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THE DYNAMICS OF STEM NECROSIS OCCURRENCE IN MOUNTAIN STANDS OF VARYING FOREST COVER INDEX AND GROUND SLOPE

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Abstract. The aim of this study was to analyse the frequency and extent of mechanical damage of tree stems in mountain spruce stands of varying forest cover index and ground slope, without taking into account the technology used in obtaining wood. The study was conducted in 17 spruce stands located in the Sudetes and the Carpathians. In the stands the 1 ha test surfaces were established. The damage on trees with dbh ≥ 18 cm was measured. As a result of the analysis it was found that the most damaged trees grew in the stand with forest cover ratio of 0.7 and 1.0, while taking into account the decline of the area most damage was found in the stands with a slope of 16 to 25°. The study, however, showed no clear relationship between the position of necrosis on tree stems (its size and height) and forest cover and a decrease of the area.

Key words: mechanical damage, spruce, necrosis, stand density index, slope

INTRODUCTION AND AIM

The problem of stand damage increases with the interference in the forest due to mechanization of forest operations. Damage is found mainly in soil, undergrowth, seedlings and saplings as well as on the stems of trees remaining in the stand. The damage that is the most measurable and has long-term effects is done to the trees that remain in the stand after forest management operations. Damage to tree stems caused by logging or timber harvesting is classified as open necrosis, and later, after several years, as overgrown necrosis. Depending on the tree species, its resilience and ability to heal injuries caused by such damage may be different. Below an injury, there may appear only some discoloration of wood but rot can also develop there.

The problem of the damage from timber harvesting has long been of interest to many researchers [Gil et al. 1987, Paschalis and Porter 1994, Giefing and Mana 1995, Suwała 2003 a, b, Zastocki 2003, Sowa and Stańczykiewicz 2004, 2005, Sowa et al. 2011, Stańczykiewicz et al. 2011]. The studies listed above focus mainly on the current

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assessment of the number and size of injuries resulting from timber harvesting and skidding by means of different technologies. By contrast, few scholars are concerned with the number and size of injuries to the stems of trees remaining in the stands until the age of felling (following all the treatments: stand cleanings and thinnings), and the impact of stand indexes of a stand or terrain conditions on the frequency of these injuries.

The aim of this study is to analyse the frequency and size of mechanical damage to stems in mature spruce stands of different stand density indexes and slopes, located in the mountains (the Sudeten and the Carpathians), without regard to timber harvesting technologies used in these stands in the past.

MATERIAL AND METHODS

The study was conducted in 17 spruce stands located in the Sudeten (8 stands) and Carpathian Mts (9 stands). Selected stands reached the age of felling and all of the planned operations had already been completed. The stands were selected with regard to different stand indexes (Table 1). In these stands, research plots of 1 ha each were set up, in the shape of squares, in the most representative places of a given stand. On these plots, measurements were taken of damage occurring in the trees with the breast-height diameter ≥ 18 cm (the minimum size for large-sized wood) [Warunki techniczne... 2002]. When determining the height of a necrosis, in the case when it occurred several times on a single stem, the lowest located cases were taken into account. Necrosis that is located in this way is critical in the classification of spruce timber. The analyses compared only the absolute locations of necrosis.

Table 1. Characteristics of research plots
Tabela 1. Charakterystyka powierzchni badawczych

Number of research plot Numer powierzchni badawczej	Regional Directorate of State Forests, forest district, forest subdistrict, division, subdivision RDLP, Nadleśnictwo, leśnictwo, oddział, pododdział	STL	Age Wiek	Stand density index Wskaźnik zadrzewienia	Crown closure Zwarcie	Slope Spadek terenu °	Altitude a.s.l. Wysokość n.p.m. m
1	2	3	4	5	6	7	8
1	Wrocław, Śnieżka Karpacz, 292 f	BWG	128	0.8	przer	27	1 100
2	Wrocław, Śnieżka Karpacz, 282 f	BG	138	0.7	przer	23	860
3	Wrocław, Szklarska Poręba Szronowiec, 310 b	LMG	94	0.8	przer	10	670
4	Wrocław, Kamienna Góra Jarkowice, 249 h	BMG	114	1.0	um	16	590

Table 1 – cont. / Tabela 1 – cd.

1	2	3	4	5	6	7	8
5	Wrocław, Zdroje Piekiełko, 318 d	LG	148	0.9	um	26	500
6	Wrocław, Lądek Zdrój Kamienica, 240 b	BMG	106	0.9	przer	19	930
7	Wrocław, Lądek Zdrój Kamienica, 278 a	BMG	101	1.1	przer	16	1 110
8	Katowice, Prudnik Moszczanka, 191 j	LG	105	0.8	przer	5	470
9	Katowice, Jeleśnia Sopotnia Dolna, 164 a	BMG	118	0.8	przer	20	1 150
10	Katowice, Jeleśnia Sopotnia Dolna, 160 d	LMG	118	0.8	przer	15	950
11	Katowice, Jeleśnia Sopotnia Dolna, 150 g	LMG	123	0.9	um	22	1 025
12	Kraków, Myślenice Sidzina, 137 a	BMG	95	1.2	pełne	15	1 070
13	Kraków, Myślenice Sidzina, 133 b	LMG	95	1.1	pełne	17	950
14	Kraków, Myślenice Sidzina, 146 a	BMG	105	1.1	pełne	12	1 020
15	Kraków, Krościenko Czarna Woda, 10 a	LMG	105	0.7	przer	25	1 100
16	Kraków, Gorlice Małastów, 298 b	LG	92	0.7	przer	15	650
17	Tatrzański Park Narodowy Łysa Polana, 84 b	LG	110	0.8	um	6	1 200

Explanations: STL – site type of forest, BWG – high mountain coniferous forest, BG – mountain coniferous forest, LMG – mountain mixed forest, BMG – mixed mountain coniferous forest, LG – mountain forest, przer – broken, um – moderate, pełne – full.

Objaśnienia: STL – siedliskowy typ lasu, BWG – bór wysokogórski, BG – bór górski, LMG – las mieszany górski, BMG – bór mieszany górski, LG – las górski, przer – przerywane, um – umiarkowane.

The sizes of necrosis located in the butt parts of the trees up to the height of 2 meters from the ground surface were determined by measuring, in accordance with the principles specified in the standard [PN-79/D-01011 1980] (in the case of overgrown necrosis, the trace left by it on the bark was measured). When necroses were located on the stems at the height above 2 meters, their sizes were estimated in accordance with the principles adopted in the course of standing timber quality assessment. Then, during classification of the necroses with respect to their size, those with the largest size were selected for examination as it is this feature that determines the rate of injury overgrowing. The necrosis areas were calculated using the formula for the ellipse field. The analysis included determination of the share of damaged trees in relation to the number of trees in a particular group of the analysed stands.

Due to the fact that the analysed data showed no normal distribution, further tests were performed with the use of the nonparametric Kruskal-Wallis test. This test was used to demonstrate the significance of differences in the location and area of necrosis located on the stems of trees which came from stands of different stand density and slope indices.

RESULTS

Analysing the level of damage, it was found that the largest number of damaged trees, i.e. 44.7%, occurred in stands with the lowest stand density index = 0.7, while the smallest number, i.e. 24.6%, was found in the stands with the highest stand density index = 1.2 (Fig. 1). Taking into account the slope, the largest share of damaged trees, i.e. 43.6%, was recorded in stands growing in areas with the slope of 21-25°, and the smallest share, i.e. 14.1%, in areas with the slope of 26-30°.

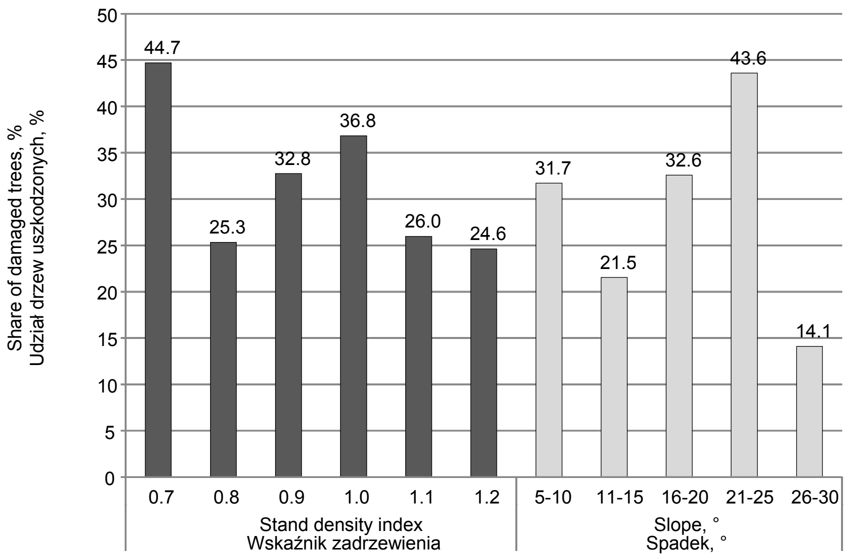

Fig. 1. Share of damaged trees in stands with different stand density indices and slopes

Rys. 1. Udział drzew uszkodzonych w drzewostanach o różnym wskaźniku zadrzewienia i spadku terenu

Considering forest stands of different stand density indices, it was observed that the average height of location of open necrosis was the largest both in the stands with the lowest (0.7) index: 0.78 m, and in the stands with the highest (1.2) index: 0.83 m (Fig. 2). The highest location of necrosis was, however, reported in the stands with the index of 1.1, where it amounted to 6.0 m (Table 2). The lowest position of the defect in question was found in the stands with the index of 1.0. When studying the height of overgrown necrosis, it was noted that in almost all stands the height of this damage was similar: approximately 1 m. Only in the stands with the index of 1.1 was open necrosis

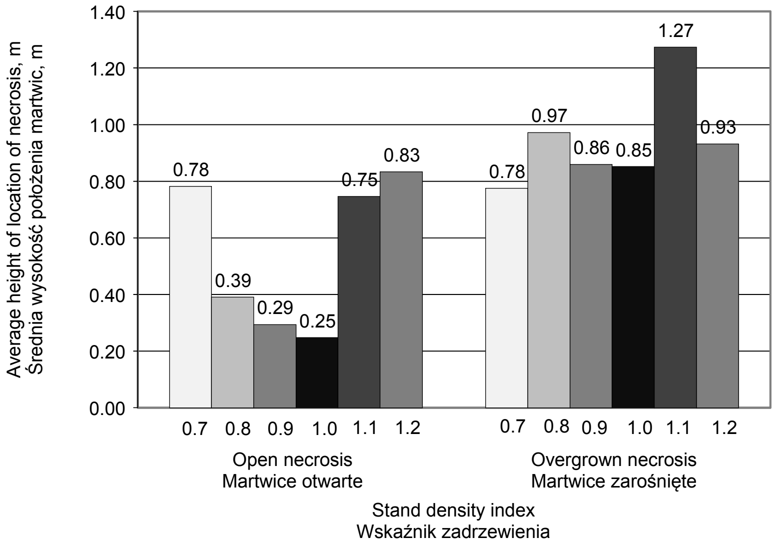

Fig. 2. Average height of location of open and overgrown necrosis in stands with different stand density indices

Rys. 2. Średnia wysokość położenia martwic otwartych i zarośniętych w drzewostanach o różnym wskaźniku zadrzewienia

located on average at a height of 1.27 m, with the highest value noted at 10.0 m (Fig. 2 and Table 2). Analyzing the damage area, it was found that the highest average size of open necrosis occurred in the stands with the stand density index of 0.7 and 1.0; respectively 920.29 cm^2 and 1,165.91 cm^2 (Fig. 3). In the other groups of stands, necrosis sizes were at a similar level: from about 500 to 600 cm^2. The group stands with the stand density index of 0.7 also had the maximum area of open necrosis: 6,868.8 cm^2 (Table 2). A similar situation occurred in the case of overgrown necrosis. Also here the stands with the stand density index of 0.7 had the highest average and maximum necrosis areas: 701.84 cm^2 (on average) and up to 31,400.0 cm^2 (max) respectively (Table 2). Comparing the height of location and the size of necrosis (open and overgrown) on the stems of trees from stands with different stand density indices, statistically significant differences were found between all the groups of data (H from 26.9609 to 88.0191 and p = 0.0000).

Analysing the slope, in the case of the height of location of open necrosis, one can notice a generally higher location of necrosis occurring with a greater slope (Fig. 4). The lowest average height of location of open necrosis was observed in the stands with the slope in the range of 5-10°, while the highest was in the range of 26-30°. Overgrown necrosis showed no such trend. The lowest average location of overgrown necrosis was noted in stands with the slope in the range of 21-25°; while the highest was in the range of 11-15°. Those stands also showed the largest maximum height of this defect: 10 m (Table 3). Considering the size of the damage, in the case of open necrosis it was found that the largest average size of necrosis characterised the trees growing in stands with the slope of 5-10° (742.48 cm^2) while the smallest size was noted in the stands with the slope of 11-15° (478.81 cm^2). In the other groups of stands, the size of necrosis was at a similar level: from about 635 to 657 cm^2. Overgrown necrosis showed a tendency

Table 2. Statistical characteristics of open and overgrown necrosis in stands with different stand density indices
Tabela 2. Charakterystyki statystyczne dla martwic otwartych i zarośniętych w drzewostanach o różnym wskaźniku zadrzewienia

Statistical characteristic Charakterystyka statystyczna	Stand density index – Wskaźnik zadrzewienia					
	0.7	0.8	0.9	1.0	1.1	1.2
Open necrosis – Martwice otwarte						
Necrosis location height Wysokość położenia martwicy						
Standard deviation Odchylenie standardowe	0.5392	0.6289	0.4695	0.7750	1.1036	0.9695
Coefficient of variability Współczynnik zmienności	68.96	160.96	159.59	312.98	147.80	116.34
Max	2.30	4.00	3.00	3.50	6.00	4.00
Min	0	0	0	0	0	0
Necrosis area Powierzchnia martwicy						
Standard deviation Odchylenie standardowe	1 085.0369	704.5539	897.5216	1 282.4666	805.8653	667.5333
Coefficient of variability Współczynnik zmienności	117.90	129.83	149.65	110.00	163.09	125.05
Max	6 868.8	4 003.5	6 280.0	4 710.0	4 710.0	2 355.0
Min	31.4	7.1	19.6	188.4	12.6	12.6
Overgrown necrosis – Martwice zarośnięte						
Necrosis location height Wysokość położenia martwicy						
Standard deviation Odchylenie standardowe	0.4661	0.8425	0.6623	0.7362	1.2011	0.7630
Coefficient of variability Współczynnik zmienności	60.12	86.67	77.03	86.44	94.31	81.87
Max	3.00	5.00	3.00	3.50	10.00	3.00
Min	0	0	0	0	0	0
Necrosis area Powierzchnia martwicy						
Standard deviation Odchylenie standardowe	1 817.2689	642.0638	464.0310	594.4426	1 190.3602	745.9680
Coefficient of variability Współczynnik zmienności	258.93	154.74	153.78	180.14	203.74	235.11
Max	31 400.0	5 338.0	3 140.0	5 887.5	10 990.0	5 887.5
Min	25.1	9.4	11.8	15.7	11.0	3.1

Table 3. Statistical characteristics of open and overgrown necrosis in stands with different slopes
Tabela 3. Charakterystyki statystyczne dla martwic otwartych i zarośniętych w drzewostanach o różnym spadku terenu

Statistical characteristic Charakterystyka statystyczna	Slope, ° – Spadek terenu, °				
	5-10	11-15	16-20	21-25	26-30
Open necrosis – Martwice otwarte					
Necrosis location height Wysokość położenia martwicy					
Standard deviation Odchylenie standardowe	0.5929	0.7422	0.8975	0.5695	0.5429
Coefficient of variability Współczynnik zmienności	132.49	151.63	173.94	123.07	73.80
Max	3.00	4.00	6.00	3.00	2.00
Min	0	0	0	0	0
Necrosis area Powierzchnia martwicy					
Standard deviation Odchylenie standardowe	817.5906	828.4664	996.7999	867.0480	477.0568
Coefficient of variability Współczynnik zmienności	110.12	173.03	151.59	136.64	73.89
Max	4 003.5	4 710.0	6 280.0	6 868.8	1 648.5
Min	37.7	12.6	7.1	19.6	157.0
Overgrown necrosis – Martwice zarośnięte					
Necrosis location height Wysokość położenia martwicy					
Standard deviation Odchylenie standardowe	0.6507	1.3027	0.8128	0.4886	0.6903
Coefficient of variability Współczynnik zmienności	76.07	98.93	83.52	64.47	70.68
Max	3.50	10.00	5.00	3.00	3.00
Min	0	0	0	0	0
Necrosis area Powierzchnia martwicy					
Standard deviation Odchylenie standardowe	728.2527	2 452.8658	765.4073	721.4214	637.8316
Coefficient of variability Współczynnik zmienności	143.19	493.65	181.06	128.05	169.31
Max	5 338.0	31 400.0	9 812.5	4 710.0	3 140.0
Min	9.4	3.1	15.7	12.6	11.8

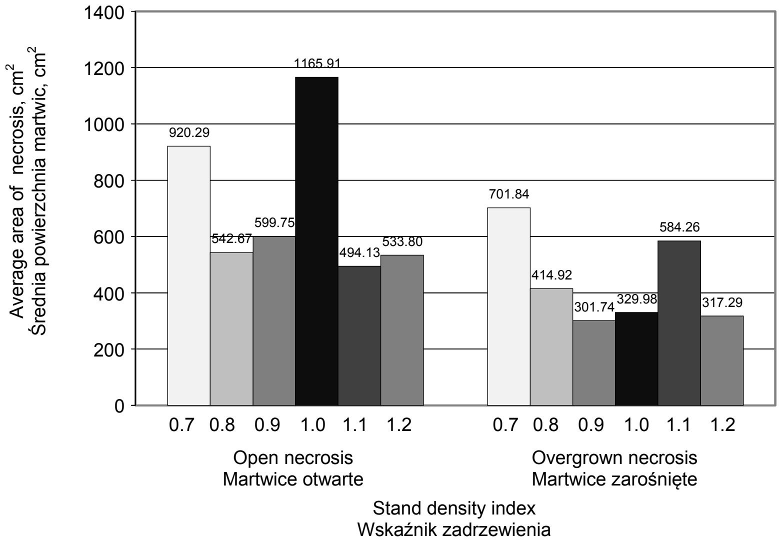

Fig. 3. Average area of open and overgrown necrosis in stands with different stand density indices
Rys. 3. Średnia powierzchnia martwic otwartych i zarośniętych w drzewostanach o różnym wskaźniku zadrzewienia

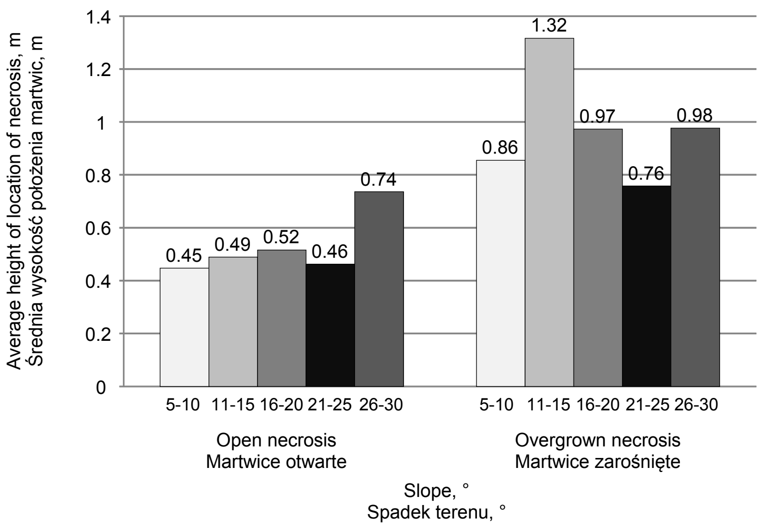

Fig. 4. Average height of location of open and overgrown necrosis in stands with different slopes
Rys. 4. Średnia wysokość położenia martwic otwartych i zarośniętych w drzewostanach o różnym spadku terenu

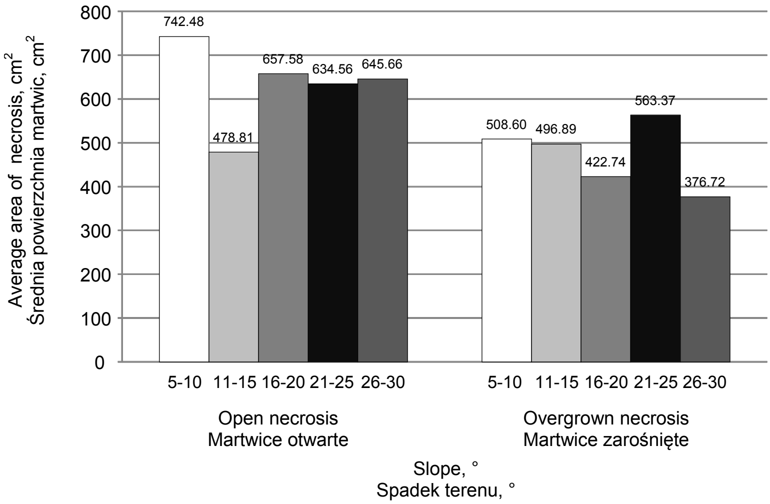

Fig. 5. Average area of open and overgrown necrosis in stands with different slopes

Rys. 5. Średnia powierzchnia martwic otwartych i zarośniętych w drzewostanach o różnym spadku terenu

to have smaller sizes with increasing slope (Fig. 5). The exception were the stands growing in areas with the slope of 21-25°, which had the highest average necrosis size: 563.37 cm^2. The maximum size of overgrown necrosis was noted in the stands with the slope of 11-15°: as large as 31,400 cm^2 (Table 3). When testing statistically the height and size of necrosis on the stems of trees growing in stands of different slopes, in most of the data groups the differences were statistically significant (H from 25.2709 to 85.3865 and p = 0.0000). Only when testing the height of location of open necrosis in trees growing in stands of different slopes, no significant differences were found between them (Kruskal-Wallis test: H = 5.9349, p = 0.2041).

DISCUSSION

The number and size of mechanical injuries of the stems, depending on the logging technology used and especially on the skidding means may fall in a wide range. Suwała [1999, 2003 a] noted that in timber harvesting with the short wood method using the chain saw and the forwarder 4.1% of standing trees were damaged whereas in the whole stem method using the saw and the skidder 8.6% were damaged. When harvesting with the use of the chain saw and horse skidding, 2.8% of standing trees were damaged. Other authors [Paschalis and Porter 1994] found that skidding with the use of horses damaged 2.8% of trees, the agricultural tractor: 1.8%, and the LKT skidder: 4.7% of trees. In turn, Gil et al. [1987] observed that during the skidding the Ursus C-328 tractor damaged 21.6% of trees, while using the Tree Farmer C-5 D skidder damaged up to 38.8% of trees. Measurements carried out in beech stands [Giefing and Mana 1995] showed that horse skidding of logs damaged from 1.5% to 4.1% of trees while the tractor damaged from 1% to 10.7% of trees. Sowa and Stańczykiewicz [2004] found that in mountain stands almost 10% of trees were damaged, in foothill stands: over 6%, and in lowland areas: over 3%. In the course of the present research, cutting and bucking of timber assortments were done using the chain saw; skidding was carried out by various means: the horse, the farm tractor and the skidder.

The examples mentioned above show that there is great interest in the level of damage caused by selected skidding means or technologies but few researchers deal with the number of damaged trees in mature stands, i.e. after all forest management treatments, as analyzed in the present study. In spruce stands this is particularly important because the presence of necrosis affects the result of quality-dimensional classification of wood. Any presence of necrosis disqualifies raw material by assigning it to class WC [Warunki techniczne... 2002], which also negatively affects its value. In the present study, when analyzing the stand density index, it was found that the share of damaged trees ranged from about 25 to 45%; when taking into account the slope, the share ranged from 14 to 44%. It follows that, in extreme cases, nearly half the trees in the stands had a reduced value. Another negative factor is the rapid development of rot in places of injury. Bressem [1996] states that in spruce only a small injury size (to about 10 cm^2) did not affect the health of the trees, while in the case of larger injuries, as soon as in the second year after injury from 80 to 100% of the injuries become infected by fungi. In the present study, the average area of an injury was very large. Depending on the stand groups, it ranged from about 300 to 1,165 cm^2 with the maximum size of 31,400 cm^2.

In the analyzed stands it can be seen that with the slope ranging from 11 to 25° the number of damaged trees increases. In stands with the slope above 25°, the lowest share of damaged trees was reported. This may be due to the skidding method (not analysed in this study). In stands with a large slope Gil [1999] recommends skidding with the use of the horse, which also causes little damage to the tree stand. The present study confirms the results obtained by Barszcz [1999] and Stańczykiewicz [2003], who found that with increasing slope, the number of trees injured as a result of treatments increases in the stands.

Taking into account the height of location of open necrosis in stands of different slopes, it was found that it reached a similar level: about 0.5 m. These results confirm those obtained by Sowa and Stańczykiewicz [2004], who showed that in the mountains the average height of location of injuries was about 0.5 m, while in the foothills and lowland areas those values were larger. This was explained by the skidding method, which in mountain areas consisted in hauling by means of horses. These authors reported surface damage with the average area up to 95 cm^2. In this study, depending on the stand group, the size of open necrosis ranged from 478 to 742 cm^2 while overgrown necrosis: from 376 to 563 cm^2.

CONCLUSIONS

1. In a vast majority of groups of the analysed stands, the share of trees with necrosis in relation to all the trees in the surveyed areas ranged from 20 to 50%. Most necroses were located at the height of about 0.5 m. Damage that is located so low adversely affects the quality and value of the thickest, and also the most valuable part of the stem. During maintenance jobs, damage should be maximally limited because injuries

on spruce stems determine the outcome of the quality-dimensional classification of timber, and thus also affect its value.

2. The injury area found in the present study was significantly larger than stated in research by other authors. Probably in the material analyzed in the present study it may be due to repeated damage done to the same trees (in subsequent cuts), resulting in the expansion of the necrosis. In the case of spruce, this phenomenon is very worrying because any minor damage results in the development of rot and further, progressive depreciation of the wood.

3. Statistically significant differences (in most cases) were shown between the height or area of necrosis located on the stems of trees in stands differing in the stand density index or the slope. Only when testing the height of location of open necrosis in trees growing in stands with different slopes, no significant differences were noted.

REFERENCES

Barszcz A., 1999. Analysis of the relations between wood defects. Zesz. Nauk. AR Krak. Leśn. 28, 5-16.

Bressem U., 1996. Wundbehandlung. AFZ Der Wald 17, 953-954.

Giefing D.F., Mana M., 1995. Uszkodzenia drzew w następstwie prowadzenia cięć przedrębnych w drzewostanach bukowych [Tree damage resulting from intermediate cutting in beech stands]. Pr. Kom. Nauk Roln. Nauk Leśn. PTPN 80, 43-48 [in Polish].

Gil W., 1999. Problemy wyboru środków do operacji pozyskaniowo-zrywkowych [Problems of the choice of means for harvesting-skidding operations]. Sylwan 6, 47-56 [in Polish].

Gil W., Sosnowski J., Stanibuła S., 1987. Szkody wyrządzane przy zrywce drewna przez ciągnik Tree Farmer C-5D oraz Ursus C-328 [The harm caused during skidding by the Tree Farmer C-5D tractor and the Ursus C-328 tractor]. Zesz. Nauk. AR Krak. Ses. Nauk. 17, 215, 107--119 [in Polish].

Paschalis P., Porter B. 1994. Próba oceny uszkodzeń drzew w wyniku prac zrywkowych w sosnowych drzewostanach przedrębnych [An attempt to assess damage to trees resulting from skidding in ripening pine stands]. Sylwan 9, 17-21 [in Polish].

PN-79/D-01011. Drewno okrągłe. Wady [Roundwood. Defects]. 1980. PKN, MiJ Warszawa [in Polish].

PN-91/D-95018. Drewno średniowymiarowe [Medium-sized wood]. 1993. PKN, MiJ Warszawa [in Polish].

Sowa J.M., Kulak D., Stańczykiewicz A., Szewczyk G., 2011. Rozmiar i charakter naruszeń wierzchniej warstwy gleby powstałych podczas pozyskiwania i zrywki drewna w trzebieżach wczesnych drzewostanów świerkowych [The size and nature of the violations of the top soil layer formed during timber harvesting and skidding in the early thinning of spruce stands]. Sylwan 155 (5), 330-339 [in Polish].

Sowa J.M., Stańczykiewicz A., 2004. Analysis of injuries occurring in trees as a result of timber harvesting. In: Proceedings of the International Scientific Conference on "Forest engineering: new techniques, technologies and the environment". Lviv, 329-337.

Sowa J.M., Stańczykiewicz A., 2005. Determination of selected logging technologies impact, in thinned coniferous stands, on damage level of trees. Zesz. Nauk. AR Krak. 419, Ses. Nauk. 91, 275-281.

Stańczykiewicz A., 2003. Wpływ wybranych technologii pozyskiwania drewna na rodzaj i wielkość szkód w drzewostanie [The effect of selected harvesting technologies on the type and size of damage in the stand]. KULiD Kraków [typescript, in Polish].

Stańczykiewicz A., Sowa J.M., Szewczyk G., 2011. Uszkodzenia drzew i odnowienia w wyniku ręczno-maszynowego pozyskania drewna z wykorzystaniem urządzeń agregowanych z ciągnikami rolniczymi [Damage to trees and the regeneration layer as a result of manual--machine timber harvesting using devices aggregated with agricultural tractors]. Sylwan 155 (2), 129-137 [in Polish].

Suwała M., 1999. Uszkodzenia drzew i gleby przy pozyskaniu drewna w późnych trzebieżach drzewostanów sosnowych [Damage to trees and soil done during timber harvesting in late thinning in pine stands]. Pr. Inst. Bad. Leśn. Ser. A, 873, 1-86 [in Polish].

Suwała M., 2003 a. Uszkodzenia drzew w drzewostanach sosnowych przy pozyskaniu drewna w praktyce leśnej [Damage to trees in pine stands done during timber harvesting in forestry practice]. Pr. Inst. Bad. Leśn. Ser. A, 959, 61-80 [in Polish].

Suwała M., 2003 b. Uszkodzenia drzew i gleby przy pozyskaniu drewna w wybranych rębniach złożonych na terenach nizinnych [Damage to trees and soil done during timber harvesting in selected complex cutting operations in lowland areas]. Pr. Inst. Bad. Leśn. Ser. A, 949, 23-38 [in Polish].

Warunki techniczne – Drewno wielkowymiarowe iglaste [Technical conditions – Large-sized coniferous wood]. Załącznik nr 1 do zarządzenia nr 47 Dyrektora Generalnego Lasów Państwowych z dnia 31 maja 2002 r. 2002. Warszawa.

Zastocki D., 2003. Wpływ stosowanych technologii pozyskiwania drewna przez Zakłady Usług Leśnych na obecną i przyszłą jakość techniczną sosnowych drzewostanów przedrębnych [The influence of timber harvesting technologies used by the Forest Service Enterprises on the present and future technical quality of ripening pine stands]. Sylwan 3, 28-34 [in Polish].

DYNAMIKA WYSTĘPOWANIA ZABITEK NA PNIU W DRZEWOSTANACH GÓRSKICH O RÓŻNYM WSKAŹNIKU ZADRZEWIENIA I SPADKU TERENU

Streszczenie. Celem pracy była analiza częstotliwości i rozmiaru uszkodzeń mechanicznych pni drzew w górskich drzewostanach świerkowych, o różnym wskaźniku zadrzewienia i spadku terenu, bez uwzględniania technologii wykorzystywanych przy pozyskaniu drewna. Badania prowadzono w 17 drzewostanach świerkowych zlokalizowanych na terenie Sudetów i Karpat. W drzewostanach zakładano powierzchnie badawcze o wielkości 1 ha. Pomiarowi poddano uszkodzenia występujące na drzewach o pierśnicy ≥ 18 cm. W wyniku przeprowadzonych analiz stwierdzono, że najwięcej uszkodzonych drzew powstało w drzewostanach o wskaźniku zadrzewienia 0,7 i 1,0, natomiast z uwzględnieniem spadku terenu najwięcej uszkodzeń powstało w drzewostanach o nachyleniu od 16 do 25°. Przeprowadzone badania nie wykazały jednak wyraźnych zależności między wielkością i wysokością położenia martwic na pniach drzew a wskaźnikiem zadrzewienia drzewostanu i spadkiem terenu.

Słowa kluczowe: uszkodzenia mechaniczne, świerk, zabitka, wskaźnik zadrzewienia, spadek terenu

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