Characteristics and Share of European Beech False Heartwood in Felling Sites of Central Croatia

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Abstract – Nacrtak

False heartwood, as the phenomenon considerably affecting the quality of beech logs and trees, has been the object of professional and scientific interest for more than 100 years. Occurrence and characteristics of false heartwood were investigated depending on diameter class of average trees and type of cut in beech stands on a sample of 2308 trees. The age of trees in thinnings ranges between 50 and 91, in preparatory cuts between 96 and 111, in seeding cuts between 101 and 112 and in final cuts between 98 and 112. In thinnings 11.7% of trees were found with false heartwood, in preparatory cut 54.7%, in seeding cut 71.3% and in final cut 84.6%. The length of processed logs, and absolute shares of false heartwood in trees, increase from thinning to final cut, while the volume percentage of false heartwood in trees for all types of cuts, except final cut, decreases. With seeding and final cuts approximately 15% of volume of processed assortments of the highest quality (A and B quality class) has an excessive share of sound false heartwood for A and B quality class. With respect to the volume of large wood, depending on diameter class, the share of quality subclass A–s ranges between 0.3 and 2% and the share of quality subclass B-s between 1.1 and 3.2% of large wood volume.

Keywords: beech false heartwood, beech cuts

1. Introduction – *Uvod*

Roundwood faults are related to irregularities in structure, texture, colour and consistency. They reduce technical properties, make processing difficult and decrease the degree of wood utilization. Some wood faults are created as the effect of the phenomenon of growth and development of the tree so that the term »wood fault« is relative. European beech is the tree species of one colour, whose aging generates optionally or always coloured heartwood of irregular shape. Such coloured beech heartwood is called false heartwood, red heartwood, brown heartwood or corewood. In Croatia, local population also use the term »kern« (from the German noun der Falschkern – false heartcore).

Beech false heartwood, as the phenomenon that affects considerably the quality of logs, has been the object of professional and scientific interest for more than 100 years (Krpan et al. 2006). Numerous theories and interpretations of the formation of false heartwood are hypothetical even today. As stated by Glavaš, Tusson (1905) supposes that false heartwood of beech is formed as the reaction of wood cells to the attack of fungi. It was established later (Zycha 1958) that the primary cause of formation of false heartwood in beech trees is not a biotic but rather an abiotic factor. The formation of false heartwood of beech is the effect of reaction of living wood cells to the penetration of air or oxygen into the tree trunk. Oxygen acts as poison on living cells, and they defend themselves by anatomical and chemical changes (tyloses, oxidation, formation of coloured substances) trying to prevent further penetration of air. Substances formed as the result of such cell reactions are not introduced into cell walls, but deposited on them, and this is the basic difference between true and false heartwood (Glavaš 1999).

The factors of formation of all types of heartwood are divided into obligatory and optional. For the formation of false heartwood, a certain quantity of air must penetrate into the inside of the tree. Optional factors are as follows: natural aging of parenchyma cells, excessive penetration of air into the tree, low temperatures (along with a serious draught in the previous summer), presence of fungi that destroy wood and fungi that change wood colour, genetic predispositions and forest silvicultural measures and other human impact. The occurrence and development of individual types of false heartwood is not always caused by influence of one factor only, but rather by a combination of several factors. It has been confirmed that there is a correlation between the formation and degree of development of false heartwood and tree physiology. In the last twenty years, the then knowledge has been considerably updated by Torelli's researches (1984, 1994). According to this author, false heartwood of beech is caused by environmental impact, and all factors that cause the reduction of water content in the inside of the tree trunk are responsible for its formation. At the age between 80 and 90 of beech trees (depending on growth conditions), a certain disruption of physiology balance occurs. At that age, the leaf area and root system of beech trees are not enlarged anymore, despite the diameter increment. This leads to the disruption of balance of the water regime inside the tree and the central part of the tree trunk dehydrates. The process of dehydration of the central part of the tree trunk is, from the physiological aspect, similar to the genetically conditioned formation of false heartwood. The following factors are crucial for the development of false heartwood of beech: the size of tree top and tree diameter, i.e. quick growth of the tree and intensity of tree top reduction. The development of false heartwood is also affected by the soil condition, position, social status of the tree and tree top height. The process of false heartwood formation starts much later on soils of poor quality. Any mechanical damages of trees with dehydrated central part result in the penetration of oxygen into the tree by which the enzymatic process of tyloses formation is initiated.

Fig. 1 Beech false heartwood

Slika 1. *Crveno bukovo srce*

The share of false heartwood in beech processed roundwood has a considerable impact on the quality of beech logs. The differences in the quality of discoloured and optionally coloured heartwood (false heartwood), under assumption that wood with optionally coloured heartwood is sound, are almost the same as differences in characteristics of discoloured and obligatorily coloured heartwood. The boundary line of false heartwood does not correspond to the boundary line of the growth ring. At the cross section the boundary line of false heartwood may be radial, star-like and completely irregular. False heartwood may be differently nuanced and it is not always symmetrical with respect to the longitudinal axis of the tree trunk, and drying causes considerable change of colour.

The largest diameter of false heartwood (red heart) appears between the 1st and 4th metre from the stump, and thereafter it decreases towards the stump and tree top. There is another increase of the diameter of read heart, although lower, between the 6th and 8th metre of tree trunk. False heartwood in beech tree trunk has the form of two cones connected by their bases, and however this shape is not necessarily regular. It achieves the greatest width at the point where the formation started (Tomaševski 1958).

Conductive elements in parts of wood attacked by false heartwood are blocked by tyloses, and consequently the impregnation can hardly penetrate into the wood (Govorčin et al. 2003). The impregnated beech wood with false heartwood is, therefore, highly susceptible to decay. Right due to susceptibility to decay of beech wood with false heartwood, this phenomenon is extremely important in practice and in wood trading (Glavaš 1999, Glavaš 2003).

A specific kind of decay in beech trees with false heartwood is the phenomenon of specific white rot. It occurs when rot fungi penetrate into wood through wounds, broken branches, front end of logs, etc., and then develops inside the wood. White rot of beech trees is caused by different types of specific fungi, and most commonly they are as follows: *Schizophyllum commune* Fr., *Hypoxylon coccineum* (Pers.) Wind., *H. fragiforme* (Person ex Fries) Kicky, *Tremella faginea* Britz., *Stereum purpureum* Pers., *Biospora monilioides* Corda and others. White rot in wood with false heartwood is not spread evenly but rather in the form of a leaf, tongue or similar. The reason lies in the fact that different parts of beech wood are differently affected by false heartwood and tyloses and hence they offer different resistance to rot fungi. However, false heartwood cannot prevent the rotting process. It only makes the rotting process slower and more uneven (Glavaš 1999, Glavaš 2003).

The share of false heartwood is prescribed for roundwood by European standards (for wood assortments and quality classes except those of the lowest value), and it is assessed or measured on the front end of roundwood by measuring the diameter of the part where false heartwood is formed and by expressing it in centimetres or as the percentage of the diameter at the place of measurement (EN 1310: 1997).

The presence and share of false heartwood in beech trees is unknown until the tree is felled and assortments processed. From the standpoint of forest harvesting and knowledge of quality or assortment structure of beech stands, the interest in the origin and development of false heartwood of beech trees is quite understandable. Although it has been known for some time that beech coming from Bilogora is highly appreciated in the market due to low presence of false heartwood (Pećina 1943), right because it is unknown until felling and processing of trees, false heartwood represents an additional problem in planning revenues and in considering issues related to assortment structure of beech. For these reasons, it is necessary to expand the current knowledge with the information on frequency of occurrence of false heartwood and its impact on the quality of wood assortments by breast height diameter classes based on the age of our even-aged stands and type of cut.

2. Place and methods of research – *Mjesto i metode istraživanja*

Researches of false heartwood of beech were carried out in the mountainous continental part of the Republic of Croatia in the management unit »Bjelovarska Bilogora« Forest Office Bjelovar. The management unit »Bjelovarska Bilogora« is situated on south-west and south slopes of Bilogora, at the altitude ranging between 115 and 307 m above sea level. The total area is 7,632.62 hectares, of which an area of 7,444.17 hectares is stocked, and it is divided in 180 compartments and 533 sub-compartments. Original substratum mostly consists of dry layer of carbonate loess. Soils are classified as deep soils and they have a very favourable mechanical composition. They usually make loams, clay loams and light clays. Natural drainage and permeability is favourable, and the reaction is poorly acid to highly acid, most frequently within the limits of best suitability for forest. Total growing stock is 2,317,147 m^3 (2003), and the beech as the most represented species accounts for 1,036,386 m^3 or 44.73%. Total 10-year allowed cut is 586,231 m^3, of which 443,752 m^3 are main felling and 142,479 m^3 are thinning and salvage felling. In 10-year allowed cut, beech accounts for 297,753 m^3 (67.2%) of main felling and 45,939 m^3 (32.2%) of thinning and salvage felling, or in total for 343,692 m^3 (58.6%). The aim of management is the production of veneer logs of Sessile oak and European beech, beech peeling logs, sawmill logs of Sessile oak, beech and hornbeam, electricity pillars and fuelwood.

Collection of data, i.e. field research of suitable beech trees, was carried out on 36 (sub)compartments in 46 cuts. All of them belong to ecological-management type II–D–11 and management class »Beech« with a 100-year rotation, whose share in the area of the management unit is 76.1%, and in the growing stock 80.6%.

The occurrence and characteristics of false heartwood of beech trees were investigated with respect to diameter class of trees and type of cut.

Beech false heartwood was measured on the front ends of the processed roundwood of the pertaining tree in accordance with the procedure prescribed by the standard, i.e. minimum and maximum diameter of false heartwood is measured on the front ends, and the mean value is taken rounded to the nearest lower centimetre. The mean diameter of the relative front of the log is measured and determined in the same way. Measurements are carried out on both ends (fronts) of roundwood. If false heartwood is only present on one front end of the log, at the other front end only the mean diameter is measured and determined. Absolute and percentage shares of false heartwood are expressed in wood volume of roundwood in accordance with the standard, which prescribes Huber's formula for the calculation of log volume (EN 1309-2:2006). Smalian's formula is used for the calculation of false heartwood volume in a log:

$$V_k = \frac{(g_1 + g_2)}{2} \cdot L \qquad (1)$$

where:

V_k False heartwood volume, m^3

g_1 Crosscut area of false heartwood at the thicker end of the log, m^2

g_2 Crosscut area of false heartwood at the thinner end of the log, m^2

L Log length, m

This formula is known as the formula of two crosscuts, and it is used for accurate determination of the volume of an imperfect paraboloid (Pranjić and Lukić 1997).

The volume of false heartwood was determined with some simplifications, which are conditioned by the procedure of felling and processing roundwood. For a more accurate determination of false heartwood volume, it would be necessary to make more cross cuts or longitudinal cut in each piece of roundwood, and this cannot be done for obvious reasons. Since a similar way of measuring false heartwood is applied in classifying wood assortments into quality classes and in trading with wood assortments, this way of measurement of false heartwood is acceptable. In the same way, the research of the share of false heartwood is restricted only to logs, as in other wood assortments (parts of tree) it has almost no significance. Mathematical and statistical processing of data was carried out by use of computer programme *Microsoft Excel 97*.

3. Results of investigation and discussion – *Rezultati istraživanja i rasprava*

3.1 Share of trees with false heartwood in felling sites – *Udio stabala s nepravom srži u sječinama*

A sample of 787 beech trees was processed in thinnings. Almost the same number of samples, 788 trees, came from preparatory cut. The sample of 467 beech trees was prepared in seeding cut, and of 266 beech trees in the final cut (Table 1).

Total percentage share of beech trees with false heartwood in individual types of cut increases from thinning, where it is 11.7%, to final cut, where it is 84.6%. The increase of total share of the number of trees with false heartwood by type of cut may be explained by the increase of the mean diameter at breast height (in terms of the increase of number of thicker trees in the sample) and stand age from thinning to final cut. The average age of the sample by type of cut is 76 years for thinnings, 104 years for preparatory cut, and for seeding and final cut the average age of the sample trees is 106 years.

As the distribution of diameters at breast height are different for individual types of cut, the number of trees with false heartwood was determined by diameter classes for each type of cut. Percentage share of beech trees with false heartwood by diameter classes and type of cut is shown in Fig. 2. Diameter class with the highest number of trees with false heartwood increases from thinning to final cut, and diameter class in which more than half of trees with

Table 1 Sample size and share of trees with false heartwood

Tablica 1. *Veličina uzorka i udio stabala s nerpavom srži*

Diameter class *Debljinski stupanj*	Thinning *Proreda*		Preparatory felling *Pripremni sijek*		Seeding felling *Naplodni sijek*		Final felling *Dovršni sijek*	
	without false heartwood *bez neprave srži*	with false heartwood *s nepravom srži*	without false heartwood *bez neprave srži*	with false heartwood *s nepravom srži*	without false heartwood *bez neprave srži*	with false heartwood *s nepravom srži*	without false heartwood *bez neprave srži*	with false heartwood *s nepravom srži*
cm	Number of trees – *Broj stabala*							
17.5	25	-	1	-	-	-	3	-
22.5	104	1	18	1	-	-	3	-
27.5	154	8	61	19	7	2	4	1
32.5	257	27	123	45	25	9	3	2
37.5	133	25	161	79	44	20	8	7
42.5	59	12	177	104	87	52	27	21
47.5	38	9	131	95	114	87	45	39
52.5	8	4	62	42	81	69	65	57
57.5	6	4	35	28	51	41	46	40
62.5	1	1	8	8	38	33	27	24
67.5	-	-	6	6	12	12	17	16
72.5	2	1	4	3	7	7	9	9
77.5	-	-	1	1	1	1	7	7
82.5	-	-	-	-	-	-	2	2
Total – *Ukupno*	787	92	788	431	467	333	266	225
Percentage *Postotni udio*	11.7%		54.7%		71.3%		84.6%	

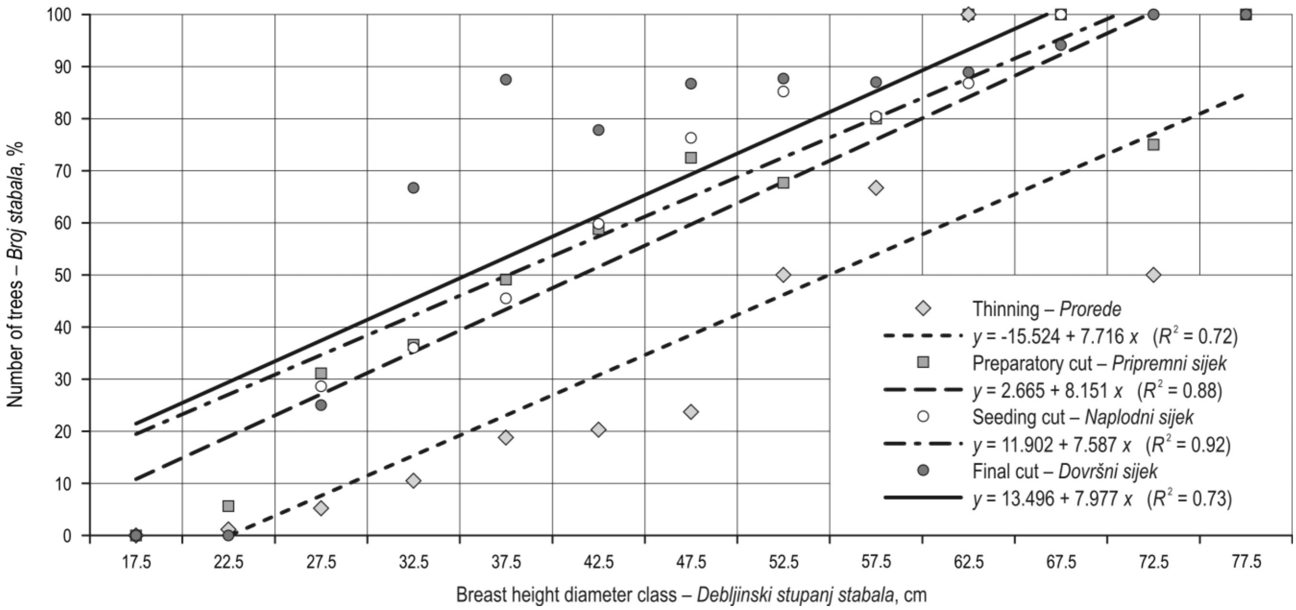

Fig. 2 Share of number of trees with false heartwood

Slika 2. *Udio broja stabala s nepravom srži*

false heartwood may be expected decreases from thinning to final cut.

These results confirm past researches (Vasiljević 1972, Prka 2003, Prka 2005) dealing with the origin of the process of formation of false heartwood at the age approximately ranging between 60 and 75. It can be concluded from these researches that the phenomenon of false heartwood does not considerably affect the structure of assortments of thinning stands, and however its impact on the structure of assortments of a shelterwood system (preparatory cut, seeding cut and final cut) cannot be absolutely excluded.

The increase of the number of trees with false heartwood within individual diameter classes from thinning to final cuts implies that the formation of false heartwood depends less on diameter at breast height, and more on stand age. Such distribution of trees in the sample with false heartwood, by type of cut and diameter class, fits fully into the latest researches of the cause of formation of false heartwood in beech trees (Torelli 1984, Torelli 1994). Therefore, these results should be interpreted as the disruption of balance of water regime within the tree and dehydration of the central part of the tree trunk due to the disturbance of physiological balance in older trees.

3.2 Length of logs with false heartwood – *Duljina tehničke oblovine s nepravom srži*

The length of logs made from the tree affected by the process of formation of false heartwood was measured during roundwood scaling. It represents total length of logs made from the tree where false heartwood appears at least at one front end (cross cut) of the log during bucking and cross-cutting of stem in accordance with European Standards (EN 1316-1:1999). According to the way of measurement, it can be seen that the actual longitudinal presence of false heartwood in the tree, i.e. in logs, remains partly unknown for understandable reasons. Total length of false heartwood in processed logs is surely somewhat smaller than the length measured in this way (Fig. 3). On the other hand, false heartwood may remain hidden with some logs, i.e. it must not necessarily appear at the front ends of logs. For these reasons, data obtained in this way have only an approximate value.

Fig. 3 presents the data on mean (average) value of length of processed logs affected by false heartwood by type of cut and breast height diameter class. As the decision on the place of the trunk cut in the production of logs is made based on external characteristics, data on the length of logs affected by the process of formation of false heartwood collected in this way have a certain operating value.

Mean values of the length of false heartwood and the trend line are presented in Fig. 3 only for breast height diameter classes containing three or more trees of diameter classes with false heartwood. The increasing trend of the length of processed logs with false heartwood can clearly be seen from thinnings to final cut. The reasons of such trend may be explained by the above stated factors that cause the

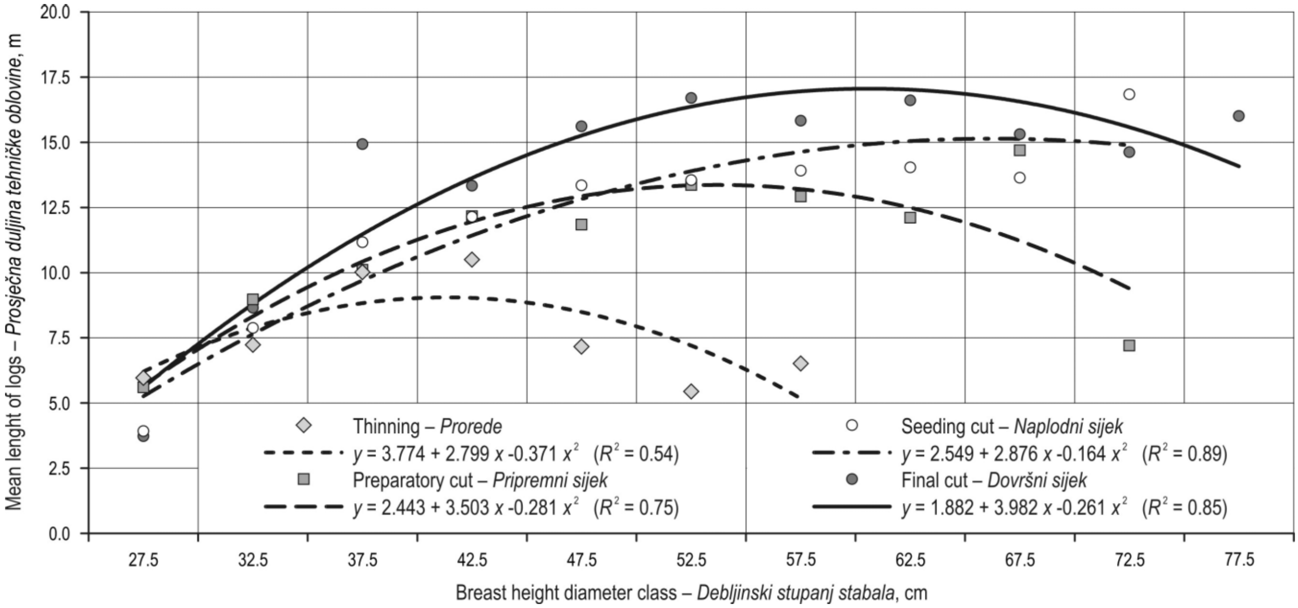

Fig. 3 Mean length of processed logs with false heartwood

Slika 3. *Prosječna duljina tehničke oblovine s nepravom srži*

formation of false heartwood. This fact affects the absolute value of false heartwood volume in the volume of processed logs of a certain type of cut. Lower values of the average lengths of false heartwood in the volume of logs in larger diameter classes of thinnings (and even in preparatory cut) imply that the diameter at breast height is not a decisive factor in the formation of false heartwood.

3.3 Share of false heartwood in volume of logs – *Udio neprave srži u obujmu tehničke oblovine*

The data presented in Fig. 4 show the increase of the average absolute values of the volume of false heartwood in processed logs by breast height diameter classes and from thinnings to final cut.

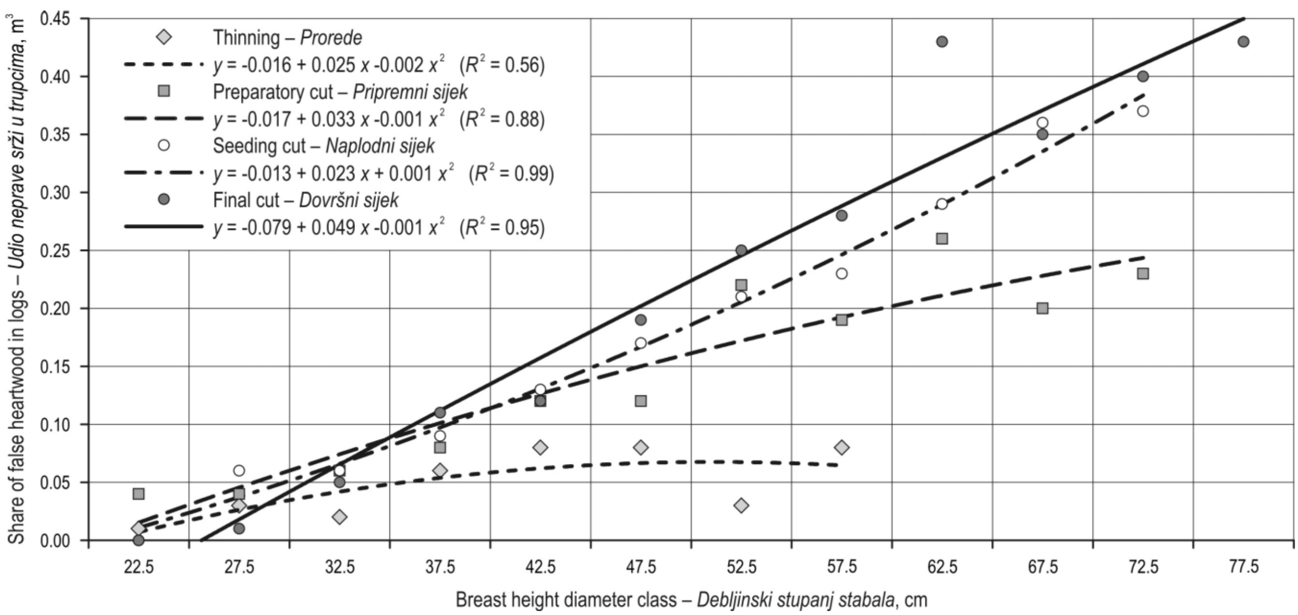

Fig. 4 Mean share of false heartwood volume in the volume of processed logs of beech trees

Slika 4. *Srednji udjeli obujma neprave srži u obujmu tehničke oblovine bukovih stabala*

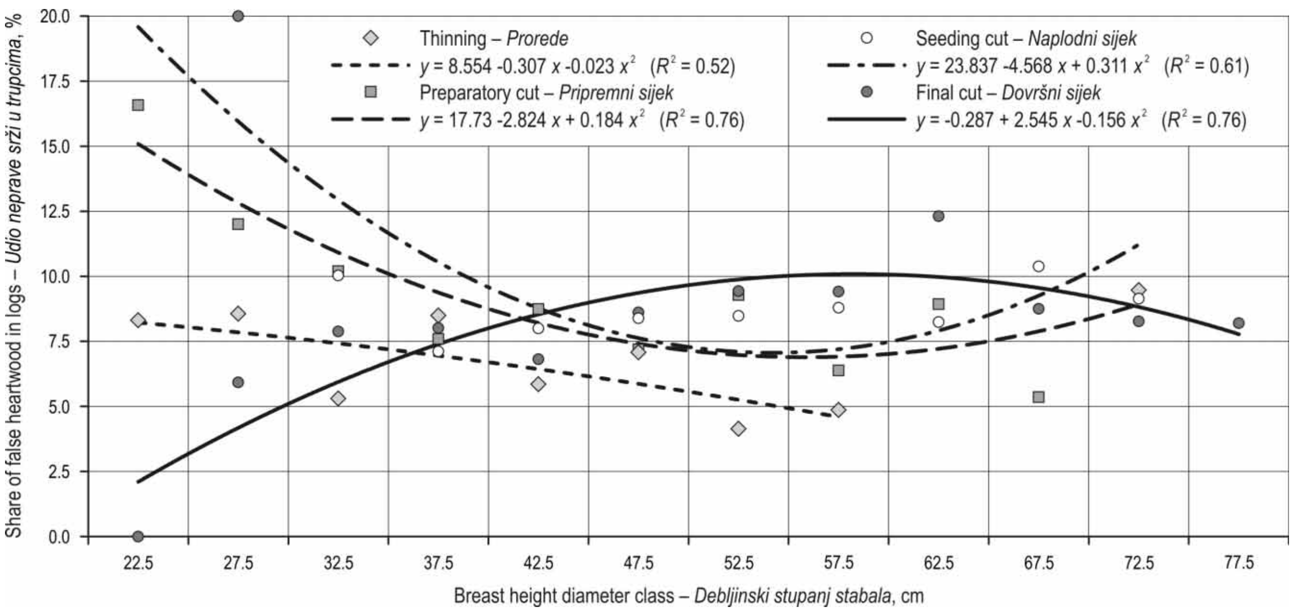

Fig. 5 Share of false heartwood volume in the volume of processed logs of beech trees

Slika 5. *Postotni udjeli obujma neprave srži u obujmu tehničke oblovine bukovih stabala*

The lowest mean values were recorded with trees with false heartwood in thinnings and then trees in preparatory cut. With trees in preparatory cut the increase of heartwood volume of logs of larger diameter classes is not as significant as with trees in seeding and final cut. In this respect, trees with false heartwood in seeding and final cut show very close values and an almost linear dependence.

Mean percentage values of the share of false heartwood volume of processed logs, presented in Fig. 5, show considerably different characteristics, almost contrary to absolute values. The more or less regular increase of mean percentage values of false heartwood volume in the volume of processed logs from thinning to final cut is a common feature with absolute values of false heartwood volume in the volume of logs.

A weaker correlation between the mean absolute values of false heartwood volume in the volume of processed logs and the trend line is the effect of a considerably higher range of stand age of thinnings, where the measurements were carried out. This age ranges between 50 and 91 in thinnings, between 96 and 111 in preparatory cuts, between 101 and 112 in seeding cuts, while in final cuts it ranges between 98 and 112. As the above mentioned researches outlined the older age of beech trees (from 60 to 90 years) as the beginning of intensive formation of false heartwood, the sample of trees from thinning stands is the least homogenous in that respect (stand age). Mean values of absolute volume of false heartwood by breast diameter classes in seeding and final cuts show a great similarity and strong correlation, as well as trend lines of these types of cut.

For all types of cut, except for final cut, the percentage shares of false heartwood volume in the volume of processed logs show a decreasing trend by breast height diameter classes. This trend may be explained by the fact that absolute volume of processed logs increases with the increase of the diameter at breast height, and consequently the percentage share of processed logs with false heartwood decreases. On the other hand, trees with smaller diameter at breast height with false heartwood show larger shares of false heartwood in the volume of processed logs due to a lower share of volume of logs. This all leads to a more or less decreasing trend of percentage shares of false heartwood in the volume of processed logs. In this respect mean values of thinning stands show a linear correlation.

3.4 Influence of heartwood on quality and market value of logs – *Utjecaj neprave srži na kakvoću i vrijednost tehničke oblovine*

False heartwood affects most significantly the structure of beech assortments of the highest quality in terms of lowering their quality and market value. European Standards (EN 1316-1:1999) allow up to 20% of sound false heartwood in A quality class and up to 30% in B quality class, while there are no limits for C and D classes. Star-like heartwood is not allowed in A class, in B class it may be present up to

Table 2 Share of logs of A-s and B-s in A and B class according to number and volume

Tablica 2. *Udio trupaca podrazreda A-s i B-s u A i B razredu kakvoće prema broju komada i obujmu*

Type of felling *Vrsta sijeka*	(Sub)compartment *Odjel/Odsjek*	A		A-s				B		B-s			
		Number of logs *Broj trupaca*	Volume of logs *Obujam trupaca*	Number of logs *Broj trupaca*	Volume of logs *Obujam trupaca*	Share in number *Udio u broju*	Share in volume *Udio u obujmu*	Number of logs *Broj trupaca*	Volume of logs *Obujam trupaca*	Number of logs *Broj trupaca*	Volume of logs *Obujam trupaca*	Share in number *Udio u broju*	Share in volume *Udio u obujmu*
		n	m^3	n	m^3	%		n	m^3	n	m^3	%	
Seeding *Naplodni*	66a	47	32.54	4	2.99	8.51	9.20	122	79.79	8	66a	47	32.54
Final *Dovršni*	11a	25	21.61	6	5.31	24.00	24.59	76	62.56	7	11a	25	21.61
Final *Dovršni*	38a	69	79.45	10	12.70	14.49	15.98	108	103.4	18	38a	69	79.45
Final *Dovršni*	94b	82	104.8	14	19.47	17.07	18.58	140	141.6	24	94b	82	104.8
Final *Dovršni*	95b	47	65.78	3	3.22	6.38	4.90	70	67.33	2	95b	47	65.78
Total – *Ukupno*		270	304.18	37	43.69	13.70	14.36	516	454.68	59	69.45	11.43	15.27

10%, and in C class up to 40%, while in D class there are no limits. The influence of false heartwood on the quality and value of wood assortments can be primarily determined through the share of sub-classes in the classes of the highest quality (A and B class) of beech processed logs. The European standard EN 1316-1:1999 for beech provides the possibility of application of sub-class A-red (A-s) and B-red (B-s) depending on trade agreements. In these sub-classes, unlimited presence (up to 100%) of homogenous

Table 3 Share of trees with A-s and B-s logs in the number of trees with A and B class logs according to diameter class

Tablica 3. *Udio broja stabala s trupcima A-s i B-s podrazreda u odnosu na broj stabala s trupcima A i B razreda kakvoće ovisno o debljinskom stupnju*

Diameter class *Debljinski stupanj*	A	A-s		B	B-s	
	Number of tress *Broj stabala*	Number of tress *Broj stabala*	Share *Udio*	Number of tress *Broj stabala*	Number of tress *Broj stabala*	Share *Udio*
cm	n	n	%	n	n	%
32.5	–	–	-	2	–	-
37.5	1	–	–	10	–	-
42.5	17	1	5.9	34	2	5.9
47.5	27	2	7.4	60	3	5.0
52.5	33	3	9.1	76	7	9.2
57.5	43	5	11.6	75	9	12.0
62.5	49	7	14.3	67	9	13.4
67.5	31	7	22.6	41	9	22.0
72.5	31	8	25.8	32	8	25.0
77.5	15	4	26.7	19	7	36.8
82.5	2	–	–	6	1	16.7
87.5	2	–	–	3	–	-
Total – *Ukupno*	251	37	14.7	425	55	12.9

and sound false heartwood (red heartwood) is allowed. In other words, processed logs is classified into these sub-classes (A-s and B-s) if by its dimensions and other criteria it meets the requirements of A and B class, and however contains an excessive share of homogenous and sound false heartwood.

As the appearance, development and share of false heartwood in thinnings and preparatory cuts is not very significant, which was determined by previous researches (Prka 2003, Prka 2005, Krpan et al. 2006), these sub-classes of wood assortments of the highest quality have no significant effect on the assortment structure of thinnings and preparatory cuts. The presence of these sub-classes was investigated on 519 trees of seeding and final cut. Table 2 shows the percentage share of sub-class A-s and B-s according to number of pieces of processed logs and share in the volume of processed logs of quality class A and B. A-s logs account, on average, for 14.36% in total volume of A class logs, and B-s logs account for 15.27% in total volume of B class logs.

It can be concluded that approximately 15% of the volume of wood assortments of the highest quality (A and B quality class) have these characteristics in seeding and final cuts (excessive share of sound false heartwood for A and B quality class). It was determined by previous researches that with respect to the volume of large wood the share of A-s sub-class in A quality class, depending on the diameter class, ranges between 0.3 and 2%, and the share of B-s sub-class in B quality class between 1.1 and 3.2% (Prka 2008).

Table 3 shows the percentage share of the number of trees by diameter classes that contain A-s and B-s quality sub-classes in the number of trees with A and B class logs. The increase can be clearly seen of the percentage share of the number of trees containing logs of these two sub-classes with the increase of diameter at breast height (diameter class) of the tree, which corresponds to the results of researches stated above. The share of A-s logs is, on average, 14.7% of the number of trees with A logs, and it ranges between 5.9% and 26.7%. The share of B-s is 12.9% with respect to the number of trees with B logs and it ranges between 5.0% and 36.8% (Table 3).

4. Conclusion – *Zaključak*

False heartwood of beech affects considerably the quality of processed assortments in beech felling sites. The impact of individual types of cut on the assortment structure of beech felling sites will primarily depend on the number of trees affected by the process of development of false heartwood. This number ranges between 11.7% of trees in thinnings, more than 54.7% of trees in preparatory cut and 71.3% in seeding cut and up to 84.6% of trees with false heartwood in final cut. Hence, with the increase of the diameter at breast height of the tree, the number of tree with false heartwood increases, as well as the length of processed logs with false heartwood and the volume of red heartwood in the volume of processed logs of the tree. Contrary to that, the percentage share of false heartwood in the volume of processed logs decreases with the increase of diameter at breast height of the tree, except in final cut.

The appearance of false heartwood has no special significance in planning assortment structures in thinnings of even-aged beech stands, considering the fact that about 10% to 15% of trees with false heartwood may be expected in older thinnings. On the other hand, in planning assortment structures of preparatory, seeding and final cuts, the appearance of false heartwood may be expected in approximately 55% to 85% of marked trees. In seeding and final cuts approximately 15% of the volume of wood assortments of the highest quality (A and B quality class) has an excessive share of sound false heartwood in A and B quality class. With respect to the volume of large wood, the share of A-s sub-class, depending on the diameter class, ranges between 0.3 and 2%, and the share of B-s quality class between 1.1 and 3.2% of the volume of large wood (up to 7 cm over bark).

The distribution of trees in the sample with false heartwood, by type of cut and diameter class, fits fully into the latest researches of the cause of formation of false heartwood in beech trees (Torelli 1984, Torelli 1994). Therefore, these results should be interpreted as the disruption of balance of water regime within the tree and dehydration of the central part of the tree trunk due to the disturbance of physiological balance in older trees. In investigating assortment structure of beech felling sites, the frequency of occurrence and volume of false heartwood in main fellings is the factor that affects considerably the quality of processed logs.

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Sažetak

Obilježja i udio neprave bukove srži u brdskim sječinama središnje Hrvatske

Greške se obloga drva odnose na nepravilnosti građe, teksture, boje i konzistencije. One smanjuju tehnička svojstva, otežavaju obradu i umanjuju stupanj upotrebljivosti drva. Neke greške drva nastaju kao posljedica

fenomena rasta i razvoja stabla pa je i sam pojam »greške drva« relativan. Obična bukva pripada bakuljavim vrstama, koje starenjem fakultativno ili uvijek stvaraju obojenu srž nepravilnoga oblika. Takva obojena bukova srž naziva se neprava srž (prevedenica od njem. Falschkern – lažna jezgra), crveno srce, smeđe srce ili jezgra. Osim spomenutih naziva udomaćen je naziv kern (njem. Kern).

Neprava bukova srž, kao pojavnost od značajnoga utjecaja na kakvoću tehničkoga drva, izaziva stručni i znanstveni interes već više od 100 godina (Krpan i dr. 2006). Brojne teorije i tumačenja nastanka neprave srži i danas su hipotetske. Kako navodi Glavaš, Tusson (1905) pretpostavlja da neprava bukova srž nastaje kao reakcija drvnih stanica na napad gljiva. Poslije je utvrđeno da primarni uzrok nastanka neprave srži kod bukve nije biotski već abiotski čimbenik (Zycha 1958). Nastanak neprave bukove srži posljedica je reakcije živih drvnih stanica na prodor zraka odnosno kisika u deblo. Kisik na žive stanice djeluje kao otrov, a one se brane anatomskim i kemijskim promjenama (tile, oksidacija, tvorba obojenih tvari) u pokušaju da spriječe daljnje prodiranje zraka. Tvari nastale kao rezultat takvih staničnih reakcija ne ulažu se u stanične stijenke, nego su uz njih prilegnute, a to je osnovna razlika između prave i neprave srži (Glavaš 1999).

Čimbenici postanka svih tipova srži dijele se na obligatne i fakultativne. Za stvaranje je neprave srži potreban prodor određene količine zraka u unutrašnjost stabla. Fakultativni su čimbenici: prirodno starenje stanica parenhima, suviše velik prodor zraka u stablo, niske temperature (s velikom sušom u prethodnom ljetu), prisutnost gljiva razarača drva i gljiva koje mijenjaju boju drva, genetske predispozicije te šumskouzgojne mjere i ostali čovjekov utjecaj. Pojava i razvoj pojedinoga tipa neprave srži nije uvijek uvjetovana utjecajem jednoga čimbenika, nego je to obično kombinacija više njih. Potvrđeno je da postoji veza između postanka i stupnja razvoja neprave srži i fiziološkoga stanja u unutrašnjosti stabla. U posljednjih je dvadesetak godina dotadašnje spoznaje u velikoj mjeri nadopunio svojim istraživanjima Torelli (1984, 1994). Prema tom autoru neprava bukova srž uzrokovana je djelovanjem okoliša, a svi čimbenici koji izazivaju smanjenje sadržaja vode u središnjem dijelu debla odgovorni su za njezin nastanak.

U bukovih stabala s crvenom srži česta je pojava specifične bijele truleži nazvane piravost, prozuhlost ili prešlost bukova drva. Ona nastaje kada gljive uzročnici truleži prodru u drvo kroz ozljede, prijelome grana, čeone strane trupaca itd., te se u njem razvijaju. Piravost bukovine uzrokuje više specifičnih gljiva, a najčešće su Schizophyllum commune Fr., Hypoxylon coccineum (Pers.) Wind., H. fragiforme (Person ex Fries) Kicky, Tremella faginea Britz., Stereum purpureum Pers., Biospora monilioides Corda i druge. Piravost, kao specifičan oblik bijele truleži u drvu s nepravom srži, ne teče jednoliko, nego se širi u obliku lisa, jezika i slično. Razlog tomu je činjenica da su se različiti dijelovi bukova drva različito osržili te u njima tvari osržavanja i tile pružaju različit otpor gljivama truležnicama. Neprava srž ipak ne može spriječiti truljenje. Ona samo uvjetuje da trulež teče sporije i nejednoliko (Glavaš 1999, 2003).

Istraživanja su neprave bukove srži provedena u brdskom kontinentalnom dijelu Republike Hrvatske u gospodarskoj jedinici »Bjelovarska Bilogora« Šumarije Bjelovar. Matični je supstrat pretežito suhi facijes karbonatnoga prapora. Tla pripadaju kategoriji dubokih tala i imaju vrlo povoljan mehanički sastav te najčešće tvore ilovače, glinaste ilovače i lake gline. Terensko je istraživanje primjernih bukovih stabala obavljeno u 36 odsjeka pri 46 sjekova. Svi odsjeci pripadaju ekološko-gospodarskomu tipu II–D–11 i uređajnomu razredu »bukva« s ophodnjom od 100 godina.

Apsolutni i postotni udjeli neprave srži (kerna) izražavani su u drvnom obujmu tehničke oblovine prema normi, koja za izračun obujma trupaca propisuje Huberovu formulu. Za izračun obujma neprave srži u trupcu primijenjena je Smalianova formula. U prorednim je sječinama obrađen uzorak od 787 bukovih stabala. Gotovo identična veličina uzorka, 788 stabala, iz pripremnoga je sijeka. U naplodnom je sijeku veličina uzorka 467, a u dovršnom 266 bukovih stabala (tablica 1).

Ukupna postotna zastupljenost bukovih stabala s nepravom srži kod pojedine vrste sijeka raste od proreda, gdje iznosi 11,7 %, do dovršnoga sijeka, gdje je osrženo 84,6 % stabala. Prosječna starost stabala uzorka po vrsti sijeka iznosi 76 godina za proredne sječine, 104 godine za pripremni sijek, a za naplodni i dovršni sijek prosječna je starost primjernih stabala 106 godina. Postotna zastupljenost bukovih stabala s nepravom srži po debljinskim stupnjevima i vrsti sijeka prikazana je na slici 2. Debljinski stupanj s najvećim brojem osrženih stabala povećava se od prorede do dovršnoga sijeka. Takva raspodjela stabala uzorka s nepravom srži, po vrsti sijeka i debljinskim stupnjevima, potpuno se uklapa u najnovija istraživanja uzroka nastanka neprave srži u bukovih stabala (Torelli 1984, 1994).

Duljina tehničke oblovine stabla koja je zahvaćena stvaranjem neprave srži mjerena je prilikom preuzimanja tehničke oblovine. Ona predstavlja ukupnu duljinu tehničke oblovine stabla kod koje se neprava srž pojavljuje barem na jednom čelu (prerezu) trupca prilikom prikrajanja i prerezivanja tehničke oblovine prema Hrvatskim normama. Prema načinu mjerenja vidi se da je stvarna uzdužna rasprostranjenost neprave srži u deblu stabla, odnosno u tehničkoj oblovini iz razumljivih razloga ostala djelomično nepoznata. Ukupna duljina neprave srži u tehničkoj oblovini svakako je nešto manja od tako izmjerene veličine. Podaci o srednjoj (prosječnoj) vrijednosti duljine tehničke oblovine zahvaćene nepravom srži po vrsti sijeka i debljinskim stupnjevima prikazani su na slici 3.

Na slici 4 vidljiv je porast prosječnih apsolutnih vrijednosti obujma osrženoga dijela tehničke oblovine po debljinskim stupnjevima od proreda prema dovršnom sijeku. Najnižim srednjim vrijednostima ističu se stabla s nepravom srži prorednih sječina te zatim stabla pripremnoga sijeka. Kod stabala pripremnoga sijeka porast osrženoga obujma tehničke oblovine većih debljinskih stupnjeva nije tako značajan kao kod stabala naplodnoga i dovršnoga sijeka.

Srednje postotne vrijednosti udjela obujma osrženoga dijela tehničke oblovine stabala, koje su prikazane na slici 5, pokazuju bitno različita, gotovo suprotna obilježja od apsolutnih vrijednosti. Zajedničko s apsolutnim vrijednostima osrženoga dijela tehničke oblovine manje je ili više pravilno povećanje srednjih postotnih vrijednosti udjela osrženoga dijela u obujmu tehničke oblovine od proreda prema dovršnomu sijeku.

Za sve vrste sijeka, osim dovršnoga, postotni udjeli obujma osrženoga dijela tehničke oblovine po debljinskim stupnjevima pokazuju padajući trend. Taj se trend može tumačiti činjenicom da s porastom prsnoga promjera stabla raste i apsolutni obujam tehničke oblovine te zbog toga postotni udio tehničke oblovine s nepravom srži opada. S druge strane, stabla manjih prsnih promjera s nepravom srži pokazuju veće udjele osrženoga dijela tehničke oblovine zbog manjega udjela obujma same tehničke oblovine. Sve to dovodi do manje ili više padajućega trenda postotnih udjela osrženoga dijela tehničke oblovine. Srednje vrijednosti prorednih sječina u tom pogledu pokazuju linearnu međuzavisnost.

Najznačajniji utjecaj neprava srž ima na strukturu najkvalitetnijih bukovih sortimenata jer smanjuje njihovu kakvoću, odnosno tržišnu vrijednost. Europske norme dopuštaju do 20 % zdrave neprave srži u A razredu kakvoće i do 30 % u B razredu kakvoće, dok za C i D razrede nema ograničenja. Zvjezdasta srž nije dopuštena u A razredu, u B razredu može je biti do 10 %, a u C razredu do 40 %, dok za D razred nema ograničenja. Utjecaj neprave srži na kakvoću i vrijednost drvnih sortimenata ponajprije je moguće odrediti preko zastupljenosti podrazreda u najkvalitetnijim razredima (A i B razredu) kakvoće bukove tehničke oblovine. Naime, Europska norma EN 1316-1:1999 za bukvu predviđa mogućnost primjene podrazreda A-crvena (A-s) i B-crvena (B-s), što ovisi o trgovačkim dogovorima. U tim podrazredima dopuštena je neograničena (do 100 %) prisutnost homogene i zdrave neprave srži (crvenoga srca). Drugim riječima, tehnička oblovina razvrstana u ove podrazrede (A-s i B-s) po svojim dimenzijama i ostalim greškama zadovoljava kriterije A i B razreda, ali ima prevelik udio homogene i zdrave neprave srži.

S obzirom na to da pojava, razvoj i udio neprave srži kod proreda i pripremnih sjekova nema veliko značenje, što je utvrđeno ranijim istraživanjima (Prka 2003, 2005, Krpan i dr. 2006), ti podrazredi najkvalitetnijih drvnih sortimenata nemaju značajniji utjecaj na sortimentnu strukturu proreda i pripremnih sjekova. Zastupljenost ovih podrazreda kakvoće istražena je na 519 stabala naplodnoga i dovršnoga sijeka. Postotni je udio podrazreda A-s i B-s prema broju komada tehničke oblovine i udjelu u obujmu tehničke oblovine A i B razreda kakvoće prikazan u tablici 2. Trupci A-s podrazreda kakvoće prosječno sudjeluju s 14,36 % u ukupnom obujmu trupaca A razreda kakvoće, a trupci B-s podrazreda kakvoće sudjeluju s 15,27 % u ukupnom obujmu trupaca B razreda kakvoće. Može se zaključiti da približno 15 % od obujma najkvalitetnijih drvnih sortimenata (A i B razreda kakvoće) kod naplodnih i dovršnih sjekova ima ove značajke, odnosno prevelik udio zdrave neprave srži za A i B razred kakvoće. Prijašnjim je istraživanjima utvrđeno da se u odnosu na obujam krupnoga drva za A razred kakvoće udio A-s podrazreda, ovisno o debljinskom stupnju, kreće od 0,3 do 2 %, a udio B-s podrazreda u B razredu kakvoće od 1,1 do 3,2 % (Prka 2008).

Postotni udio broja stabala po debljinskim stupnjevima koji sadrže trupce A-s i B-s podrazreda kakvoće u broju stabala s trupcima A i B razreda kakvoće prikazan je u tablici 3. Vidljiv je porast postotnoga udjela broja stabala koja sadrže trupce tih dvaju podrazreda s porastom prsnoga promjera (debljinskoga stupnja) stabla, što se uklapa u prije iznesene rezultate istraživanja. Udio trupaca A-s podrazreda kakvoće prosječno iznosi 14,7 % od broja stabala s trupcima A razreda kakvoće, a kreće se od 5,9 % do 26,7 %. Udio trupaca B-s podrazreda kakvoće iznosi 12,9 % u odnosu na broj stabala s trupcima B razreda kakvoće te se kreće od 5,0 % do 36,8 % (tablica 3).

Raspodjela stabala uzorka s nepravom srži po vrsti sijeka i debljinskim stupnjevima uklapa se u najnovija istraživanja uzroka nastanka neprave srži kod bukovih stabala (Torelli 1984, 1994). Stoga ove rezultate treba tumačiti narušavanjem ravnoteže vodnoga režima unutar stabla i dehidracijom središnjega dijela debla zbog poremećaja fiziološke ravnoteže u kasnijoj životnoj dobi stabla. Pri istraživanju sortimentne strukture bukovih sječina učestalost pojave i obujam neprave srži u sječinama glavnoga prihoda čimbenik je od vrlo velike važnosti na kakvoću tehničke oblovine.

Ključne riječi: neprava bukova srž, bukove sječe

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