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EVALUATION STANDARDS OF EUROPEAN ASH TREE CROWN PHYTOMASS COMPONENTS IN THE CONDITIONS OF RIGHT-BANK FOREST-STEPPE OF UKRAINE

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The results of the development of an alternative embodiment of evaluation standards of aerial crown and wood phytomass are shown. Modeling of forest indicators and quantitative parameters of European ash tree crown phytomass components in the conditions of Right-Bank Forest-Steppe of Ukraine are the basis of normative-reference tables algorithm constructing.

European ash, Right-Bank Forest-Steppe, taxational indicators of crown, mass of tree crown woody greenery, mass of tree crown branches.

Productivity of forest plantations was associated mainly with stocks and annual increments of stem woody in volume units. Little attention was paid to the assessment of tree phytomass components, especially its crown. Taking into account current environmental and energy problems, standards evaluation development of main tree species plantations phytomass components in mass units is one of the most important tasks of forest resource management [4].

Today the researchers in many countries have developed the evaluation tables of trees and plantings biomass components, which differ by the procedure of their creation, maintenance, measurement units, set of evaluating components, designated purpose etc [3].

The development of regulations of forest stands biotic productivity of European ash in the Right-Bank Forest-Steppe of Ukraine was conducted on the base of P.I. Lakida's [3] general scheme of the open assessment model of biotic stands

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productivity by the phytomass components and in accordance with the regularities of their structure in diameter.

Distance forest inventory methods of forest fund can significantly reduce the cost and accelerate the implementation of this work, but appropriate regulatory and informational materials are needed for the determining of bioproductivity of trees and forest stands.

The purpose of the research is the development of evaluation regulations of forest stands biotic productivity of European ash by crown parameters on the basis of appropriate mathematical models by crown parameters on the basis of appropriate mathematical models developed in accordance with the correlation dependencies of taxation features and quantitative crown components and taxational tree indicators.

Research methodology. During carrying out of carbon stocks regional assessments in ecosystems the most common basis approaches are cartographic, conversion, distance and model ones.

Cartographic method assumes carbon estimation as the square sums expression (released on the basis of geographical maps, remote information) of polygons on the establishment (in accordance with local databases) of carbon stock values [2].

The basis of the conversion approach is precise physical dependence of reserves phytomass components volume and their mass through density. Phytomass reserves are calculated with transferring of volumetric reserves of phytomass components to the mass of organic substances using conversion coefficients. This approach is used to forest ecosystems, where forest inventory is regularly conducted. Conversion approach is recommended by IPCC [2] to calculate carbon of forest ecosystems.

Distance approach is based on the active surface sensing when the phytomass value is determined by decrease of signal strength, reflecting from the earth's surface. Evaluation of carbon stocks obtained with using of remote information of optical range according to this approach is practically cartographic, as satellite information in this case is used to highlight polygons or classification of digital map pixels, and carbon stocks are determined on the basis of associated typical values or models [2].

Model approach to the evaluation of stock assessment and carbon budget at the regional level is partly combined with cartographic or conversion approaches.

In the international scientific practice evaluation of phytomass stands components depending on ultimate goal of the research and the way of its achievement is conventionally divided into three groups [3]:

1. Research of phytomass stands components of certain tree species depending on the type of forest site conditions. This technique was developed and used in the implementation of LVI. The result of these studies is represented mainly in a descriptive form.

2. Determination of single and multi-component dependencies of major components of phytomass stands on their average taxational characters. The final results of this research are the developed evaluation standards of phytomass stands components in statics.

3. Development of the dynamics of biological productivity models based on the dependencies of modeled components of phytomass stands and taxational characters of plantations growth tables.

Parameters of common ash tree crown and their interrelation with major taxational characters were studied according to the 64 sample trees from 21 study plots, grounded in the study region (of which 45 sample trees from 15 study plots are planted by the author in the stands of Khmelnitsky, Vinnitsa and Kiev regions, and 19 sample trees from 6 study plots are planted by Morozyuk O.V. in ash plantations in Cherkasy region). Selection, processing of experimental data and determination of mass, volume and density of phytomass components of sample European ash trees has been carried out on the basis of P.I. Lakida's techniques [3].

Statistical processing of the experimental data was carried out on a personal computer using programs "STATISTIKA" and "Microsoft Excel-2003" in the following sequence: verification (detection and removal of uncharacteristic, wrong experimental data); establishing of correlative dependence of taxational indicators of a tree and crown; determination of the diameter and the length of crown; calculation the area of lateral surface and volume of the crown; establishing the ratio of the trunk

diameter and crown volume, mass of woody greenery and crown branches and its volume and volume of trunk and crown diameter [4].

Results of the study.

During the research of biotic productivity of trees and forest stands of European ash in the Right-Bank Forest-Steppe of Ukraine dependences of formation of crown parametric indicators from silviculture-taxational indicators of ash trees were established and mathematical models of crown phytomass components depending on the parameters were developed [4].

The basis of crown modelling diameter (*dc*), expressing correlation of this index with a diameter at a height of 1.3 m ($d_{1,3}$) and tree height (*h*) is G. Pretch function [1]:

$$dc = \exp\left(\left(-1{,}649 + 1{,}347 \cdot \ln\left(d_{1,3}\right) - 0{,}050 \cdot h + 1{,}082 \cdot \ln\left(\frac{h}{d_{1,3}}\right)\right)\right), \ (R^2=0{,}62) \quad (1)$$

The ratio between the length (*lc*) and the diameter of the crown, considering minor variability, was determined by the coefficient:

$$lc = 2{,}408 \cdot dc. \quad (2)$$

As the spatial form of European ash crown corresponds to an elongated ellipsoid, its volume (v_c) was calculated by a modified classical mathematical formula [4]:

$$v_c = \frac{4}{3} \cdot lc \cdot \frac{1}{2} \cdot dc^2 = \frac{2}{3} \cdot lc \cdot dc^2, \quad (3)$$

Exponential functions (4, 5) are chosen as adequate dependence models of wood greens mass (q_{wg}) and branches (q_{br}) from crown volume:

$$q_{wg} = 2{,}038 \cdot e^{0{,}015 v_{kp}}, \ (R^2=0{,}75), \quad (4)$$

$$q_{br} = 0{,}639 \cdot e^{0{,}026 v_{kp}}, \ (R^2=0{,}82). \quad (5)$$

Having expressed in formulas 1 and 2 the volume using formula 3, regulatory-reference data to determine the mass of woody greens and branches in freshly-cut condition depending on the diameter and crown length have been developed,

fragments of which are shown in Tab. 1 and 2.

1. Mass of woody greens of European ash tree in freshly-cut condition depending on diameter and crown length, kg

Crown diameter, м	Crown length, m								
	3	4	5	6	7	8	9	10	11
1,6	2,3	2,4							
1,8	2,4	2,5	2,6						
2,0	2,5	2,6	2,8	2,9					
2,2		2,7	3,0	3,2					
2,4		2,9	3,2	3,5	3,8				
2,6		3,1	3,4	3,8	4,2				
2,8		3,3	3,7	4,2	4,7	5,3			
3,0			4,1	4,7	5,4	6,2	7,1		
3,2			4,5	5,2	6,1	7,2	8,4		
3,4			5,0	5,9	7,1	8,5	10,1	12,1	
3,6			5,5	6,7	8,2	10,0	12,3	15,0	18,3
3,8				7,7	9,7	12,1	15,1	18,8	23,5
4,0				8,9	11,4	14,6	18,7	23,9	30,6

2. Mass of European ash tree branches in freshly-cut condition depending on diameter and crown length, kg

Crown diameter, м	Crown length, m								
	3	4	5	6	7	8	9	10	11
1,6	0,8	0,8	0,9						
1,8	0,8	0,9	1,0						
2,0	0,9	1,0	1,1	1,2					
2,2		1,1	1,2	1,4					
2,4		1,2	1,4	1,6	1,9				
2,6		1,3	1,6	1,9	2,3				
2,8		1,5	1,9	2,3	2,8	3,5			
3,0			2,2	2,8	3,6	4,5	5,8		
3,2			2,6	3,4	4,5	5,9	7,8		
3,4			3,1	4,2	5,8	7,9	10,8	14,9	
3,6			3,7	5,3	7,5	10,7	15,3	21,7	30,9
3,8				6,8	10,0	14,4	22,0	32,5	48,2
4,0				8,7	13,5	20,8	32,2	49,7	76,8

The Tables allow determining of woody greens mass and branches for separate trees which under the same taxational indicators of a trunk differ in crown parameters.

For mass measurements, including the use of remote sensing, identification of the overall biomass of a tree on the available measurements is actual; crown diameter may be one of them.

The crown diameter and trunk volume in bark (v) of European ash tree have close correlation [4] that is also confirmed by graphical analysis (Fig.).

Model (6) expresses the dependence:

$$v = 0{,}0033 \cdot dc^{3{,}0939} \ (R^2 = 0{,}67). \qquad (6)$$

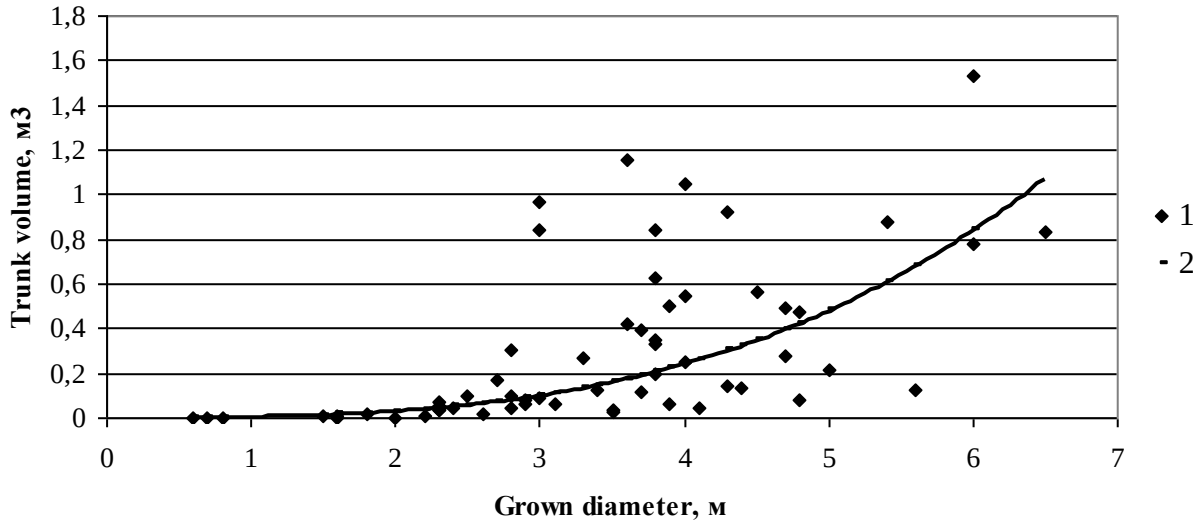

Fig. The dependence of trunk volume of European ash tree on crown diameter: 1 – actual values of model trees; 2 – model

The wood density in a bark ($p^{growth}_{tree+bark}$) of European ash tree is one of the indicators with the least variability among other quality parameters of trunk phytomass [5]. So, trunk phytomass in bark in freshly-cut condition can be determined by the density and simulated volume.

Phytomass components of European ash tree crown in freshly-cut condition are calculated by a single input parameter – crown diameter, based on the formulas 2-5.

Fragment of standards are given in Table 3.

3. Mass components of European ash tree in freshly-cut condition depending on diameter, kg

Crown diameter, м	Mass of the components				
	trunk in bark	woody greens	branches	crown	tree

1,6	12,9	2,4	0,8	3,2	16,1
1,8	18,5	2,5	0,9	3,5	22,0
2,0	25,7	2,7	1,1	3,8	29,5
2,2	34,5	3,0	1,3	4,3	38,8
2,4	45,2	3,4	1,6	5,0	50,1
2,6	57,9	3,9	2,0	5,9	63,8
2,8	72,8	4,6	2,7	7,3	80,0
3,0	90,1	5,5	3,7	9,3	99,3
3,2	110,0	6,8	5,4	12,3	122,3
3,4	132,7	8,7	8,3	17,0	149,7
3,6	158,4	11,4	13,5	24,9	183,2
3,8	187,2	15,5	23,0	38,5	225,7
4,0	219,4	21,7	41,8	63,4	282,8

A calculation of phytomass in a completely dry condition is carried out on the base of algorithm of standards development for evaluating of main components of phytomass tree [6].

Conclusions

On the basis of parameter dependencies of European ash trees phytomass components on taxational indicators alternative variants of regulatory-reference data have been suggested.

The first variant of standards allows determining crown phytomass by its diameter and length for the trees with the same taxational parameters of a trunk, but different crowns parameters. Measurement of diameter and length of the crown is available in the field conditions with modern instrumentation.

The second variant of the tables allows determining the mass of all components by means of crown diameter. These standards are suitable for mass measurements and, of course, require detailed testing for future use.

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Приведены результаты разработки альтернативного варианта нормативов оценки компонентов надземной фитомассы кроны и дерева. В основу алгоритма построения нормативно-справочных таблиц положено моделирование таксационных показателей и количественных параметров компонентов фитомассы кроны деревьев ясеня обыкновенного в условиях Правобережной Лесостепи Украины.

Ясень обыкновенный, Правобережная Лесостепь, таксационные показатели кроны, масса древесной зелени кроны дерева, масса ветвей кроны дерева.