Науковий вісник НЛТУ України
Scientific Bulletin of UNFU
http://nv.nltu.edu.ua
https://doi.org/10.15421/40270818
Article received 27.10.2017 р.
Article accepted 24.11.2017 р.
UDC 630*[5+228]:582.632.2

ISSN 1994-7836 (print)
ISSN 2519-2477 (online)

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ABOVEGROUND BIOMASS OF COMMON OAK WINDBREAKS IN CENTRAL UKRAINE

The article is devoted to research of above-ground biomass of oak (*Quercus robur* L.) windbreaks. Described are the morphological, biological, ecological and forest meliorative properties of common oak growing in windbreaks. The dependence between the amount of biomass components and the main mensurational and meliorative indices such as protective height and openness in the crowns of windbreaks has been established. As a result, mathematic models for the assessment of both the above-ground components of a tree, the crown, and a windbreak, as a whole, have been developed. It is determined that the relative density of the trunk has less accuracy than openness in the crown in the assessment of the components of above-ground phytomass of a windbreak. For a separate tree of 36 cm in diameter at breath height, 24 m in height, a 0.8 windbreak density and a 10 % openness of crown in windbreak, the share of trunk biomass is higher in a massive stand in comparison with a windbreak. However, the crown biomass in a windbreak is 6% larger than in a massive stand. The standards for determination of the amount of phytomass components for trunks and crowns of separate trees and oak windbreaks, as well as that of sequestered carbon have been developed. The developed models and standards were analyzed. and the structure of phytomass on the components and sequestered carbon done. The comparative analyze has revealed the trends towards increased share of crown phytomass in the oak windbreaks with increasing their biometric characteristics as compared to massive stands.

Keywords: windbreak, biomass; protective height; openness; natural density; basic density; wood; bark; woody green stuff; branches; leaves; sequestered carbon.

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Introduction

Today, in Ukraine, there is a problem of complex inventory and continuous regulation of forest shelterbelts (windbreaks). In light of current environmental and economic needs of humanity, the complete inventory of forest objects is not possible without providing information about their biological productivity, the impact on the carbon balance of the atmosphere and energy value (Buksha & Pasternak, 2005; Yukhnovskyi, et al., 2009). The study of forest biomass of plant communities plays a key role in solving these problems.

Expert assessment of forest resources of Ukraine shows its great potential concerning reduction in the concentration of greenhouse gases in the atmosphere and achieving the goal of the Framework Convention. Under the Kyoto Protocol, Ukraine has regularly to conduct annual inventory of changes in net emissions by sources and removals of greenhouse gases by sinks (Shevchuk, 2004; IPCC, UNEP, OECD, IEA,1995a, 1995b, 1995c, 1997). Carbon pools and flux of forest ecosystems were studied by many scientists (Lakyda, 2002; Utkin, et al., 1998; Khodash, 2010; Crane, 1985; Dixon, et al., 1994; Zhou, 2000/2001).

There is a significant amount of data on biological productivity of massive stands of main forest-forming species. Windbreaks were not the subject of a separate detailed study of patterns of accumulation of biomass components and atmospheric carbon. This situation needs correcting as windbreaks directly affect forest cover percent, and hence the carbon balance of sparsely wooded agricultural areas. Comprehensive assessment and the use of resource potential of protective forest plantations is a strong argument for their establishment, especially given the continued shift of agricultural sector to private ownership (Anuchin, 1982; Bazilevich, 1993).

Цитування за ДСТУ: Yukhnovskyi V. Yu., Lobchenko G. B., Khodash A. B., Mosquera Losada M. R., Borek R. Aboveground biomass of common oak windbreaks in the central part of Ukraine. Науковий вісник НЛТУ України. 2017. Вип. 27(8). С. 111–117.
Citation APA: Yukhnovskyi, V. Yu., Lobchenko, G. B., Khodash, A. B., Mosquera Losada, M. R., & Borek, R. (2017). Aboveground biomass of common oak windbreaks in the central part of Ukraine. *Scientific Bulletin of UNFU, 27*(8), 111–117. https://doi.org/10.15421/40270818


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The purpose and tasks of the study

The aim of research is the development of complex information support and regulatory evaluation of components of the aboveground biomass and deposited carbon of trees and stands of common oak in windbreaks. The research object is represented by windbreaks of common oak (*Quercus robur L.*) in the central part of Ukraine, which include the territory of Chernihiv-, Kyiv-, Cherkasy- and Poltava regions.

Optimal soil conditions, moderate temperatures and significant amount of rainfall in the study region are favourable factors for the growth of woody and herbaceous plants, including agricultural crops. Thus, a large area of land in the region has become a forest-agricultural landscapes (FAL), in which systems of windbreaks are an integral part of FAL. These protective plantations are established on arable lands for neutralization of adverse environmental factors and to increase crop yields. However, windbreaks also play an important ecological role, and have a significant forest resourses potential (Shvidenko, et al., 1987).

Common oak is the most suitable tree species to create windbreaks because of its biological stability, longevity and high agroforestry properties.

The studies of biological productivity of protective forest plantations have not become extensive yet. The existing works are fragmentary, but ther are all the prerequisites for their further enhancement. In particular, A. Kodash (Khodash, 2010) evaluated the main components of the biological productivity of protective forest plantations at the local level, V. Yukhnovsky (Yukhnovskyi, 2003) assessed the above indicator for optimized forest-agricultural landscapes of Ukraine. A. Kabantsov (Kabancov, 1990) studied the relationship of fractional composition of pine shelterbelts biomass with their openness and their aerodynamic properties. American scientists from the National Agroforestry Center conducted diverse studies (2005-2008) on accumulation of carbon stock by protective forest plantations in the US, including windbreakes (NAC, n. d.), J. Brandle and G. Ruark researched windbreaks for carbon sequestration (Brandle & Ruark, 2000/2001), Coocha J. at al determined carbon reservations in the aerial biomass of agroforestry systems (Concha, Alegre & Pocomucha, 2007).

Research Objects and Methods

Windbreaks are part of forest-agricultural landscapes in which they transform arable territory; forest and field here are a single ecological system (Pylypenko & Yukhnovskyi, 1998; Law of Ukraine of 21.09.2000, No. 1989-III, 2000; Tkach, Hladun & Tkach, 2000).

Conducting scientific research on such a specific object has significant features and, therefore, the methods of research on biological productivity and phytomass should be generalized and adapted for it. Our research methodology is based on the following principles: conventional methods in forest inventory (Anuchin, N. (Pylypenko & Yukhnovskyi, 1998), Nikitin, K. (Nikitin & Shvidenko, 1978), Shvidenko, A. (Shvidenko, et al., 1996)); silvicultural techniques, researching in protective afforestation (Bodrov, V. (Bodrov, 1974), Pylypenko, O. (Pylypenko & Yukhnovskyi, 1998), Yukhnovsky, V. (Yukhnovskyi, 2003), Khodash, A. (Khodash, 2009) and others); methods for determining quantitative and qualitative indicators of biomass in forests (Vatkovskyy, A. (Vatkovskij, 1968), Lakyda, P. (Lakida, 1996), Tokmurzin, T. (Tokmurzin, 1977), Usoltsev, V. (Usolcev, 1988, 2002), Utkin, A. (Utkin, 1986; Utkin, et al., 1998), Whittaker, R. (Whittaker, 1965) and others).

The field research was conducted on 15 temporary trial plots laid down in the oak windbreaks, created by clump planting method in three administrative districts of Chernihiv region. The mensurational operations were done to get the biometric characteristics of the stands. To study the parameters of biomass, 46 model oak trees were chosen. To determine the density of fractions of the trunk and branches, their moisture content and the content of absolutely dry matter, 50 test sections of the trunk and 149sections of branches were cut out. (Figures. 1 and 2).

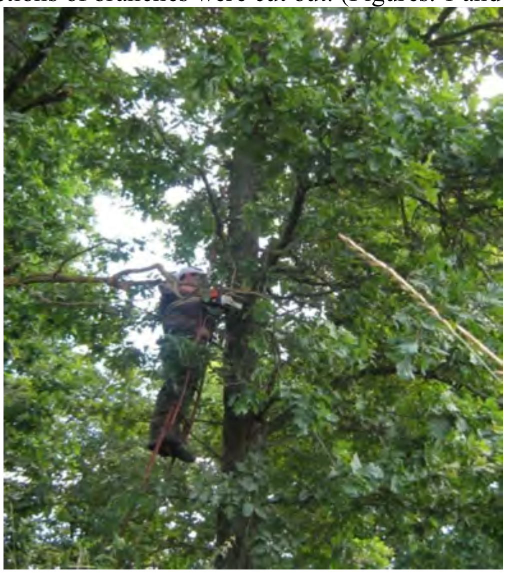
Figure 1. Cutting of model branches from a growing tree


Figure 2. The test samples cut from the trunk of oak to determine density of biomass fractions

About 20 % of model trees were selected from the middle rows of windbreaks. The data on 23 trial plots including biometric characteristics of 51 model trees, cut for the analysis of the growth, was taken from the database of the Agroforestry Department of NULESU.

Comparative characteristics of the results of weighing crown biomass fractions, using different methodological approaches, for a total of 10 felled model trees are shown in Table 1.

Table 1. Comparison of the results of weighing crown biomass fractions obtained from different methodological approaches

Parameters	Fraction of biomass			
	Woody green stuff	leaves	branches	crowns
Freshly-cut total biomass of 10 trees, kg	As a result of weighing crown			
	295.2	184.6	876.4	1,171.6
	As a result of weighing model branches			
	324.6	202.0	884.4	1,209.0
Deviation				
Absolute, kg	-29.4	-17.4	-8.0	-37.4
Relative, %	-10.0	-9.4	-0.9	-3.2

The data in Table 1 leads to the conclusion that the experimental material obtained by weighing separate model branches have larger absolute values than that obtained by weighing total fractions of crown biomass of model trees. But this relative deviation between the results obtained by different methodological approaches does not exceed 10 % for certain fractions and is 3 % for the whole crown.

Applied our method of cutting branches model to determine the parameters of crown biomass is obtained and correct and using the data can be used for further research to determine patterns of biological productivity of oak windbreaks.

Results and discussion

At the first stage of research the qualitative characteristics of components of biomass oak growing in winbreaks were analized. Comparative analysis of the values of the average compactness of biomass components of trunk oak in windbreaks and compatness values of the respective fractions of the same species obtained in massive plantations by P. Lakyda (Lakyda, 2002), are presented in table 2.

Table 2. Comparative characteristics of density of biomass components of oak trunk for relative heights, kg/m³

Component biomass (category stands)	The relative height of the trunk				
	0 *h*	0.1 *h*	0.25 *h*	0.5 *h*	0.75 *h*
Freshly-cut state					
Wood without bark (research data)	1,128	1,136	1,080	1,109	1,119
Wood without bark (data by P. Lakyda)	1,098	1,036	1,009	1,005	1,015
Deviation, %	2.7	8.8	6.6	9.4	9.3
Bark (research data)	931	943	1,025	1,079	1,258
Bark (data by P. Lakyda)	775	766	807	862	914
Deviation, %	16.8	18.8	21.3	20.1	27.3
Absolute dry matter					
Wood without bark (research data)	683	703	671	701	677
Wood without bark (data by P. Lakyda)	640	609	592	585	586
Deviation, %	6.4	13.4	11.8	16.5	13.5
Bark (research data)	537	569	591	591	638
Bark (data by P. Lakyda)	429	430	447	452	447
Deviation, %	20.2	24.4	24.4	23.5	30.0

According to Table 2, the wood and bark of the trunk in the windbreaks have larger absolute values for density in natural and absolutely dry conditions than in the massive plantations. An analysis of changes in the density of biomass components with height of the trunk has shown that the lowest density is observed at 0.25 *h*, while in the massive plantations – at 0.5 *h*. This phenomenon is explained by a large extent of the crown and that in the narrow strips the trees growing in the open space have a larger diameter and smaller height than the trees of massive plantations.

The average values for density, compared with corresponding data obtained by P. Lakyda (2002) for massive oak plantations in Ukraine are given in Table 3.

Table 3. Comparison of the average values of the density of trunk biomass components in windbreaks and massive plantations

Objects	Density ($p^{\pm m_p}$), kg/m³				
	natural			basic	
	wood	bark	wood+bark	wood	bark
Windbreaks (research data)	$1{,}096^{\pm22}$	$1{,}030^{\pm36}$	$1{,}083^{\pm19}$	$677^{\pm10}$	$579^{\pm20}$
Massive plantations (data by P. Lakyda)	$1{,}032^{\pm10}$	$819^{\pm13}$	$985^{\pm9}$	$602^{\pm12}$	$436^{\pm27}$
Deviation, %	5.8	20.5	9.0	11.1	24.8

According to Table 3, the average density of the biomass fractions of oak trunk in the windbreaks is higher than for massive forest plantations. The density of freshly-cut wood is more than by 5.8 %, and in the absolute dry state – by 11.1 %. The comparative characteristics of values for natural and basic density of the wood and bark of branches in the windbreaks and in massive stands are shown in Table 4.

According to the data in Table 4, the deviation between values for density of the crown biomass components of oak, growing in the windbreaks, and the similar indicators for massive stands does not exceed 10 % and reach maximum for basic density of branch bark of 9.4 %. The minimum deviation, characteristic for the basic density of wood branches, is 0.6 %.

Table 4. Comparison of the average values for density of components of biomass in branches of oak windbreaks and in massive plantations

Objects	Density ($p^{\pm m_p}$), kg/m³				
	natural			basic	
	wood	bark	wood+bark	wood	bark
Windbreaks (research data)	$1{,}005^{\pm10}$	$999^{\pm28}$	$1{,}000^{\pm10}$	$597^{\pm11}$	$550^{\pm17}$
Massive plantations (data by P. Lakyda)	$995^{\pm12}$	$949^{\pm25}$	$980^{\pm9}$	$601^{\pm7}$	$498^{\pm13}$
Deviation, %	1.0	5.0	2.0	-0.6	9.4

Table 5 shows the comparison of the average values for leaves share in woody green stuff and the content of dry matter in it for the windbreaks, with corresponding values for massive oak plantations. The data obtained for the windbreaks is exceeding the counterparts of massive plantings by around 5.9 % and 6.8 %, respectively.

Table 5. Comparison of the average values for leaves percentage in woody green stuff and absolutely dry matter in the leaves of oak growing in the windbreaks and massive plantations

Objects	The share of leaves in woody green stuff, %	The share of absolute dry matter in leaves, %
Windbreaks (research data)	$61.6^{\pm1,0}$	$44.0^{\pm0,9}$
Massive plantations (data by P. Lakyda)	$57.9^{\pm1,6}$	$41.0^{\pm2,0}$
Deviation, %	5.9	6.8

The average values for the share of absolutely dry matter in wood, bark and wood of branches in the crowns of oak winddbreaks are 60.7, 56.8 and 59.0 %, respectively. Large differences in the values for quality characteristics are identified for biomass fractions of the trunk of oak windbreaks and massive plantations. The larger values of density of wood and bark in the windbreaks are due to the influence of the complex adverse environmental factors on the growing trees.

The statistical analysis of experimental data, their correlation and regression analysis were done before the establishment of aboveground biomass and carbon deposited in the oak windbreaks. Mathematical models were developed to estimate the parameters of biomass components of trees and stands of oak in the windbreaks. They formed the basis of the relevant standards for identifying different functions of biomass-accumulated carbon.

Simulation of relation parameters of tree biomass with major biometric indices is methodologically divided into: modeling of biomass components of the trunk in terms of volume, followed by the transfer of a unit mass of freshly-cut (natural) wood and absolute dry biomass components and modeling components of freshly-cut wood with further transferring them in absolutely dry state.

Mathematical models of evaluation components of biomass of the trunk in volume units are shown in Table 6. To determine the volume of wood biomass, bark and wood of branches of the crown, the mathematical models were obtained using main biometric parameters: the diameter of the tree at breast height ($d_{1,3}$) and tree height (h).

Table 6. Models of relations between volumes of trunk biomass components with the main biometric indices

Model number	Type model	Q^2
To assess the volume of wood tree trunks		
1	$V_{wood}=2.94\cdot10^{-5}\cdot d^{1,916}\cdot h^{1,096}$	0.99
To assess the volume of the bark of tree trunks		
2	$V_{bark}=2.71\cdot10^{-5}\cdot d^{1,856}\cdot h^{0,622}$	0.96

The high coefficients of determination (0.96-0.99) are characteristic for mathematical models presented in Table 6, which provides their adequacy in determining the amounts of trunk biomass with high accuracy.

The models for determination of the components of crown biomass with the introduction of index of openness in the crowns of the windbreaks (I_{por}) are given in Table 7.

The standards for the determination of the volume of aboveground biomass components in natural (freshly-cut) and absolutely dry states were developed using the models 3-5. The fragments of standards are given in Table 8.

Table 7. Mathematical models to estimate biomass components of the tree crown

Model number	Type model	Q^2
To assess the biomass of woody green stuff		
3	$q_{wv}=3.5\cdot10^{-2}\cdot d^{3,663}\cdot h^{-1,784}\cdot I_{por}^{0,373}$	0.72
To assess the biomass of branches		
4	$q_{br}=2.77\cdot10^{-4}\cdot d^{4,007}\cdot h^{-0,045}\cdot I_{por}^{0,129}$	0.84
To assess the biomass of leaves		
5	$q_{l}=2.3\cdot10^{-2}\cdot d^{3,735}\cdot h^{-1,903}\cdot I_{por}^{0,364}$	0.72

Table 8. Weight of oak trees in natural condition, kg

Diameter, cm	Height, m								
	8	10	12	14	16	18	20	22	24
Openness in crowns – 10 %									
12	53	64	75	-	-	-	-	-	-
14	74	88	104	119	-	-	-	-	-
16	100	118	137	157	177	-	-	-	-
18	131	153	177	201	226	-	-	-	-
20	169	195	223	253	283	-	-	-	-
22	-	244	277	312	348	385	-	-	-
24	-	301	339	380	423	466	-	-	-
26	-	367	411	458	507	557	-	-	-
28	-	443	493	546	602	659	-	-	-
30	-	-	586	646	709	774	-	-	-
32	-	-	692	758	829	902	977	-	-
34	-	-	-	885	963	1,044	1,128	1,213	1,299
36	-	-	-	1,026	1,112	1,202	1,295	1,389	1,485
38	-	-	-	-	1,279	1,377	1,479	1,583	1,689
40	-	-	-	-	1,463	1,571	1,682	1,796	1,912

The tables are formed with two outputs (diameter and height) for the tree trunk of oak and with three outputs (diameter, height and openness) for crowns in the windbreaks). The average values for openness in crowns were used for development of the Tables.

There is a concept of construction (design) of windbreak (Bodrov, 1974; Pylypenko & Yukhnovskyi, 1998). *Construction of windbreak* is defined by structure of its longitudinal vertical profile in the leaved state that determines its aerodynamic properties. According to the ISO 48-74: 2007, there are the following design of windbreaks (Fig. 3):

- **Blown design** with openness of more than 60 % and 10 % respectively in the bottom and top of the vertical longitudinal profile;
- **Dense (not-blown) design** with almost no gap (10 %) around the longitudinal vertical profile;
- **Sieve-looked design** with evenly spaced lumen area from 15 to 35 % for all vertical longitudinal profile.

The tables for estimation of biomass were developed for the blown, dense and sieve-looked designs of windbreaks that respectively are characterised by 5, 10 and 25 % of openness in crowns.

Distribution of biomass components in absolute dry state for the windbreaks and massive plantations can be seen in Fig. 4. The charts presented here indicate the relationship between typical biomass components of oak trees in the windbreaks in massive plantations. In windbreaks,the share of trunk wood is decreased by 8 %, bark - by 2 % and branch biomass is increased by 10 % as compared with massive stands.

As for the comparison of the distribution of biomass components in massive plantations, for $d_{1,3}$=36 cm, h=24 m the share of stem wood and bark is larger by 3 % in the massive plantations, while the share of branches and overall crowns is 6 % less due to significantly powerful oak crown in the windbreaks.

Figure 3. Different types of windbreak constructions: a) blown design; b) dense (not-blown) design; c) sieve-looked design

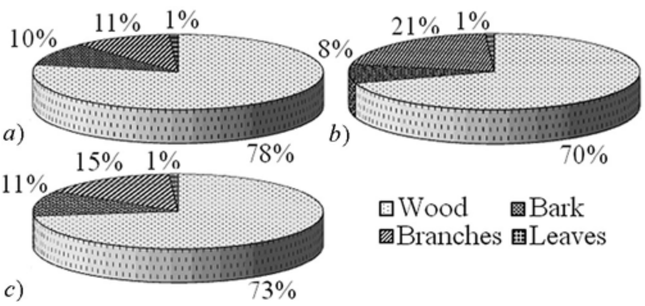

Figure 4. Relationship between some components of aboveground biomass of oak trees in an absolute dry state: *a)* $d_{1,3}$=20 cm, h=16 m, I_{por}=10 %; *b)* $d_{1,3}$=36 cm, h=24 m, I_{por}=10 % (windbreaks, research data), *c)* $d_{1,3}$=36 cm, h=24 m, D=0.8 (massive stands, P. Lakyda's data)

Developing models and standards for determination of the biomass of oak stands growing in windbreaks is of paramount importance to monitor the accumulation of carbon stocks by these objects. Simulation subject are wood biomass of trunks ($m_{w.tr}$); biomass of trunk bark ($m_{b.tr}$); biomass of overbark trunks (m_{tr}); biomass of branches (m_{br}); biomass of woody green stuff ($m_{w.vr}$); leaf biomass (m_{lv}); crown biomass (m_{cr}). In search of mathematical relationships, the three factoral models for the researching and biomass indices of stands were developed.

Mathematical models for estimation of parameters of biomass components of trunks of oak growing in windbreaks are presented in Table 9. The table data shows that there is dependence of oak trunk biomass on the average diameter, height, relative density, protective height (H_{pr}) of windbreak and openness in the crowns. They are characterized by high rates of determination (Q^2 = 0.71-0.83). In order to move from freshly-cut state to absolute dry state of fractions, the corresponding values were used for basic density and the content of absolute dry matter.

Table 9. Mathematical models to estimate the amount of biomass components of oak windbreaks in a natural state

Model number	Type model	Q^2
To assess the biomass of wood trunks		
6	$m_{wood}=4.859 \cdot D^{0,099} \cdot H_{pr}^{1,315} \cdot P^{0,909}$	0.78
To assess the biomass of bark trunks		
7	$m_{b,tr}=1.007 \cdot D^{-0,014} \cdot H_{pr}^{1,463} \cdot P^{0,908}$	0.76
To assess the biomass of wood verdancy		
8	$m_{w.vd}=7.7 \cdot 10^{-2} \cdot D^{2,277} \cdot H^{0,604} \cdot I_{por}^{0,431}$	0.83
To assess the biomass of branches		
9	$m_{br}=8.46 \cdot 10^{-3} \cdot D^{1,985} \cdot H^{1,018} \cdot I_{por}^{0,189}$	0.71
To assess the biomass of leaves		
10	$m_{lv}=4.9 \cdot 10^{-2} \cdot D^{2,341} \cdot H^{0,704} \cdot I_{por}^{0,429}$	0.83

Having obtained assessment standards of aboveground biomass components of oak windbreaks, it is possible to develop the tables to evaluate the carbon amounts using the known conversion factors: for stem wood and bark – 0.50, for leaves – 0.45 (Matthews, 1993, 1996). Such tables are needed to assess the cycle of carbon in the biosphere

A fragment of tables to estimate carbon in above-ground biomass components for trunks and crowns of oak plantations in the windbreaks at a 0.8 density, openness of crowns - 10 %, is given in Tables 10 and 11.

Table 10. The amount of carbon in the trunks of oak windbreaks, t/ ha

Diameter, cm	Protective height, m						
	10	12	14	16	18	20	22
Density – 0.8							
16	42	53	-	-	-	-	-
18	42	53	66	-	-	-	-
…	…	…	…	…	…	…	…
30	-	-	-	-	-	110	-
32	-	-	-	-	-	111	126

Table 11. The amount of carbon in the crowns of oak windbreaks, t/ ha

Diameter, cm	Height, m						
	10	12	14	16	18	20	22
Porosity in crowns – 10 %							
16	4.60	5.39	-	-	-	-	-
18	5.84	6.83	7.85	-	-	-	-
…	…	…	…	…	…	…	…
30	-	-	-	-	-	30.41	-
32	-	-	-	-	-	34.60	37.89

Figure 5 illustrates the accumulation of different components, and biomass of oak windbreaks in natural (freshly-cut) and in absolute dry state with an average diameter of 28 cm, protective average height of 18 m, density of 0.8 and openness of crowns - 10 %.

As Fig. 5 demonstrates, the biomass of trunks is dominant among biomass components of oak windbreaks. The fraction of branches is the main part of the crown biomass.

The main function of the leaves fraction is the assimilation of carbon from the atmosphere, and it does not play an important role in the accumulation of total biomass of stands.

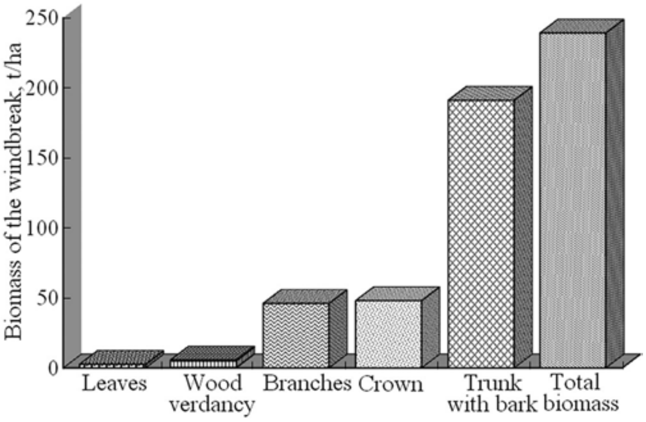

Figure 5. Above-ground biomass of oak windbreaks in an absolutely dry state at D =16 cm, $H=H_{pr}$=10 m, P=0.8, I_{por}=10 %

Conclusions

The main conclusions of the studies are as follows:

1. The arable lands of the region has been transformed into forest-agricultural landscapes with systems of windbreaks. The presence of the latter increases forest cover of agricultural landscapes, forms their microclimate, contributes to the soil erosion control, improve the hydrological regime of the area, provides for absorption and accumulation of free carbon from the atmosphere, serves as wood resource and a source of additional energy.

2. Common oak, due to its longevity, powerful crown, productivity and biological stability, is the main species to form forest shelterbelts with high protective properties. Windbreaks are the specific object of forest inventory, which, in addition to forestry-biometric characteristics, have inherent meliorative and specific indicators, namely, protective height, openness, width and design.

3. The components of trunk biomass of oak are characterized by higher values of local and average natural and basic density and their absolute values. Changing the basic density of biomass components with trunk height is such that the smallest value of wood density is observed at a height of 0.25 *h*, most – at 0.1 *h* and 0.75 *h*. The highest value for basic density of bark is found at a height of 0.75 *h*, the lowest – at the root.

4. Found are the resulting impact factors of forestry-meliorative indicators which are underlying in modeling of aboveground biomass of tree and forest stand. Such parameters as diameter at breast height, tree height, the relative density and openness of the crown were chosen to determine the amounts of wood biomass components for an individual tree, and average diameter, protective height, average height, density, growing stock volume, openness of crowns – to calculate amounts of biomass for the whole windbreak (stand).

5. As a result of modeling aboveground biomass of windbreaks, the models of biomass components for trunk and crown of a separate tree were obtained. The structure of oak wood biomass by its components was established. For a separate tree with a diameter at breast height of 36 cm, height of 24 m, and a density of stand of 0.8 and openness in crowns of 10 %, the share of trunk biomass in the massive plantations is higher, and for crown biomass is less by 6% than in windbreaks.

6. The math models of evaluation of the components of aboveground biomass are calculated for oak windbreak in its natural state. The normative-reference tables of three inputs to determine the volume of aboveground biomass components in absolute dry state and the accumulated carbon in them were developed.

7. The analysis of the developed standards showed a tendency towards increasing the share of biomass in the crown of oak windbreaks with age, in contrast to the massive plantations.

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НАДЗЕМНА ФІТОМАСА ДУБА ЗВИЧАЙНОГО У ПОЛЕЗАХИСНИХ ЛІСОВИХ СМУГАХ ЦЕНТРАЛЬНОЇ ЧАСТИНИ УКРАЇНИ

Досліджено надземну фітомасу дуба звичайного (*Quercus robur* L.), що росте у полезахисних лісових смугах (ПЛС). Описано морфологічні, біологічні, екологічні та лісомеліоративні властивості дуба звичайного. Встановлено залежність між кількістю компонентів фітомаси та основними таксаційними і меліоративними показниками – захисною висотою та ажурністю у кронах. Розроблено математичні моделі оцінки надземних компонентів для окремого дерева і насадження. Встановлено, що для оцінки компонентів надземної фітомаси ПЛС відносна щільність стовбура має меншу точність, ніж ажурність крони. Для окремого дерева діаметром 36 см на висоті грудей, висотою 24 м, повнотою смуги 0,8 і просвітністю у кроні (ажурність) фітомаса стовбура в масивних насадженнях на 10 % перевищує аналогічний показник у лісових смугах. Однак фітомаса крони дуба полезахисних смуг на 6% перевищує цей показник для масивних насаджень. Розроблено нормативи кількості компонентів фітомаси і депонованого вуглецю для стовбурів і крон дерев дуба у ПЛС.

Ключові слова: полезахисна лісова смуга; фітомаса, захисна висота; ажурність; природна щільність; базова щільність; деревина; кора; деревна зелень; гілка; листя; депонований вуглець.

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НАДЗЕМНЫЕ ФИТОМАССЫ ДУБА ОБЫКНОВЕННОГО В ПОЛЕЗАЩИТНЫХ ЛЕСНЫХ ПОЛОСАХ ЦЕНТРАЛЬНОЙ ЧАСТИ УКРАИНЫ

Исследована надземная фитомасса дуба обыкновенного (*Quercus robur* L.), произрастающего в полезащитных лесных полосах (ПЛП). Описаны морфологические, биологические, экологические и лесомелиоративные свойства дуба обыкновенного. Установлена зависимость между количеством компонентов фитомассы и основными таксационными и мелиоративными показателями – защитной высотой и ажурностью в кронах. Разработаны математические модели оценки надземных компонентов для отдельного дерева и в целом для насаждения. Установлено, что для оценки компонентов надземной фитомассы ПЛП относительная плотность ствола имеет меньшую точность, чем ажурность кроны. Для отдельного дерева диаметром 36 см на высоте груди, высотой 24 м, полнотой полосы 0,8 и просветностью в кроне (ажурность) фитомасса ствола в массивных насаждениях на 10% превышает аналогичный показатель в лесных полосах. Однако фитомасса кроны дуба полезащитных полос на 6% превышает этот показатель для массивных насаждений. Разработаны нормативы количества компонентов фитомассы и депонированного углерода для стволов и крон деревьев дуба в ПЛП.

Ключевые слова: полезащитные лесные полосы; фитомасса; защитная высота; ажурность; естественная плотность; базовая плотность; древесина; кора; древесная зелень; ветка; листья; депонированный углерод.