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Factors affecting the timber quality of black alder (*Alnus glutinosa* (L.) Gaertn.)

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Abstract: *Factors affecting the timber quality of black alder* (*Alnus glutinosa* (L.) Gaertn.). Black alder covers 5.4% of the forest area and 5.1% of the volume in Polish forests. The most valuable timber of this species are veneer and plywood, which can be obtained when trees reach large dimensions in the late stage of their development. However, in older age, alder is vulnerable to heart rot which dramatically affects its wood quality. The objective of this paper was to: 1) compare the wood quality share of *Alnus glutinosa* (L.) Gaertn. in older (SPO) and younger (SPY) stands after cutting age and 2) discover which defects most frequently lower the round wood quality. The study was conducted in two alder stands, both after the recommended cutting age (80 years of age): the older, 96 years of age. and younger, 87 years of age. 150 logs were classified according to the grading systems in Poland (veneer and plywood, sawmill wood, medium-size wood). As a result, no veneer, plywood or top class sawmill timber (WA0) were obtained. A large share of medium-size wood was classified: 36 and 60% of the volume in SPO and SPY, respectively. A larger amount of good quality sawmill timber WB0 was graded in SPY than in SPO (16 and 5%, respectively) despite SPY being a younger stand and WB0 timber class requiring large size. Heart rot degraded the timber in SPY less frequently as this defect develops intensively in older trees. It is therefore recommended that alder forest is not grown over the prescribed cutting age. At the same time, to grow the most valuable large-size veneer timber, trees with wider spacing should be kept in the final stage of growth (between 61 and 80 years of age).

Keywords: black alder alnus glutinosa (l.) Gaertn., defects distribution, round wood quality, grading

INTRODUCTION

Black alder (*Alnus glutinosa* (L.) Gaertn.) is scattered across Europe with its bigger share (ca. 5% of the forest area) in North Central Europe: the Netherlands, Northern Germany, Poland and the Baltic States, as well as in South Central Europe: the Plains of Slovenia and Croatia (Glavac 1972; Roisin and Thill 1972; Turok et al. 1996; after Claessens et al. 2010).

All alder species in Poland cover 5.4% of forests, which is equal to 5.1% of the volume of forest resources. The average age of alder in Poland is 49 years old and the average stocking of merchantable timber is 249 m^3 ha^{-1} (Leśnictwo… 2012).

The distribution of black alder suggests that the species is adapted to various temperatures, but it does not extend into areas where the mean temperature above freezing is shorter than 6 months (Mac Vean 1953). At the same time, alder has large water demands, including ground water, precipitation and humidity. According to Herbst et al. (1999), evapotranspiration in alder stands is equal to the annual rainfall, which suggests that trees can be exposed to a lack of water during the dry summer season. In the eastern range of the species distribution, natural growth is limited by an annual precipitation lower than 500 mm. In the drier regions of Eastern Europe, alder depends on rivers, e.g. the Volga, Don and Dniepr (Jalas and Suominen 1976; after Claessens et al. 2010). In the case of ground water shortage, trees can grow in areas with high precipitation amounting to 1500 mm (Fremstad 1983; Mac Vean 1953).

Roots adapted to moist and wet soils are able to fix atmospheric nitrogen with the participation of symbiotic root nodules (Bond et al. 1954). This phenomenon increases wood production by ca. 25-33% (Hendrickson et al. 1993) which also has an impact on the leaves, which have a higher nitrogen content.

Alder wood is quite versatile and can be used for different purposes, for example, in joinery as solid wood or as veneer (Claessens 2005; after Claessens et al. 2010) and plywood. It is useful for particle boarding and in the paper industry, though the red colouration may be problematic (Crave 1990, after Claessens et al. 2010). At the same time, the wood is easy to impregnate and dye. Alder wood is very durable under water and used as piles in Amsterdam and Venice (Fontnoire 1974; Abrami et al. 2001; after Claessens et al. 2010).

Depending on the region, alder can reach an age of 100-160 years with its highest longevity in Central Europe, where it grows up to 35 m in height and 1 m in dbh. In its older years it is susceptible to heart rot which can develop between the ages of 50-70 years (Claessens 2005; Thibaut et al. 1998; Immler 2004; Lockow and Chizon 1996; after Claessens et al. 2010).

Taking into account the above findings, it was hypothesised that in the presented research, when comparing the wood quality in older and younger stands, the alder trees in the former group would be affected by heart rot to a greater extent. In general, the objective of the research was to: 1) compare the wood quality share of *Alnus glutinosa* (L.) Gaertn. in older and younger stands and 2) discover which defects most frequently determined round wood quality with special attention to heart rot.

MATERIAL AND METHODS

The study was carried out in Leśnik (compartment 43g) and Witrogoszcz (compartment 32j) subdistricts (SD), Złotów Forest District, Regional Directorate of the State Forests in Piła. Both stands consisted of 100% alder species. The sample plot in the older stand (SPO) in Leśnik SD was 96-years-old and grew on rich soil (class II). The sample plot in the younger one (SPY), in Witrogoszcz SD, was 87-years-old and grew on a less rich site (class III). In total, 150 logs were measured (103 in SPO and 47 in SPY), with a total timber volume of 87.01 m^3. The length of each log was measured, as were the top and mid diameters, and the distance of the first defect from the butt was recorded. The type and size of the defects were also determined.

The quality-dimension class (sawmill timber: WA0 – the highest, WB0, WC0 and WD – the lowest; medium-size timber: S) of each log was determined according to regulation PN-92/D-95008. A division of the determined quality classes was carried out according to the total timber volume in each class. Furthermore, bark damage (rubbing) was taken into account as this disqualified the logs for the veneer timber. A classification of the timber for veneer and plywood was performed on the basis of grading guidelines in Poland. After the defects were identified, the extent to which they influenced the degrading of the timber class was evaluated. The main defect degrading a log to a lower class was recorded when the size of the log could potentially qualify the timber for a higher class. The number of logs with such cases was recorded and expressed as a percentage of each sample plot.

RESULTS

In both the sample plots, the most valuable timber - veneer, plywood or WA0 - was not recorded (fig. 1). In SPO, 58.82 m^3 of timber was classified in total, where 40% of the volume was WC0 class.

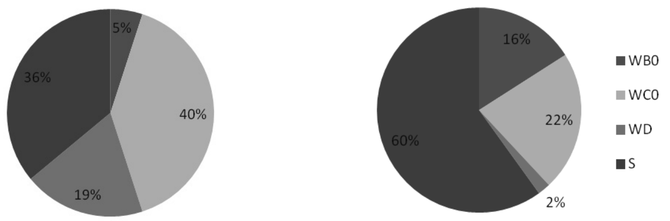

Figure 1. Volume share of logs in quality-dimension classes (SPO – left, SPY – right)

Medium-size timber amounted to 36% and the least represented (5%) was WB0, most expensive in this case.

In SPY, 28.19 m^3 of the timber was classified and the majority (60%) was medium-size timber. However, the most valuable, WB0, amounted to 16%, three times more than in SPO. At the same time, a very small volume (2%) of WD timber was recorded.

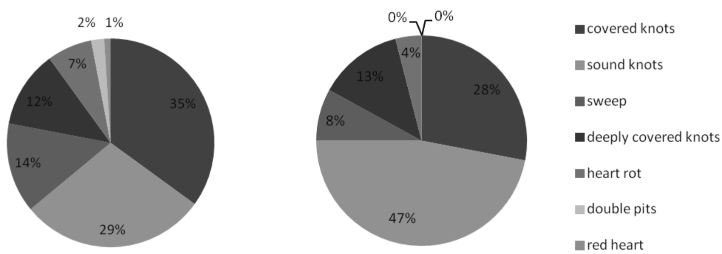

Figure 2. Frequency of cases when a particular defect degraded a log to a lower class when the log size could potentially qualify for a higher class (SPO – left, SPY – right)

Knots were the most common defects degrading the timber to a lower class, especially in SPY (88% degraded logs, 76% of cases in SPO). In SPO, the most common case of the degrading of timber to a lower class involved covered knots (in 35% of logs). This was not the case in SPY, where sound knots were the most influential, in 47% of the logs. Large differences were also observed in the case of heart rot, which more often declassified the timber in SPO, in 7% of cases. In SPY, this defect affected only 4% of the logs.

DISCUSSION AND CONCLUSION

Harvested timber in both the analysed stands was of low quality: no veneer, ply wood or the highest class of sawmill wood (WA0) were. Both stands were over the prescribed cutting age, which in Poland is 80 years of age, if from generative propagation, or 60 years of age for alder coppice forest. In the analysed cases, the trees either did not achieve the expected size or had disqualifying defects: covered knots or with excessive heart rot or sweep.

A large participation of medium-size timber was recorded. This may suggest that trees in both the stands were grown in small spaces (a large number of trees per hectare), especially in SPY, where 60% of the volume was medium-size timber. At the same time, in SPY the share of WB0 (the most expensive in this case study) was more than three times bigger than in SPO. This suggests that earlier final felling is optimal, because even though longer production gives larger timber size, it can lead to heart rot development. Larger tree size can be achieved when heavier thinning is provided at an earlier stage of stand development. This recommendation could allow the production of logs which are large enough for veneers without heart rot and, thanks to faster increment growth, well overgrown knots.

In SPY, covered knots and heart rot caused timber to be degraded less frequently, by 20 and 43%, respectively. Covered knots had less impact, but much more often sound knots caused degrading in SPY. This is probably because the younger stand was less naturally pruned in comparison with older one. Heart rot usually develops in older trees, and according to Claessens (2005, after Claessens et al. 2010) it starts after 60-70 years. Other studies have shown that it can start as early as 50 years of age (in Bavaria, Immler 2004), and at the age of 70, all the trees can be affected (in Belgium, Thibaut et al. 1998, after Claessens et al. 2010). According to Lockow and Chizon (1996), the frequency of heart rot depends on the site. It is commonly accepted that heart rot develops earlier in alder coppice forests, therefore in Poland, the cutting age for vegetative propagated trees is earlier, at 60 years of age. However, this knowledge comes from common observation rather than from solid scientific data as there is no published data confirming the phenomenon.

It can be concluded that growing alder stands over the prescribed cutting age of 80 years old is not recommended in Polish conditions due to heart rot development. More intensive heart rot development in older trees has also been observed in spruce in studies carried out in Poland by Dardziński and Giefing (2010). In the studies presented, there was no veneer timber, the most valuable and the most expensive. This was due to the large participation of medium-size timber, and the high frequency of both covered knots and extensive heart rot, which are not permitted. Therefore, increased space (heavier thinning) should be given to trees in the final stage of stand development (the last age class: 61-80-years-old). When intensive thinning affects natural pruning negatively – artificial pruning can be applied (Giefing 1999). However, branches of alder trees never reach large dimensions, they quickly die due to their light demanding nature and, as a consequence, quickly decay, which leads to very good natural pruning (Claessens et al. 2010).

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Streszczenie: *Czynniki determinujące jakość drewna olszy czarnej* (*Alnus glutinosa* (L.) Gaertn.). Olsza czarna stanowi 5,4% powierzchni lasów w Polsce (5,1% miąższości). Najcenniejsze sortymenty uzyskiwane z tego gatunku to surowiec okleinowy i łuszczarski. Aby je otrzymać niezbędne jest prowadzenie drzewostanów do późnego wieku w celu uzyskania wymaganych wymiarów sortymentów. Jest to o tyle trudne, iż w starszym wieku olsza stosunkowo łatwo ulega zgniliznom, co dyskwalifikuje drewno na sortymenty cenne. Celem niniejszego badania było: 1) porównanie udziału klas jakościowo-wymiarowych w starszym (SPO) i młodszym (SPY) drzewostanie oraz 2) określenie, które wady najczęściej wpływają na przesunięcie surowca do niższej klasy. Klasyfikację przeprowadzono w dwóch przeszłorębnych drzewostanach olszowych: starszym, 96-letnim oraz młodszym, 87-letnim. Analizie poddano 150 sortymentów, które klasyfikowano wg obowiązujących norm i ramowych warunków technicznych. W wyniku klasyfikacji nie uzyskano sortymentów okleinowych i łuszczarskich, jak również najwyższej klasy drewna tartacznego (WA0). Wymanipulowano znaczne ilości drewna średniowymiarowego: 36 i 60% miąższości, odpowiednio w SPO i SPY. Najcenniejszy wymanipulowany surowiec, WB0, stanowił trzykrotnie większy udział sortymentów w SPY w porównaniu z SPO, mimo iż był to drzewostan młodszy, a drzewa o mniejszych dymensjach. Zgnilizny rzadziej deklasowały surowiec w SPY, przede wszystkim dlatego, iż wada rozwija się silniej w starszych drzewostanach. W związku z powyższym drewno olszowe należy pozyskiwać najpóźniej w wieku rębności. Jednocześnie wskazane jest aby w ostatniej fazie wzrostu (IV klasa wieku) prowadzić drzewostany w rozluźnionej więźbie, w celu uzyskania większych rozmiarów drzew pozwalających na wymanipulowanie sortymentów okleinowego i łuszczarskiego.

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