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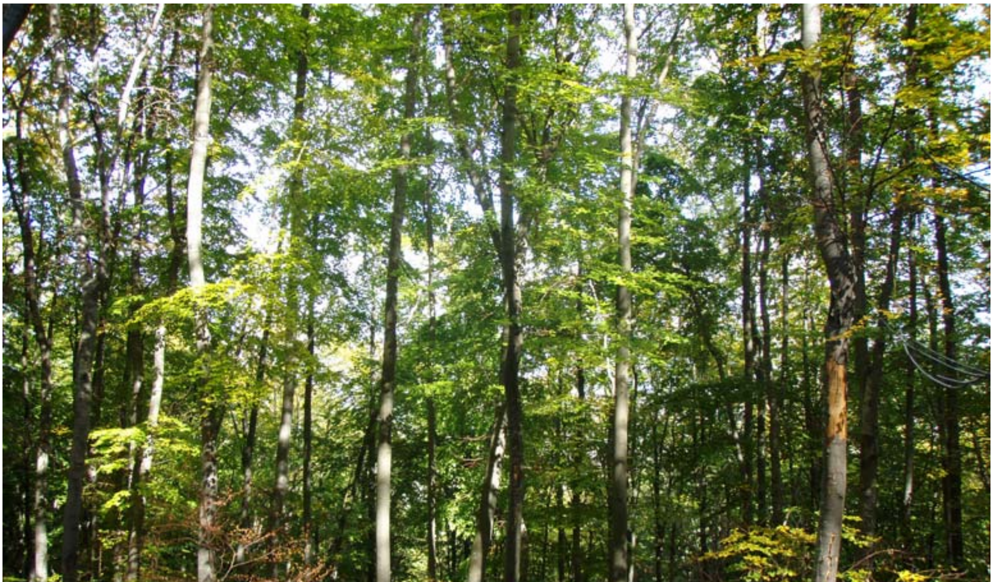

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DIAMETER INCREMENT TREND OF THE AUSTRIAN PINE PLANTATIONS IN RAŠKA

Miloš KOPRIVICA[1], Bratislav MATOVIĆ[1], Snežana STAJIĆ[1], Vlado ČOKEŠA[1]

Abstract: *This paper presents the results of the research of the multi-annual trend of the diameter increment of the trees of the middle-aged Austrian pine plantations. The age of the plantations ranges from 35 to 55 years, and the site classes from I-V. The impact of the climate factors and thinning on the trend of the diameter increment for the period 1988-2009 was analyzed. The statistically significant dependence of the diameter increment on the quantity of precipitation was determined, whereas the dependence on the air temperature and thinning is random. The quantity of precipitation over the vegetation season is directly reflected in the diameter increment, whereas the air temperatures and thinning are reflected indirectly. The thinning partially alleviates the adverse effects of the extremely low precipitation and high air temperatures on the diameter increment of the dominant trees. These relations are most clearly expressed in the analysis of the diameter increment of the dominant trees.*

Key words: plantations, Austrian pine, diameter increment, precipitation temperature, thinning.

[1] Ph.D. Miloš Koprivica, M.Sc. Bratislav Matović, M.Sc. Snežana Stajić, M.Sc. Vlado Čokeša, Institute of Forestry, Belgrade.
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Translation: Marija Stojanović

TREND DEBLJINSKOG PRIRASTA CRNOG BORA U KULTURAMA NA PODRUČJU RAŠKE

Izvod: *U radu su izneti rezultati istraživanja višegodišnjeg trenda debljinskog prirasta stabala srednjedobnih kultura crnog bora. Starost kultura je 35-55 godina, a bonitet staništa I-V. Analiziran je uticaj klimatskih faktora i proreda na veličinu i tok debljinskog prirasta. Obuhvaćen je vremenski period od 1988. do 2009. godine. Utvrđeno je da postoji statistički značajna zavisnost debljinskog prirasta stabala od količine padavina, dok je zavisnost od temperature vazduha i izvedenih proreda slučajna. Količina padavina u vegetacionom periodu odražava se direktno na veličinu debljinskog prirasta, a temperatura vazduha i prorede indirektno. Prorede u izvesnoj meri ublažavaju negativne efekte ekstremno niskih padavina i visokih temperatura vazduha na debljinski prirast. Ovi odnosi su najjasnije izraženi u analizi debljinskog prirasta dominantnih stabala.*

Ključne reči: kulture, crni bor, debljinski prirast, padavine, temperatura, prorede.

1. INTRODUCTION

The coniferous plantations have an important place in the Serbian forests. The Austrian pine, spruce and Scots pine plantations are dominant. In the mid-20th century, the great barren areas in the very vicinity of Raska were reforested, mainly by Austrian pine. Later, in the 1980s, the large-scale reforestation of the other parts of Ibarska klisura was conducted (Šmit, S. et al. 1997., Koprivica, M. et al. 1996). Generally speaking, in Serbia the Austrian pine plantations were most frequently established on the low-productivity sites (Koprivica, M., Ratknić, M. 1999., Koprivica, M. et al. 2000., Miletić, Z. et al. 2002., Rakonjac, Lj. et al. 2003).

Since the site conditions change as a result of the global climate change, study of the impact of the climate factors on the forest growth and increment is of the permanent importance. It is particularly significant in the forest plantations, as well as in the anthropogenically formed forest ecosystems (Koprivica, M., Matović, B. 2004).

The adverse effects of the climate and all other abiotic and biotic factors can be alleviated by the preventive action, i.e. by the intensifying professional activities aimed at the improvement of the forest vitality, stability and resistance. In the plantations the best results are obtained by thinning (Vučković, M., Stajić, B. 2003 i 2004).

The diameter increment of trees and stands is used as a reliable indicator of the analysis of the impact of site and stand factors, and particularly of the applied management methods – thinning. Undoubtedly, the biological position of the tree in the stand, i.e. the crown development and illumination also has the great impact on the diameter increment.

This paper is aimed at the research of the impact of the climate factors and thinning on the diameter increment of the trees in the middle-aged Austrian pine plantations, in order to estimate their development, productivity, quality and vitality.

2. OBJECT OF RESEARCH

The Austrian pine plantations aged from 35 to 55 years, belonging to the site classes I-V, were researched at several sites in the vicinity of Raška. Twenty permanent sample plots were set in 1998, on which two mensurations were performed, in 1998 and 2003. However, in 2007 the great wildfire broke out, in which the forest plantations covering an area of 75 hectares were destroyed, i.e. two previously set sample plots. In addition, two sample plots have been destroyed by the construction of the forest roads, by the attack of the bark beetles, and due to the heavy snow. Therefore, sixteen sample plots were used for this research.

The sample plots are the located at the altitudes ranging from 450 to 680 meters, with the exception of two sample plots, located at the 1,100 meters above the sea level. The terrain slope ranges from 8 to 33 degrees, and the northern exposure is dominant. The most sample plots are located on the eutric rankers on the ultrabasites, and only one sample plot is located on the acidified brown podzolic soil on the pyroclastic materials. The sites at which the studied Austrian pine plantations are located mainly refer to the natural oak sites: *Quercetum deleschampii sepentinicum* and *Quercetum montanum poetosum nemoralis*. Only one researched plantation is located on the beech site: *Fagetum mesiacae montanum* (K o p r i v i c a , M. et al. 2002).

3. METHOD

On the sample plots in September 2009 the trees were measured and their quality was assessed. The diameter at the breast height of all trees was measured, and the quality of them was estimated, by the use of the Oxford classification. The tree heights and diameter increment were measured on half of the trees. The applied methodology was specially designed for these purposes (K o p r i v i c a , M. et al. 2008).

In the aim of the determination of the diameter increment trend of the Austrian pine for the period 1988-2009 the trees were cored by the Presler increment borer. The data on the diameter increment of the trees were accurately measured and processed in the laboratory of the Institute of Forestry. The total of 280 trees were analyzed (seven three-year periods).

In next phase the trees on the sample plots, were divided into the diameter classes by the current diameter 5 and 10cm wide, and the mean values of the current diameter increment were determined. Finally, the sample plots were grouped into the previosly formed yield classes (K o p r i v i c a , M. et al. 2002., K o p r i v i c a , M., M a t o v i ć , B. 2004). In this way, the increment was assessed, and the diameter increment trend of the depressed (10 cm), co-dominant (20 cm) and dominant (30 cm) Austrian pine trees was determined.

In the aim of the determination of the impacts of the climate factors on the diameter increment of the trees the data obtained by the weather stations in Sjenica and Mt.Kopaonik were used. These stations are the nearest to the object of research which have the climate data for the research period. For the period in which the diameter increment is analyzed (1988-2009) the data on the quantitity of precipitation and air temperature over the year and during the vegetation season were collected. In the aim of the determination of the impact on the thinning on the diameter increment, timing, weight and intensity of the thinning were registered. The thinning was performed on all sample plots over the past ten years. Before this period no thinning was performed.

4. RESULTS

4.1 The diameter increment trend of the Austrian pine plantations

By the preliminary analysis of the diameter increment of the Austrian pine it was determined that the sample plots can be divided into four previosly formed yield classes (K o p r i v i c a , M., M a t o v i ć , B. 2004). However, the certain changes were made and the new distribution of the sample plots by the yield classes is the following:

Yield class	Sample plot	Age	Site class
1	1, 3, 8, 12, 16	57, 53, 55, 55, 55	2, 2, 2, 2, 1
2	5, 15, 18, 19	57, 57, 49, 52	3, 3, 3, 3
3	2, 17	54, 52	3, 4
4	7, 10, 11	37, 37, 36	4, 5, 5

The sample plots 6 and 20 were not grouped into the yield classes, owning to their peculiarity. The sample plot 6 is located on the beech site, the plantations are 35 years old and the site class is 3. The sample plot 20 is located in the 44-year-old plantations, and the site class 4.

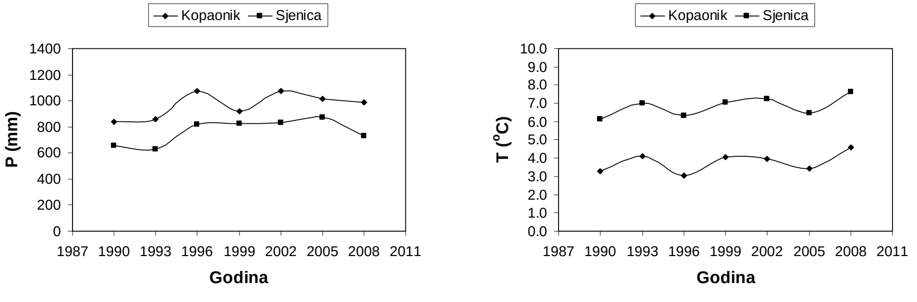
On all sample plots three mensurations have been performed so far: 1988., 2003, and 2009. Results of two mensurations have been presented earlier (K o p r i v i c a , M., M a t o v i ć , B. 2004). The mensuration results in 2009 are presented in Table 1.

In the yield class 1 the mean diameter increased by 1.4 cm in the last six years, whereas the mean height increased by 1.1 m. The number of the trees is less than 62 per a hectare, and basal area, volume and volume increment increased by: 3.1 m^2/ha, 65.1 m^3/ha and 1.3 m^3/ha. The percentage of the volume increment, i.e. the plantation increment intensity, did not change. The concrete comparisons cannot be made for the other yield classes, since the composition of their sample plots changed.

Table 1. *Taxation elements of the yield classes of the Austrian pine based on the mensuration date from 2008.*

Yield class	Age (years)	Site class	Mean diametar (cm)	Mean height (m)	The number of trees (trees/ha)	Basal area (m^2/ha)	Volume (m^3/ha)	Volume increment		Thinnig (years)
								m^3/ha	%	
1	55	I/II	21,6	19,4	1,088	39,8	398,1	7,28	1,83	1999
2	54	II/III	20,2	16,6	1,061	34,2	303,5	6,42	2,11	1999
3	54	III/IV	17,4	15,5	1,349	32,1	281,1	5,16	1,83	2004
4	37	IV/V	12,3	8,9	1,987	23,3	93,2	2,52	2,70	2004

In the aim of the easier study of the annual trends of the quantity of precipitation and air temperature in the period 1988-2009 the data are presented graphically (Graph 1).



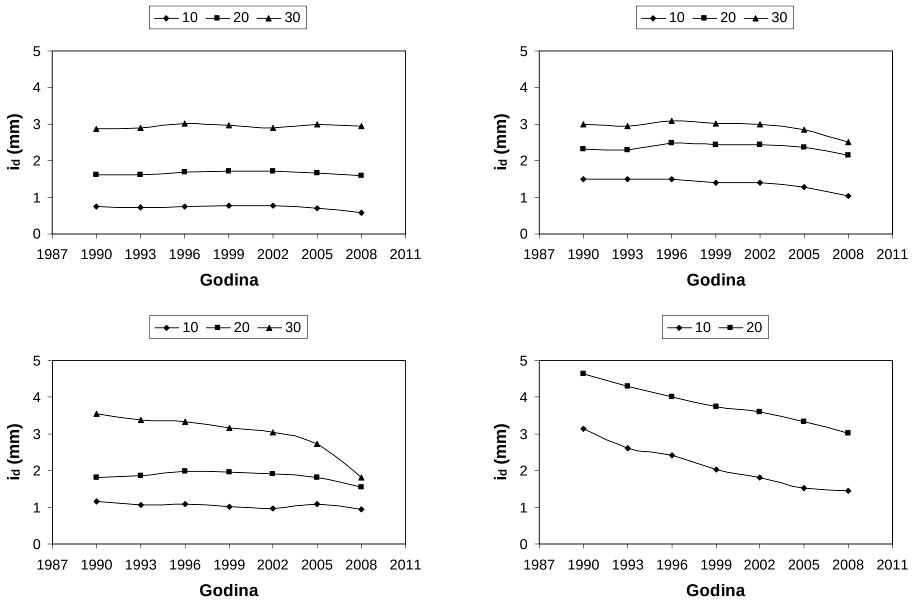
Graph 1. *The average quantity of the precipitation and air temperature in the period 1988-2009*

The data on the current diameter increment, obtained in the three-year period and numerous cored trees, are presented in the Table 2.

Table 2. *Diameter increment of the Austrian pine for the period 1988-2009 (mm/per a year).*

Diametar (cm)	Year						
	2008	**2005**	**2002**	**1999**	**1996**	**1993**	**1990**
Yield class 1							
10	0,57	0,71	0,78	0,77	0,76	0,73	0,76
20	1,59	1,67	1,72	1,72	1,69	1,61	1,63
30	2,95	2,99	2,91	2,97	3,02	2,90	2,88
Yield class 2							
10	1,05	1,28	1,39	1,40	1,50	1,49	1,50
20	2,16	2,36	2,44	2,44	2,48	2,30	2,33
30	2,51	2,85	3,00	3,02	3,10	2,95	3,00
Yield class 3							
10	0,93	1,09	0,97	1,01	1,09	1,07	1,17
20	1,55	1,82	1,92	1,95	1,97	1,86	1,82
30	1,81	2,74	3,04	3,17	3,33	3,37	3,54
Yield class 4							
10	1,44	1,51	1,81	2,03	2,41	2,62	3,15
20	3,02	3,33	3,60	3,75	4,01	4,30	4,64
30	-	-	-	-	-	-	-

In the aim of the better observation of the diameter increment, the data are presented graphically as well (Graph 2).



Graph 2. *The trend of the diameter increment of the Austrian pine trees by the yield classes in the period 1988-2009*

On the Graph 2 the following facts are observed:

* The increase in the diameter of the trees also implies the increase of the diameter increment in all yield classes, regardless of the age of the Austrian pine cultures. The thick (dominant) trees have the highest increment, then the middle-aged (co-dominant) trees, whereas the thin (depressed) trees have the lowest increment.

* In the yield class 1 the diameter increment remains at the same level, with the small oscillations, whereas in the yield classes 2 and 3 over the past six years there was a small decrease in the diameter increment, regardless of thinning. It can be explained by the lower site class, as well as by the delay of the thinning. All the plantations in these yield classes are about 55 years old.

* In the yield class 4 the plantations are located on the lowest site classes, and are about 35 years old. Although the diameter increment is the highest, it has a negative trend. The diameter increment of the trees with the diameter 10 cm and 20 cm is the highest, since these plantations are 20 years younger than the Austrian pine plantations in the first three yield classes.

It should be emphasized that the Austrian pine plantations classified in the first three groups are about 55 years old, that the analyses of the diameter increment started when the trees were 35 years old, and lasted until the trees were 55 years old. In the plantations of the fourth yield class, about 35 years old, the analyses of the diameter increment started when the trees were 15 years old, and lasted until the trees were 35 years old. As a result, in spite of the fact that the researches were conducted in the same period (1988-2009), only the first three yield classes can be compared.

Also, it should be taken into account that the results of the previous researches showed that in these Austrian pine plantations the maximum current diameter increment of the medium trees from the dominant layer in the first three yield classes was reported when the trees were from 10 to 15 years old, whereas in the fourth class the maximum current diameter increment was reported when the trees were from 15 to 20 years old. The annual increment ranged from 6.3 to 11.1 mm (K o p r i v i c a , M. et al. 2002).

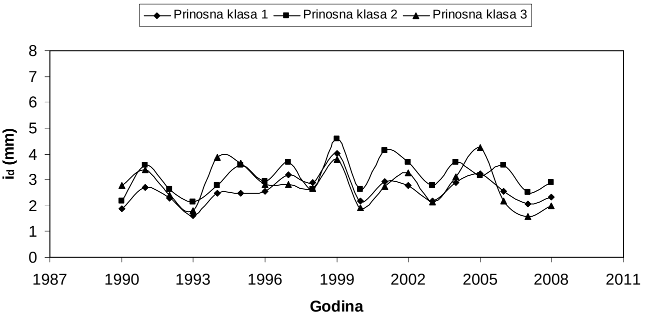
Therefore, in the first tree yield classes the period in which the diameter increment was stabilized is analyzed, whereas in the fourth class the period immediately after the culmination of the diameter increment was studied. The negative trend of the diameter increment was expressed in the first three yield classes, when the plantations were 15 to 35 years old, which is mainly the result of the delay in thinning (K o p r i v i c a , M. et al. 2002).

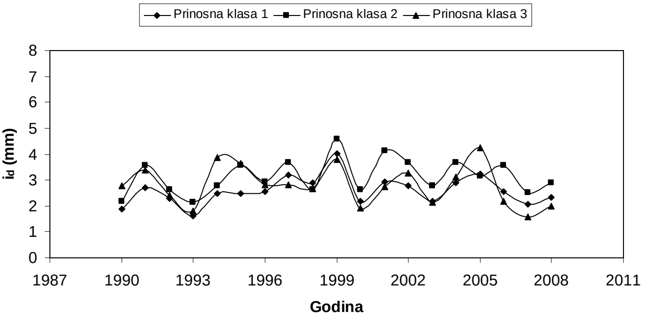
By comparing the Graph 2 and Graph 1 the dependence of the diameter increment on the quantity of precipitation and air temperature can be noticed only partially. Interestingly enough, by our previous researches of the diameter increment, conducted in the same Austrian pine plantations, and on the same tress, the relation between one dry period (1990-1994) and low diameter increment was more clearly visible (K o p r i v i c a , M., M a t o v i ć , B. 2004).

Given the fact that the same method was applied in these researches, it is hard to explain the fact that the different results were obtained. However, it is probably the result of the fact that the trees moved from the lower to the higher diameter categories, as well as the approximation of the data on the quantity of the precipitation, air temperature, and the diameter increment by three-year periods. The situation is similar to the analysis of the influence of the thinning on the diameter increment of the trees. As a result, the diameter increment of the dominant trees, depending on the quantity of precipitation, air temperature, and thinning, was separately analyzed for every year of the researched period.

4.2. The diameter increment trend of the Austrian pine dominant trees

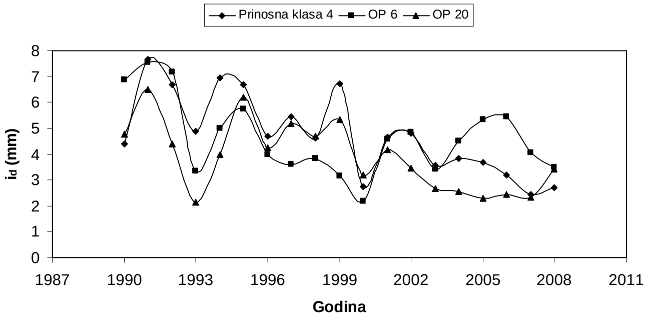
On all sample plots one typically dominant tree was selected and the diameter increment was determined for every year of the period 1988-2009. Then, the trees were divided into the yield classes and the average diameter increment was determined. The obtained results of the trend of the diameter increments are presented on the Graphs 3 and 4.





Graph 3. *The diameter increment trend of the Austrian pine dominant trees in the yield classes 1,2, and 3 in the period 1988-2009.*

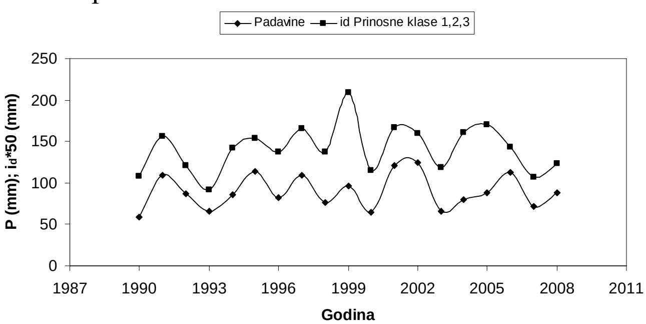
On the Graph 3 it can be noticed that there are no great differences in the diameter increment of the dominant trees of the yield classes 1, 2, and 3. The trend of the increment resembles the sine wave by the form, whereas the maximum and minimum diameter increment occurs in the same years over the research period. It is interesting that the almost identical fluctuations of the increment was also reported during the research of the multi-annual trend of the diameter increment of the dominant 55 years old trees in the Austrian plantations in Mt.Maljen, with the similar site conditions (S t o j a n o v i ć , Lj. et al. 2008).



Graph 4. *The trend of the diameter increment of the Austrian pine dominant trees in the yield class 4 and on the sample plots 6 and 20 in the period 1988-2009.*

In addition, the Graph 4 presents the similar oscillations of the diameter increment of the dominant trees, but of the downward trend, since these Austrian pine plantations are younger than the plantations in the yield classes 1, 2, and 3. On the sample plots 6 and 20 the positive impact of the thinning performed in 2004 on the diameter increment can be partially noticed.

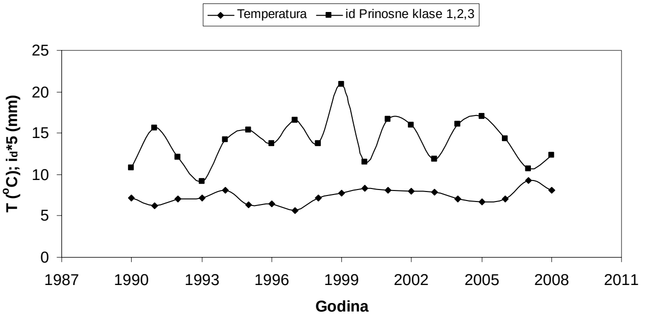
The relation between the diameter increment and climate factors is presented on the Graphs 5 and 6.



Graph 5. *The trend of the quantity of precipitation and the diameter increment of the dominant trees in the yield classes 1,2, and 3 for the period 1988-2009.*

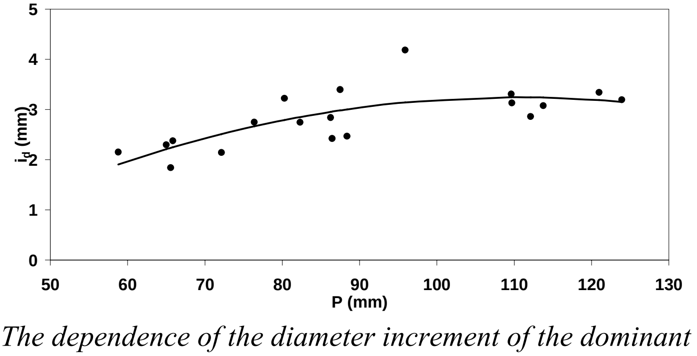
On the Graph 5 it can be observed that there is the almost complete correlation between the trend of the precipitation in the vegetation period, and the trend of the diameter increment of the dominant trees. The quantity of precipitation has a direct influence on the increment. The increase or decrease of the quantity of precipitation in the vegetation season is reflected in the diameter increment in the same year.

On the Graph 6 the significantly lower correlation between the trend of the air temperature in the vegetation period and the trend of the diameter increment of the dominant trees is presented. In this instance the increase or decrease of the air temperature in the vegetation period does not influence the diameter increment. It can be partially explained by the inverse relation between the quantity of precipitation and air temperature in the vegetation season, i.e. by the interaction between these two climate factors.



Graph 6. *The trend of the air temperature and diameter increment of the dominant trees in the yield classes 1, 2, and 3, for the period 1988-2009.*

The relation between the climate factors and the diameter increment of the dominant trees for the period 1988-2009, can be also observed by the application of the regression methods (Graphs 7 and 8).



Graph 7. *The dependence of the diameter increment of the dominant trees from the quantity of precipitation for the period 1988-2009.*

On the Graph 7 it is observed that the increase of the quantity of precipitation in the vegetation season implies the increase of the diameter increment of the Austrian pine trees.

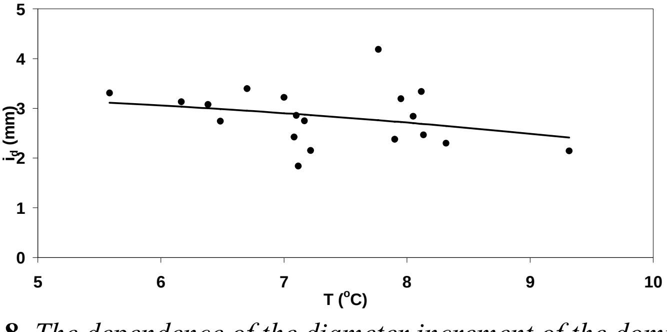
The regression indicators are the following:

$$I_d = -2{,}91215 + 0{,}111718\,P - 0{,}00050685\,P^2 \qquad (1)$$

$S_e = 0{,}41$ mm, $R^2 = 0{,}5427$, $R = 0{,}7367$

The regression (1) is statistically significant, at the probability level 99%, and variations in the diameter increment was explained by 54.27%, since the relative error of regression is +/- 14.4%.

By the application of the test of the differences among environments (t-test) it was proved that there was a statistically significant difference among the quantity of the precipitation in the dry and rainy years, at the probability level 99%. The mean quantity of precipitation in the dry years is 65 mm, whereas in the rainy years it is 99 mm. Likewise, the statistically significant difference in the diameter increment of the dominant trees was reported, at the probability level 99%. The mean diameter increment in the dry years is 2.16 mm, and in the rainy years it is 3.49. The increment in the dry years decreases by 38%.



Graph 8. *The dependence of the diameter increment of the dominant trees on the air temperatures in the period 1988-2009.*

On the Graph 8 it is observed that by the increase of the air temperature in the vegetation season the diameter increment of the Austrian pine trees decreases.

The regression indicators are the following:

$$I_d = 3.39792 + 0.0259409\,T - 0.0138623\,T^2 \qquad (2)$$

$S_e = 0.58$ mm, $R^2 = 0.0784$, $R = -0.2800$

The regression (2) is not statistically significant, and the variations in the diameter increment were explained by only 7.84%, and the relative error of regression is +/- 20.3%.

By the application of the test of the differences among environments (t-test) it was proved that there was no statistically significant difference among the air temperature precipitation in vegetation season in the dry and rainy years. The mean air temperatures in the dry years is 7.0^{0}C, and in the rainy years it is 8.0 ^{0}C.

5. CONCLUSION

Based on the measuring of the Austrian pine plantations in Raška in 2009, and the analysis of the diameter increment of the trees and data on the quantity of precipitation and air temperature for the period 1988-2009, the following conclusions can be derived:

* Over the past six years in the Austrian pine plantations classified in the yield class 1 (55 years old trees and the site class I/II) the mean diameter increases by 1.4 cm, and the mean height increases by 1.1 m. The basal area increased by 3.1 m^2/ha, volume by 65.1 m^3/ha, and the current volume increment by 1.23 m^3/ha. The percentage of the volume increment, i.e. the intensity of the yield of the plantations, did not change (1.82%). In the yield classes 2, 3, and 4, the accurate comparisons cannot be made due to the change in the percentage of the sample plots in them.

* The trend of the diameter increment in the period 1988-2009, by yield classes 1, 2, and 3 showed only insignificant oscillations. The trend line is almost parallel to the x-coordinate for the trees with the diameters 10, 20, and 30 cm (depressed, co-dominant, and dominant). In the yield class 4 the increment trend is linear and downward, which is the result of the age of the plantations, site conditions and delay in the thinning. In the first tree yield classes the plantations are about 55 years old, the site productivity classes I-III, and the thinning was performed late. In the fourth yield class the plantations are about 35 years old, the site classes IV-V, and the first thinning was performed only five years ago.

* The dependence of the diameter increment of the Austrian pine on the annual quantity of precipitation and air temperature, as well performed thinning, did not reflect clearly in the samples of the great number of the analyzed trees by the diameter and yield classes. However, by analyzing the small number of the dominant Austrian pine trees the statistically significant dependence, at the probability level 99%, of the diameter increment on the quantity of precipitation in the vegetation period, was reported. The diameter increment depended on the air temperature in the vegetation season, but the dependence was not

statistically significant. In addition, there was no significant influence of the late thinning on the diameter increment of the dominant trees.

REFERENCE

K o p r i v i c a, M., R a t k n i ć, M., R a k o n j a c, Lj., Č o k e š a, V. (1996): The Reforestation of the Barren Lands and the Condition of the Forest Plantations in Ibarska Gorge. The Collection of Works, Institute of Forestry, Volumes 40-41 pp. 52-62, Belgrade *(Original: Pošumljavanje goleti i stanje šumskih kultura na području Ibarske klisure. Zbornik radova, Institut za šumarstvo, br. 40-41, Beograd, str. 52-62).*

K o p r i v i c a, M., R a t k n i ć, M. (1999): Production and Development Characteristics of Young Autochthonous Coniferous Stands in the Region of Southwest Serbia. IUFRO Conference "Empirical and Process-based Models for Forest Tree and Stand Growth Simulation", Proceedings, pp. 195-203, Lisbon, Portugal.

K o p r i v i c a, M., Č o k e š a, V., M a r k o v i ć, N. (2000): Productivity Characteristics of Artificially Established Austrian Pine Stands on Serpentine-peridotite Rankers in Central Serbia. Jubileen sbornik naučni dokladi "75 godini visše lesotiehničesko obrazovanie v Blgaria", Lesotehničeski universitet, pp. 308-317, Sofia, Bulgaria.

K o p r i v i c a, M., T a b a k o v i ć - T o š i ć, M., T o p a l o v i ć, M., R a k o n j a c, LJ., Č o k e š a, V., M a r k o v i ć, N. (2002): The Ecologically-Productive and Health Characteristics of the Artificially Estaliblished Coniferous Stands in Raska. The State Enterprise "Srbijasume" – The Institute of Forestry, pp. 1-84, Belgrade. *(Original: Ekološko-proizvodne i zdravstvene karakteristike veštački podignutih sastojina četinara na području Raške. JP "Srbijašume" - Institut za šumarstvo, str. 1-84, Beograd.)*

K o p r i v i c a, M., M a t o v i ć, B. (2004): The Impact of the Climate Factors and Thinning on the Diameter Increment of the Austrian pine in Ibarska Gorge. The Collection of Works, Volume 50-51. The Institute of Forestry, pp. 22-31, Belgrade. *(Original: Uticaj klimatskih faktora i proreda na debljinski prirast crnog bora u Ibarskoj klisuri. Zbornik radova, tom 50-51. Institut za šumarstvo, str. 22-31, Beograd.)*

K o p r i v i c a, M., M a t o v i ć, B., Č o k e š a, V., S t a j i ć, S. (2008): The Methodology of the Collection and Procession of the Field Data in the Aim of the Study of the Changes in the Forest Ecosystems Affected by the Global Warming. Manuscript. The Institute of Forestry, pp. 1-10, Belgrade. *(Original: Metodika prikupljanja i obrade terenskih podataka u cilju proučavanja promena u šumskim ekosistemima pod uticajem globalnog zagrevanja. Rukopis. Institut za šumarstvo, Beograd, str. 1-10.)*

M i l e t i ć, Z., K o p r i v i c a, M., M a r k o v i ć, N. (2002): The Dependence of the Productivity of the Austrian and Scots Pine Plantations on some Soil Characteristics in Pester Plateau. The Collection of Works, Volume 46-47, State Enterprise "Srbijasume"

– The Institute of Forestry, pp.1-12 Belgrade. *(Original: Zavisnost proizvodnosti kultura crnog i belog bora od nekih svojstava zemljišta na Pešterskoj visoravni. Zbornik radova, Tom 46-47, JP Srbijašume - Institut za šumarstvo, Beograd, str. 1-12.)*

Rakonjac, Lj., Koprivica, M., Tabaković-Tošić, M., Miletić, Z., Čokeša, V., Marković, N (2003): The Forest Stands and Coniferous Plantations in Pester Plateau. Monograph. State Enterprise "Srbijasume" – The Institute of Forestry, pp. 1-163, Belgrade. *(Original: Šumska staništa i kulture četinara na Pešterskoj visoravni. Monografija. JP "Srbijašume" - Institut za šumarstvo, Beograd, str. 1-163.)*

Stojanović, Lj., Krstić, M., Bjelanović, I. (2008): The Stand Status and Thinning in the Austrian pine plantations at Mt. Maljen. Forestry, Number 4, pp. 15-29, Belgrade. *(Original: Sastojinsko stanje i proredne seče u kulturama crnog bora na Maljenu. Šumarstvo, br. 4, Beograd, str. 15-29)*

Šmit, S., Veselinović, N., Topalović, M., Koprivica, M., Minić, D., Ratknić, M., Miletić. Z., Dražić, M. (1997): The Reforestation of the Barren Land in Ibraska Gorge. The Institute of Forestry, Monograph, pp. 1-104, Belgrade. *(Original: Pošumljavanje goleti u Ibarskoj klisuri. Institut za šumarstvo, Monografija, Beograd, str. 1-104)*

Vučković, M., Stajić, B. (2003): The Impact of the Climate Change on the Growth and Vitality of Forests. "The Environmental Protection of the Cities and Suburb Inhabited Places", pp. 227-232, Novi Sad. *(Original: Uticaj promena klime na rast i vitalnost šuma. „Zaštita životne sredine gradova i prigradskih naselja". Novi Sad, str. 227-232)*

Vučković, M., Stajić, B. (2004): The Tasks and Importance of the Research of the Growth and Productivity Rate of the Forests for the Ecology and Forestry. The Herald of the Faculty of Forestry in Banja Luka, Number 1, pp. 15-35, Banja Luka. *(Original: Zadaci i značaj istraživanja rasta i proizvodnosti šuma za ekologiju i šumarstvo. Glasnik Šumarskog fakulteta u Banjoj Luci, br. 1, Banja Luka, str. 15-35.)*

***Meteorological Annual Reports from 1988 to 2009. Republican Hydrometeorological Service of Serbia, Belgrade. *(Original: Meteorološki godišnjaci od 1988. do 2009. godine. RHMZ Republike Srbije, Beograd.)*

DIAMETER INCREMENT TREND OF THE AUSTRIAN PINE PLANTATIONS IN RASHKA

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Summary

The paper presents the research results of the multi-annual trend of the diameter increment of the trees in the Austrian pine plantations, from 35 to 55 years old, and the site classes I-V. The impact of the climate factors and thinning on the trend of the diameter increment for the period 1988-2009 was analyzed. The research was conducted based on sixteen permanent sample plots, set in 1998 in the Austrian pine plantations in Raska. Three periodical mensurations have been performed so far: in 1998, 2003, and 2009. The results of the first two mensurations have been reported earlier. This paper presents some of the research results, in regard to the diameter increment of the Austrian pine plantations, based on mensuration in 2009. The methodology, which was specially designed for these purposes, was used for the collection and procession of the data. The data on the trees on the sample plots were obtained by the accurate measurement, and the quality of them was assessed by the use of the Oxford tree classification. The diameter increment of 280 trees, cored by the Presler increment borer, was analyzed. The data on the quantity of precipitation and air temperature were obtained from the weather stations located in Sjenica and in Mt. Kopaonik, and also refer to the period 1988-2009. The sample plots were classified in the yield classes 1-4. It was determined that there was the statistically significant dependence of the annual diameter increment of the dominant trees from the quantity of precipitation in the vegetation period, whereas the dependence on the air temperature and thinning was random. The quantity of the precipitation in the vegetation season had the strong and direct influence on the diameter increment, whereas the air temperature and thinning had the small and indirect influence. By the increase of the quantity of precipitation, the diameter increment increases parabolically, and by the increase of the air temperature it decreases linearly. The thinning to a certain extent alleviates the adverse effects of the extreme low precipitation and of the high air temperatures on the diameter increment of the trees. However, the dependences are less expressive if the dependence of the diameter increment of the great number of trees of the different yield and diameter classes on the annual quantity of precipitation and on the air temperature per three-year periods are observed.

TREND DEBLJINSKOG PRIRASTA CRNOG BORA U KULTURAMA NA PODRUČJU RAŠKE

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Rezime

U radu su izneti rezultati istraživanja višegodišnjeg trenda debljinskog prirasta stabala u kulturama crnog bora, starosti 35-55 godina i boniteta staništa I-V. Analiziran je uticaj klimatskih faktora i proreda na veličinu i tok debljinskog prirasta u periodu 1988-2009. godina. Istraživanje je provedeno na bazi šesnaest stalnih oglednih polja, postavljenih 1998. godine u kulturama crnog bora na području Raške. Do sada su izvršena tri periodična premera: 1998. 2003. i 2009. godine. Rezultati prva dva premera saopšteni su ranije. Ovde je dat deo rezultata istraživanja, vezanih za debljinski prirast, o kulturama crnog bora na bazi premera 2009. godine. Za prikupljanje i obradu podataka korišćena je metodika posebno izrađena u ove svrhe. Podaci o stablima na oglednim poljima dobijeni su preciznim merenjem, a njihov kvalitet ocenjen je primenom Oxford-ske klasifikacije stabala. Analizirano je debljinski prirast 280 stabala, bušenih Preslerovim svrdlom. Podaci o količini padavina i temperaturi vazduha uzeti su za meteorološke stanice u Sjenici i na Kopaoniku, takođe za period 1988-2009. godina. Ogledna polja su svrstana u prinosne klese 1-4. Utvrđeno je da postoji statistički značajna zavisnost godišnjeg debljinskog prirasta dominantnih stabala od količine padavina u vegetacionom periodu, dok je zavisnost od temperature vazduha i izvedenih proreda slučajna. Količina padavina u vegetacionom periodu odražava se jako i direktno na veličinu debljinskog prirasta, a temperatura vazduha i prorede slabo i indirektno. Sa povećanjem količine padavina parabolično se povećava debljinski prirast a sa povećanjem temperature vazduha linearno smanjuje. Prorede u izvesnoj meri ublažavaju negativne efekte ekstremno niskih padavina i visokih temperatura vazduha na debljinski prirast stabala. Međutim, ove zavisnosti su slabije izražene.kada se posmatra zavisnost debljinskog prirasta većeg broja stabala različitih prinosnih i debljinskih klasa od godišnje količine padavina i temperature vazduha po trogodinjim periodima.

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