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THE ANALYSIS OF THE TAXATION STRUCTURE *Robinia pseudoacacia L.* STANDS IN THE FORESTS WHITHIN OF NORTHERN STEPPE, UKRAINE

SUMMARY

In the article, it was analyzed the main biometric indicators of modal forest stands with *Robinia pseudoacacia* L. within the Dnieper Steppe of Ukraine. Under conditions of the Dnieper Northern Steppe, forest stands with *Robinia pseudoacacia* occupy an area of 17683.7 ha, representing 26.9 % of total area covered with forests. The range of habitat conditions in *Robinia pseudoacacia* varied from A_0 to D_4. Age-class structure and distribution of *Robinia* wood stock cannot be evaluated as optimal because over-mature stands amounted the largest share 72.3 % of total *Robinia* area when small share of young stands. The trend of productivity increasing with age in *Robinia* forest stands is not established. Taking into account the *Robinia* normative maturity age amounted 26–35 years, it is necessary to take and implement some silvicultural measures to such type of forest stands growing at the present time.

Keywords: *Robinia pseudoacacia* stands, Northern Steppe of Ukraine, biometric parameters, growing stock

INTRODUCTION

The works of silvicultural researchers A. Belgard, A. Lokhmatov, O. Furdychko (Belgard, 1971; Furdychko, 2003; Gritsan, 2000; Kobets et al., 2015; Lokhmatov and Gladun, 2004) are dedicated on issues of forest functioning under conditions of Steppe zone, and searching the mechanisms to improve resistance and productivity of main forest-forming species. Within Steppe zone of Ukraine, forests mostly represented by artificial plantings, that is why the surveys of their current state, compliance physiological requirements to forest-forming species with their site conditions, and determination of main environmental factors influencing forest productivity are actual.

Forest stands in the Dnieper Steppe formed with environmentally significant species is *Robinia pseudoacacia* L. (black locust), introduced from Northern America. This species is economically and ecologically significant in Ukraine. The black locust plantations were created over a hundred years in the Steppe zone of country (Hensiruk, 1992; Gladun, 2005; Gritsan et al., 1997; Gritsan, 2005).

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Firstly, *Robinia* plantations had been created in 1860–1880 in the steppe forest district; numerous shelter-belt forests were planted in 30th of XX century. Then *Robinia* was used in afforestation of gully systems and broken slopes. For the last 50 years, this species stands have been created in the form of forest shelter belts, protective plantations along water reservoirs, ravine and riverine slopes, watersheds or ravine-gully systems. *Robinia* stands are especially widely distributed along the Kakhovsky and Dneprodzerzhinsky reservoirs (Lokhmatov and Gladun, 2004). Currently, they dominate in total area of forest plantations within Steppe zone of Ukraine, and that perform a variety of protective, environmental-transforming and utilitarian functions (Gritsan et al., 2007; Sytnyk et al., 2015).

According to zoning by S. Hensiruk (Hensiruk, 1992), the studied black locust forest stands occurred within Northern Steppe. They are quite varied in relation to spatial forms, habitats and farming creating, functionality, protection; therefore, such stands require a differentiated silvicultural care. *Robinia* stands are divided three historically formed silvicultural groups (Lokhmatov and Gladun, 2004):

1-st group: plantings of the first and second vegetative generation (root shoots);

2-nd group: plantations established in 30s of XX century. These plantations include forest shelter belts, ravine-gully and slope forests. Such plantations are widely spread on the designated forest lands; their origin is mainly seed, mixed (seed + vegetative), and vegetative (from first generation root shoots);

3-rd group: forest stands planted in 1950–1990. These protective forest stands grow along river banks, and under condition of ravine and slopes, ravine-beam systems, watersheds, shelter belts, and fully stocked woods of the steppe forests. These stands are especially numerous in the Dnipropetrovsk area along reservoir banks, eroded slopes and ravine-gully systems.

The purpose of this study is analysis of current state of the modal *Robinia pseudoacacia* stands within the Dnieper Northern Steppe, Ukraine. In perspective, it may be used for dynamics simulation and forecast of growth and productivity by the main biometric indicators.

MATERIAL AND METHODS

In biometric analysis, it was used the information from stratum database ”Ukrderzhlisproekt“ (http://www.lisproekt.gov.ua/), which characterized pure and mixed stands with *Robinia pseudoacacia* within the Dnieper Steppe, Ukraine (Gulchak et al., 2011).

Total sample size of the database was 4739 stratums with total area of 17683.7 ha. In this case, the analysis was subjected to such taxation characteristics as well as stand area (S), average plantation age (A), average diameter (D), average height (H), stock per 1 ha, total stock on the wood stock (M), site quality class or bonitat (B), forest site type (FST). In data analysis, it

was used the general principles of mathematical statistics and conventional methods used in forest inventory (Gulchak et al., 2011; Migunova, 2014; Nikitin and Shvidenko, 2008; Sytnyk et al., 2015).

The classification schemes of trophotops and hygrotops is based on the edaphic factors, such as soil fertility and humidity. Soil fertility is characterized by trophogenic sequence and denoted by the letters A, B, C, and D. Each individual unit of trophogenic sequence called trophotope. Each trophotope is represented by the forest site with equal soil fertility within its boundaries, distinguished from the next by one gradation (Migunova, 2014).

Trophotope "A" or "bir" indicate very poor soil conditions, predominantly with sandy soil, sometimes loamy sands with a short rhizosphere zone; gritty consistency stipulate their poorness. It includes peaty soils, which occurred as a result of swamping by the sphagnum (raised) type. Vegetation is exclusively oligotrophic.

Trophotope "B" or "subir" is characterized by relatively poor soils. It is represented by loamy sand or sandy soil with thin sandy-loam or loamy layers, or with a heavy layers of that at a considerable depth. In the other cases, this trophotope is represented by sandy-loam and loamy soil with low thickness of soil layer, including skeletal soil on mountain slopes. It includes the peat soil with transitional swamping. The vegetation consists of pine-forest oligotrophes with admixed mesotrophes.

Trophotope "C" or "suhrud" has a relatively rich habitat conditions. Soils are represented by sandy-loam, sometimes sand with layers of loam and sandy-loam, or denuded shallow grey forest soil, sometimes brown soil with the little humus horizon, skeletal, derived from volcanic rocks and sandstones. Vegetation is composed of oligo-, meso- and megatrophes.

Trophotope "D" or "hrud" has the most fertile habitat conditions. The soils are loam with the heavy (greater than 0.8 m) rhizosphere, more rarely sandy and sandy-loam soils with the layers of loam and clay, available to plant roots. Sometimes the sandy and sandy-loam soils occur with shallow horizon of flow "mineralized" groundwater. This includes also the richest soils of lowland swamps. Megatrophes dominated in composition of climax forest vegetation.

Every trophotopes differs in the degree of soil moisture (hyhrotopes), with indicate in the range from 0 to 5. Hyhrotope of 0 range respond to very dry (xerophilic) conditions; 1 – dry-mesic (meso-xerophilic); 2 – mesic (mesophilic); 3 – wet-mesic (meso-hygrophilic); 4 – wet (hygrophilic); 5 – moist (ultrahyhrophilic).

Very dry types. The habitat conditions include the top of sand dune hills, denuded soil of the beam foreheads, and drained upland edaphotopes within the Steppe. Groundwater under these conditions is very deep, and the only source of water is precipitation, which is able to moisten the top of soil, usually dry, only for a short period of time.

*Dry types***.** Conditions for sandy soils with low water storage capacity; dryness of them depends on the groundwater depth; on the clay soils it depends

on dryness of climate, surface runoff (on the slopes), high evaporation (southern exposure), and low total water capacity (shallow and lithosolic clay soils of mountain slopes).

*Dry-mesic types***.** Sandy soil in well-moistened habitat is provided by higher groundwater level (2–4 m); in the loamy lands the groundwater is deeper than 4 m, often outside the layer available for plant roots. In southern regions, the satisfactory moistening is carried out by surface runoff reducing, increasing total soil water capacity, and more complete saturation of the soil by winter precipitation (steady winters).

Mesic types. In southern regions, good moisture is provided by the same conditions as in the previous type, and in Northern regions due to the better drainage (tops of hills, slopes). The groundwater level in sandy soils is 1–2 m, and 2–4 m in loamy and clay soils. The subsoil is blowdown, the land form is undulating or gently rolling.

Wet types. The overwetting habitats. Increasing of soil moisture depends on the higher groundwater level (at a depth of about 1 m in the sands, and 1–3 m in the sandy-loam soil).

Moist types. The habitats have excessive moisture and peat soils. Much of vegetative period, the groundwater level is near of the soil surface.

RESULTS AND DISCUSSION

Forests within the Dnieper Northern Steppe are subordinated to the State Forest Resources Agency the *Robinia pseudoacacia* forest stands occupy an area of 17683.7 ha, or 26.9 % of the total area covered with forest vegetation. These plantations have the following representation relative to functional categories (Gulchak et al., 2011):

- reserve forests with historical, cultural and scientific purposes: 1831.1 ha (18.8 % of the total forest area covered with this category);
- recreational forests: 7173.5 ha (22.9 % of the total area covered with recreational forests);
- protective forests: 8679.1 ha (35.2 % of the total area of protective forests).

Robinia pseudoacacia mainly forms pure stands, 82.5 % of the total area this species. 17.5 % of this stands occupied by black locust mixed stands with oak, ash and poplars.

Based on the thesis that uniform distribution of forest areas by age groups is biologically and economically expedient. The results of analysis of the age structure in stands this species allow us to ascertain the unequal distribution of areas by age groups. Distribution of area, total productivity, and average stock of *Robinia pseudoacacia* stands by age structure are given in Table 1. Distribution of stands by age groups is carried out depending on the main felling age. For the studied speciesfelling stage depends on regime of forest use: in forests with a special regime of use 31–36 years, in forests with a restricted regime of use 26–30 years. For the black locust as for fast-growing species, age class of such is 5

years. Furthermore, age groups consist of follow age classes: young growth – 1, 2; middle-aged – 3–5; premature – 6; mature – 7; overmature – 8 and above.

Table 1. Age structure of Robinia pseudoacacia stands

Index	Total	Age groups				
		Young growth	Middle-Aged	Premature	Mature	Over-mature
Area, ha	17683.7	370.2	1414.6	486.3	2626.6	12786.0
Total productivity, ths. m^3	2625.2	6.4	45.8	34.9	346.4	2191.6
Average stock per 1 ha, $m^3.ha^{-1}$	149	17	32	72	132	171

As it can be seen from the data in Table 1, that the smallest part of the area belongs to young stands, i.e. stands aged up to 10 years, which is 2.2 % of the total area of *Robinia* stands. Premature stands are 2.7 %, middle-aged and mature stands are 8.0 % and 14.8 %, respectively. Overmature stands occupy the largest part 72.3 % of the total area of this species stands within research area. For total productivity indexes, the lowest part is young stands 0.2 %. Premature stands amounted 1.3 %; middle-aged are 1.7 %, and mature stands are 13.2 %. Forest stands composed with overmature *Robinia* plantations have the largest total stock – 83.6 %. The average age of such stands is 43 years.

The present age-class composition and the distribution of average stocks in *Robinia pseudoacacia* forests of Dnieper Steppe is a consequence of insufficient number of the forest sanitary and cleaning fellings, and it cannot be considered as optimal.

The average stock per hectare by age classes was calculated in analysis of age structure in *Robinia* plantations. According to confidence index of approximation, it was selected the model described by polynomial function. Thus, to describe the dependence between productivity and age of forest stands, obtained model is presented in the chart (Figure 1).

The chart demonstrates that over-mature *Robinia pseudoacacia* stands aged 80–85 years (17^{th} age class) has the greatest average wood stock (194 m^3/ha), whereas both 8^{th} class (36–40 years, 141 m^3/ha) and 18^{th} class (86–90 years, 142 m^3/ha) have the smallest average wood stock within overmature age group. The data given in the chart demonstrate lack of dependence in forest stands productivity on age; there is a polynomial dependence was not detected

The bonitat class is the index of the forest stands productivity. The biggest of the area is occupied by stands with 1^{st} bonitat class. The II^{nd}, III^{rd} and IV^{th} classes occur. Very small proportion of poor stands (V^{th} class) demonstrates accordance with the regional site conditions. A third part of the stands with *Robinia pseudoacacia* with characteristics of 1^{st} bonitat class were formed mainly in the halogen variant of dry suhrud (4161.4 ha; or 35.3 % of total area occupied by the stands with such species of 1^{st} forest bonitat class).

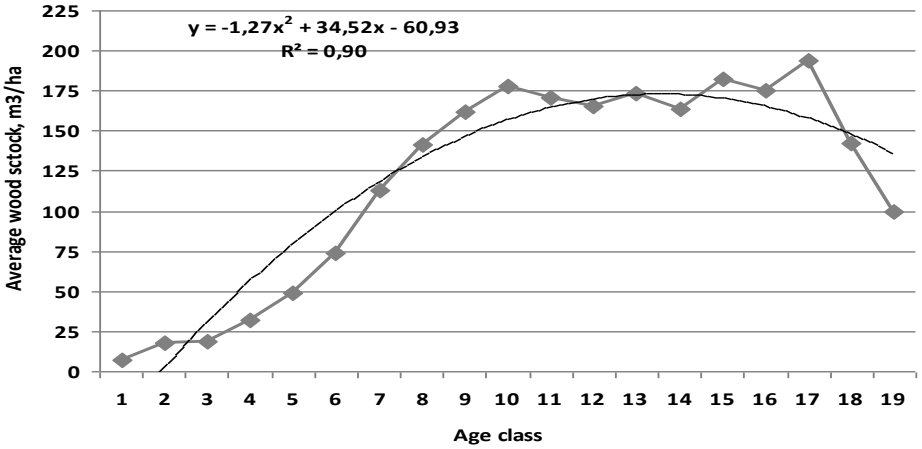

Figure 1: Dynamics of average wood stock Robinia pseudoacacia stands by age classes

Determination of habitat conditions makes possible not only to estimate sufficiently the forest site potential of different soil types, but also to determine the advanced species composition for them, the nature and methods of growing stands for various functional purposes (Nikitin and Shvidenko, 2008; Migunova, 2014).

The range of habitat conditions for *Robinia pseudoacacia* within Dnieper Northern Steppe of Ukraine is very wide, from A_0 to D_4. This species is located in seventeen edatopes: A_0–A_2, B_0–B_3, C_0–C_5, D_1–D_4 (Table 2).

Table 2. The distribution area *Robinia* stands by forest site types

Hyhrotops	Trophotops								Total for hyhrotops	
	A		B		C		D			
	ha	%	Ha	%	ha	%	ha	%	ha	%
0	4.6	0.02	38.9	0.22	990.7	5.60	–	–	1034.2	5.9
1	32.7	0.18	700.6	3.96	7471.0	42.20	5712.4	32.30	13916.7	79.0
2	102.3	0.58	437.3	2.47	1072.3	6.06	982.2	5.55	2594.1	14.7
3	–	–	38.6	0.22	46.8	0.27	29.2	0.16	114.6	0.7
4	–	–	–	–	1.2	0.01	8.4	0.05	9.6	0.1
5	–	–	–	–	14.5	0.08	–	–	14.5	0.1
Total	139,6	0.78	1215.4	6.87	9596.5	54.28	6732.2	38.07	17683.7	100.0

Area distribution by the variants of trophotop series leads to the conclusion that the largest area black locust stands belongs to mixed oak forest (9596.5 ha), which is 54.3 % of total area this species. The mixed oak forest occupy more than one third of the total area (6732.2 ha, or 38.1 %). *Robinia* stands growing under the poorest soil conditions of pine forest occupy the minimum area (139.8 ha, or 0.8 %) (Figure 2).

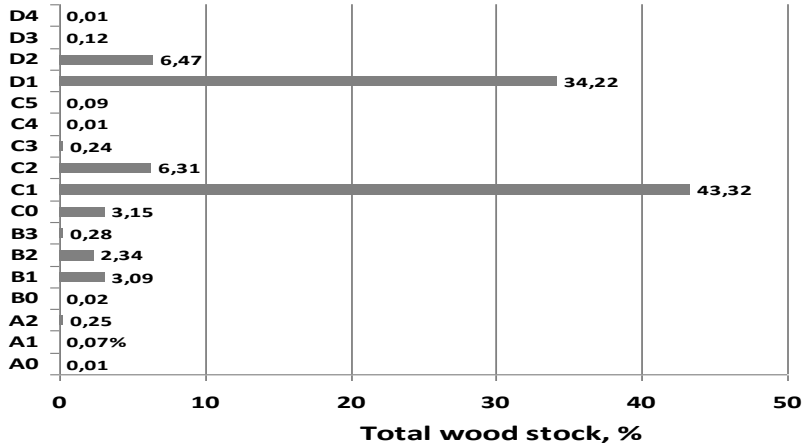

Figure 2: The distribution of *Robinia pseudoacacia* total growing stock by forest site types

Robinia pseudoacacia can form the forests within very dry, dry, dry-mesic, mesic, wet, and moist hyhrotopes. Most of the *Robinia* stands area are located on the dry hyhrotop (A_1, B_1, C_1, D_1): 13916.7 ha (78.7 %). 2594.1 ha (14.9 %) of the *Robinia* stands area grow in dry-mesic conditions (A_2, B_2, D_2), and a very small proportion of such stands occupied moist hyhrotope: 14.5 ha (0,1 %). Note that 55.5 % of the total *Robinia* stands area (9808.8 ha) grow under stressful environmental factors such as salinity, i.e. under halogen forest site conditions The forest site type is an important indicator effecting significantly on the forest productivity. Data on the total wood stock distribution by forest site types are shown in Figure 4. The data in Fig. 4 evidence that *Robinia* forest stands grow mainly on the relatively rich soils, and they formed follow shares of stock: C_1 – 42.2 %; D_1 – 32.3 %; C_2 – 6.1 %, C_0 – 5.6 %; the rest of stock belongs to mixed pine forests (6.9 %), and a very small proportion is concentrated within pure pine forests (0.8 %).

CONCLUSIONS

Robinia pseudoacacia stands occupy an area of 17683.7 ha, representing 26.9 % of the total area covered with forests, under conditions of Dnieper Northern Steppe. The range of habitat conditions for this spesies is very wide within Dnieper Northern Steppe of Ukraine: from A_0 to D_4. Black locust is located in seventeen edatopes: A_0–A_2, B_0–B_3, C_0–C_5, D_1–D_4. *Robinia pseudoacacia* mainly forms pure stands in 82.5 % of the total area. This species mixed forests with oak, ash, poplars occupy 17.5 % of the total area of black locust plantations. The present age-class structure and distribution of the total wood stocks in stands with this species are consequence of the insufficient forest sanitation, and it cannot be considered as optimal; young stands aged up to 10 years old occupy the smallest share of the total area, overmature stands account

for the largest share of 72.3 % of the total area within study region. The trend of productivity increasing with age in black locust stands is not established.The main part of the area is occupied by these stands with I-st classes of forest capacity. A third of *Robinia pseudoacacia* stands of the I-st bonitat class were formed mainly in the halogen variant of the suhrud.Taking into account the *Robinia* normative maturity age amounted 26–35 years, it is necessary to take and implement some silvicultural measures to the such type of forest stands growing at the present time.

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