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Analysis of release cutting effects on increment and growth in Oriental beech (*Fagus orientalis* Lipsky) stand

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Abstract

In the present study, the effects of release cuttings on stand structures and increment and growth relations were investigated in afforested oriental beech (*Fagus orientalis* Lipsky) stands. To maximize spatial variation in dataset, stratified random sampling was used to layout transects. 24 sampling plots were determined which reflects average characteristics of actual stand structure. 8 sampling plots were selected from unthinned stands, 8 sampling plots were selected from lightly thinned (19% of the total basal area removed) stand and 8 sampling plots were selected from heavily thinned (40% of the total basal area removed) stand. Light thinning was done in the year 2008 and heavy thinning in 2009. Stem analyses were carried out and pre- and post-treatment height, diameter, basal area and volume increments were examined according to thinning intensities. Obtained results showed that removal of 40% of the basal area does not contribute to stand increment and growth more positively than those in stands treated by removal of 19% of the basal area. Expected increase in height and diameter increment did not occurr post-treatment in 2008 and 2009. However, in only lightly thinned stands mean basal area increment increased after treatment. Release cuttings in beech stand needs to be practiced at least twice every 5 to 6 years, provided that peculiar characteristics of every habitat are considered.

Key words

Increment and growth, Oriental beech, Release cutting

Introduction

Turkey has 21.7 million ha state forest area and 50% of the forests in Turkey consist of unproductive forest areas.The annual average wood production amount from state forests, and private plantations are roughly 20 million m³ of which 14 million m³ is industrial wood (Kök, 2009; Kurt *et al.,* 2011). Annual capacity of the forest products industry has reached 25 million m³ (Kök, 2009), but only 55 % of this capacity can be used.

Sustainability in forestry is defined as transferring to the next generation by ideally protecting the recovery of unproductive forests and vitality of the productive ones. Supply-demand relations should be easily regulated with the help of sustainable forestry and silvi culture is important for improving the supply amount of wood products in sustainable forestry. At this point, release cutting is one of the most important start-up phase to the productive forestry. Different thinning regimes and degrees have different impact on stand structure and growth (Rytter and Stener, 2005; Mäkinen *et al.,* 2006). Release cutting is implemented at time after canopy is realized in thickets and should be repeated several times until it reaches the pole stage. Technically applicable release cutting contributes to stable, more qualified stands and increases productivity (Demirci, 2005; Odabaşı *et al.,* 2004; Genç, 2007). In this regard on the basis of tree species; scientifically involving endemically silvicultural practices in hypothesis, testing and verifying and thus introducing optimal approach will simplify operators' work.

Because of economic value of the obtained product and insufficient number of qualified staff many places, tending operations in thickets have not been practiced adequately in Turkey (Tüfekçioğlu, 2006). Young forests mostly reach pole and pole size timber stage without any dilution and improvement cutting (Genç, 2007). As a result of this, there are a broad range of plots delayed in release cutting treatment in Turkey. In thicket stage stands, there can be a multitude of individuals which have pole stage norms as a result of delaying. In the wide areas where the number of individuals per hectare is quite high, it can be seen in the stands in thicket stage that foresters are mostly undecided about the individuals to be removed from the area and stands are left to their fate with a treatment density out of the required intensity. In this respect depending upon the habitat property of every species of a tree, it should be suggested at what intensity and structure release cutting treatments need to be fulfilled by surveys and operators should be given help for the working of decision-making mechanism.

Temporal arrangement is pretty important to the preparation of tending plans. For temporal arrangement, knowing about the temporal span of growth stages of tree species provides convenience in practice (Çolak and Odabaşı, 2004). Genç (2007) has predicted that stands, depending on habitat yield potential, will be able to gain a stand structure included in thicket stage between 20-25 and 40 years. According to what Çolak and Odabaşı (2004), how long the species remain in growth stage is changeable; beech is in its infancy for 5-15 years and in thicket stage for 10-15 years. In the year when release cutting has been applied, tree wealth per unit area decreases; however, as individuals have got more independent growth conditions in coming years, a noticeable increment in size and height of these individuals have been observed. As a result of decreasing the number of trees, tree wealth per unit area becomes less, but the size and volume increments of the tended stands are high (Tolunay, 2003) on ground that the rest of the trees are looser and thinner when compared to thick stands and that nutrition-growth relationships are high.

Tending operations, especially release cuttings are significant parts of silvicultural treatments. Consciously and systematically applied release cutting has a positive effect on the future of stand (Nyland, 1996; West, 2006). Studies on release cutting are generally carried out based on observations by forest administration rather than scientifically in Turkish forestry. It is difficult to make suggestions about cleaning according to regions and conditions (Boydak, 1996). For this reason, scientific research on tending operations should be done both endemically and based on tree species, and thus, operators should be enlightened.

The aim of the study was to link release cutting treatment intensity and increased-growth together and to present the points to take into account endemically in release cutting operations in beech thickets, especially for the afforested stands.

Materials and Methods

The study area is located in Trabzon City, Düzköy County, Söğütlü Basin in North East of Turkey (Fig. 1). Study area is an afforestation area which was constructed in 1991 by 1+0 years old oriental beech saplings. Study area was approximately 3 hectares in size and between 1320-1430 meters from the sea level. The main aspect was west and according to the management plans, site productivity was high in the study area. Most of the individuals in the sampled stands were in thicket stage and the silvicultural objective was release cutting in update management plans. According to the data obtained from the nearest meteorology station in Düzköy (850m), average annual temperature was 8.6 °C, average annual precipitation was 853.7 mm. However, average altitude of the research area was 1350 meters.

To maximize spatial variation in the dataset, stratified random sampling was used to layout transects. 24 sampling plots were determined which reflects average characteristics of the actual stand structures. 8 sampling plots were selected from unthinned stand, 8 sampling plots were selected from lightly thinned stand and 8 sampling plots were selected from heavily thinned stand. Light thinning was done in 2008 and heavy thinning was done in 2009 by the local directorate of forest enterprise. 19% of the total basal area was removed in lightly thinned stand and 40% was removed in highly thinned stand on the average during release cutting operations.

Each sampling plots were sampled in 10 m wide and 20 m long, at intervals of at least 50 m. Slope gradient, aspect, tree coordinates, stump diameter, breast height diameter (DBH), tree height, and crown height were measured in the sampling plots. Harvested basal area values were determined per sampling plot by using stump diameter/breast height diameter relationship. To calculate breast height diameter of the harvested individuals, stump diameter/breast height diameter relationship was used in the sampling plots and DBH values were estimated with the help of regression model. Basal area per harvested individual was calculated with estimated breast height diameter and the total harvested basal areas in 2008 and 2009 were obtained. Treatment intensity was determined in accordance with harvested basal area and total basal area before treatment in thinned stands. Volume and volume components were calculated by stem analysis. In 2012, "a mean tree" was selected in each sampling plot. Stem analysis transects of mean basal area tree were obtained from the height of 0.30, 1.30, 2.30, 3.30, 4.30… meters by accepting the fact that a tree mean in basal area is also mean in volume (Fırat, 1973; Kalıpsız, 1993). Increments in transects were annually measured.

In order to assess the effects of thinning intensity on the individual's further growth in more detail; pre- and post-treatment diameter, height, basal area and volume increment in each sampling plot were calculated. In lightly thinned samples, post-treatment increments between 2008 and 2012 were averagely calculated, based on those of 2008. In order to reveal the effect of the treatment, post-treatment increments were compared with

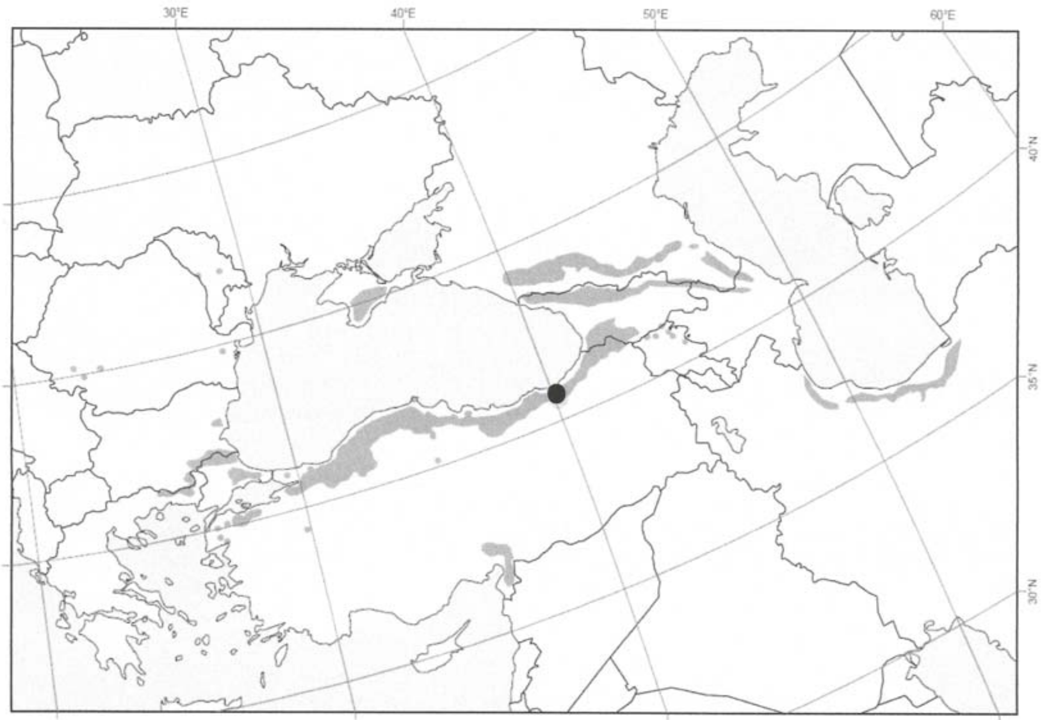

Fig. 1 : Location/afforestation area in Trabzon City, Turkey (map obtained from the website http://www.euforgen.org/distribution_maps.html)

the pre-treatment increments between 2004-2008 years. As for heavy thinning in 2009, average increments pre-treatment (2006-2009) and post 3 years (2009-2012) were compared. Also, average pre- (2004-2008) and post-increments (2008-2012) were compared for unthinned control sample plots, in order make assessment about thinning effect.

Results and Discussion

Om comparing the area treated in 2008, meanly twice more basal area was removed from the area treated in 2009 during release cutting and before thinning both sampled stands had similar basal area in total (Table 1). On the other hand average available tree number per hectare in the sample plots thinned in 2008 was one and a half times higher than the plots thinned in 2009. Average diameter at breast height was also similar in both thinned sample plots (Table 1).

Table 2 and Fig. 2 shows the increments before and after 4 years for sampling plots thinned in 2008 and the increments before and after 3 years for sampling plots thinned in 2009 were compared. However, increments before and after 4 years were compared, based on the year 2008, in control sample plots. As seen in Table 2 and Fig. 2, diameter increment decreased considerably since any release cutting was not performed in control areas after 2008.

Even though there was no noticeable change in diameter in stands thinned in 2008, it was observed that diameter increment performance was getting low after 2009. This shows that treatment intensity in 2008 was insufficient or the reaction to thinning was not performed yet. When it comes to the stands thinned in 2009, it was determined that decline occurred in diameter increments as well. However, average diameter increment value was higher in heavily thinned stands when compared with lightly thinned and control sampled plots.

On the other hand, when height increments were considered, it was determined that most height increment existed in control sample plots (Table 2). As for height increment in thinned plots, it was discovered that there occurred an apparent decline in post-treatment height increment of sampling plots heavily thinned (Table 2). Despite decrease in height increment, it becomes evident that increment was relatively greater in heavily thinned plots than control and lightly thinned plots.

It is seen that control sample plots did not experience any increment in basal area. There happened a post-treatment basal area increment in lightly thinned stands; on the other side, less increment than in lightly thinned was observed in heavily thinned sampling plots. It is possible to assume this is due to the fact that treatment intensity in 2009 (40%) was twice more than that in 2008 (19%). Therefore, an expected increment in total basal area

Table 1 : Observations on diameter at breast height, basal area, tree numbers and harvested parameters of sample areas in 2008 and 2009

Silviculture treatment	Number of sampling plots	Average diameter at breast height (cm)	Average basal area (m^2 ha^{-1})	Available tree numbers (n ha^{-1})	Available total basal area (m^2 ha^{-1})	Harvested number of trees (n ha^{-1})	Total basal area of harvested trees (m^2 ha^{-1})	Total basal area before treatment (m^2 ha^{-1})	Harvested volume (%)
Release	1	7.25	0.240	4400	21.073	1750	6.161	27.235	23
cutting	2	8.29	0.319	2700	17.215	1400	4.604	21.820	21
in 2008	3	7.26	0.254	3950	20.032	1750	3.662	23.694	16
(Light	4	7.62	0.2649	3100	16.420	1500	4.687	21.107	22
thinning)	5	7.74	0.277	3100	17.179	800	3.098	20.277	15
	6	5.76	0.164	3800	12.461	1400	5.376	17.836	30
	7	8.26	0.315	2350	14.821	2150	3.718	18.539	20
	8	7.46	0.257	3150	16.218	650	1.199	17.417	7
	Average	***7.46***	***0.261***	***3319***	***16.927***	***1425***	***4.063***	***20.991***	***19***
Release	1	8.45	0.305	1850	11.271	2850	10.645	21.917	49
cutting	2	8.37	0.293	1850	10.854	2150	6.451	17.305	37
in 2009	3	8.99	0.345	2050	14.139	3100	10.462	24.601	43
(Heavy	4	7.22	0.253	2250	11.400	1400	5.962	17.362	34
thinning)	5	7.50	0.255	2150	10.983	2000	5.481	16.463	33
	6	8.09	0.309	2000	12.358	2850	7.222	19.580	37
	7	7.65	0.286	1900	10.859	2650	7.196	18.055	40
	8	8.51	0.310	2400	14.851	3750	11.210	26.061	43
	Average	***8.098***	***0.295***	***2056***	***12.089***	***2594***	***8.0786***	***20.168***	***40***

Table 2 : Observation on basal area, height, volume and diameter increment values of sample areas in 2008 and 2009

Sample Area	Diameter increment (cm)		Height increment (cm)		Basal area increment (cm^2 ha^{-1})		Volume increment (m^3 ha^{-1})	
Control	2004-2008	2008-2012	2004-2008	2008-2012	2004-2008	2008-2012	2004-2008	2008-2012
1	0.4625	0.4625	55.6428	46.3196	0.0275	0.0342	0.2062	0.2900
2	0.5750	0.3500	53.1661	55.6197	0.0264	0.0211	0.1572	0.1918
3	0.5375	0.3500	51.1545	53.1429	0.0281	0.0232	0.1465	0.1707
4	0.4875	0.3875	55.5729	58.0829	0.0223	0.0230	0.1391	0.1835
5	0.5375	0.4000	37.7100	37.4700	0.0210	0.0215	0.0889	0.0977
6	0.7125	0.4750	46.0300	42.9900	0.0337	0.0313	0.1764	0.2046
7	0.6000	0.4125	49.2400	22.6000	0.0245	0.0234	0.1381	0.1379
8	0.5000	0.5000	63.0900	43.8900	0.0238	0.0316	0.1750	0.2209
Average	0.5516	0.4171	51.4508	45.0144	0.0259	0.0262	0.1534	0.1871
Treatment in 2008	2004- 2008	2008-2012	2004-2008	2008-2012	2004-2008	2008-2012	2004-2008	2008-2012
1	0.3833	0.3500	25.5100	11.7500	0.0193	0.0220	0.1593	0.1593
2	0.5250	0.3875	42.8700	39.5100	0.0251	0.0241	0.1413	0.1898
3	0.6250	0.4500	38.3800	32.7800	0.0297	0.0290	0.1445	0.1945
4	0.5625	0.5875	45.1300	47.7700	0.0246	0.0363	0.1212	0.2096
5	0.4000	0.4875	49.1200	19.9200	0.0204	0.0317	0.1449	0.2167
6	0.4750	0.6375	49.2100	54.6500	0.0129	0.0284	0.0542	0.1483
7	0.3750	0.4750	37.8500	36.5700	0.0156	0.0261	0.1039	0.1625
8	0.4876	0.3750	38.7000	12.0700	0.0220	0.0221	0.1009	0.1305
Average	0.4791	0.4688	40.8462	31.8780	0.0212	0.0275	0.1213	0.1764
Treatment in 2009	2006- 2009	2009-2012	2006-2009	2009-2012	2006-2009	2009-2012	2006-2009	2009-2012
1	0.7500	0.5667	54.3500	26.6700	0.0361	0.0360	0.1787	0.2093
2	0.5833	0.6000	43.2500	11.4370	0.0303	0.0396	0.1946	0.2274
3	0.5667	0.4333	56.5000	36.5000	0.0309	0.0287	0.1992	0.2009
4	0.6333	0.6167	54.3200	52.6400	0.0336	0.0418	0.1862	0.1958
5	0.2833	0.4000	41.0700	40.2700	0.0131	0.0217	0.0739	0.1295
6	0.5667	0.4333	42.8600	16.9100	0.0305	0.0284	0.1812	0.2087
7	0.6500	0.5333	60.8300	37.2300	0.0300	0.0320	0.1795	0.2161
8	0.7000	0.5500	51.0070	52.9160	0.0401	0.0396	0.1889	0.2537
Average	0.5917	0.5166	50.5233	34.3216	0.0306	0.0335	0.17276	0.2052

Table 3 : Observations on basal area, volume and diameter increment of sample areas in 2012

	Sampling number	Sample tree				Sample area					Total volume per hectare (m^3)
		Age (Year)	Height (m)	Diameter at breast height (cm)	Volume (m^3)	Tree number (N)	Average diameter at breast height (cm)	Average basal area (m^2)	Total basal area (m^2)	Total volume (m^3)	
Control	1	22	11.3	10.35	0.053	85	8.13	0.0097	0.0744	4.505	225.25
	2	22	10.4	8.40	0.035	110	6.85	0.0045	0.1091	3.85	192.5
	3	22	10.2	9.15	0.034	72	7.35	0.0053	0.0593	2.448	122.4
	4	22	10.9	8.35	0.034	96	7.25	0.0050	0.0768	3.264	163.2
	5	20	7.6	7.65	0.019	70	5.92	0.0034	0.0458	1.33	66.5
	6	20	9.4	9.35	0.037	93	6.21	0.0039	0.0652	3.441	172.05
	7	21	9.3	8.05	0.028	68	6.28	0.0038	0.0470	1.904	95.2
	8	21	10.3	9.05	0.040	98	6.17	0.0038	0.0677	3.92	196
Average	21	9.9	8.79	0.035	87	6.77	0.0049	0.0682	3.045	152.25	
Release Cutting in 2008	1	21	8.1	8.70	0.033	88	7.26	0.0049	0.0687	2.904	145.2
	2	22	9.7	8.70	0.035	54	8.29	0.0064	0.0487	1.89	94.5
	3	21	8.9	9.10	0.034	79	7.26	0.0051	0.0635	2.686	134.3
	4	21	8.5	9.05	0.031	62	7.62	0.0053	0.0509	1.922	96.1
	5	22	10.2	9.25	0.038	62	7.74	0.0054	0.0521	2.356	117.8
	6	19	8.2	6.95	0.018	76	5.76	0.0033	0.0491	1.368	68.4
	7	22	8.4	7.95	0.028	47	8.26	0.0063	0.0421	1.316	65.8
	8	21	7.6	8.25	0.024	63	7.46	0.0052	0.0510	1.512	75.6
Average	21	8.7	8.49	0.030	66	7.46	0.0052	0.0533	1.980	99	
Release Cutting in 2009	1	21	8.8	8.95	0.031	37	8.45	0.0061	0.0326	1.147	57.35
	2	22	8.7	9.30	0.038	37	8.37	0.0059	0.0320	1.406	70.3
	3	22	9.6	9.10	0.037	41	9.99	0.0069	0.0384	1.517	75.85
	4	21	9.9	9.55	0.035	45	7.22	0.0051	0.0362	1.575	78.75
	5	22	8.9	7.50	0.022	43	7.50	0.0051	0.0347	0.946	47.3
	6	21	8.8	9.00	0.036	40	8.09	0.0062	0.0355	1.44	72
	7	21	9.9	8.45	0.032	38	7.65	0.0057	0.0324	1.216	60.8
	8	22	10.2	10.00	0.039	48	8.53	0.0062	0.0426	1.872	93.6
Average	22	9.35	8.98	0.034	41	8.23	0.0059	0.0356	1.394	69.7	

could not be obtained because the number of individuals remaining in the area was less in 2009 (Table 2).

When it comes to volume increments, it is obvious that sampling plots, to which release cutting was applied in 2009, was increasing in volume after treatment. This case releases in post-treatment area that an environment was arising for individuals to grow in diameter and in height. Though volume increment was present in control sample plots and in areas where release cutting was applied in 2008, it was less in increment amount than in 2009.

When height values were compared with each other (Table 3), it was observed that the average height was higher in control sample plots than in lightly and heavily thinned sample plots. This can be thought to result from the individuals' heading toward light as a consequence of dense structure in stand and the increment in height. In comparison to breast height diameter values, no significant distinction between sampling plots was noted on comparising volume values; it becomes apparent that total volume amount was high, depending upon too much number of individuals in unthinned stands. The treatments in 2008 and 2009 proved that the number of individuals and accordingly the amount of total volume per hectare decreased as a consequence of thinning (Kaymakçı *et al.,* 2000; Yılmaz *et al.,* 2010). Specific numbers of trees are cut from stands during thinning operations; thus stand wealth is decreased and it is aimed to provide larger habitats (thus water and food) to remaining trees in the stand and by the way to increase their volume (Genç, 2007). This situation reveals that anticipated volume increment has not occurred in stand yet.

According to the results obtained (Fig. 2); diameter and height increments lowered considerably since thinning was not performed in control sample plots. Although maximal decrease in diameter increment was shown in control sample plots, but maximal decrease in height increment was shown in heavily thinned sample plots as well. With removal of nearly 19% of the basal area by light thinning, it is understood that static development occurred in diameter increment and it created dynamism similar to pre-treatment. On the other hand with removal of nearly 40% of the basal area by heavy thinning, decline occurred in diameter increment and thus an unexpected

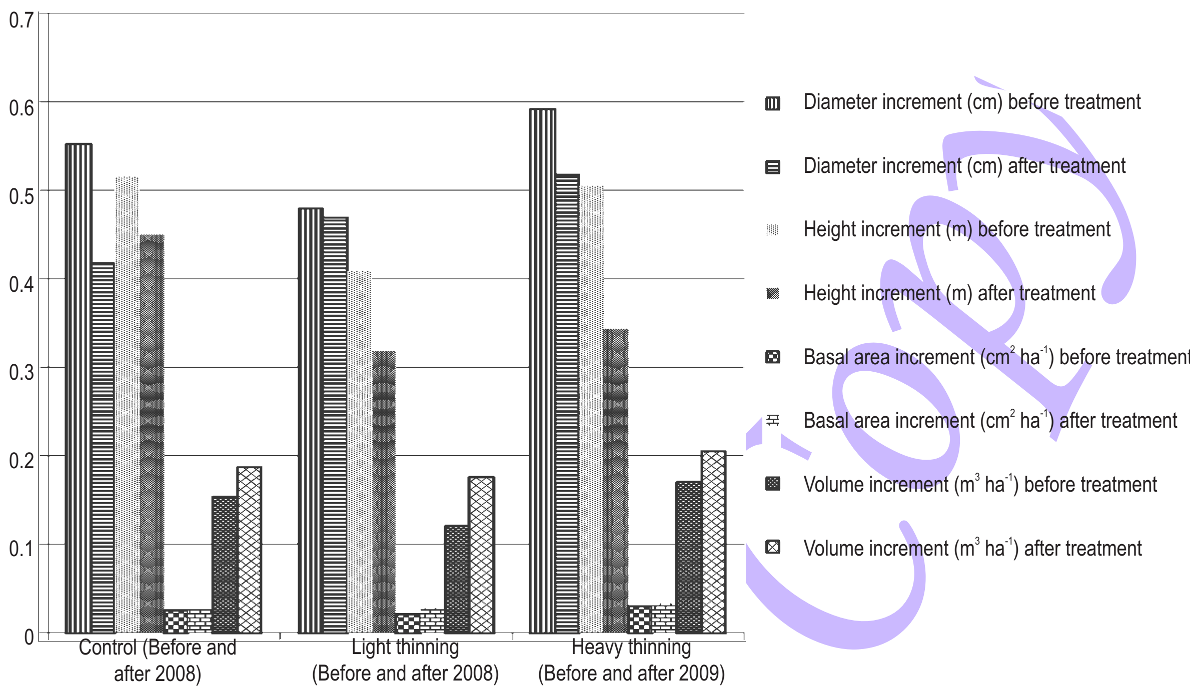

Fig. 2 : Observation on diameter, height, basal area and volume increment values

dynamism arose after thinning. Average basal area increment value increased in only lightly thinned stands after treatment. In the present study, it becomes clear that 19% treatment intensity was not enough in stand and did not create a positive impact; on the other hand, 40% treatment intensity was extreme, gaps were larger, individuals in over storey were extremely thinned in 2009, canopy was damaged, storied structure was destroyed and there were not many individuals in over storey and caused unexpected negative growth dynamism similar to that of control sample plots. Thinning, heavy enough to cause major changes in the form and taper of boles may be detrimental trees may no longer meet the specifications for poles and piling if they taper too much or have excessively large branches high on stems (Smith *et al.,* 1997). In control sampling plots and sampling plots treated in 2009, height increment increased more than diameter increment and this caused negative impact in tree individual stability (Wilson and Olivier, 2000; Hinze and Wessels, 2002). It is obvious that big decrease occurred among the rest of the individuals in height increment after tending (Göktürk *et al.,* 2010). We can see a big decrease in height increment after heavy thinning in 2009 but the most important idea for suitable tree stability should be increase in the amount of diameter but declining with height growth.

With removal of 40% of the basal area in 2009 when increments pre- and post-treatment were compared in basal area, basal area increment change happened to be the same in 2009 as in control sample plots. On comparing pre- and post-treatment in 2008 and 2009, sample plots thinned by 19% intensity in 2008 occurred to increase more in basal area than those thinned by 40% rate in 2009 (Fig. 2). When sampling plots are like each other in volume increment, it becomes apparent that the highest post-treatment increment occurred by light thinning. In the wake of heavy thinning, attraction there existed an increment in volume in sampling plots, but this increment was less than the plots thinned in 2008. In relation to that, Göktürk *et al.* (2010) proved that the amount of basal area developed in parallel with increase in thinning intensity. Umut *et al.* (2000) proposed that strong tending treatments applied in stand similar to beech stands of East Mediterranean Region caused diameter and basal area to increase dramatically. However, it is clear that the increment of basal area was less in the wake of treatment in sampling plots thinned by 40% intensity. Therefore, the expected result could not come true. Erikson and Karlsson (1997) expressed that some declines took place in volume increment based on the intensity of thinning. Makinen and Isokami (2004a) similarly state that volume increment decreased by 25% in intense release cuttings, and the decline in volume increment was less in moderate cuttings. Makinen et al. (2006) also explained that intense tending reduced volume increment by 34%. According to Makinen and Isokomi (2004b); high volume-trees in number are obtained in intense tending despite volume decreasing on the ground that weak stemmed and low diametric trees are removed. However, mostly thick diametric individuals were treated in the study conducted in 2009. Therefore, anticipated volume increment could not be provided in the rest of the individuals.

Determining stand density with tending operations is of importance in enhancing wood quality and growing trees (Mäkinen *et al.,* 2006; Genç *et al.,* 2012). It is critical to properly apply tending treatments in stand at the right time. Since age is a significant factor in tending operations, release cuttings should be done without delayed at the right age (Özçelik, 2000). Often, a tree actually accelerates in volume growth even while ring width slowly declines. Pronounced growth can be welcome, but they indicate that it would be better to do thinning earlier (Smith *et al.,* 1997). Beech species generally reach thicket stage at the age of 10-15 (Odabaşı *et al.,* 2007). The first release cutting practices in sampling study area were achieved in 2008 when the stand was 18 year old and in 2009 when it was 19 year old. West (2006) emphasized that at the age of 5 diameter range from 1-17cm, and had spread to 6-34 cm by 15 years, even further to 7-39 cm by 25 years of age. On the other hand, at 5 years of age, the plantation contained 1119 trees per hectare. Obtained results given in Table 2 show that study area is compatible to literature according to the age and diameter relation. However, number of the trees per hectare is not compatible to literature. So, it should be said that it was necessary to performe the first release cutting operation in the past in the study area. Delayed release cuttings can be thought to be the reason for lack of required stand increment. To reach a specific diameter in shorter time, stand tending needs to be done adequately and as needed at the right time beginning from young stage (Özçelik, 2000). During release cuttings except for spreading individuals, tall and thick diametric individuals which can cover the site homogenously; weak ones should not be kept at the site, except for compulsory situation like gaps. This is because the expected progress cannot be provided if undeveloped trees get enough growing space by cutting neighbouring trees (Özçelik, 2000; West, 2006; Ward, 2008). General areawide treatments have often proved less effective. Better results have followed cuttings that removed all adjacent trees whose crowns touched those of the crop trees (Nyland, 1996).

It is obvious that release cutting, by removing 40% of the basal area, does not contribute to stand increment and growth more positively than those in stands treated by removal of 19% of the basal area, conversely damaging collective composition, storied structure, stand canopy and thus, decreasing diameter increment than height increment after treatment and tree stability and basal area increment slow down than expected. Release cuttings should not be restricted to only one treatment and should be performed at least twice until pole stage. The results obtained from the present study, reveal that individuals cannot reach the expected diameter and height 3-4 years after first release cutting, hence 5-6 years should pass between two release cutting operations. Therefore, it is suggested that release cuttings in beech stands need to be practiced twice every 5 to 6 years, provided peculiar characteristics of every habitat are considered.

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