ASSESSMENT OF OAK TREE HEALTH ON THE BASIS OF ASSIMILATION APPARATUS REDUCTION IN SELECTED OAK STANDS IN SMOLARZ FOREST DISTRICT

W. Szewczyk, M. Baranowska-Wasilewska and M. Bełka

Abstract

The objective of this work was assessment of the health condition of oak trees on the basis of the assimilation apparatus loss of selected oak stands in Forest District Smolarz. Analysis of the health status of oak trees showed that the trees had been damaged mainly to the medium degree (40% of surveyed trees), and in a slight degree (28% of surveyed trees). 27% of the surveyed oak trees displayed no damage.

Key words: Quercus spp., oak decline, defoliation

Introduction

Oak trees cover 6.9% of forest area in Poland (www.stat.gov.pl 2011). They represent one of the most valuable deciduous tree species in Poland from both – the economic and ecological point of view. Recently an intensified deterioration of oak tree health condition – oak decline has been observed (Przybył 1995, Dmyterko 1998, Oszako 2004, Hilszczanński and Sierpiński 2006, Szewczyk and Czeryba 2010). The disease (oak decline) has been reported regularly since the 18th century, however in the past 20 years the disease has shown a dramatic increase all over Europe (Oszako 2004). The reason of oak decline has not been ultimately defined yet (Mańska 2005). Many studies proved that fungal pathogens and insects can be partially blamed as a cause of this phenomenon (Oszako 2007). The causes of oak decline can be divided into three groups of factors: predisposition, initiating and cooperating factors which occur at the same time and result in a disease complex (Bugała 2006).
One of the most important symptoms of this disease complex, and the easiest to detect, is tree crown defoliation – a gradual leaf loss caused by different factors, both biotic and abiotic (Kryczyński et al. 2002). Oak decline affects different stands regardless of their age, provenience or habitat (Szewczyk and Czeryba 2010).

Materials and methods

The studied areas were localized in the stands of Smolarz Forest District (Regional Directorate of the State Forests Szczecin, Lubuskie Region; 52°51'25''N, 15°48'48''E).

The assessment of the assimilation apparatus loss degree was carried out in 10 compartments of Górzyska Forest Department and in one compartment belonging to Czarny Las Forest Department (Table 1).

Table 1

<table>
<thead>
<tr>
<th>Compartment</th>
<th>Age (years)</th>
<th>Forest site</th>
<th>Mean diameter at breast height (cm)</th>
<th>Mean stand height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>435i</td>
<td>167</td>
<td>FMBF</td>
<td>55</td>
<td>32</td>
</tr>
<tr>
<td>436h</td>
<td>157</td>
<td>FMBF</td>
<td>49</td>
<td>30</td>
</tr>
<tr>
<td>436i</td>
<td>167</td>
<td>FMBF</td>
<td>60</td>
<td>32</td>
</tr>
<tr>
<td>437h</td>
<td>168</td>
<td>FMBF</td>
<td>60</td>
<td>33</td>
</tr>
<tr>
<td>438a</td>
<td>113</td>
<td>FMBF</td>
<td>36</td>
<td>28</td>
</tr>
<tr>
<td>438d</td>
<td>147</td>
<td>FMBF</td>
<td>47</td>
<td>31</td>
</tr>
<tr>
<td>439a</td>
<td>132</td>
<td>FMBF</td>
<td>47</td>
<td>30</td>
</tr>
<tr>
<td>450a</td>
<td>152</td>
<td>FMBF</td>
<td>51</td>
<td>39</td>
</tr>
<tr>
<td>450c</td>
<td>147</td>
<td>FMBF</td>
<td>46</td>
<td>30</td>
</tr>
<tr>
<td>451b</td>
<td>137</td>
<td>FMBF</td>
<td>45</td>
<td>31</td>
</tr>
<tr>
<td>452c</td>
<td>167</td>
<td>FMBF</td>
<td>57</td>
<td>30</td>
</tr>
<tr>
<td>453a</td>
<td>162</td>
<td>FMBF</td>
<td>47</td>
<td>31</td>
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<tr>
<td>464b</td>
<td>137</td>
<td>FMBF</td>
<td>55</td>
<td>32</td>
</tr>
<tr>
<td>465a</td>
<td>137</td>
<td>FMBF</td>
<td>51</td>
<td>32</td>
</tr>
</tbody>
</table>

FMBF – fresh mixed broadleaf forest (according to the Polish forest site typology).

The evaluation of the loss of leaves was made on 100 randomly selected trees in 10 randomly selected oak stands, older than 113 years. The assessment was made in August 2005 and in August 2007 with the help of an atlas developed by Borecki and Keczyński (1992). Based on the data in this way, each tree was assigned, according to European classification (Wyrzykowski and Zajączkowski 1995) for each degree of defoliation: 0 – defoliation up to 10% of assimilation apparatus loss, I –
slight defoliation from 11% to 25% loss of assimilation apparatus, II – medium defoliation from 26% do 60% loss of assimilation apparatus, III – high defoliation from 61% to 100% loss of assimilation apparatus, IV – dead tree.

**Results**

In compartments where the study was carried out in 2009 no damage occurred in 28% of trees, first defoliation degree was found in 24% of trees and 40% of trees displayed the second degree of defoliation, while the third defoliation degree was shown by 7% of selected trees. Dead trees represented 1% of all trees that were taken into consideration (Fig. 1). The average results for trees growing in three compartments (437h, 451b, 450c) ranged from 11% to 15% of assimilation apparatus loss and were classified to the first classification degree.

The zero defoliation degree in the particular compartments in 2009 was distributed as follows: in 451b and 450c – 46%, in 450a – 36%, in 435i – 31%, in 439a – 30%, in 438d – 28.89%, in 437h – 27%. In the remaining compartments, the zero defoliation degree was represented by less than 20% of trees.

In 2009 the first defoliation degree was close to 20% in the majority of surveyed compartments. In compartment 436i 56% of examined trees showed the second degree of damage, in 453a compartment – 54%. The least number of trees damaged to the second degree was found in the following compartments: 438d – 46.67%, 439a – 46% and 435i – 43%.

On the remaining areas, the third degree damage amounted less than 10%, in compartment 453a – 9%, 450a – 8%, 450c – 6%, 438d – 5.56%, 439a – 5%, 451b and 435i – 4% each, while in 437b compartment – 1%. One percent of dead trees was found in all compartments.
In 2010, only a negligible number of dead trees was found (0.1%). Two percent of oak trees showed the third degree of defoliation, the situation was better than in the previous year when it amounted 5% more. The second degree of defoliation was found in 40% of trees. In this case, the situation was similar to that in the previous year. First degree of defoliation was shown by 32% of oak trees and it has increased by 8% as compared to 2009. No damage was showed by 26% of oak trees which was by 2% less than in the previous year. Figure 2 presents the share of trees in the defoliation degrees in the total area studied in 2010.

Over a half of oaks (57%) in compartment 436h showed no defoliation. In compartment 439a, defoliation occurred in 48% of trees and in compartment 436i in 33% of trees. However, the results indicated a significant improvement as compared to the previous year. The same positive change of situation was recorded in the compartments 438d and 451b (26%, both). In comparison with 2009, in these compartments there was 20% trees less in the zero defoliation degree. In compartment 437h – 22% and in 450a and 464b – 19% of areas did not lose their assimilation mass either. The least number of oak trees with no defoliation was found in compartments 465a (9%) and 452c (7%).

In compartments 465a 50% of oaks showed the first defoliation degree. In the other compartments the share of trees with a slight defoliation ranged as follows: 452c – 44%, 464b – 43%. Greater losses of assimilation apparatus were observed in the divisions: 451b – 34% trees and 450a – 33% trees. The share of trees in the first defoliation degree in the remaining compartments ranged from 30 to 19%.

The second degree, i.e. medium defoliation was displayed by 54% of trees in compartment 437h and 46% in 450a and 452c. In compartment 450a, in comparison with the year 2009, the situation deteriorated by 12%. In remaining compartments, the situation was as follow: 438d – 45%, 436i – 41.5%, 465a – 40%, 451b – 39%, 464b – 38%, 439a – 32%, 436h – 15%.
In 2010 the third defoliation degree was observed on a small number of oak trees. This situation referred to eight out of 10 compartments analyzed in 2010. In compartment 450a, only one dead tree was found.

In both years (2009 and 2010), the second degree of defoliation was the most frequent. The first defoliation degree in the studied area was found in 28% of trees. The zero defoliation degree was found in 27% of oak trees, the third degree in 5% and the dead trees made 0.3% out of all investigated trees. In 2009 in seven compartments oak trees showed medium degree of defoliation and in three compartments the first defoliation degree was observed. In the successive year, six compartments showed the second defoliation degree, while four compartments displayed the first degree of defoliation.

The mean defoliation value in 2009 was 30.02%, while in 2010, it was 25.27%.

In 2010, the number of trees in the first class of defoliation increased (8.25%) while the number of trees in the second defoliation degree remained on the same level. The third defoliation degree decreased by 5.87%.

**Discussion**

Analysis of the health status of oak trees carried out in the Smolarz Forest District during 2009 and 2010 showed that trees have been damaged mainly in medium (40%) and to slight degree (28%). No damages were shown by 27% of oak trees. The average defoliation degree in the studied forest district was the second degree of defoliation. According to the data of Polish Central Bureau for Statistics (GUS), in 2010 14.4% of oak showed no damage, 57.4% were damaged to a small degree, 27.2% showed medium damage and 0.9% were significantly damaged (Concise Statistical Yearbook of Poland 2010). The data published by GUS are based on defoliation and discolouration degree, and observations were carried out on permanent areas in tree stands older than 41 years. Definition of forest condition is based on the defoliation and leaves decolouration (Concise Statistical Yearbook of Poland 2010). Data from the Concise Statistical Yearbook of Poland indicate that the general situation in oak stands in Poland is better than in the Smolarz Forest District, but in the Smolarz Forest District observations were carried out in oak stands older than 113 years.

In 2009, according to research led by Wawrzoniak et al. (2010), the average defoliation of oak stands in private forests was 29.45%, in the woods remaining under the management of State Forests 24.10%. In 2010, in the Forest District Smolarz, the average defoliation was 25.27%. This result did not differ significantly from the national average (Wawrzoniak et al. 2010).

Oszako (2004) pointed out that oak decline is caused by many factors, although infectious diseases are not the main factor, but rather the poor adaptation abilities of oaks to the deteriorating conditions in which they have to live can be considered the main cause of the disease.
According to the studies carried out by Bruchwald and Dmyterko (1998) on 132 oak trees in the north-western and the south-western areas, the obtained mean defoliation value was about 38.4% and the majority of the damaged trees was in the range of 30–40% of assimilation mass loss (second degree of defoliation, Bruchwald and Dmyterko 1998). The health condition of oak trees in Smolarz Forest District did not differ from the oak tree condition in the areas studied by Bruchwald and Dmyterko (1998), but in Smolarz Forest District observation was based only on defoliation.

The general health condition of oaks described by Przybył in 1995 on experimental areas in the years 1966–1990 was following: in Jastrowie in 1986, 15% of trees were slightly and strongly damaged, while 40% of trees were damaged in a medium degree. In the successive years, the number of medium and strongly damaged trees decreased. In the second observation area in Sulechów District, 80% of trees were slightly and medium damaged, 10% were strongly damaged or not damaged (year 1986). The number of undamaged trees was increasing during the successive years, while the number of trees damaged in the second degree suddenly decreased from 51% to 16%, remaining afterwards stable at the level of 18%. Oak trees regenerated (Przybył 1995). These results are similar to those obtained in 2009 and 2010 in Smolarz District. The results show a slight improvement in the condition of trees and they reveal at their ability to regenerate the vital forces under favourable conditions. Bugała (2006) claims that an oak tree deprived at 60% leaves has little chance to survive, particularly in an older age. It is considered that older oak trees can die when they lose 20% of assimilative apparatus, while in younger trees it is 20–55% (Bugała 2006). In Smolarz District, oak trees grow on a proper habitat and one can suppose that this makes them more resistant to oak decline. The monitored tree stands of Smolarz Forest District can be qualified to the first degree of defoliation (slight defoliation).

Estimation of defoliation degree made during the two years of studies does not show whether we are dealing with a tree dieback process. However, we can define the current health condition of the trees and we can draw conclusions whether the problem could appear in Forest District in question. The assessment of health condition relies only on the assimilation apparatus loss rises some doubts because the condition of foliage was subject to the impact of many factors. However, the defoliation degree is closely connected with the condition of trees which illustrates well the health status of oak trees in the year of the performed observations (Dmyterko 1998).

It is highly advisable to continue the assessment of the defoliation degree in Smolarz Forest District. Biotic and abiotic factors influencing the phenomenon of oak decline should be taken into consideration. A correct determination of the factors causing the deterioration of the health condition of oak stands would permit to limit the oak decline.
Streszczenie

OCENA ZDROWOTNOŚCI DĘBU NA PODSTAWIE STOPNIA UBYTKU APARATU ASYMIILACYJNEGO WYBRANYCH DRZEWOSTANÓW DĘBOWYCH NADLEŚNICTWA SMOLARZ

Dąb bezszypułkowy i dąb szypułkowy mają ogromne znaczenie w gospodarce leśnej kraju. Ich drewno charakteryzuje się dużą wartością użytkową, a co za tym idzie – ekonomiczną. Nie należy także pomniejszać roli, jaką dęby odgrywają w ekologii lasu oraz w tworzeniu siedlisk leśnych. Celem pracy była ocena stanu zdrowotności drzewostanów dębowych w Nadleśnictwie Smolarz wykonana na podstawie stopnia defoliacji. Ocenę stopnia ubytku aparatu asymilacyjnego przeprowadzono w 10 oddziałach Leśnictwa Górzyska i w jednym oddziale należącym do Leśnictwa Czarny Las. Drzewostany, w których przeprowadzono obserwacje, należą do VI klasy wieku (od 113 do 167 lat); ich wiek rębności wynosi 180 lat. Większość oddziałów stanowią wyłączone drzewostany nasienne regionu matecznego 104 dębu bezszypułkowego. Oceną stopnia ubytku aparatu asymilacyjnego to integralna część monitoringu fitopatologicznego przyjętego powszechnie w Europie. Analiza stanu zdrowotnego dębów przeprowadzona w Nadleśnictwie Smolarz wykazała, że drzewa były uszkodzone głównie w stopniu średnim – 40% drzew, 28% – w stopniu lekkim, 27% drzew nie wykazało uszkodzeń. Przeciętny stopień defoliacji w nadleśnictwie to stopień drugi, czyli uszkodzenie w stopniu średnim. Według danych Głównego Urzędu Statystycznego z 2010 roku 14,4% dębów w Polsce nie wykazało uszkodzeń, 57,4% charakteryzowało się słabymi uszkodzeniami, 27,2% – średniimi, a 0,9% – silnymi. Obserwacje przeprowadzone w Nadleśnictwie Wołów w 2005 i w 2010 roku wykazały, że sytuacja dębów na tym terenie jest zła. Drzewostany Pomorza Zachodniego są najbardziej uszkodzonymi drzewostanami w Polsce, a ich sytuacja pogarsza się gwałtownie z roku do roku.

Literatura


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