forests in planning unit, the bipartite and tripartite mixed stand types such as black pine+Scotch pine, black pine+Scotch pine+abies, black pine+oak, black pine+beech, black pine+beech+abies, and abies+black pine dominate the region. The pure forests of region consist of pure beech stands (Anon. 2011).

According to the micro-climate types classification, Araç region is under the effect of Western Black Sea sub-climate type (IIc) (Saatçioğlu 1969; Özyuvacı 1999). There isn't any meteorology station in research site. For having general information about climate of a region having no meteorology station but having known altitude, Çepel (1995) and Özyuvacı (1999) suggest the interpolation of precipitation and temperature values of a meteorology station of which the altitude is known via using Schreiber and Lapse-Rate formulas. That's why, for drawing the climate diagram of the site according to the Walter method, the long-term (73 years) mean values of Kastamonu Meteorology Station (which is the closest one) have been utilized. For this purpose, the precipitation and temperature values obtained from Kastamonu Meteorology Station have been interpolated for Araç region via Schreiber and Lapse-Rate formulas. The climate diagram of Araç region prepared according to Walter method is given in Figure 1.

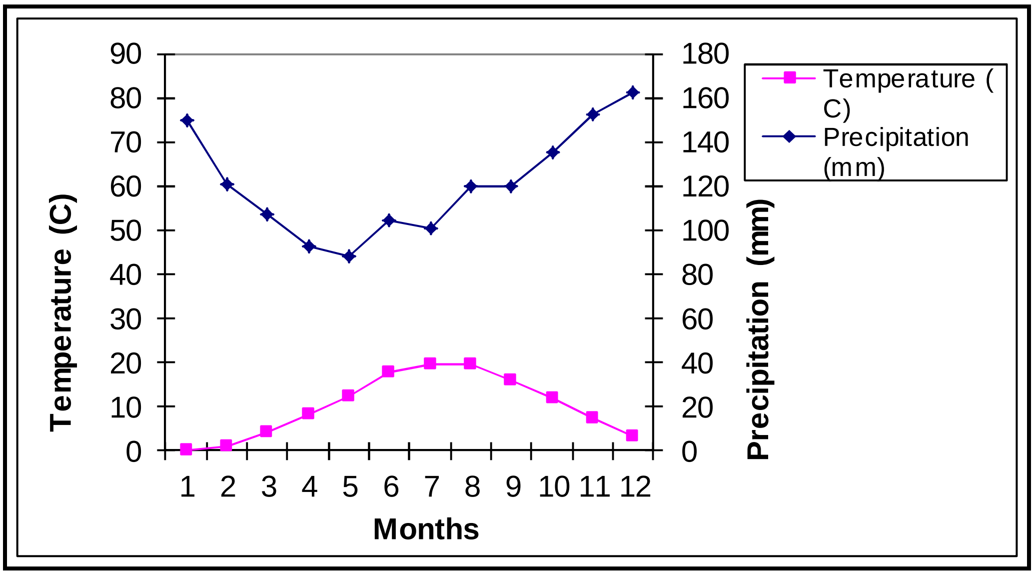

Figure 1. Araç region's climate diagram prepared with Walter Method

2.1.2 The Implementations in Experiment Sites

According to the actual forestry plan, 54b, 63c and 76a parts of Araç are within III. bonitet class, and the actual stand type is showed to be Çkcd$_2$ (Anon. 2011). The parts located in AB-Black Pine process unit are northward and northeastward in general, and their altitudes are 935m, 943m and 910m while the land grade varies between 20% and 35%. The natural regeneration efforts have been made in those segments in 2003, 2005 and 2007 over 10ha, 13,5ha and 8,7ha areas via LFCM method, respectively. For this purpose, seeding-cutting has been performed in Septembers of related years (Figure 2). In that operation, finally 675,356 m^3 revenue etas have been obtained from black pines in all segments. After seeding-cutting, a land preparation consisting of living cover removal and soil processing has been performed on field. During living cover removal process, the pasture brake and blackberry existing densely in field have been removed by cutting in whole surface, and the obtained cutting residuals have been massed in 1-m diameter field. In all segments, because young black pines got their independencies, the removal cutting has been done in November 2010, and totally 788,649 m^3 final revenue etas have been obtained (Anon. 2010).

Figure 2. A general view from research site after seeding-cutting in 2003

2.2 METHOD

2.2.1 Conditions of Experiment Sites

In this study, where various measurement and determinations have been performed about the young black pines, the research sites have been derived in various sizes from total 5 natural regeneration segments of Araç Forest Sub-District Directorate in 2011 within the context of implemented model forestry plans.

The determination of sampling size plays an important role on reliability of the results of a scientific research. In our country, scientists working on similar objects have taken various sampling sizes as bases for determining the stand organizations and youth biology. For example; Pamay (1962, 1967) has worked on 4x16 m, 10x50 m and 20x100 m of experiment site sized depending on the situation to be determined in stand. Saatçioğlu (1971), in his study on natural regeneration of beech in Forest Belgrad, has worked on experiment site sizes varying between 2116 m^2 and 3625 m^2. Odabaşı (1976), in his research on coppice forest and copse forests, has taken various sizes varying between 10x20 m and 20x50 m. Ata (1975), Aksoy (1978), Bozkuş (1987) and Özalp (1989), have generally worked on 10x50 m of experiment site sizes. Suner (1978), in his pure oriental beech study in Düzce, Cide and Akkuş regions, has worked on 90x90 m experiment area size. In this study conducted in Araç Forest Sub-District Directorate, considering the duration and object of study, work resources, and land conditions, the size of experiment sites has been determined as 25x40 m (1000 m^2).

The shape of experiment sites is very important from the aspect of easy and appropriate implementation of borders to land. Taking experiment sites in circle form is an appropriate method because of minimization of the number of trees located on borders and leading to failures. But because of difficulty of implementation of 0.1 h and smaller experiment areas to land due to inclination, it is not used in order to avoid form increasing the suspected trees on border line. In those situations, it is recommended to use square- or rectangle-formed experiment sites (Kalıpsız 1993; Atıcı 1998; Carus 1998). In this study, considering the points such as detail measurements and countings in youth period, we have decided to take rectangular experiment sites.

The determination of the number of samples is very important during planning the research. Excessive amount of samples leads the waste of time and resources. On the other hand, the deficient amount of samples will lead people to estimate the population parameters within a very large range. That’s why; the sampling size should be the optimum for representation of the population in best way (Kalıpsız 1976, 1994; Ercan 1997). In our country, various sampling sized have been utilized in studies about comparing the forest populations, determining the growth relationships and adaptation capabilities of various species and origins. For example; Saatçioğlu (1970), in his study on natural regeneration of beech, has established a 7 experiment sites (total area of 2.5 ha) within a beech area with total surface area of 7.6 ha. Within general habitat of Kazdağı abies over 512 ha, Ata (1975) has taken total of 30 experiment sites. And Bozkuş (1987), in his study about natural spread and silvicultural properties of Toros abies, have taken totally 48 experiment sites among the specie’s natural habitat which he determined as 350,000 h. Daşdemir (1987), in his study where he has investigated the relationship between habitat factors and productivity of oriental beech, has used the data obtained from 66 experiment sites. Karadağ (1999), in his study on black pine, has carried out his investigation on 14 experiment sites. Çalışkan et al. (2004), in their study on regeneration of oak, have worked on 3 groups containing different amounts of oak seed trees. In this study, where various measurements and determination have been done, the surface areas of regeneration experiment sites have been taken as main criterion during determining the number of experiment sites in terms of segments. Within the scope of mentioned points, the numbers of experiment sites are given in Table 2.

Table 2.Introduction of experiment sites

Sub-district directorate	Segment	Experiment Site Nr.	Altitude (m)	Exposure	Slope (%)	Shoulder Status
Araç	54b	1	810	North	25	Top
		2	835	North	32	Middle
		3	846	Northwest	20	Bottom
		4	850	North	18	Bottom
		5	852	Northwest	23	Middle
		6	855	Northwest	27	Top
		7	861	North	20	Middle
		8	874	North	22	Bottom
		9	892	North	26	Middle
		10	896	North	17	Middle
	63c	1	910	Northeast	34	Bottom
		2	913	Northeast	30	Middle
		3	918	Northeast	33	Top
		4	924	North	35	Bottom
		5	930	North	30	Middle
		6	932	Northeast	32	Top
		7	944	Northeast	36	Top
		8	958	Northeast	31	Middle
		9	963	Northeast	32	Bottom
		10	968	Northeast	30	Bottom
	76a	1	910	North	28	Bottom
		2	912	North	24	Middle
		3	916	Northwest	26	Top
		4	910	North	25	Top
		5	918	Northeast	21	Middle
		6	915	Northeast	25	Bottom
		7	914	North	30	Middle
		8	910	North	27	Bottom
		9	914	North	26	Top
		10	910	Northeast	22	Middle

2.2.2 Determination of Habitat Conditions in Experiment Sites

Forests are living creatures, and have a very special ecosystem occurring as a result of under many factors. This life cooperation which is named "Forest Ecosystem" can show significant variation among regions and even in same region depending on changes in factor or factors forming the forests (Çepel 1966, 1995). That's why; in order to be successful in silvicultural efforts (regeneration, keeping, and forestation) for ensuring the sustainability of the forests, it is very important to know the habitat conditions. For this purpose, we have performed some measurement and determinations on experiment sites about climatic, edaphic and physiographic properties being effective on development of black pine regeneration habitat condition. Those properties have been evaluated as a separated factor in analyses.

2.2.2.1 Determination of Climatic Factors

The climatic factors such as mean annual precipitation, mean annual temperature, and light intensity of experiment sites from natural regeneration areas have been determined. As there was no meteorology station in research sites, the mean annual precipitation and mean annual temperature values in research sites have been determined via interpolation from mean annual precipitation and mean annual temperature values measured in Kastamonu meteorology station. For interpolating the mean annual precipitation and mean annual temperature values to experiment sites, the Schreiber and Lapse-rate formulas have been utilized.

Within the scope of this study, in order to determine how much of full light in regeneration area penetrates into stand and to include it into analyses, the light intensity of research sites have been calculated. For this purpose, in noon hours when the sunlight reaches earth vertically, the light measurements have been carried out with 2 lux-meters with 240.000 lux capacity synchronously in stand and open area.

2.2.2.2 Determination of Edaphic Factors

In order to investigate the soil properties of regeneration fields, soil profiles have been opened. The numbers and locations of soil profiles vary depending on soil investigation aim and the sampling methods. When one wants to determine the soil properties of a segment, part or experiment site, according to randomized sampling method, it is enough to open profile in points where the physiographic conditions obviously change (exposure, altitude, slope, relief, and etc.) in parts or segments, and in middle point or near it in experiment sites (Irmak 1972; Çepel 1966; Kantarcı 2000; Scheffer and Schachtschabel 2001). The determination of the number of soil profiles has been performed differently by various researchers. For example, Çepel et al. (1977), in their study about Scotch pine in important habitats of Turkey, have opened soil profiled in all of 187 experiment sites with sizes varying from 150 m^2 and 870 m^2 and obtained from 14 forest district directorates. Eruz (1980), in his study in Forest Belgrad, has opened 46 soil profiles over 5441.7 h of research site. Akgül and Aksoy (1976), in their research in Bolu-Şerif Yüksel Research Forest, have carried out their research on totally 440 soil profiles opened in 1544 h of research area. Pamay (1962), in his research on natural regeneration of Scotch pine, considering the differences in exposure in altitude, has opened 12 soil profiles in total. Karadağ (1999), in his study on natural regeneration conditions of black pine, has opened 8 soil profiles on process segments with size of 5600 m^2 in total. As a result of performed assessments, it has been appropriate to open total of 9 soil profiles (3 in each segment) in order to determine the soil properties of natural regeneration area.

While opening the soil profiles, the rules stated by Çepel (1996) have been taken into account. In those profiles, the absolute and physiologic soil depths have been measured, and determinations have been made about root distribution and structure type. But, about the research topic, we focused on properties of top soil being effective on the number and development of young black pines, and the values about this property have been statistically analyzed.

For smooth penetration of roots and rain waters into the soil, improved aspiration in soil, and high nutrient exchange, the best structure type is clastic structure. Because, the plants can distribute their roots through a wider range in soils having clastic structure, and can profit the nutrient medium better. This situation significantly smooths the profiting of small rootlets from water and nutrients in early years of natural and artificial regeneration efforts (Çepel 1995). In this point, it has been found that the best developments of Scotch pine, black pine, Turkish pine, oak, Uludağ abies and Toros abies have occurred in clastic-structured soils having better aspiration and water-retention capabilities (Pamay 1962; Özdemir 1977; Çepel et al. 1977; Kantarcı 1978; Bozkuş 1987; Karadağ 1999). Under the light of those information, it has been determined that the structure type is important for development of young black pines, and the data about this variable has been included in analyses, as mentioned in Table 3.

Table 3 The numerical values of structure type in statistical analyses

Structure type	Numeric value
Granular structure	1
Clastic structure	2

There is no close relationship between the numbers of rootlets (< 2mm) in topsoil and soil productivity. The increase in number of rootlet creates positive effect on development of youth. That's why; the number of rootlets having diameter less than 2mm has been determined as mentioned in Table 4, and has been added into statistical analyses as a variable.

Table 4 The numerical value of rootlet status in statistical analyses

Definition of rootlet status	The number of thin rootlet per 1 dm^2 (Ǿ < 2 mm)	Numeric value
None	0	1
Very weak	1 – 2	2
Weak	2 – 5	3
Middle	5 – 10	4
Strong	10 – 20	5
Very strong	20 – 50	6
Root network	50 <	7

The soil samples taken from soil profiles according to the horizons have been analyzed in laboratories for determination of physical and chemical properties according to certain principles (Çepel 1996; Kacar 1996; Scheffer and Schachtschabel 2001), and soil properties such as soil reaction (pH), soil texture, organic matter, and macro plant nutrient elements (N, P, K) have been determined.

Soil texture is an important soil factor having important effect on nourishment of forest trees. From this aspect, sandy soils are poor in terms of water and nutrient matters. That’s why; the tree species having high organic matter requirements cannot show good development in sandy soils. On the other hand, the clayed soils retain more water and this leads to oxygen deficiency in tree roots. Also, despite the clayed soils retain high amount of water, the plants cannot profit from that water well. That’s why; the most appropriate soil types for plant development are sandy loam, loam, and sandy clayed loam where the water and air economy is optimum (Brady 1990; Çepel 1995; Scheffer and Schachtschabel 2001). Also, the soil type is an important factor affecting the regeneration success (Çepel 1982). That’s why; the determinations have been made in opened soil profiles about texture of top soil, which is important for the number and development of youth, the numerical values have been obtained and those values have been used in statistical analyses.

Table 5 Numeric values of soil texture (type) in statistical analyses

Soil type (Texture)	Numeric value
Clay	1
Clayed loam	2
Sandy clay	3
Sandy clayed loam	4
Sandy loam	5

Soil reaction (pH) is an important soil property in terms of plant’s nutrient intake. Hence, this situation has been proved in various researches of many researchers (Çepel et al. 1977; Kantarcı 1978; Eruz 1980; Kerr 1995). That’s why; it is thought that there may be a relationship between the number of youth and pH value of top soil. In parallel with that, the pH value of top soil determined under laboratory conditions are given in Table 6, and those numeric values have been used in statistical analyses.

Table 6 Numeric value of soil reaction (pH) in statistical analyses

pH	Soil reaction	Numeric value
< 3.5	Extremely acidic	1
3.5 – 4.5	Severely acidic	2
4.5 – 5.5	Mildly acidic	3
5.5 – 6.5	Weakly acidic	4
6.5 – 7.2	Neutral	5
7.2 – 8.5	Alkaline	6
> 8.5	Severely alkaline	7

Organic matters in soil play important role in disintegration of soil minerals and creation of clastic soil texture, so affect the soil development. Also, because they include the nutrients required for plants, they are important for mineral circulation. Besides them, they create the nutrient medium for soil micro-organisms, so it is an important factor affecting the soil biology (Çepel 1995; Kantarcı 2000).

About the amount of organic matter being effective on physical and chemical structure of soil, Çepel et al. (1977), in their research on Scotch forests, have found a relationship between organic matter in forests in Eastern Anatolia and increase. In another research conducted by Eruz (1980), it has been determined that the organic matter content in beech stands in Forest Belgrad varies significantly depending on soil type. In parallel with those explanations, it has been thought in this study about evaluation of natural black pine regeneration efforts that organic matter content in soil may be a factor on youth success, and that factor has been added into statistical analyses as stated in Table 7.

Table 7 The numeric values of organic matter content of soil in statistical analyses

Organic matter amount	Numeric value
%1 – 2 (Low)	1
%2 – 5 (Medium)	2
%5 – 10 (High)	3
%10 – 15 (Very high)	4

The macro nutrient elements of azote, phosphor and potassium are the most important elements required for normal development of the plants (Irmak 1972; Brady 1990; Çepel 1995; Smith et al. 1997; Türüdü 1997; Scheffer and Schachtschabel 2001).

Many researches investigating the relationship between azote, potassium and phosphor macro nutrient elements and plant development have been made, and very interesting results have been obtained in those researches. For example; Çepel et al. (1977), in their study on pure Scotch pine forests in important habitats, have significant relationships between reserve values of azote, phosphor and potassium elements and top heights of stands. Eruz (1980), in his research on beech and oak stands, has found that the diameters and heights of beech and oak trees increase in direct proportion to increase in amounts of especially azote and potassium in top soil. Uğurlu and Çevik (1990), in their study on coppice oak forests, have revealed that there is a linear relationship between potassium, magnesium and calcium elements in soil and sucker lengths. According those explanations, with thought of that the azote, phosphor and potassium content in top soil segment (Ah) may be effective on regeneration success in natural black pine regeneration efforts, including them into statistical analyses as stated in Table 8 has been considered to be suitable.

Table 8 Numeric values of azote, phosphor and potassium elements in statistical analyses

Nutrient matters	Limit values	Levels	Numeric value
Azote (%)	< 0.70	Low	1
	0.70 – 1.60	Medium	2
	> 1.60	High	3
Phosphor (ppm)	< 65	Low	1
	65 – 130	Medium	2
	> 130	High	3
Potassium (ppm)	< 80	Low	1
	80 – 160	Medium	2
	> 160	High	3

An increase in level of soil saltiness which has direct and indirect effects on creation of various physical properties of soils and plant nourishment affects the physical properties (structure, texture, and etc.) negatively, and the plants cannot obtain the nutrients required for their development from soil adequately as a result of that (Kacar 1996). Hence, Dündar (1973), in his study on relationship between dryness seen in black pine and Scotch pine stands and the concentration levels of nutrient matter in soil, has revealed that water-soluble total salt content was high in soils of experiment sites where black pine and Scotch pine stands exist. On the other hand, Eruz (1980), in his study in beech and oak stands' soils, has determined that there are high level of salt content, but in accumulation horizon where the saltiness is slightly higher than other soil horizons, the cation exchange capacity decreases and consequently the density of plant root density decreases in that horizon. Considering that saltiness level of top soil layer where the root development of youth occur may affect the number and development of youth, the level of saltiness in taken soil samples has been determined and the values about saltiness of top soil have been directly used in statistical analyses.

The main resource of macro and micro nutrient matters in soil is the litter. The litter generally consists of leaf, thin branch, peel, cone scale and organism residuals. The litter consists of 3 main layers of leaf, molds, and humus. That's why; for introducing the latter well, it is necessary to determine the changes in thickness of those 3 layers (Çepel 1995). In this study, in order to make detail measurements in youth and to count youth, the thicknesses of latter layers (leaf, mold, humus) have been measured in total of 20 sample sites with 5x5 m size (25 m^2) established in research site with dimensions of 25x40 m.

Besides establishing the most important nutrient resource of the soil, latter has important effects on temperature, moisture, aspiration, permeability, and acidity (reaction) of the soil (Saatçioğlu 1969; Irmak 1972, 1974; Çepel 1995, 1996).

It is possible to define the living cover (plant cover of soil) as a living layer consisting of annual and perennial plants existing over forest soil. From this aspect, the living cover, with latter, is a factor characterizing the status of outer soil (Çepel, 1995). Besides many physical and chemical properties of soil, the living cover layer has also direct and indirect effects on plant development. That's why; the interventions in forests during regeneration efforts to be made should be made by considering the density of living cover layer. In parallel with that information, the living cover density has been determined in sample areas with size of 25 m^2. The living cover density has been added into statistical analyses in accordance with determined numeric values.

2.2.2.3 Determination of Physiographic Factors

One of the important factors affecting the creation of habitat conditions is physiographic factors. Physiographic factors include various characteristics about geographic and geomorphologic properties. The presentation of physiographic characteristics of any region means specific local conditions belonging to that region. And the presentation of special location properties is carried out via altitude, exposure, land slope level, and land surface form (shoulder status) variables. So, the presentation of physiographic properties of a forest ecosystem can be possible only with variables used in presentation of specific location (Çepel 1966, 1995; Smith et al. 1997). In order to define the physiographic factors of stands where the experiment sites have been taken from, the measurements and determinations have been made for specific location conditions such as altitude, exposure, land slope and shoulder status.

The altitude (height from sea level) is an important factor affecting the climate, soil properties and vegetation structure. The low temperature and high moisture conditions in higher altitudes lead significant changes in soil properties. In parallel with those explanations, with the thought that the altitude may be a factor affecting the number and development of young black pines, the altitudes of experiment sites have been measured via altimeter and those values have been added into statistical analyses as variable.

The exposure of a land affects especially the temperature and precipitation climate of that place. In our country, the shadowed exposures (north, northeast, northwest, and east) are colder, sunny exposures (southeast, south, southwest, and west) are warmer. The reason is that the hours and strength of sunshine in sunny exposures are higher in north hemisphere. The shoulders facing the winds bringing the moisture get more precipitation. As their evapotranspiration is less because of coolness, the soil in shadowed exposures is moister than those in sunny exposures in same region. Because of excessive warming in days on one hand and excessive water loss in nights on the other hand, the frost danger in sunny exposures is more than that in shadowed exposures. The existence of snow cover in shadowed exposures more than in sunny exposures plays important role in this point. From this aspect, this characteristic must be considered in natural regeneration and forestation efforts (Çepel 1995). But Kapucu (1978) has reported that site quality is higher in shadowed exposures of spruce tree + Scotch pine + abies + beech stands than in sunny exposures. In a study of Daşdemir (1987) conducted in order to determine the factors affecting the productivity of fagus orientalis forests, it has been reported that there is no significant relationship between exposure and site quality index, but the shadowed exposures have more appropriate conditions for oriental beech stands' development than sunny exposures because of negative relationship between the variables. Bozkuş (1987), in his study on Toros abies, has reported that this specie creates its best stands in shadowed exposures. Çalışkan (1991) and Demirci (1991), in their researches on Scotch pine + abies + beech and spruce + beech mixed stands, have reported that the stand development is better in shadowed exposures than sunny exposures. That's why; the exposure of research sites has been determined via compass, and added into analyses as a variable after being given a numeric value.

The land slope has an important factor affecting the local climate and soil properties of any place and the styles of profiting the land. As land slope increases, the surficial flow and consequently the erosion severity increase and soil depth decreases. So, in sloped locations, shallow and droughty soil conditions having rich skeleton structure occurs. Bur in lowly sloped places, there are deep, moist and appropriate soil textures with low skeleton content. Also the land slope is an important factor affecting the nutrient economy of the soil. But biologic activity increased in lowly sloped lands with appropriate moisture and temperature conditions of soils, consequently the soil obtains high nutrient matter capacity as a result of better disintegration of organic matter (latter) (Çepel 1995; Kantarcı 2000; Scheffer and Schachtschabel 2001). According to the results obtained from various researches, the land slope is an important physiographic factor affecting the habitat productivity. That's why; with the thought that land slope can be factor affecting the natural regeneration efforts on black pine, this variable has been measured as percentage (%) via an abney level. Then the results have been added into statistical analyses.

Different land forms have various ecological properties. That's why; the land form (shoulder status) is an important physiographic factor affecting the local climate characteristics and soil conditions. Indeed, annual and daily temperature changes in parts of shoulder at and near the ridge are higher than those in flat lands at same altitude. Also, the damages of leaching and wind are more in ridge lands. The soil depth is higher in ridge and top shoulder lands are lower than that in middle ridge and bottom ridge lands (Çepel 1966; Brady 1990; Çepel 1995; Smith et al. 1997). In various researches on this topic, it has been determined that the ridge lands are the most unproductive sites for stand development, and the increase increases from upper parts of shoulders to lower parts, and then the most productive sites are the flat areas (Çepel et al. 1977; Kapucu 1978; Daşdemir 1987; Bozkuş 1987; Çalışkan 1991; Demirci 1991; Boydak et al. 2006). For this purpose, the land forms (shoulder status) of land where the experiment sites are located have been grouped into 3 groups, and those groups have been added into statistical analyses after being given a numeric value as stated in Table 9.

Table 9. The numeric values of land forms of experiment sites in statistical analyses

Land Form (Shoulder Status)	**Numeric Value**
Upper shoulder	1
Middle shoulder	2
Bottom shoulder	3

2.2.4 Counting, Measurement and Determinations about Juvenility

2.2.4.1 Juvenility Countings

The most important criterion used in determination of success of natural regeneration effort is the number of youth in square meter (Baker 1934; Smith 1962; Pamay 1962; Saatçioğlu 1979; Atay 1982; Smith et al. 1997; Nyland 2002; Odabaşı et al. 2004). Hence, in many researches conducted in order to determine the success of natural regeneration efforts performed on various species, the number of youth in square meter (pcs/m^2) has been considered to be a success criterion (Saatçioğlu 1970; Atay 1971; Sevimsoy 1984; Eyüboğlu et al. 1995; Umut et al. 1996; Karadağ 1999; Agestam et al. 2003; Pariona et al. 2003; Çalışkan et al. 2004). In practice, the number of youth in m^2 is considered while evaluating the success of natural regeneration efforts (Anon. 2006; Genç 2006). In this study, the number of youth in m^2 is considered to be a success criterion. For this purpose, the number of young black pines in square meter has been calculated.

Used in determination of the number of youth in square meter considered as an indicator of the success of natural regeneration efforts, the sampling method has great importance from the aspect of accuracy of the results. In practice, the method called “40 steps method” is used for determining the success of natural regeneration efforts. In this method, a rectangle (2 m2) or a circle (160 cm diameter) is placed after each 40 steps in parallel with leveling lines, and then the youth counting is performed. In sapling counting sheets prepared during those countings, the sampling sites where there is no young tree is given a value of 0, while the number of young trees is written besides the sampling sites where there are young trees. After those processes, while calculating the youth success, the total number of points where there are young trees is divided to total number of calculation sites, and the result is multiplied with 100 in order to determine the number of youth in percentage. In youth success calculations, the sites having at least 70% youth regeneration success are considered to be successful, while complementation is made in sites below 70% (Anon. 2006). But Kalıpsız (1988) has suggested to repeat the countings of cones, seeds and saplings in 1-4 m2 experiment sites for 30-100 times. Saatçioğlu (1970), in his study ın natural regeneration of beech, has carried out youth countings on experiment sites with varying areas from 1696 m2 to 3625 m2. Suner (1978), in his study on natural regeneration of beech, has carried out those countings on parcels with dimensions of 30x30m in 90x90m blocks. Umut et al. (1996), in their natural regeneration study ın Turkish pine, have conducted countings on 25x10 m sampling areas and repeated for 48 times. Kaymakçı et al. (2002), in their study ın regeneration of high-zone black pine forests, have carried out the countings on 10x25 m experiment sites and repeated for 9 times. In a study conducted between 2004 and 2006, the youth countings have been performed on 5x5m sized sites established in grid form on 25x40 m sized area. So, through the sampling method applied in research, the youth countings have been conducted on total of 20 experiment sites (500 m^2). Using the data obtained in countings in sampling sites on experiment areas, the number of youth per m^2 has been calculated via formulas below.

$$GS = \frac{\sum GSi}{\sum \ddot{O}B}$$

where;

GS : the number of youth per square meter (pcs/m^2),

$\sum GSi$: Total number of youth in sampling sites (pcs/500 m^2),

$\sum \ddot{O}B$: Total of sampling area (500 m^2).

2.2.4.2 Measurement of Juvenility Height

The height of youth is one of the most important criteria used for determination of growth of youth since first years (Saatçioğlu 1979; Atay 1982, 1987; Ata 1995; Oliver and Larson 1996; Smith et al. 1997; Nyland 2002; Odabaşı et al. 2004). That's why; in many studies conducted on natural regeneration of various species, the height measurements have been carried out since first years in order to determine the changes (Sevimsoy 1984; Tosun and Gülcan 1985; Eyüboğlu et al. 1995; Umut et al. 1996; Karadağ 1996; Dündar et al. 2002; Kaymakçı et al. 2002; Çalışkan et al. 2004). For this purpose, the height values of young black pines during 2 years have been determined for each of experiment sites.

Figure 4. Measurement of youth height

As a result of height measurements carried out in black pine youths in sample sites during the study, the average of obtained results has been calculated via the formula below, and the mean annual growth values of black pine youths have been calculated. The mean height values of young black pines determined in each experiment site have been included in statistical analyses as individual variables.

$$\bar{h}g = \frac{\sum hgi}{n}$$

where;

$\bar{h}g$: mean height of young black pines in experiment site (cm),

$\sum hgi$: Total height of young black pines in experiment site (cm),

n : Total number of young black pines in experiment site (pcs).

2.2.4.3 Measurement of Root Collar Diameter of Juvenilities

Another variable used for determining the growth in youth in terms of years is the root collar diameter. The root collar diameter is also an important criterion for determination whether newly germinated seedlings could develop their root systems. Hence, it has been found as a result of researches on some species that there is an important relationship between root neck diameter and the opportunities of seedlings for profiting the water and nutrient elements in soil (Dündar et al. 2002). That's why; the determination of root neck diameters of young natural black pines has been considered to be important from the aspect of revealing the opportunities of seedlings for profiting the actual soil conditions.

$$\overline{KBÇ} = \frac{\sum KBÇi}{n}$$

where;

$\overline{KBÇ}$: The mean root collar diameter of young black pines in experiment site (mm),

$\sum KBÇi$: Total mean root collar diameter of young black pines in experiment site (mm),

n : Total number of young black pines in experiment site (pcs).

2.2.5 Statistical Analyses Used in Research

For statistical analysis of data obtained as a result of research, SPSS (Statistical Package for Social Science) 9.0 package software has been utilized. In order to determine whether data used in statistical analyses show normal distribution, the Kolmogoraf Simirnov test has been utilized (Kalıpsız 1994; Batu 1995; Ercan 1997; Özdamar 2004).

In natural regeneration implementations, there are individual and cooperative effects of many factors on regeneration success (the number of youth per square meter), development of youth (height increase and root neck diameter development) and some morphologic characteristics (the status of tip and leaf color) (Pamay 1962; Atay 1971; Saatçioğlu 1979; Çepel 1982). Especially the number of youth per square meter which is used for determining the success of regeneration efforts is significantly affected by environmental factors, genetic factors and implemented silvicultural techniques. So, it is recommended to utilize multi-dimensional statistical analyses for determining the factors affecting the quantitative character such as youth number (Oliver and Larson 1996; Madsen and Larsen 1997; Tegelmark 1998; Beck 2000; Elliott and Knoepp, 2005).

The multi-dimensional statistical analyses are techniques where many different variables being in relationship with each other are handled and evaluated (Daşdemir 1987, 1995). In this study, the multi-dimensional factor analysis and multiple regression analysis from statistical analyses have been utilized for assessment of factors affecting the success of youth.
Firstly, the correlation analysis has been utilized in order to determine the level and direction of mutual relationships between variables. As a result of analysis, it has been evaluated if the mutual linear correlation coefficients between variables are significant at confidence levels of, 0.05 and 0.01. The factor analysis has been utilized according to correlation coefficients between variables. After preparing the data table related with factor analysis, among widely used factor creation methods, Principal Components Analysis has been taken as base for determining the factors explaining the variance at best way. So, the variables having high correlation coefficients among each other have formed factors by gathering. For determining the number of factor to represent the relationship between variables at highest level, "Kaiser" and "Scree Test" criteria are used. In this study, the Kaiser method based on creation of factors having eigenvalue statistics higher than 1 has been utilized.

In order to name factors and smooth the interpretation, the factor matrix which has been obtained via Principal Component Analysis but not transformed must be rotated. For this purpose, by choosing the orthogonal rotation based on zero correlation between factors, *Varimax* technique has been implemented and the transformed factor matrix has been obtained.

The naming and interpretation of factors can be performed according to common feature of one or more variable having high factor load. Sometimes, the variable having highest factor load can be taken as factor standard (Kalıpsız 1994). Considering the aim of the study, common factors are named in 3 ways. Those are symbolic names, descriptive names, and causal names (Daşdemir 1987). In this study, the naming and interpretation of factors have been carried out generally based on variable with highest factor load. But in some situations, the common reasons lying behind the variables seeming to be in relationship with factor have been taken into account.

In this research, it has been thought to create an opinion about the variables (climatic, edaphic, and physiographic variables) determined during 3 years on the number of young trees. For this purpose, in order to determine the effects of all of the variables on the number of youth, the number of young black pines per square meter determined in 2006 has been taken as base in multiple regression analysis. As the independent variable in multiple regression analysis, the most important factor found as a result of factor analysis (eigenvalue higher than 1) was used. *Enter* method has been chosen for implementation of multiple regression analysis.

3. FINDINGS

3.1 FINDINGS ABOUT THE HABITAT CONDITIONS

3.1.1 Findings About the Climatic Factors

The mean annual precipitation and mean annual temperature values of experiment sites have been obtained via interpolation. During those interpolations in precipitation and temperature values, the annual increases and decreases in mean precipitation and temperature values in meteorology stations in same years with research have been taken into account (Table 10).

Table 10. Mean annual precipitation and mean annual temperature values of experiment sites

Sub-District Directorate	**Parcel Nr**	**Experiment Site Nr**	**Year 2012**	
			Mean Precipitation (mm)	**Mean Temperature (°C)**
Araç	54b	1	853.6	13.6
		2	862.5	14.2
		3	843.2	13.8
		4	875.9	13.5
		5	883.2	13.7
		6	887.5	13.2
		7	881.4	14.5
		8	886.3	14.8
		9	880.5	13.6
		10	883.6	13.4
	63c	1	945.2	12.4
		2	943.5	12.2
		3	937.8	12.0
		4	948.6	11.8
		5	952.5	12.3
		6	965.7	12.5
		7	973.8	12.8
		8	971.5	12.0
		9	955.3	11.7
		10	942.6	11.5
	76a	1	894.5	14.2
		2	892.6	14.5
		3	891.4	14.6
		4	890.2	14.3
		5	897.6	14.5
		6	898.3	14.2
		7	887.6	14.4
		8	890.1	14.6
		9	892.4	14.3
		10	898.7	13.6

Evaluating the mean annual precipitation and mean annual temperature values obtained via interpolation and showed in Table 10, it has been found that the mean annual precipitation value of year 2012 in Araç region where the research has been conducted has varied between 880.5 and 973.8mm, while the mean temperature value has varied between 11.5 and 14.8^{o}C.

Another factor taken into account within the climate conditions is the light intensity. For this purpose, in order to determine the light intensity, light measurements have been carried out simultaneously in an out of stand under open air (cloudless) conditions. As a result of conducted light measurements, the light intensity values obtained as a result of proportioning the light measurements in and out of the stand are stated in Table 11.

Table 11. Light intensities in experiment sites

Sub-District Directorate	Parcel Nr	Experiment Site Nr	Light Intensity (%)
Araç	54b	1	56
		2	58
		3	52
		4	63
		5	65
		6	62
		7	68
		8	67
		9	59
		10	61
	63c	1	68
		2	72
		3	75
		4	74
		5	73
		6	76
		7	75
		8	73
		9	71
		10	70
	76a	1	63
		2	62
		3	64
		4	65
		5	68
		6	63
		7	65
		8	66
		9	69
		10	71

3.1.2 Findings About The Edaphic Factors

The findings determined as a result of investigations conducted in 9 soil profiles opened in 3 parcels of regeneration implementation site are given in Table 12.

Table 12. The results of measurement and determinations in soil profiles.

Sub-District Directorate	Parcel Nr	Profile Nr	Physiologic Depth (cm)	Absolute Depth (cm)	Rootlet Status	Structure Type
Araç	54b	1	88	100	Medium	Granular
		2	86	75	Medium	Granular
		3	82	88	Medium	Granular
	63c	1	76	64	Medium	Clastic
		2	79	73	Frequent	Clastic
		3	75	53	Weak	Granular
	76a	1	81	38	Weak	Granular
		2	87	50	Frequent	Clastic
		3	84	87	Weak	Granular

The second phase of investigations of edaphic conditions consists of various physical and chemical analyses on soil samples taken from soil profiles in terms of horizons under laboratory conditions. In those analyses, important soil characteristics such as pH, organic matter content, total azote, phosphor, potassium and saltiness have been investigated. The minimum and maximum values of chemical analysis results determined in terms of trabeculas are given in Table 13.

Table 13. Maximum and minimum values of chemical analysis results of soil samples

Sub-District Directorate	Trabecula Nr	pH		Organic Matter (%)		Azote (N) (%)		Phosphor (P) (ppm)		Potassium (K) (ppm)		Saltiness (dS/m)	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Araç	54b	6.20	6.80	5.53	7.28	0.45	1.25	12.0	36.0	79.0	228.0	0.17	0.84
	63c	6.15	7.26	8.56	9.18	0.56	1.35	7.0	27.0	65.0	210.0	0.23	0.65
	76a	6.35	7.11	9.23	10.21	0.46	0.72	8.0	32.0	58.0	165.0	0.35	0.72

3.2 FINDINGS ABOUT JUVENILITY

3.2.1 Findings About the Number of Juvenilities

The most important criterion in determining the success of natural regeneration is the number of young trees per square meter. That's why; the number of young trees per square meter in research site is given in Figure 5.

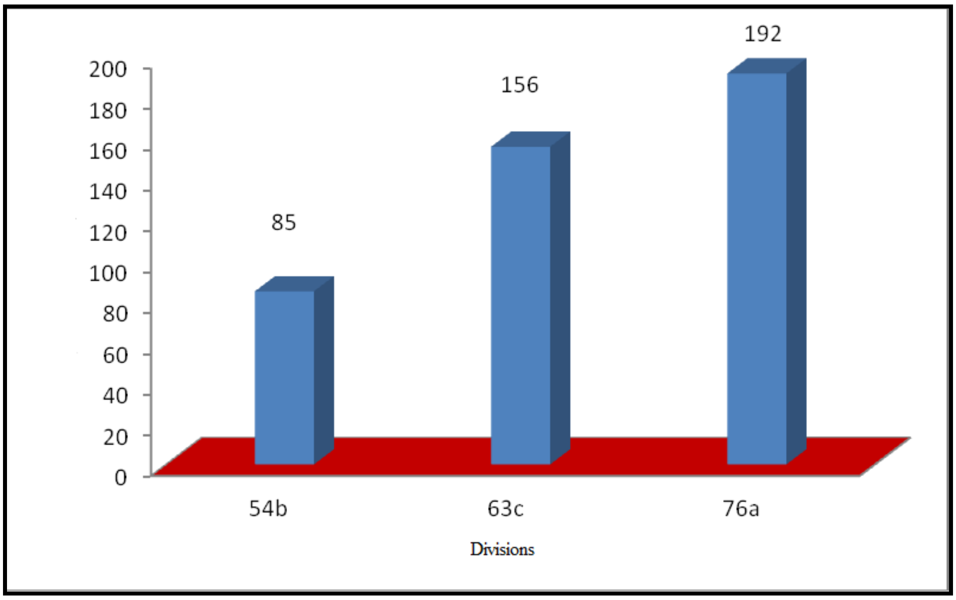

Figure 5. Mean number of young black pines by trabecula

3.2.2 Findings about the Height Growth of Young Black Pines

The most important criterion used in determining the growth of young trees in first years of regeneration studies is the youth height. That's why; height measurements have been carried out on natural young black pines with different heights in 25 m^2 sample sites. The values of height measurements are given in Figure 6.

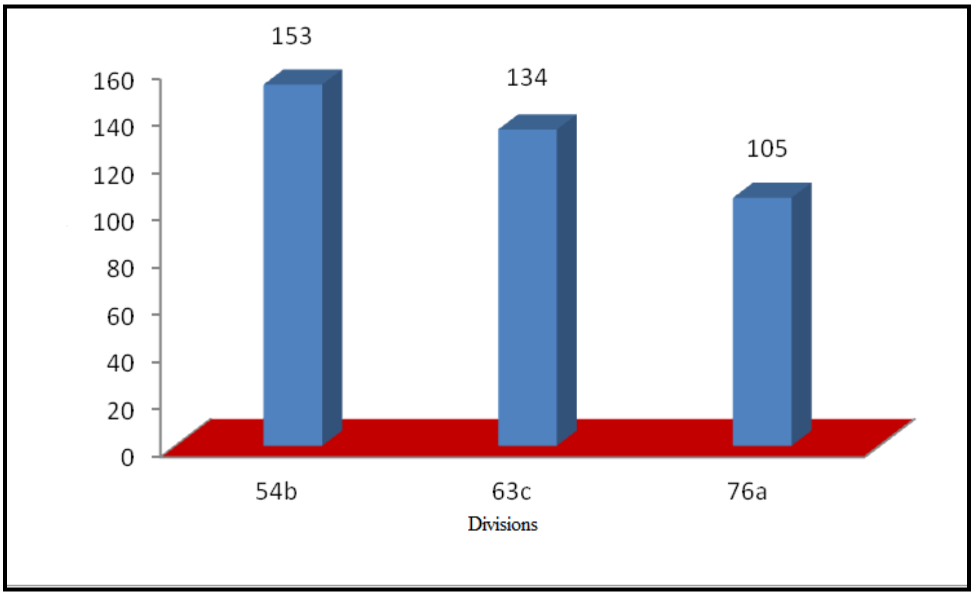

Figure 6. Mean heights of young black pines by trabeculas

3.2.3 Findings about the Root Collar Diameters of Young Black Pines

One of the variables used for tracking the growth in first years of young trees in regeneration studies is the root collar diameter growth of youth. That's why; the root collar diameter measurements have been carried out on young black pines in research site, and the results obtained are given in Figure 7.

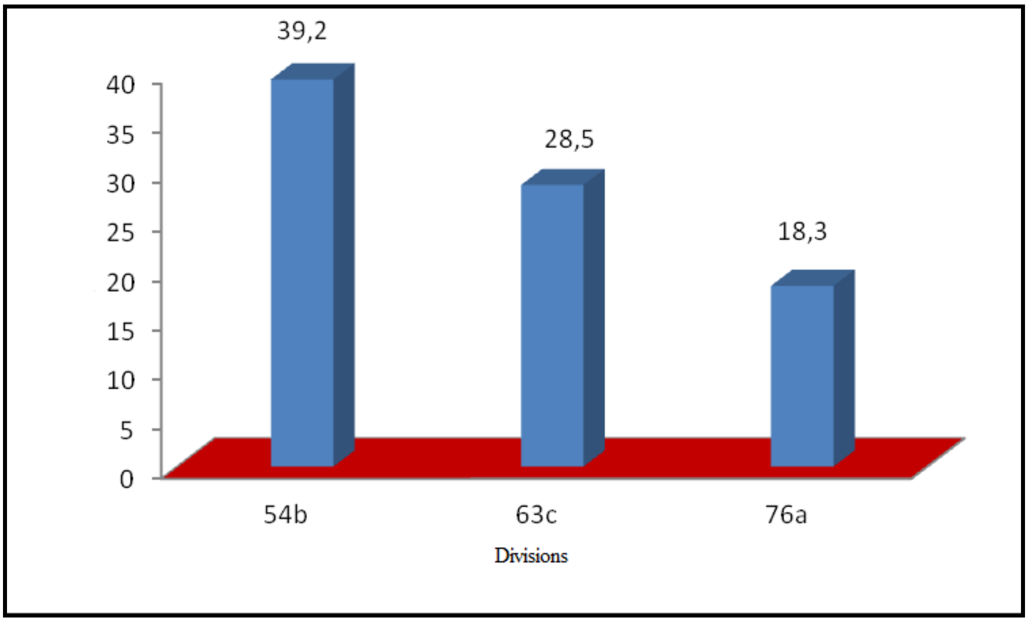

Figure 7. Mean root collar diameters of young black pines by trabeculas

3.3 FACTORS AFFECTING THE SUCCESS OF REGENERATION

In order to determine various factors which may be effective in regeneration success of natural black pine regeneration studies, the factor analysis has been utilized. For this purpose, the measurement units and analysis symbols of 19 variables investigated and taken into analyses are given in Table 14.

Table 14. Variables investigated within the scope of research

Nr	Variables	Unit	Symbol in analysis
1	Altitude of experiment sites	m	RAKIM
2	Exposure of experiment sites	---	BAKI
3	Slope of experiment sites	%	EGİM
4	Shoulder status of experiment sites	---	YD
5	Absolute soil depth	cm	MD
6	Physiographic soil depth	cm	FD
7	Rootlet status	---	KOKD
8	Structure type	---	STRT
9	Soil type	---	TOPT
10	Soil reaction in top soil layer (Ah)	---	PH
11	Organic matter content in top soil layer (Ah)	%	ORGM
12	Azote amount in top soil layer (Ah)	%	AZOT
13	Phosphor amount in top soil layer (Ah)	ppm	FSFR
14	Potassium amount in top soil layer (Ah)	ppm	PTSYM
15	Saltiness of top soil layer(Ah)	dS/m	TUZ
16	Precipitation of 2012	mm	YAG12
17	Mean temperature in 2012	˚C	SIC12
18	Thickness of latter in 2012	cm	OLUORT12
19	Living cover density in 2012	%	DORT12

As the measure of regeneration success, the number of young black pines per square meter in 2012 has been taken, and the factors affecting it have been investigated.

To explain the mutual relationship of variables mentioned above and affecting the number of young black pines is not enough for determining the combined effect on young black pines. That’s why; the factor analysis has been utilized in order to group the variables having high correlation in that complex structure and to reveal variable groups transparently. The Principal Component Analysis model and Kaiser criteria have been taken as base, and 5 common (basic) factors have been derived (Table 15).

Table 15. The explanation of total variance according to factor analysis results

Factors	Initial eigenvalues			Square of Untransformed Factor Loads Before Rotation			Square of Transformed Factor Loads After Rotation		
	Total	**Variance (%)**	**Accumulated Variance (%)**	**Total**	**Variance (%)**	**Accumulated Variance (%)**	**Total**	**Variance (%)**	**Accumulated Variance (%)**
1	16.129	32.321	32.321	16.129	32.321	32.321	16.129	23.176	**39.40**
2	7.782	16.557	55.066	7.782	16.557	55.066	9.127	19.419	**41.56**
3	5.153	10.964	66.030	5.153	10.964	66.030	4.571	9.725	63.44
4	2.894	6.156	72.187	2.894	6.156	72.187	4.167	8.865	69.73
5	2.355	5.010	77.197	2.355	5.010	77.197	2.356	5.013	**72.96**
6	2.026	4.310	81.507						
7	1.208	2.570	84.077						
8	1.163	2.475	86.552						
9	1.086	2.310	88.862						
10	0.881	1.874	90.736						
11	0.657	1.398	92.134						
12	0.628	1.337	93.470						
13	0.573	1.220	94.690						
14	0.443	0.942	95.632						
15	0.370	0.788	96.420						
16	0.320	0.682	97.102						
17	0.251	0.534	97.636						
18	0.219	0.465	98.101						
19	0.179	0.380	98.480						
20	0.149	0.318	98.798						
21	0.146	0.310	99.108						
22	0.120	0.256	99.364						
23	8.325E-02	0.177	99.542						
24	6.480E-02	0.138	99.679						
25	4.231E-02	9.001E-02	99.769						
26	3.982E-02	8.472E-02	99.854						
27	2.971E-02	6.321E-02	99.917						
28	2.370E-02	5.042E-02	99.968						
29	8.818E-02	1.876E-02	99.987						
30	6.324E-02	1.346E-02	100.00						
31	1.694E-15	3.604E-15	100.00						
32	7.177E-16	1.527E-15	100.00						
33	4.005E-16	8.521E-16	100.00						
34	3.324E-16	7.072E-16	100.00						
35	3.001E-16	6.385E-16	100.00						
36	2.441E-16	5.194E-16	100.00						
37	1.048E-16	2.229E-16	100.00						
38	7.043E-18	1.498E-17	100.00						
39	-7.625E-17	-1.622E-16	100.00						
40	-1.007E-16	-2.143E-16	100.00						
41	-2.037E-16	-4.335E-16	100.00						
42	-3.172E-16	-6.748E-16	100.00						
43	-3.896E-16	-8.289E-16	100.00						
44	-5.771E-16	-1.228E-15	100.00						
45	-6.922E-16	-1.473E-15	100.00						
46	-8.352E-16	-1.777E-15	100.00						
47	-1.448E-15	-3.081E-15	100.00						

Extraction Method: Principal Component Analysis

As seen in Table 15, 5 factors having eigenvalue statistics higher than 1 have been derived. The 1st factor explains 39.40% of the variance. 1st and 2nd factor, together, explain 41.56% of variance. The 5 factors derived explain 72.96% of total variance.

In order to name the factors and smooth the interpretation, the transformed factor matrix has been taken as base (Table 16). In order to make interpretations and naming easier, the factor loads lower than 0.5 are not included in this chart.

Table 16. Transformed Factor Matrix

Variables	Factors				
	1	2	3	4	5
RAKIM	-0.975				
BAKI	0.963				
EGİM	0.958				
YD	-0.943				
MD		0.932			
FD		0.926			
KOKD		0.923			
STRT		0.921			
TOPT		0.917			
PH			0.883		
ORGM			-0.872		
AZOT			0.864		
FSFR			0.851		
PTSYM			0.842		
TUZ			-0.824		
YAG12				0.792	
SIC12				0.781	
OLUORT12					0.754
DORT12					0.743

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

As seen in transformed factor matrix; the correlations among 19 variables are represented with total of 5 factors. The variable having the highest correlation has taken the first rank in each of factors. So, the 1st factor's first variable is altitude (effective in negative direction), 2nd factor's first variable is absolute soil depth, 3rd factor's first variable is top soil reaction, 4th factor's first variable is mean precipitation of year 2012, and 5th factor's first variable is latter thickness.

As seen in chart 3.29; all of the 4 variables in 1st factor are related with physiographic conditions. Consequently, 1st factor has been named "**PHYSIOGRAPHIC CONDITIONS**". In order to represent this group in multiple regression analysis, **ALTITUDE** having the highest factor load (-0.975) has been chosen.

All of the 5 variables in 2nd factor are related with soil conditions. Consequently, 1st factor has been named "**PHYSICAL SOIL PROPERTIES**". In multiple regression analysis, **MD** having the highest factor load (0.932) has been chosen as representative of this factor.

In 3rd factor, there are 6 variables. All of those variables are related with organic matter content and macro nutrient elements. That's why; this factor is named **"ORGANIC MATTER"**. 3rd factor has been represented with **ORGM** in regression analyses.

There are 2 variables in 2nd factor. All of the variables are related with climate conditions of regeneration site. Within this context, 4th factor has been named "**CLIMATE**" and in order to represent this group in multiple regression analysis, **YAG12** having the highest factor load (0.792) has been chosen.

The variables in 5th factor are related with outer soil condition. That's why; 5th factor has been named "**OUTER SOIL CONDITION**" and in order to represent this group in multiple regression analysis, **OLUORT12** having the highest factor load (0.754) has been chosen.

In order to investigate the effects of 9 most important factors (independent variables) determined as a result of factor analyses on the number of young black pines, the multiple regression analysis has been carried out. As dependent variable in performed multiple regression analysis, the number of young black pines per square meter in 2012 (KGS06) has been used. The result of analysis performed via enter method are given in Table 17.

Table 17. Multiple regression analysis results

Independent Variables	Regression Coefficients	Standard Failure	F	R^2
(Fixed)	0.683	0.617	8.536***	0.78
RAKIM	-0.815*	0.105		
MD	0.00582	0.002		
PH	-0.00367	0.001		
YAG12	0.380*	0.005		
OLUORT12	0.0122	0.006		

Dependent Variable: KGS.12
(******): Significance level is P=0.01
(*******):Significance level is P=0.001

According to the regression analysis results, 78% of the success of regeneration in research site originates in those 5 factors. But the most important ones of those factors are RAKIM and YAG12. The multiple regression model can be written as follows in parallel with obtained results;

$$\mathbf{Y}_{(KGS12)} = 0.683 - 0.815\mathbf{X}_{(RAKIM)} + 0.00582\mathbf{X}_{(MD)} - 0.00367\mathbf{X}_{(PH)} + 0.380\mathbf{X}_{(YAG12)} + 0.0122\mathbf{X}_{(OLUORT12)}$$

But these results obtained are not enough for making an absolute decision about the factors affecting the success of natural regeneration efforts on black pine. In order to obtain more reliable results in this topic, it is required to investigate the data covering much longer time (10-20 years). This analysis can give only a pre-understanding about the determination of the most effective factors on success of natural regeneration efforts.

4. DISCUSSION, RESULT AND SUGGESTIONS

4.1 The Quantitative Properties of Black Pines Juvenilities

Through the height and root neck diameter measurements in 6th, 8th and 10th years, the changes in growth of young black pines in research site have been determined. The mean height increase of young black pines determined at the end of 6th year is 105cm. On the other hand, the mean height increase determined at the end of 8th year is 134 cm and the value determined at the end of 10t year is 153 cm. These results indicate the accuracy of location choice for regeneration sites and that the plants could profit better from organic matter and other nutrient elements (N, P and K) which exist in top soil layer and are important for plant nourishment. Hence, according to the measurement and determinations made in soil profiles, the medium and frequent rootlet densities indicate that young trees profit better from water, organic matter and nutrient elements located especially in top soil layer. In this topic, Karadağ (1999) has revealed in his research on points to pay attention during black pine regeneration efforts in Bolu region that the organic matter content in top soil layer and soil moisture have direct effect on development of young black pines. In a study conducted in Kütahya and Muğla regions in order to determine the factors affecting the success level of natural regeneration studies in black pine forest of those regions, it has been found that the mean height value of young trees varies between 96 and 112 cm (Çelik et al. 2000). Tüfekçioğlu et al. (2002), have found that as biomass increases in black pine, it can profit more from water and nutrient content of soil, and it contributes to development significantly.

The root collar diameter development of young black pines at the end of 10th year was 39.2 mm, that determined at the end of 8th year was 28.5mm and the mean root collar diameter development at the end of 6th year was 18.3mm. As well as in height development, this result in root collar diameter development indicates the adequate profiting from water, organic matter content and other nutrient elements in top soil layer. Different results have been obtained in studies on this topic in our country. According to that, in a study on natural black pine youth in Forest Belgrad, the mean root neck diameter has been determined to be 15.6 mm at the end of 5th year (Atahan, 1986). In another study conducted on young black pines in Bolu region, it has been stated that the height and root neck diameter are important criteria for evaluating the adhesion of youth over the region (Karadağ 1999).

4.1.2 The Number of Juvenility

In this study, the number of young black pines per square meter (pcs/m^2) in regeneration site has been determined. During the countings in experiment sites, the mean number of 6 years-old young trees was 192 pcs/m^2, that of 8 years-old young trees was 156 pcs/m^2 and the same value of 10 years-old young trees was 85 pcs/m^2. In studies on this topic in our country, it has been determined that the number of 3 years-old young black pines varies between 182.000 and 225.000 pcs/ha (Karadağ 1999). In another study in Kütahya and Muğla regions, it has been determined that the number of 5 years-old black pines varies between 65.000 and 132.500

pcs/ha (Çelik et al. 2000). Comparing those results with the results of this study, it can be seen that the number of young trees in research site is low. Many factors have effect on this situation. The leading one of those factors is thought to be that it wasn't a productive year in terms of black pine seeds. Another reason of unsuccessfulness in natural regeneration efforts is the lowness of habitat productivity (site quality) of the region where the natural black pine regeneration efforts have been made via LFCM. Because, the regeneration sites are within 3rd site quality class in general. One of the important reasons of low number of young black pines in natural black pine regeneration site is that the living cover removal and soil processing implementations performed in 2003, 2005 and 2007 in those sites haven't been applied in appropriate density and in harmony with the right technique. As a result of determinations during 2 years, it has been determined that the thicknesses of latters in natural regeneration sites were excessive. These thickness values of latter layer indicate that the soil processing has not been applied in right density while opening the group sites. Hence, in natural and artificial regeneration efforts, it is known that the maintenances performed in right time and with right technique after youth is brought into region create positive effects on the number and development of young trees (Atay 1978; Ata 1995).

4.2 The Factors Affecting the Success of Regeneration

As a result of factor analysis applied to 19 variables in order to determine the factors affecting the regeneration success I natural black pine regeneration studies, 5 factors have been obtained.

As a result of analysis, the obtained factors affecting the regeneration success are Physiographic Conditions, Physical Soil Properties, Organic Matter, Climate, and Outer Soil Condition, respectively.

The first factor determined to be effective on regeneration success as a result of factor analysis is physiographic conditions. This factor is represented by variable "Altitude" having the highest factor load. Hence, as altitudes of natural black pine regeneration sites' altitude increased, the number of youth decreased. The altitude is an important physiographic variable affecting the local habitat conditions. Depending on changes in altitude, the micro-climatic and edaphic conditions significantly change (Çepel 1995). Within this context, the implementation of natural regeneration studies in stands at the optimal spreading altitude of black pine increases the success of regeneration (Karadağ 1999; Atalay and Efe 2010)

Second factor affecting the success of natural black pine regeneration efforts is physical soil properties. As absolute and physiologic soil depth and top soil type change from rough textured soils (clay, loam, clayed loam, loamed clay) to more shallow and thinner textured soils (sandy clay, sandy clayed loam), the number of young black pines decreases. Depending on depth and soil type (texture), the plants' capability of profiting from water and nutrient elements in soil through their roots varies. Hence, the thinner textured (sand, sandy clay, sandy clayed loam) soils having better aspiration and higher cation exchange capacity have better water and nutrient element conditions than rough textured soils (clay, clayed loam, loamed clay) (Çepel, 1966, 1996). Within this context, various researchers have stated that the most appropriate soil type for development of black pine is the soils with sandy clay or sandy clayed loam texture having clastic structure (Saatçioğlu 1969; Atalay and Efe 2010).

The third factor affecting the success of natural black pine regeneration efforts in this study is determined as organic matter level. Organic matter content plays important role in development of plants and their adaptation to field conditions. Although the black pine is a half-light tree, the organic matter content and soil moisture have great importance in adhesion of young black pines in first years (Karadağ 1999). The need for organic matter content in soil increases especially in advancing years. The most important reason of that is the seed production. In a study where the first results of origin experiments on Scotch pine in Turkey, it has been determined that the successful origins in terms of seed efficiency are the origins which have profited more from the soil moisture. Within this context, in a comprehensive research study on seed field of Yenice-Bakraz-origin black pine in Bartın region, it has been determined that the soil fertility and maintenance have significant importance on seed productivity of black pine clones (Ertekin 2006).

According to the results obtained from factor analysis implemented in study, the fourth factor affecting the success of natural black pine regeneration efforts is climate factor. The unexpected changes especially in precipitation and temperature parameters may lead to various effects on creation and development of youth. Although black pine is the specie which can penetrate into the anthropogenic step site at most, it is also a forest tree which can be affected negatively from climate changes as well as other tree species. Especially the excessive summer temperatures experiences in our country in summer 2012 and long drought period seen as a result of that have led an important portion of young black pines to move away from the site by drying out. In a study on ecology of black pine and its seed transfer regioning, it is stated that the long durations of drought period affect the black pine negatively even though it is abstinent specie (Atalay and Efe 2010).

The last factor affecting the success of natural black pine regeneration efforts has been determined to be outer soil conditions. The outer soil conditions consist of latter accumulation and living cover density. In experiment sites of natural black pine regeneration area, the adequate amount of young black pines couldn't develop as a result of inadequate contact with mineral soil in parts where the latter accumulation is relatively thicker. Also the dense and strong living cover layer has created negative effects on success of natural regeneration efforts. Especially in parts of stands where there are dense living cover consisting of sword fern and blackberry, the youth has choked and be selected from the site. Similar findings have been found by Karadağ (1999) and Çelik et al. (2000) too.

In this study where the habitat conditions, youth development and regeneration success in natural black pine regeneration efforts within the scope of implemented model forestry plans in Araç region have been investigated, the measurements and determinations have been carried out on the research site consisting of 30 parts and 3 parcels.

As a result of investigations about the habitat conditions, it has been determined that the habitat productivity in regeneration sites is low, and the stands where those sites are located are within 3rd site quality class.

Within the context of this study, it has been determined during the investigations about the latter cover thickness and living cover density that the latter cover thickness and living cover density have increased significantly by years and the regeneration sites has started to become wild.

The mean numbers of natural young black pines determined in experiment sites are 192 pcs/m^2 at 6th year, 156 pcs/m^2 at 8th year and 85 pcs/m^2 at 10th year. According to those results, it can be seen that the number of young black pines has significantly decreased in natural regeneration sites.

The mean height growth values of young black pines are 105 cm at 6th age, 134 cm at 8th age and 153 cm at 10th age. The root neck diameter growth values of youth are 18.3 mm at 6th age, 28.5 mm at 8th age and 39.2 mm at 10th age. According to those values, it has been determined that the height and root neck diameter values of young black pines are significantly low.

In order to improve the success of natural regeneration studies on black pine which is one of the important species of our country, following suggestions should be considered;

1. The fertile seed years in regeneration sites should be determined accurately.
2. The regeneration studies should be carried out on optimum spread sites of specie and in normal organization stands.
3. Before seeding in regeneration site, the living cover layer especially consisting of rhododendron should be removed completely by rooting away, and the latter cover layer should be adequately mixed with mineral soil via intensive soil processing.
4. After taking young black pines in research site, until those young trees will obtain their biological independencies, the youth caring measures, especially the struggle with living cover layer, must be taken at right time and in right density.

ACKNOWLEDGEMENT

This study which has been prepared as post-graduate thesis by İlhan YAZGAN with counseling of Associate Prof. Dr. Halil Barış ÖZEL has been totally funded with the code number of ***BAP-2011-2-22*** by Bartın University's Research Project Directorate within the scope of post-graduate thesis projects. Herewith, we thank all of the contributors making effort for accomplishment of this study and supporting the post-graduate thesis.

REFERENCES

- **Agestam, E.** (1995) Natural regeneration of beech in Sweden (Some results from a field trial, Genetics and Silviculture of Beech, *In Proceedings from the 5th Beech Symposium of the IUFRO Project Group* P1.10-00, Denmark, pp.117-125.

- **Akgül, E. ve Aksoy, C.** (1976) Bolu-Şerif Yüksel araştırma ormanının toprak karakterleri ve toprak haritaları, Ormancılık Araştırma Enstitüsü, Teknik Bülten Serisi No: 95, Ankara, 52 s.
- **Aksoy, H.** (1978) *Karabük-Büyükdüz Araştırma Ormanındaki Orman Toplumları ve Bunların Silvikültürel Özellikleri Üzerine Araştırmalar*, İ.Ü Orman Fakültesi, Doçentlik Tezi, Fakülte Yayın No: 2332/237, İstanbul, 130 s.
- **Anon.** (2010) Araç Orman İşletme Müdürlüğü, Araç Orman İşletme Şefliği Model Amenajman Planı, Ankara, 236 s.
- **Anon.** (2011) Araç Orman İşletme Müdürlüğü, Araç Orman İşletme Şefliği Detay Silvikültür Planı, Bartın, 55 s.
- **Anon.** (2006) Orman Varlığımız, Çevre ve Orman Bakanlığı, Orman Genel Müdürlüğü, OGM Matbaası, Ankara, 152 s.
- **Anşin, R. ve Özkan, Z.C.** (1993) *Tohumlu Bitkiler (Spermatophyta)*, K.T.Ü Orman Fakültesi, Genel Yayın No: 167, Fakülte Yayın No: 19, Trabzon, s.320-325.
- **Ata, C.** (1975) Kazdağı Göknarı (*Abies equi-trojani* Aschers et Sinten)'nın Türkiye'deki Yayılışı ve Silvikültürel Özellikleri, İ.Ü Orman Fakültesi, Silvikültür Kürsüsü, Doktora Tezi (yayımlanmamış), İstanbul, 155 s.
- **Ata, C.** (1981) Doğal ve Yapay Gençleştirmenin Koşulları, *K.T.Ü Orman Fakültesi Dergisi*, Cilt: 4, Sayı: 1, Trabzon, s.80-97
- **Ata, C.** (1995) *Silvikültür Tekniği*, Z.K.Ü Bartın Orman Fakültesi, Üniversite Yayın No: 4, Fakülte Yayın No: 3, Bartın, 453 s.
- **Atalay, İ. ve Efe, R.** (2010) Anadolu Karaçamı (Pinus nigra Arnold. subsp. pallasiana (Lamb.) Holmboe)'nın Ekolojisi ve Tohum Nakli Açısından Bölgelere Ayrılması Orman Bakanlığı, Orman Ağaçları ve Tohumları Islah Araştırma Müdürlüğü, Yayın No: 4-424/37, Ankara, 272 s.
- **Atay, İ.** (1971) Tabii Gençleştirmenin Başarılı ve Başarısız Oluşuna Etki Yapan En Önemli Faktörler Üzerine Açıklamalar, *İ.Ü Orman Fakültesi Dergisi*, B Serisi, Cilt: 2, Sayı: 3, İstanbul, s. 7-20.
- **Atay, İ.** (1987) *Doğal Gençleştirme Yöntemleri I-II*, İ.Ü Fen Bilimleri Enstitüsü, İ.Ü Yayın No: 3461, F.B.E Yayın No: 1, İstanbul, 290 s.
- **Atay, İ., Odabaşı, T., Aksoy, H. ve Ata, C.** (1989) Karışık ormanlarda doğal gençleştirmenin planlanması esasları, *Ormancılık Araştırma Enstitüsü Dergisi*, No: 169, Ankara, s.7-26.
- **Avşar, M.D.** (1999) Kahramanmaraş-Başkonuş Dağı Ormanlarında Başlıca Meşcere Kuruluşları ve Silvikültürel Öneriler, K.T.Ü. Fen Bilimleri Enstitüsü, Orman Mühendisliği Anabilim Dalı, Silvikültür Programı, Doktora Tezi (yayımlanmamış), Trabzon, 211 s.
- **Ayhan, A.Ş.** (2002) Kızılçamın (*Pinus brutia* Ten.) Doğal Yolla Gençleştirilmesi, *Orman Mühendisliği Dergisi*, Sayı: 3-4, Ankara, s. 5-8.
- **Baker, F.S.** (1934) *Principles of silviculture*, McGraw-Hill Book Company, New York, 413 p.
- **Barnes, B.V., Zak, D.R., Denton, S.R. and Spurr, S.H.** (1998) *Forest Ecology*. John Wiley and Sons, Inc. 774 p.

- **Batu, F.** (1995) *Uygulamalı İstatistik Yöntemler*, K.T.Ü Orman Fakültesi, Genel Yayın No: 179, Fakülte Yayın No: 22, Trabzon, 312 s.
- **Beck, W.** (2000) Silviculture and Stand Dynamics of Scots Pine in Germany, Invest. Agr. Sist. Recur. For. Serie No: 1, Germany, pp. 199-212.
- **Brady, N.C.** (1990) *The Nature and Properties of Soils*, Macmillan Publishing company, 10th Edition, New York, 620 p.
- **Boydak, M.** (1993) Kızılçamın silvikültürel özellikleri, uygulanabilecek gençleştirme yöntemleri ve uygulama esasları. *Uluslararası Kızılçam Sempozyumu Bildirileri*, Orman Bakanlığı Yayını, Ankara, s.146-158.
- **Boydak, M.** (2003a) Problems and Recommondations Related to Plantations of Fast Growing Tree Species in Turkey. *In Proceedings of Establishment of Industrial Plantation in Turkey, International Workshop*, TEMA and Ministry of Environment and Forestry, Poplar and Fast Growing Forest Tree Research Institute, İzmit, pp. 4-14.
- **Boydak, M.** (2003b) Regeneration of Lebonan Cedar (*Cedrus libani* A. Rich.) on Karstic Lands in Turkey. *Forest Ecology and Management*, Vol: 178, pp. 231-243.
- **Bozkuş, H.F.** (1987) Toros göknarı (*Abies cilicica* Carr)'nın Türkiye'deki doğal yayılışı ve Silvikültürel Özellikleri, Orman Genel Müdürlüğü, Yayın No: 660, Seri No: 60, Ankara, 166 s.
- **Cairns, E.** (2001) How could continuous cover forestry work in New Zealand? *N. Z. Tree Grower 22*, New Zealand, pp. 42-43.
- **Çalışkan, A.** (1991) Karabük-Büyükdüz Araştırma Ormanın Sarıçam (*Pinus sylvestris* L.)-Göknar (*Abies bornmülleriana* Mattf.)-Kayın (*Fagus orientalis* Lipsky) Karışık Meşcerelerinde Büyüme

İlişkileri ve Gerekli Silvikültürel İşlemler, İ.Ü. Fen Bilimleri Enstitüsü, Orman Mühendisliği Anabilim Dalı, Silvikültür Programı, Doktora Tezi (yayımlanmamış), İstanbul, 283 s.

- **Çalışkan, A., Özalp, G. ve Karadağ, M.** (2004) Karabük-Büyükdüz Araştırma Ormanında Karaçam+Meşe+Göknar+Kayın Karışık Meşcerelerinde Meşenin Gençleştirilmesi, Çevre ve Orman Bakanlığı, Batı Karadeniz Ormancılık Araştırma Enstitüsü Müdürlüğü, Teknik Bülten No: 10, Bolu, 59 s.
- **Çanakçıoğlu, H.** (1995) *Orman Entomolojisi (Genel Bölüm)*, Üniversite Yayın No: 2, Fakülte Yayın No: 2, Bartın, 385 s.
- **Çelik, O., Umut, B., Kaymakçı, E., Dündar, M., Ayhan, Ş.** (2000). Karaçam (*Pinus nigra* Arnold. ssp. *pallasiana* (Lamb.) Holmboe) Doğal Gençleştirmesi Üzerine Araştırmalar, İç Anadolu Ormancılık Araştırma Enstitüsü Teknik Bülten No:280, Ankara, 90 s.
- **Çepel, N.** (1966) *Orman Yetişme Muhiti Tanıtımının Pratik Esasları ve Orman Yetişme Muhiti Haritacılığı*, Kutulmuş Matbaası, İstanbul, 187 s.
- **Çepel, N., Dündar, M. ve Günel, A.** (1977) Türkiye'nin Önemli Yetişme Bölgelerinde Saf Sarıçam Ormanlarının Gelişimi İle Bazı Edafik ve Fizyografik Etkenler Arasındaki İlişkiler, Türkiye Bilimsel ve Teknik Araştırma Kurumu (TÜBİTAK), Tarım ve Ormancılık Araştırma Grubu, Ankara, 165 s.
- **Çepel, N.** (1982) Doğal Gençleştirmenin Ekolojik Koşulları, *İ.Ü Orman Fakültesi Dergisi*, B Serisi, Cilt: 32, Sayı: 2, İstanbul, s. 6-27.
- **Çepel, N.** (1995) *Orman Ekolojisi*, İ.Ü Orman Fakültesi, 4. Baskı, İstanbul, 536 s.
- **Çepel, N.** (1996) *Toprak İlmi*, İ.Ü. Orman Fakültesi, Üniversite Yayın No: 3945, O.F. Yayın No: 438, İstanbul, 288 s.
- **Çepel, N.** (2003) *Ekolojik Sorunlar ve Çözümleri*, Türkiye Bilimsel ve Teknik Araştırma Kurumu (TÜBİTAK), Popüler Bilim Kitapları, Aydoğdu Matbaası, Ankara, 183 s.

- **Çiçek, E.** (2002) Adapazarı-Süleymaniye Subasar Ormanında Meşcere Kuruluşları ve Gerekli Silvikültürel Önlemler, İ.Ü Fen Bilimleri Enstitüsü, Orman Mühendisliği Anabilim Dalı, Silvikültür Programı, Doktora Tezi (yayımlanmamış), İstanbul, 137s.
- **Çolak, A.H. ve Pitterle, A.** (1999) *Yüksek Dağ Silvikültürü (Genel Prensipler)*, Orman Genel Müdürlüğü Personelini Güçlendirme Vakfı (OGEM-VAK), Ankara, 369 s.
- **Çolak, A.H.** (2001) *Ormanda Doğa Koruma* (Kavramlar, Prensipler, Stratejiler, Önlemler), Orman Bakanlığı, Milli Parklar ve Av-Yaban Hayatı Genel Müdürlüğü, Ankara, 354 s.
- **Çolak, A.H., Rotherham, I.D. and Çalıkoğlu, M.** (2003) Combining "Naturalness Concepts" with close-to-nature silviculture, *Forstw. Cbl*. 122, Germany, pp. 421-431.
- **Çolak, A.H. ve Odabaşı, T.** (2004) *Silvikültürel Planlama*, İ.Ü Fen Bilimleri Enstitüsü Yayınları, Rektörlük Yayın No: 4514, F.B.E Yayın No: 14, İstanbul, 326 s.
- **Daşdemir, İ.** (1987) Türkiye'deki Doğu Ladini (*Picea orientalis* L. Carr) Ormanlarında Yetişme Ortamı Faktörleri-Verimlilik İlişkisi, İ.Ü. Fen Bilimleri Enstitüsü, Orman Mühendisliği Anabilim Dalı, Orman Ekonomisi Programı, Yüksek Lisans Tezi (yayımlanmamış), İstanbul, 122 s.
- **Daşdemir, İ.** (1995) Orman İşletmelerinin Başarı Düzeylerinin Belirlenmesi (Kuzeydoğu Anadolu ve Doğu Karadeniz Bölgesi Örneği), Orman Bakanlığı, Doğu Anadolu Ormancılık Araştırma Müdürlüğü, Teknik Bülten Yayın No: 1, Erzurum, 162 s.
- **Demirci, A.** (1991) Doğu Ladini (*Picea orientalis* (L.) Link.)-Doğu Kayını (*Fagus orientalis* Lipsky.) Karışık Meşcerelerinin Gençleştirilmesi, K.T.Ü Fen Bilimleri Enstitüsü, Orman Mühendisliği Anabilim Dalı, Silvikültür Programı, Doktora Tezi (yayımlanmamış), Trabzon, 223 s.
- **Durkaya, A.** (1996) Şimşirdere Orman İşletme Şefliğine Ait Normal Amenajman Planı İle Türk-Alman Ormancılık Projesi Çerçevesinde Düzenlenen Model Amenajman Planının Kıyaslanması, Z.K.Ü Fen Bilimleri Enstitüsü, Orman Mühendisliği Enstitü Anabilim Dalı, Yüksek Mühendislik Tezi (yayımlanmamış), Bartın, 144 s.
- **Dündar, M.** (1973) Ankara Civarındaki Bazı Karaçam ve Sarıçam Kültürlerinde Görülen Kurumalarla İğne Yapraklardaki Besin Maddeleri Konsantrasyon Seviyeleri Arasındaki İlişkiler, Ormancılık Araştırma Enstitüsü, Teknik Bülten Serisi No: 53, Ankara, 101 s.
- **Dündar, M., Çelik, O., Umut, B. ve Ayhan, Ş.** (2002) Batı Karadeniz Kayın (*Fagus orientalis* Lipsky.) Meşcerelerinin Gençleştirilmesinde Sürgünden Gelen Gençliklerden Yararlanma İmkanlarının Araştırılması, İç Anadolu Ormancılık Araştırma Enstitüsü, Teknik Bülten No: 278, Ankara, 37 s.
- **Efendioğlu, M.** (1999) Türk-Alman ormancılık projesi çerçevesinde düzenlenen amenajman planları ve ülkemizde uygulama olanakları, *Orman Mühendisliği Dergisi*, Sayı: 4, Ankara, s. 27-32.
- **Eler, Ü., Genek., A. ve Yıldırım, K.** (1989) Karaçam (*Pinus nigra* Arnold.) Gençliklerinde Erken Boşaltma ve Seyreltmenin Fidan Büyümesi Üzerine Etkileri, Ormancılık Araştırma Enstitüsü, Teknik Raporlar Serisi, No: 36-39, Ankara, 20 s.

- **Eler, Ü.** (1990) Antalya Yöresinde Doğal Sedir (*Cedrus libani* A. Rich.) Meşcerelerinde Gecikmiş Aralama Kesimlerinin Gelişme Üzerine Etkileri, Ormancılık Araştırma Enstitüsü, Teknik Raporlar Serisi No: 44, Ankara, 24 s.
- **Elliott, K.J. and Knoepp, J.D.** (2005) The effects of three regeneration methods on plant diversity and soil characteristics in the southern Appalachians, *Forest Ecology and Management*, Vol: 211, pp. 296-317.
- **Emborg, J.** (1999) Research in forest reserves in Denmark, In Proceedings Research in Forest Reserves and Natural Forests in European Countries, European Forest Institute, Finland, pp 72-83.

- **Eraslan, İ., Yüksel, Ş. ve Giray, N.** (1984) *Batı Karadeniz Bölgesindeki Değişikyaşlı Koru Ormanlarının Optimal Kuruluşları Hakkında Araştımalar*, Tarım Orman ve Köy İşleri Bakanlığı, Orman Genel Müdürlüğü, Sıra No: 650, Seri No: 58, Ankara, 161 s.
- **Eraslan, İ ve Şad, H.C.** (1993) *Orman Amenajmanı*, İ.Ü Orman Fakültesi, İ.Ü Yayın No: 3742, O.F. Yayın No: 123, İstanbul, 420 s.
- **Ercan, M.** (1997) *Bilimsel Araştırmalarda İstatistik*, Orman Bakanlığı, Kavak ve Hızlı Gelişen Tür Orman Ağaçları Araştırma Müdürlüğü, İzmit, 225 s.
- **Ertekin, M.** (2006) Yenice-Bakraz Orijinli Karaçam (*Pinus nigra* Arnold. subsp. *pallasiana* (Lamb.) Holmboe) Tohum Bahçesinde Çiçeklenme, Kozalak Verimi ve Tohum Özellikleri Açısından Klonal Farklılıklar, Z.K.Ü Fen Bilimleri Enstitüsü, Orman Mühendisliği Anabilim Dalı, Silvikültür Programı Doktora Tezi (yayımlanmamış), Bartın, 191 s.
- **Eruz, E.** (1980) *Belgrad Ormanı'ndaki Meşe ve Kayın Ekosistemlerinin Bazı Önemli Kimyasal ve Fiziksel Toprak Özelliklerine İlişkin Araştırmalar*, İ.Ü Orman Fakültesi, İ.Ü Yayın No: 2641, Orman Fakültesi Yayın No: 280, İstanbul, 239 s.
- **Eyüboğlu, A.K., Atasoy, H. ve Küçük, M.** (1995) Saf Doğu Ladini (*Picea orientalis* (L.) Link) Meşcerelerinin Doğal Yolla Gençleştirilmesi Üzerine Çalışmalar, Ormancılık Araştırma Enstitüsü, Teknik Bülten No: 248, Ankara, 40 s.
- **Falcone, P.** (1999) Research in forest reserves in France, In Proceedings Research in Forest Reserves and Natural Forests in European Countries, European Forest Institute, Finland, pp 98-109.
- **FAO** (2001) State of The World's Forests, Rome, 169 pp.
- **FAO** (2005) State of The World's Forests, Rome, 305 pp.
- **Finkeldey, R. and Ziehe, M.** (2004) Genetic implications of silvicultural regimes, *Forest Ecology and Management*, Vol: 197, pp. 231-244.
- **Gadow, K.** (2001) Orientation and control in CCF systems, In Prceedings of the *International IUFRO Conference on Continuous Cover Forestry*, Assessment, Analyses, Scenerios, University of Göttingen, Germany, pp. 211-217.
- **Gadow, K., Nagel, J. and Saborowski, J.** (2002) Continuous cover forestry, Assesment, Analysis, Scenarios, Dordrecht, pp. 46-48.
- **Gamborg, C. and Larsen, J. B.** (2003) "Back to nature" a sustainable future for forestry? *Forest Ecology and Management*, Vol: 179, pp. 559-571.
- **Gärtner, S. and Reif, A.** (2005) The response of ground vegetation to structural change during forest conversion in the southern Black Forest, *European Journal of Forest Research*, Vol: 124, pp. 221-231.
- **Genç, M.** (2004) *Silvikültür Tekniği*, S.D.Ü Orman Fakültesi, Yayın No: 46, Isparta, 357s.
- **Genç, M.** (2006) *Silvikültürel Uygulamalar*, S.D.Ü Orman Fakültesi, Yayın No: 68, Isparta, 357 s.
- **Güner, S.** (2000) Artvin-Genya Dağı'ndaki Orman Toplumları ve Silvikültürel Özellikleri, K.T.Ü Fen Bilimleri Enstitüsü, Orman Mühendisliği Anabilim Dalı, Silvikültür Programı, Doktora Tezi (yayımlanmamış), 126 s.
- **Häusler, A., Scherer, L. and Lorenzen, M.** (2001) Sustainable forest management in Germany: the ecosystem approch of the biodiversity convention reconsidered, Germany, 65 p.
- **Hüttl, R.F. and Schneider, B.U.** (1998) Forest Ecosystem Degradation and Rehabilitation, *Ecological Engineering*, Vol: 10, Germany, pp.19-31.
- **Irmak, A.** (1972) *Toprak İlmi*, İ.Ü. Orman Fakültesi, Üniversite Yayın No: 1268, O.F. Yayın No: 121, İstanbul, 299 s.

- **İlter, E. ve Ok, K.** (2004) *Ormancılık ve Orman Endüstrisinde Pazarlama İlkeleri ve Yönetimi*, Form Ofset Matbaacılık, Ankara, 488 s.
- **Kacar, B.** (1996) *Toprak Analizleri*, A.Ü Ziraat Fakültesi, Araştırma ve Geliştirme Vakfı Yayınları, No: 3, Ankara, 705 s.

- **Kalıpsız, A.** (1976) *Bilimsel Araştırma*, İ.Ü.Orman Fakültesi, İ.Ü. Yayın No: 2076 O.F. Yayın No: 216, İstanbul, 187 s.
- **Kalıpsız, A.** (1988) *Orman Hasılat Bilgisi*, İ.Ü Orman Fakültesi, İ.Ü Yayın No: 3516, O.F. Yayın No: 397, İstanbul, 347 s.
- **Kalıpsız, A.** (1993) *Dendrometri*, İ.Ü. Orman Fakültesi, Üniversite Yayın No: 3793, Fakülte Yayın no: 426, İstanbul, 91 s.
- **Kalıpsız, A.** (1994) *İstatistik Yöntemler*, İ.Ü. Orman Fakültesi, Üniversite Yayın No: 3835, Fakülte Yayın No: 427, İstanbul, 558 s.
- **Kantarcı, M.D.** (2000) *Toprak İlmi*, İ.Ü Orman Fakültesi, Üniversite Yayın No: 4261, O.F. Yayın No: 462, İstanbul, 420 s.
- **Kapucu, F.** (1978) Doğu Karadeniz bölgesindeki Doğu ladini (*Picea orientalis* L. Carr), sarıçam (*Pinus silvestris* L.), Doğu karadeniz göknarı (*Abies nordmanniana* Spach) ve Doğu kayını (*Fagus orientalis* Lipsky) doğal karışık meşcerelerinin kuruluşları-amenajman yönünden değerlendirilmesi üzerine araştırmalar, K:T.Ü. orman Fakültesi, Orman amenajmanı bilim Dalı, Doçentlik Tezi (yayımlanmamış), Trabzon, 170 s.
- **Karadağ, M.** (1999) Batı Karadeniz Bölgesinde Karaçam (*Pinus nigra* Arnold. subsp. *pallasiana* (Lamb.) Holmboe) Doğal Gençleştirme Koşulları Üzerine Araştırmalar, Orman Bakanlığı, Batı Karadeniz Ormancılık Araştırma Enstitüsü Müdürlüğü, Teknik Bülten No: 4, Bolu, 226 s.
- **Kassioumis, K., Chatziphilippidis, G. Trakolis, D. and Vergos, S.** (1999) Research in forest reserves in Greece, In Proceedings Research in Forest Reserves and Natural Forests in European Countries, European Forest Institute, Finland, pp 118-133.
- **Kaymakçı, E., Erkuloğlu Ö.S. ve Eronat, A.F.** (2002) Ege Bölgesinde Çeşitli Nedenlerle Bozulmuş Yüksek Zon Karaçam (*Pinus nigra* Arnold.) Ormanlarının Gençleştirilmesi Üzerine Araştırmalar, Orman Bakanlığı, Ege Ormancılık Araştırma Müdürlüğü, Teknik Bülten No: 18, İzmir, 22 s.
- **Kelty, M.J., Larson, B.C. and Oliver, C.D.** (1992) *The Ecology and Silviculture of Mixed-Species Forests*, Kluwer Academic Publishers, Netherlands, 287 p.
- **Kozlowski, T.T.** (2002) Physiological ecology of natural regeneration of harvested and disturbed forest stands: implications for forest management, *Forest Ecology and Management*, Vol: 158, pp. 195-221.
- **Larsson, T. B., Ranneby, B. and Sjöberg, K.** (1999) Research in forest reserves in Sweden, In Proceedings Research in Forest Reserves and Natural Forests in European Countries, European Forest Institute, Finland, pp 244-253.
- **Linder, P., Elfving, B. and Zackrisson, O.** (1997) Stand structure and successional trends in virgin boreal forest reserves in Sweden, *Forest Ecology and Management*, Vol: 98, pp.17-33.
- **Ling, K.A. and Ashmore, M.R.** (1999) Influence of tree health on ground flora in the Chiltren Beechwoods, *Forest Ecology and Management*, Vol: 119, pp. 77-88.
- **Long, J. N., Dean, T.J. and Roberts, S. D.** (2004) Linkages between silviculture and ecology: examination of several important conceptual models, *Forest Ecology and Management*, Vol: 200, pp. 249-261.
- **Madsen, P. and Larsen, J.B.** (1997) Natural regeneration of beech (*Fagus sylvatica* L.) with respect to canopy density, soil moisture, and soil carbon content, *Forest Ecology and Management*, Vol: 97, pp. 95-105.
- **Mason, W.L., Kerr, G. and Simpson, J.M.S.** (1999) What is CCF?, Forestry Commission Information Note: 29, *Forestry Commission*, Edinburg, 4 p.
- **Mayer, H. ve Aksoy, H.** (1998) *Türkiye Ormanları*, Orman Bakanlığı, Batı Karadeniz Ormancılık araştırma Enstitüsü Müdürlüğü, Muhtelif Yayın no:1, Bolu, 291 s.
- **McEvoy, T.J** (2000) *Introduction to Forest Ecology and Silviculture*, Natural Resource, Agriculture and Engineering Service (NRAES) Cooperative Extension, New York, 88 p.
- **Merev, N.** (2003) *Odun Anatomisi*, K.T.Ü Orman Fakültesi, Genel Yayın No: 209, Fakülte Yayın No: 31, Trabzon, 246 s.
- **Mielikäinen, K. and Hynynen, J.** (2003) Silvicultural management in maintaining biodiversity and resistance of forests in Europe-boreal zone: case Finland, *Journal of Environmental Management* Vol: 67, Germany, pp. 47-54.
- **Mountford, E.P.** (2001) Natural canopy gap characteristics in European beech forests, Nature-Based Management of Beech in Europe Project (NAT-MAN), Working Report 6, France, 29 p.
- **Mountford, E.P. and Groome, G.** (2003) Changes in ground vegetation at Noar Hill Hanger beechwood, Nature-Based Management of Beech in Europe Project (NAT-MAN), Working Report 20, England, 12 p.

- **Mountford, E.P.** (2003) Long-term changes in the vegetation of Denny Wood, an ancient wood pasture in the new forest, Nature-Based Management of Beech in Europe Project (NAT-MAN), Working Report 20, England, 31 p.
- **Mountford, E.P., Savill, P.S. and Bebber, D.P.** (2006) Patterns of regeneration and ground vegetation associated with canopy gaps in a managed beechwood in southern England, *Forestry*, Vol: 79 (4), pp. 389-408.
- **Nyland, R.D.** (2002) *Silviculture (Concepts and Applications)*, The McGraw-Hill Company, New York, 682 p.
- **Odabaşı, T. ve Özalp, G.** (1998) *Doğaya Uygun Ormancılık Anlayışı*, Orman Bakanlığı, Orman Genel Müdürlüğü, Silvikültür Daire Başkanlığı, Ankara, 28 s.
- **Odabaşı, T.** (1976) *Türkiye'de baltalık ve korulu baltalık ormanları ve bunların koruya dönüştürülmesi olanakları üzerine araştırmalar*, İ.Ü. Orman Fakültesi, İ.Ü. Yayın No: 2079, O.F. Yayın no: 218, İstanbul, 192 s.
- **Odabaşı, T. ve Özalp, G.** (1994) Ormanların İşletilmesi Yöntemleri ve Doğaya Uygun Ormancılık Anlayışı, *İ.Ü Orman Fakültesi Dergisi*, Seri: B, Cilt: 44, Sayı: 1-2, İstanbul, pp.35-47.
- **Odabaşı, T., Bozkuş, H.F. ve Çalışkan, A.** (2004) *Silvikültür Tekniği*, İ.Ü Orman Fakültesi, İ.Ü Yayın No: 4459, O.F Yayın No: 475, İstanbul, 314 s.
- **Oliver, C.D. and Larson, B.C.** (1996) *Forest Stand Dynamics*, Update edition, John Wiley & Sons, New York, 520 p.
- **O'Sullivan, A.** (1999) Research in forest reserves in Ireland, In Proceedings Research in Forest Reserves and Natural Forests in European Countries, European Forest Institute, Finland, pp 144-163.
- **Özalp, G.** (1989) Çitdere (Yenice-Zonguldak) Bölgesindeki Orman Toplumları ve Silvikültürel Değerlendirilmesi, İ.Ü Fen Bilimleri Enstitüsü, Orman Mühendisliği Anabilim Dalı, Doktora Tezi (yayımlanmamış), İstanbul.
- **Özdamar, K.** (2004) *Paket Programlar İle İstatistiksel Veri Analizi*, Genişletilmiş 5. Baskı, Kaan Kitabevi, Eskişehir, s.517-520.

- **Özel H.B** (2007) Bartın ve Devrek Yöreleri Doğu Kayını (*Fagus orientalis* Lipsky.) Ormanlarında Meşcere Kuruluşları ve Gençleştirme Başarısını Etkileyen Faktörler, ZKÜ Fen Bilimleri Enstitüsü, Doktora (yayımlanmamış) Tezi, Bartın, 272 s.
- **Özdemir, T.** (1993). Kızılçamın Doğal Gençleştirilmesi, Uluslararası Kızılçam Sempozyumu Bildirisi, Orman Bakanlığı Yayını, Ankara, s. 159-166.
- **Özer, N.** (1989) Türk-Alman Ormancılık Projesinin Hedefleri, *Yapraklı Ormanlarda Modern Silvikültür Tekniklerinin Uygulanması Semineri*, Orman Genel Müdürlüğü ve Türk-Alman Ormancılık Projesi, Zonguldak, s. 1-4.
- **Özyuvacı, N.** (1999) *Meteoroloji ve Klimatoloji*, İ.Ü Orman Fakültesi, Rektörlük Yayın No: 4196, Fakülte Yayın No: 460, İstanbul, 369 s.
- **Pamay, B.** (1962) *Türkiye'de Sarıçam (Pinus silvestris L.) Tabii Gençleşmesi İmkanları Üzerine Araştırmalar*, Tarım Bakanlığı, Orman Genel Müdürlüğü, Sıra No: 337, Seri No: 31, İstanbul, 196 s.
- **Pamay, B.** (1967) Demirköy-İğneada Longos Ormanlarının Silvikültürel Analizi ve Verimli Hale Getirilmesi İçin Alınması Gereken Silvikültürel Tedbirler Üzerine Araştırmalar, Orman Genel Müdürlüğü Yayınları, Sıra No: 451, Seri No: 43, 82 s.
- **Pariona, W., Fredericksen, T.S. and Licona, J.C.** (2003) Natural regeneration and liberation of timber species in logging gaps in two Bolivian tropical forests, *Forest Ecology and Management*, Vol: 181, pp. 313-322.
- **Parviainen, J.** (1999) European close to nature silviculture – efforst to enhance biodiversity, The finnish Forest Research Institute, Finland, 17 p.
- **Parviainen, J., Päivinen, R., Uutera, J. And Varmola, M.** (1999) Research in forest reserves in Finland, In Proceedings Research in Forest Reserves and Natural Forests in European Countries, European Forest Institute, Finland, pp 83-99.
- **Piussi, P. and Farrell, E.P.** (2000) Interactions between society and forest ecosystems: challenges for the near future, *Forest Ecology and Management*, Vol: 132, pp. 21-28.
- **Piussi, P.** (2001) Nature Oriented Silviculture in the South-Eastern Alps, Selvinat Socrates Schema Nuovo 28.7-01. Dipartimento di Scienze e Tecniche Ambientali Forestali, Universita degli Studi Firenze., Italy 2 p.
- **Podlaski, R.** (2002) Relationship between crown characteristics and the radial increment of beech (*Fagus sylvatica* L.) the Swietokrzyski National Park (Poland), *Journal of Forest Science* (48), pp. 93-99.

- **Pommerening, A. and Murphy, S.T.** (2004) A review of the history, definitions and methods of continuous cover forestry with special attention to afforestation and restocking, *Forestry*, Vol: 77, No: 1, pp. 27-44.
- **Rojo, J.M.T and Orois, S.S.** (2005) A decision support system for optimizing the conversion of rotation forest stands to continuous cover forest stands, *Forest Ecology and Management*, Vol: 207, pp. 109-120.
- **Rosset, C. and Schütz, J. P.** (2003) A DSS as a tool for implementation and monitoring of multiple purpose, near the nature silviculture, Decision Support for Multiple Purpose Forestry, Austria, pp. 2-11.
- **Saatçioğlu, F.** (1954) *Bahçeköy ve Ayancık Ormanlarında Yapılan Silvikültür Tatbikatları, Ekskürsiyon Mevzuları*, Ziraat Vekaleti, Orman Umum Müdürlüğü, Yayın No: 140, Seri No: 23, İstanbul, 118 s.
- **Saatçioğlu, F.** (1969) *Silvikültürün Biyolojik Esasları ve Prensipleri*, İ.Ü Orman Fakültesi, İ.Ü Yayın No: 1429, O.F Yayın No: 138, İstanbul, 323 s.
- **Saatçioğlu, F.** (1971a) *Orman Ağacı Tohumları*, İ.Ü Orman Fakültesi, İ.Ü Yayın No: 1649, O.F Yayın No: 173, 3. Baskı, İstanbul, 226 s.

- **Saatçioğlu, F.** (1971b) *Orman Bakımı*, İ.Ü Orman Fakültesi, İ.Ü Yayın No: 1636, O.F Yayın No: 160, İstanbul, 118 s.
- **Saatçioğlu, F.** (1979) *Silvikültür II (Silvikültürün Tekniği)*, İ.Ü Orman Fakültesi, İ.Ü Yayın No: 1648, O.F Yayın No: 172, İstanbul, 562 s.
- **Saraçoğlu, Ö.** (1988) *Karadeniz Yöresi Göknar Meşcerelerinde Artım ve Büyüme*, İ.Ü. Orman Fakültesi, Orman Hasılatı ve biyometri bilim dalı, İstanbul, 312 s.
- **Saraçoğlu, N.** (1999) *Orman Hasılat Bilgisi (Ders Notu)*, Z.K.Ü Bartın Orman Fakültesi, Üniversite Yayın No: 5, Fakülte Yayın No: 4, Bartın, 152 s.
- **Sarıyıldız, T.** (2002) Ölü örtünün ayrışmasının önemi ve ölü örtü ayrışmasında ölü örtü bileşenlerinin etkisi konusunda yapılan çalışmalara genel bir bakış, *II. Ulusal Karadeniz Ormancılık Kongresi Bildiriler Kitabı*, Artvin, s. 807-819.
- **Sarıyıldız, T. ve Küçük, M.** (2005) Kayın (*Fagus orientalis* Lipsky.) Yapraklarının ve Ladin (*Picea orientalis* L.) İbrelerinin Ayrışma Oranları Üzerinde Orman Gülünün (*Rhododendron ponticum* L.) Etkisi, Gazi Üniversitesi, *Orman Fakültesi Dergisi*, Cilt: 5, No: 1, Kastamonu, s.55-70.
- **Scheffer, F. and Schachtschabel, P.** (2001) *Toprak Bilimi* (Çevirenler: H. Özbek, Z. Kaya, M. Gök, H. Kaptan), Ç.Ü Ziraat Fakültesi, Genel Yayın No: 73, Ders Kitapları Yayın No: A-16, Adana, 816 s.
- **Schnitzler, A. and Borlea, F.** (1998) Lessons from natural forest as keys for sustainable management and improvement of naturalness in managed broadleaved forests, *Forest Ecology and Management*, Vol: 109, pp. 293-303.
- **Schütz, J.P** (1999**)** Close-to Nature Silviculture: Is This Concept Compatible with Species Diversity, *Forestry* Vol: 72, No: 4, pp.359-366.
- **Schütz, J. P.** (2002**)** Silvicultural Tools to Develop Irregular and Diverse Forest Structure, *Forestry* Vol: 75, No: 4, pp.329-337.
- **Sezgin, M. ve Avcı, H.B.** (1990) Batı Karadeniz Bölgesindeki Yapraklı Ormanlarda Uygulanan Aralama Çalışmalarının Sorunları İle Öngörülecek Tedbirler, Bakım ve Aralama Çalışmalarında Silvikültürel ve Ekonomik Görüşler, *Yapraklı Ormanlarda Modern Bakım ve Aralama Teknikleri Semineri*, Orman Genel Müdürlüğü ve Türk-Alman Ormancılık Projesi, Kdz. Ereğli, s. 14-53.
- **Sevimsoy, M.** (1984) Göle-Sarıkamış yöresinde saf sarıçam (*Pinus silvestris* L.) ormanlarında doğal gençleştirme yöntemlerinin saptanması, Ormancılık araştırma enstitüsü, Teknik bülten serisi No: 121, Ankara, 48 s.
- **Sıvacıoğlu, A.** (1996) Sarıçam (*Pinus silvestris* L.), Karaçam (*Pinus nigra* Arnold. subsp. *pallasiana* (Lamb.) Holmboe), Uludağ Göknarı (*Abies bornmülleriana* Mattf.), Doğu Kayını (*Fagus orientalis* Lipsky.) ve Meşe (*Quercus sp*.) Türlerinin Işık İhtiyacı, Z.K.Ü Fen Bilimleri Enstitüsü, Orman Mühendisliği Anabilim Dalı, Silvikültür Programı, Yüksek Lisans Tezi (yayımlanmamış), Bartın, 60 s.
- **Sıvacıoğlu, A.** (2002) Sarıçam (*Pinus sylvestris* L.)-göknar (*Abies bornmülleriana* Mattf.) karışık meşcerelerinde gençleştirme sorunları, *II. Ulusal Karadeniz Ormancılık Kongresi Bildiriler Kitabı*, Artvin, s. 446-455.
- **Smith, D. M., Larson, B. C., Kelty, M. J. and Ashton, P. M. S.** (1997) *The practice of silviculture: Applied Forest Ecology*, 9th edition John Wiley & Sons, New York, 537p.
- **Tegelmark, D.O.** (1998) Site factors as multivariate predictors of the success of natural regeneration in Scots pine forests, *Forest Ecology and Management*, Vol: 109, pp. 231-239.
- **Tosun, S., Özpay, Z., Serin, M. ve Karatepe, H.** (2002) Doğu Kayını (*Fagus orientalis* Lipsky.) ve Meşe (*Quercus petrea* (Matt.) Lieb., *Quercus hartwissiana* Stev.) Türlerinde Boylu Fidan Üretimi ve Plantasyon Tekniğinin Araştırılması, Orman Bakanlığı, Batı Karadeniz Ormancılık Araştırma Enstitüsü Müdürlüğü, Teknik Bülten No: 6, Bolu, 53 s.

- **Tulukçu, M., Tunçtaner, K., Toplu, F. ve Akçidem, E.** (1992) Geniş Yapraklı Orman Ağacı Türlerinin Marmara Bölgesine Uyumları Üzerine Araştırmalar, Orman Bakanlığı, Kavak ve Hızlı Gelişen Yabancı Tür Orman Ağaçları Araştırma Enstitüsü, Teknik Bülten No: 157, İzmit, 34 s.
- **Tunçtaner, K.** (2007) *Orman Genetiği ve Ağaç Islahı*, Zonguldak Karaelmas Üniversitesi, Bartın Orman Fakültesi (yayımlanmamış ders kitabı), Bartın, 364 s.
- **Tunçtaner, K. and Özel, H.B.** (2007) Oriental beech (*Fagus orientalis* Lipsky.) natural regeneration practices in Turkey (Case study at Bartın-Yenihan forest district) (unpublished), University of ZKÜ, Faculty of Forestry, Bartın.
- **Turkheim, B.** (1993) The Techniques and Economic Basis of Close-to Nature Silviculture, European Union of Foresters Advocating Close-to Nature Management (PRO SILVA), *First European Congress Proceedings*, France, pp. 63-82.
- **Tüfekçioğlu, A., Gürer, S., Altun, L. ve Kalay, Z.** (2002) Kayın ve ladin meşcerelerinde ince ve kılcal kök biyokütlelerinin karşılaştırılması, *II. Ulusal Karadeniz Ormancılık Kongresi Bildiriler Kitabı*, Artvin, s. 712-717.
- **Türüdü, Ö.A.** (1997) *Bitki Beslenmesi ve Gübreleme Tekniği*, K.T.Ü Meslek Yüksek Okulları, Genel Yayın No: 171, M.Y.O Yayın No: 13, Trabzon, 257 s.
- **Uğurlu, S. ve Çevik, İ.** (1990) Bingöl Yöresi Bozuk Meşe Baltalıklarının Verimlileştirilmesi Çalışmalarında Başarıyı Etkileyen Yetişme Yeri Faktörleri, Ormancılık Araştırma Enstitüsü, Teknik Bülten No: 211, Ankara, 76 s.
- **Umut, B., Dündar, M., Çelik, O. ve Yılmaz, A.** (1996) Bursa-Orhaneli işletmesi kızılçam (*Pinus brutia* Ten.) doğal gençleştirme alanlarındaki başarısızlık nedenlerinin tespiti, Ormancılık araştırma Enstitüsü Müdürlüğü, Teknik Bülten No: 253, Ankara, 32 s.
- **Umut, B., Dündar, M. ve Çelik, O.** (2000) Sıklık Çağındaki Kayın (Fagus orientalis Lipsky.) Meşcerelerinin Bakımı Üzerine Araştırmalar, İç Anadolu Ormancılık Araştırma Enstitüsü, Teknik Bülten No: 274, Ankara, 23 s.
- **Üçler, A.Ö., Demirci, A., Ölmez, Z. ve Güner, S.** (2001) Artvin-Kafkasör Yöresindeki Bir Doğu Ladini (*Picea orientalis* L. Mirt.)-Doğu Karadeniz Göknarı (*Abies nordmanniana* Spach.) Karışık Meşceresinde Doğal Gençleştirmenin İncelenmesi, Kafkas Üniversitesi, *Artvin Orman Fakültesi Dergisi*, Sayı: 1, Artvin, s. 2-14.
- **Ürgenç, S.** (1998) *Ağaçlandırma Tekniği*, İ.Ü Orman Fakültesi, İ.Ü Rektörlük Yayın No: 3994, Orman Fakültesi Yayın No: 441, Emek Matbaacılık, İstanbul, 600 s.
- **Yaltırık, F.** (1993) *Dendroloji II (Angiospermae)*, İ.Ü Orman Fakültesi, İ.Ü Yayın No: 3767, O.F. Yayın No: 420, İstanbul, s.109-113.