

EVALUATION OF OAK TREE CONDITIONS ON THE BASIS OF LOSSES IN THE ASSIMILATION APARATUS OF SELECTED OAK STANDS IN SULĘCIN FOREST DISTRICT

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Abstract. Oak trees play a significant naturalistic and economic role. Common oaks represent the most valuable forest-creating species in Poland. In the recent years, on the area of the whole country, one can observe a visible deterioration of the health conditions in oak tree stands. It is difficult to indicate the main factor responsible for this phenomenon. Because of the wide range of this observation, it can be assumed that this process is caused by many biotic and abiotic, as well as anthropogenic factors. Studies were out in the Sulęcín Forest District. At the turn of July and August in the years 2009 and 2010, an assessment of the losses in the majority of trees showed a medium degree (49%). Another group of trees showed 36% of leaf loss, while 14% of oak trees did not show any losses at all. A very high degree of defoliation was found only in 1% of trees. The presented data indicate that an average loss in the assimilation apparatus of oak trees amounted to 29.15%.

Key words: oak, decline, defoliation, Sulęcín Forest District

INTRODUCTION

In Polish forests, there occur two native species: the common oak (*Quercus robur* L.) and the sessile oak (*Quercus petraea* (Matt.) Liebl) [Bugala 2006]. The common oak and the sessile oak show an interspecific variability of morphological and phonological features. Oak trees belong to species very sensitive to slight frosts because they early start their vegetation. Puchalski and Prusinkiewicz [1990] argue that the sessile oak is less sensitive to slight frost because its leaves develop two weeks earlier than the leaves of the common oak. Oaks represent a high naturalistic and economic value. The common oak is the most valuable forest-creating species in Poland. The oak stands occupy about 6% of the total area of Poland [Ceitel 2006]. In the last years, on the area of the whole country, one can observe a visible deterioration of oak stands health. The first

observation of the decay of oak trees had been made already in the 18th century. In Poland, a mass decay of common oaks (at the age of 70-100 years) occurred in the Krotošzyn Forest District [Krahl-Urban 1943, after Tarasiuk and Szczepkowski 2006]. Until the 1980-ies, no large scale oak tree decays had been observed. Since 1985, this process has significantly intensified and presently it occurs on the area of all European countries. In the years 1991-1999, the share of healthy oak stands decreased from about 60% to 20% [Oszako 2004]. It is difficult to find one main factor responsible for oak tree dying off. Because of a very wide range of this phenomenon, it is assumed that this process includes many biotic and abiotic, as well as anthropogenic factors. Therefore, the decay of trees has to be regarded as a complex disease. In the process of oak decay, the predisposing initiating and coparticipating factors act in the oak ecosystems at the same time. The predisposing factors include, among others, the phenotype and unfavourable habitat changes. Factors of the second group can include frequent and long-lasting droughts, violent decrease of groundwater level, strong frost and tree damages done by insects from the group of primary pests and fungal diseases. The coparticipating factors include mainly the secondary pests (e.g. insects from *Argillus* and *Scollytus* genera, as well as fungi causing root rot (e.g. *Armillaria* spp.) [Oszako 2002, after Bugała 2006]. Oszako maintains that if that tree stand was affected by drought, defoliation, or other damaging factors. Assessment of the defoliation degree is used in forest monitoring. This procedure supplies a parameter reflecting in the best way the conditions of trees and tree stands. Drought, damages caused by frost and defoliation are the most frequent factors initiating the death of oak tree stands [Oszako 2007]. In case of a 60% defoliation, trees die within a few years, while in case of a smaller damage, they are able to regenerate and most frequently they survive [Bugała 2006]. Many authors share the opinion that the common oak is more endangered by decay than the sessile oak because of its higher sensitivity to drought and to oscillations in groundwater levels [Przybył 1995, Siwecki and Ufnalski 1998].

The objective of the presented studies was health assessment in oak trees on the basis of losses in the assimilation apparatus of selected oak stands in the Sulęcın Forest District.

MATERIAL AND METHODS

Studies were carried out in the Sulęcın Forest District situated in the south-western part of the Regional Directorate Of State Forest in Szczecin. The area of the Sulęcın Forest District is situated in the Wielkopolska-Pomereania National Forest Land, in the northern part of the Lubuski Lakeland, the Mezonegion of Lubuski Land [Trampler 1990]. The climate of the studied Forest District shows transitional characteristic with a high influence of Atlantic climate and periodical influences of continental climate. The mean annual air temperature is 10.1°C. The vegetation period lasts 220-230 days. Annual precipitation sums range from 530 to 600 mm, where about 60% of precipitations take place in the spring and summer months creating in this way a mild climate and good conditions for the growth and for flora development. The studies were carried out on four observation areas situated in the following subcompartments: 212d, 210a, 211c, 211d according to the taxation description on the day of 1.01.2004. Observations were carried out on the 4th of October, in the Sieniawa Forest, where the sessile oak

(*Quercus petraea* Matt. Liebl) at the age of 46-59 years represents the main species. In each of the four subcompartments, 100 trees were randomly chosen. At the turn of July and August, in the years 2009 and 2010, an assessment of oak tree assimilation apparatus losses was carried out using the method described in the atlas elaborated by Borecki and Keczyński [1992]. On the basis of the obtained data, each tree was classified in the adequate defoliation degree group (Table 2), according to the European classification [Wyrzykowski and Zajączkowski 1995]. After adequate classification, the mean value of the assessed trees was calculated.

RESULTS

Among the oak trees studied in the year 2009, the greatest number of trees represented the first degree of defoliation. On the other hand, no trees defoliated in the 3rd degree were found (Fig. 1). In the year 2010, the greatest number of oak trees showed the 3rd degree of defoliation. The smallest difference between the years 2009 and 2010 is shown in the 1st defoliation degree, while the 0-degree is characterized by similar values in both years. Furthermore, among the studied trees, stem damages were recorded. In 2009, on one tree, a resin exudation was observed and on 6 trees, there was a frost-rib. All observed damages in stumps were found among oaks with the 2nd degree of assimilation apparatus losses. In the year 2010, no major number of damages was found. However, resin exudations were noted on oaks without defoliation. In the first year of observation, in the subcompartment 212d, over 50% of the listed trees had been counted to the 2nd defoliation degree. The least number of trees was found with the 3rd defoliation degree (Fig. 2). In the 2nd and 3rd degrees, as compared with the previous year. On the other hand, the number of oaks without defoliation increased from 8 to 15. In both years of studies, no dead trees were recorded. Among damages observed on oaks in 2009, there was a higher number of frost-ribs which were found on oaks with a medium defoliation degree. Also two fungal fruit bodies were found on oaks with

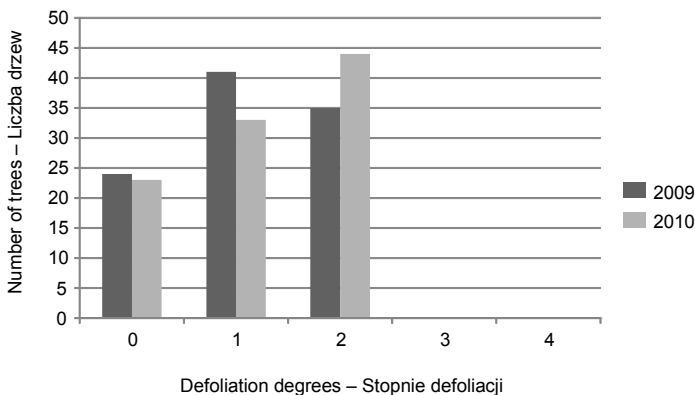


Fig. 1. Number of trees in the particular defoliation degrees in the subcompartment 221d in the years 2009 and 2010

Rys. 1. Liczba drzew w poszczególnych stopniach defoliacji w wydzielaniu 211d w latach 2009 i 2010

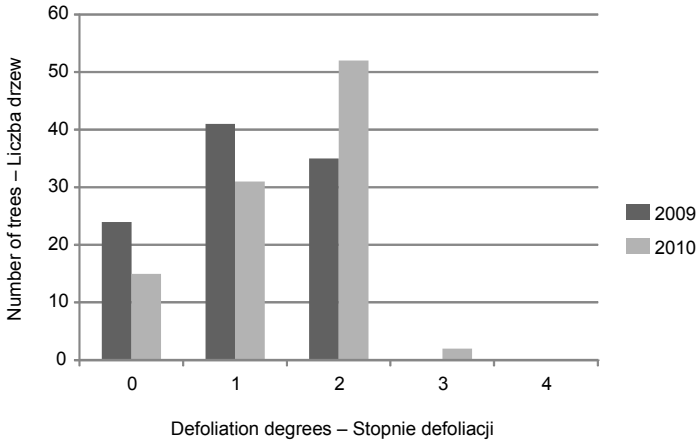


Fig. 2. Number of trees in the particular defoliation degrees in the sub-compartment 212d in the years 2009 and 2010

Rys. 2. Liczba drzew w poszczególnych stopniach defoliacji w wydzielaniu 212d w latach 2009 i 2010

a medium defoliation degree. Also two fungal fruit bodies were found on trees with a 3rd degree of assimilation apparatus loss. In the successive year, a greater number of frost-ribs (3a) was found. Two of them occurred on trees with a high defoliation. Also 2 resin exudations were observed on trees with a small and medium defoliation. In the sub-compartment 211e, during observations carried out in the years 2009, an identical number of trees with the 1st and 2nd defoliation degree was found (42 trees). Fifteen trees were found without defoliation and one tree with a high defoliation (Fig. 2). In the 2nd year of studies, the number of trees with the 2nd degree defoliation increased to 48 trees.

Table 1. Characteristics of tree stands
Tabela 1. Charakterystyka drzewostanów

Compartment Wydzielenie	Area Powierzchnia ha	Forest site type Typ siedliskowy lasu	Stocking Zadrzewienie	Canopy Zwarcie	Stand quality Bonitacja	Age class Klasa wieku
212d	6.07	fresh mixed broadleaved LMśw	1.2	moderate crown closure umiarkowane	I	III
210a	2.25	fresh mixed broadleaved LMśw	1.1	moderate crown closure umiarkowane	II	III
211c	5.25	fresh mixed broadleaved LMśw	0.8	broken crown closure przerywane	II	III
211d	2.78	fresh mixed broadleaved LMśw	0.9	broken crown closure przerywane	II	III

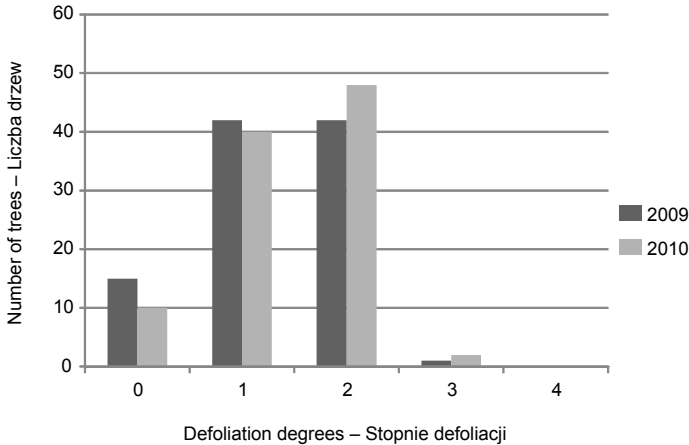


Fig. 3. Number of trees in the particular defoliation degrees in the subcompartment 211c in the years 2009 and 2010

Rys. 3. Liczba drzew w poszczególnych stopniach defoliacji w wydzieleniu 211c w latach 2009 i 2010

The number of trees without defoliation decreased by 5 trees, while the number of trees with a slight defoliation decreased by 2 trees. The smallest changes between the observation years referred to oak trees with a slight defoliation. However, it must be noted that there increased by 5 trees the participation of trees with a medium defoliation, in comparison with the previous year. The number of oaks without defoliation decreased to 10 trees. In both observation years, no dead trees were recorded. In the first year of observations, rain exudations were found on 10% of the studied trees. In the majority, the exudations were found on 10% of the studied trees. In the majority, the exudations occurred on trees with a medium defoliation. In turn, on 5% oaks, frost-ribs were observed on trees with a medium defoliation only. A higher number of damages was recorded in the second year of studies. On 12% of trees, resin exudations were found, while

Table 2. Defoliation in degrees

Tabela 2. Stopnie defoliacji

Defoliation degree Stopień defoliacji	Loss of assimilation apparatus, % – Ubytek aparatu asymilacyjnego, %
0	tree without defoliation (up to 10% of assimilation apparatus loss) do 10% ubytku aparatu asymilacyjnego, drzewo bez defoliacji
1	tree with slight defoliation (from 11% to 25% loss of assimilation apparatus) 11-25% ubytku aparatu asymilacyjnego, drzewo z lekką defoliacją
2	tree with a medium defoliation (from 26% do 60% loss of assimilation apparatus) 26-60% ubytku aparatu asymilacyjnego, drzewo ze średnią defoliacją
3	tree with a high defoliation (61% to 100% of assimilation apparatus loss) 61-100% ubytku aparatu asymilacyjnego, drzewo z dużą defoliacją
4	dead tree drzewo martwe

on 5% of trees, frost-ribs were recorded on oaks with medium defoliation degree. Fungal fruit bodies were found on 4% trees and 2 cracks were recorded among oaks with a high defoliation. In the first year of studies, during the observations in the subcompartment 201a, a great number of trees with medium defoliation degree was found (68 trees). The remaining number of trees (32 trees) included oaks with a slight defoliation (Fig. 4). In the successive year, there followed a change in the defoliation degrees, it means, that the condition of leaves improved. The number of trees with the 2nd degree loss of the assimilation apparatus decreased to the number of 49 tree. In the 1st degree of defoliation, 36 oaks were recorded and 13 trees were without any defoliation showing 0% of losses. A comparison of the two observation years distinctly shows that the assimilation apparatus loss significantly decreased. In both years of studies, the number of

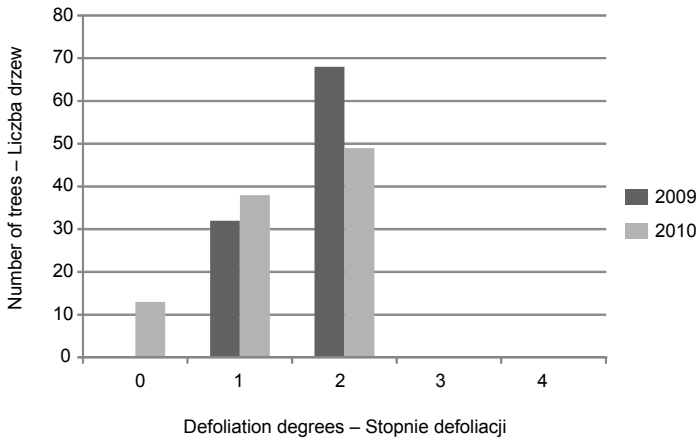


Fig. 4. Number of trees in the particular defoliation degrees in the subcompartment 210a in the years 2009 and 2010

Rys. 4. Liczba drzew w poszczególnych stopniach defoliacji w wydzielaniu 210a w latach 2009 i 2010

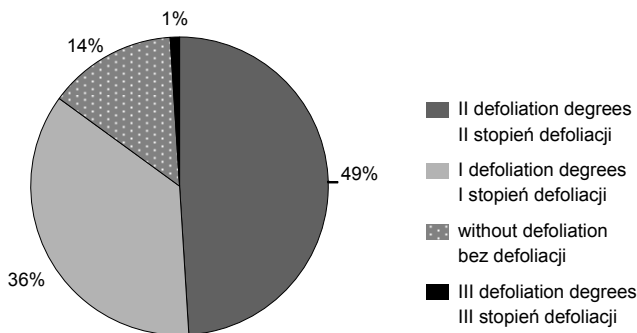


Fig. 5. Percentage distribution of defoliation degrees after the analysis of all subcompartments

Rys. 5. Procentowy rozkład stopni defoliacji – po przeprowadzonej analizie wszystkich wydziałów

trees with intensive defoliation and dead trees was not high. In a simultaneous observation of damages in the first year of studies, 29 trees were found with resin exudations. Those trees mainly included oaks with the 2nd degree loss of the assimilation apparatus. There were 5 trees with frost-ribs and, at the same time, they were in the 2nd degree of defoliation. Observations carried out in the second year of studies showed a smaller number of damages, They included 12 frost-ribs and 5 cracks in the studied trees.

An analysis of the assimilation apparatus loss (Fig. 5) in the Sulęcín Forest District indicated that 40% of oak trees showed damages typical of the 2nd defoliation degree. In the 1st defoliation degree, 30% of trees were found, while 1% of oaks included trees in the 3rd defoliation degree. No disease phenomena were observed on 14% of trees.

DISCUSSION

Assessment of the assimilation apparatus loss degree called defoliation is commonly applied in forest monitoring. The analysis of oak trees condition carried out in the Sulęcín Forest District showed a medium defoliation degree in the majority of trees (49%), 36% of trees showed slight defoliation conditions and 14% of trees did not show any damages. Only 1% of trees showed a high defoliation. The above results indicate the 2nd degree of the assimilation apparatus loss characterized the average condition of the oak tree stand (29.15%). It was found that the majority of damages was observed on trees with the 2nd defoliation degree. According to the Polish Main Statistical Office (GUS), the defoliation assessment of oak trees in Poland, in the year 2009 showed the following values: 14.4% of trees without defoliation; 52.52% – with a slight defoliation; 0.11% – dead trees [Mały rocznik statystyczny 2010]. The above quoted GUS data indicated that the general situation of oak trees in Poland, in comparison with Sulęcín Forest District, shows a more positive picture. The highest share of damaged trees (defoliation exceeding 25%, in the 2nd-4th defoliation classes) among deciduous trees was represented by oaks – 29.5%. In the zero-defoliation class – oak was characterized by the lowest number of healthy trees among the deciduous species (14.1%) [Raport... 2009]. Monitoring of oak stands health condition carried out on the basis of defoliation in the Wołów Forest District [Szewczyk and Czeryba 2010] showed a high degree of damages. There were no stands without any symptoms of damaged. The number of trees without damages decreased violently, while the number the number of damaged trees increased in the highest degree and so did the number of dead trees. Therefore, the situation of oak tree stands in Sulęcín Forest District was definitely better than the situation in the Wołów Forest District. This fact was also confirmed by the health investigation of common oak the area of West Pomerania [Szewczyk 2008]. According to Dmyterko and Bruchwald [2002], the Forest District Niepołomice, Nowa Sól and Wołów showed the most damaged oak stands in Poland. Szewczyk [2008] carried out an assessment of the oak stands in the Chojna Forest District in selected compartments. The result of those studies indicated that over one half of trees showed a zero-degree of defoliation, no dead trees were found, 26-40% of observed trees showed the 1st degree of defoliation. The examined tree stands were characterized by a very good health condition. In contrary, the health condition in Sulęcín Forest Division was definitely worse because 49% of oak trees included trees with the 2nd degree of damages. On 14% of them, no losses of the assimilation apparatus were found. In turn, in the Chojna Forest

District, the value of the 2nd degree damages was exceeded in over one half of the studied trees. Bruchwald and Dmyterko [1998] carried out inspection studies on 132 oak trees in different parts of Poland and they distinguished four areas: the central area, north-western area, south-western area and southern area. The mean value of defoliation calculated on the basis of all trees showed 38.4%, while the majority of trees was in the 2nd degree defoliation class. Only the medium defoliation value was not characterized by a better quality of the assimilation apparatus. Environmental Protection Inspection carried out in the year 2004 estimated the defoliation of stands in their age of over 40 years. A comparison of defoliation index (using Tukey's test) among deciduous tree stands distinctly indicated a higher level of oak trees damages. Taking into consideration the share of healthy trees, the Sulęcín Forest District was characterized by a better result. A comparative listing of results in Poland indicated 9.45% of oak trees without defoliation in the Sulęcín Forest District, while it was significantly higher and it amounted to 14%. When we compare the first and the second degree classes, the situation is definitively better, as compared with the situation of the whole country, since in the second degree class, 37.22% of oak trees defoliation was shown, while in Sulęcín Forest District, 49% of defoliation was found. According to Environmental Protection Inspection (IOŚ), there were 3.33% of dead trees and 7.78% of trees with a high defoliation. In Sulęcín Forest District, no dead trees were recorded, while trees with a high defoliation made 1% only. According to IOŚ listing referring to oak defoliation in naturalistic forest lands, the worst situation was presented in the Carpathian Land and in the Mazurian and Podlasiian Lands. Sulęcín Forest Division belong to Wielkopolska-Pomerania Land which is characterized by a comparatively low defoliation index, when compared with other lands. A high degree of crop density impedes the growth and expansion of crowns, oaks growing in a smaller density are characterized by big crowns and a higher regeneration ability [Wachter 1999]. The study area of subcompartment 210a in 2009 was characterized by 100% damages of the studied trees. In the successive year, the degree of crop density was definitely smaller and it exerted a positive effect on the regeneration ability because the number of undamaged trees decreased to 8%.

An evaluation of oak tree condition was also carried out on the basis of 10-year studies realized in 1991-2000. The investigations were carried out in the northern and southern parts of Poland. In 1991, on the total area of Poland, a determination of the oak tree health conditions was recorded. In the northern part of Poland, the years 1994-1996 show a comparatively constant tendency to maintain the number of damaged trees at the level of 70-80%. In the successive years, there of healthy trees. Oak tree stands in the southern part of Poland were characterized by a poorer health condition. A turning moment in that part of Poland was found in 1992, when an improvement of oak trees condition took place. However, generally, in the southern part of Poland, there decayed more trees than in the northern part (respectively 14.7% vs. 11.4% in 2000) [Oszako 2002]. Sulęcín Forest District is situated in the northern part of Poland and it is characterized by a similar percentage of damaged trees. On the basis of study analysis and observations carried out in the investigated areas, one must notice the progressing stabilization of the disease-creating process and an improvement of the tree stand condition. However, in spite of that, the health condition of the actual tree stands is not satisfactory. The evaluation of oak stands carried out during two years permits to define explicitly whether we can state whether the existence of the given problem is justified and what is the actual health conditions of the tree stands. Defoliation reflects the condition of the assimilation apparatus in the given years. According to Przybył [1995] the total process

of oak tree dying off is a strong intensity of the health condition of trees [Bartnik 1999]. In order to make a more exact evaluation whether the given phenomenon refers to the examined tree stands, the assessment of the loss in the assimilation apparatus must be carried out in a period longer than two days. Further actions must be undertaken, which take into consideration also other phenomena and factors which might exert an influence on the studied problem. Systematic and repeated observations will permit to define what exerts the negative effect on the development of oak trees. Next to defoliation, also drought and frost damages are the most frequent reasons initiating the dying off in oak stands [Delator 1983, Housten 1987, Miller et al. 1989, after Oszako 2007]. In Sulęcín Forest District, one cannot exclude the action of abiotic and biotic factors which may be responsible for the poorer condition of trees. The Institute of Meteorology and Water Management informed that in the year 2006, there took place a drought. The incoming masses of tropical air and very great insolation caused that the summer months were characterized by a strong atmospheric drought and a hydrological drought revealed by the decreased level in both the flowing waters and the groundwaters. In such situation, the mentioned factor may have contributed to the weaker condition of oak trees in the Sulęcín Forest District.

Czerniak et al. [2008] reported that smaller atmospheric precipitations in the vegetation period may exert an influence on the decrease of oak stands health condition in the Konstantynowo Forest District. Climatic changes and primarily long periods of drought exert an influence on the weakening of oak stands. Because of the complexity of the phenomenon of oak trees decay, further investigations should be undertaken to define the disease symptoms in order to detect the interactions taking place between the symptoms and the initiating factors. Oak tree stands condition should be exactly monitored and in case of necessity, intervention treatments should be undertaken. In case of assimilation apparatus loss, one should also consider other factors and analyse them because it may permit to confirm or deny whether we have to do with the phenomenon of oak tree dying off.

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OCENA KONDYCJI DĘBU NA PODSTAWIE STOPNIA UBYTKU APARATU ASYMLACYJNEGO WYBRANYCH DRZEWOSTANÓW NADLEŚNICTWA SULĘCIN

Streszczenie. Dęby mają duże znaczenie gospodarcze i przyrodnicze. Dąb szypułkowy jest najcenniejszym gatunkiem lasotwórczym w Polsce. W ostatnich latach na terenie całego kraju obserwujemy widoczne pogorszenie kondycji zdrowotnej drzewostanów dębowych. Trudno jest znaleźć jeden główny czynnik odpowiedzialny za to zjawisko. Ze względu na tak szeroki zasięg jego występowania przyjmuje się, że na ten proces składa się wiele czynników abiotycznych, biotycznych oraz antropogenicznych. Badania zostały przeprowadzone w Nadleśnictwie Sulęcín. Na przełomie lipca i sierpnia w 2009 oraz 2010 roku przeprowadzono ocenę ubytku aparatu asymilacyjnego dębów. Analiza stanu zdrowotnego dębów wykazała, że w większości drzewa były w średnim stopniu defoliacji – 49%, następnie 36% stanowiły drzewa z lekką defoliacją, 14% drzew nie wykazało uszkodzeń, natomiast 1% obejmuje drzewa z dużą defoliacją. Z przedstawionych danych wynika, że średnia wartość ubytku aparatu asymilacyjnego to 29,15%.

Słowa kluczowe: dąb, zamieranie, defoliacja, Nadleśnictwo Sulęcín

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