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EUROPEAN BLACK ALDER AND ITS SILVICULTURAL ROLE IN THE SCOTCH PINE PLANTATIONS GROWN ON SAND SOILS

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It is shown that on the sand soils interaction between an alder and pine in closed stands depends on maintenance in them silt fractions, depth of bedding of soil waters, features of micro-relief and used charts of mixing of arboreal species.

Sand, black alder, Scotch pine, wood vegetation, stand, plantations.

European Black alder (*Alnus glutinosa* Gaertn.) contains in the leave about 3 % nitrogen [8], and the root of the rate per hectare plantation can emit up to 500 kg tubers that during the growing season are able to accumulate more than 200 kg of atmospheric nitrogen [15, 17]. Due to these properties, alder used for afforestation of man-disturbed lands in a wide variety of growth conditions, both abroad [15, 18, 19], and within Ukraine [4, 5]. Alder is gas resistance species, growing, undemanding to soil fertility, can significantly improve their biochemical properties and are in a phase of personal growth effectively influence on the physiological condition of pine needles in her increasing chlorophyll content (by 9–34 %), reinforcing the growth of seedlings in height (at 35–88 %) and creating conditions for the formation of economically valuable plant communities [3, 11]. It was also found [3, 6] that after closing of crowns the development of pine-alder stands is determined by the redistribution of environmental resources, particularly light between components of phytocenoses, so since the age of 16 the difference in altitude of pine seedlings grown in pure stands and alder decreases is only 12 %.

Main areas of sandy soils of Irshansk mining plant was forested by Shershnivsky and Turka floristries during 1977–1996 years. For this period of forest plantations were planted on an area of over 926 hectares. About 93 % of area was plantated of Scotch pine with 3–4 rows of pine, and one raw of deciduous species.

The rest area was planted by black alder [1]. Applied silvicultural technologies have provided survival rate of plants at the level of 84–90 %, and further their growth and biological stability are consistent with the presence or absence of the sand silt fractions regime of hydration, as well as the species composition of woody plants and their combination in the stands. These questions barely covered in the forestry literature, and silvicultural alder role in growing pine plantations on sandy soils remains completely unclear, and therefore conducted this study.

The aim of the research is to find out the effectiveness of black alder forest management in growing pine and alder crops on sandy soils.

Objects and methods of research. The object of the study served as pine forest plantations involving black alder, set on the sandy soils of Irshansk mining plant arising from open-pit mining of ilmenite deposits. A survey of forest plantations held involving existing techniques [12]. Silvicultural characteristics of stands were determined by normative reference materials [13], and their average biometric parameters were calculated with the assistance of programs [14], adapted for use on personal computers.

Results. In Ukraine, most Polessye sand soils contain sands of water glacier and alluvial origin. It should be noted that the sand soils formed by using earth-moving equipment, have peculiar natural fractional composition, and in the case of moving sands, they mixed with loam and clay Dnieper and Wiirm exfoliation, improving their water-physical properties [2]. Afforestation success on the soils depends on the hydration of certain silvicultural areas and species composition of which formed the stands (Table 1). On the sand where groundwater occur at depth 1.0–1.5 m, 14–year-old alder grows in the I^a site index (p. 1) and despite the high density (0.91 unit) in the understore sporadically growing aspen (*Populus tremula* L.), pine (*Pinus sylvestris* L.), birch (*Betula pendula* Roth.) and oak (*Quercus robur* L.), and in the undergrowth – Ash willow (*Salix cinerea* L.). The height of woody plants is typically less than 1.5 meters in the grassy floor develops a thick cover of *Calamagrostis epigeios* (L.) Roth. In mixed pine-alder stands, alder inferior in

growth by up to 14–34 % pine, and the lowest productivity (II class growth), characteristic stands that grow on sand with groundwater at a depth of 2 m (2 Items).

1. Forestry-evaluation characteristic of 14-year-old pine and alder stands that grow on sandy soils of Irshansk Mining
(Shershnivsk forestry, bl. 57, unit 2, placing planting beds - 3.0 x 0.5-1.0 m)

N	Placing plantings beds	Compo-sition	Element of forest	Average		Site index	Den-sity	Per 1 ha	
				height, m	diameter, cm			trees	stock, m^3
1*	1rAld	10Ald +Betula	Ald Betula	7,8 3,5	7,0 2,0	I^a	0,90 0,01	2749 75	46 1
2	3rPine 1rAld	9Pine 1Ald	Pine Ald	4,5 3,6	5,5 3,2	II	0,48 0,02	278 375	18 1
3	3rPine 1rAld +Spruce	9Pine 1Ald +Spruce	Pine Ald Spruce	8,4 6,4 2,3	9,0 6,6 2,0	I^b	0,78 0,09 0,01	2967 601 46	89 7 1
4	4rPine 1rAld	10Pine+ Ald	Pine Ald	7,9 5,4	7,7 5,2	I^b	0,79 0,09	3840 461	83 4
5	4rPine+ Arm 1rAld +Arm	6Pine 4Arm +Ald	Pine Arm Ald	6,9 8,3 5,9	7,4 7,0 4,9	I^a	0,36 0,24 0,04	2250 1243 326	44 26 4
6	6rPine 1rAld	10Pine +Ald	Pine Ald	7,3 4,8	7,9 4,1	I^a	0,71 0,02	3202 239	69 1

Notes: 1 – P. 1 * in the foundation of the bl. 8, un. 1.

In the examined 14–year-old stands of forest environment formation occurs slowly, and the thickness of the forest litter is less than 1 sm. Regrowth and undergrowth were absent, while grass cover have met only a few of the curtain with *Calamagrostis epigeios* (L.) Roth., *Cetraria isladica* Asch. and *Rumex acetosella* L. It should also be noted that 30 % of alder trees and visually observed seed production and signs of desiccation peaks, indicating that the poor water regime sands [2].

When groundwater at a depth of 1.0–1.5 m pine and alder stands growing under I^b class of productivity (p. 3, 4) and a combination of 3–4 rows of pine trees with a row of alder in the stand formed forest environment. However, litter sand substrate 2–cm layer. As you grow up sporadically appearing oak and acacia white (up to 0.3 m), and in the undergrowth - *Cytisus ruthenicus* Fisch. In grass cover – dominated *Calamagrostis epigeios* (L.) Roth. On sandy soils alder forms an extensive root system and unlike zonal soils where skeletal roots fused with alder trees growing nearby [16] on sandy soils, skeletal root grows in the rhizosphere of individuals alder.

It should also be noted that the roots of alder, which grows on sand, formed bulbous. They are absolutely the root dry weight of one 14 year old alder seedlings can reach 200 g. They have a spherical shape and reach a diameter of 5 cm in Scots pine seedlings, under these growth conditions, one or sometimes two skeletal roots grow rapidly in length. In the first 2–4 years after planting roots growing along a series of sand where the density is lower (1.2–1.3 $g \cdot cm^{-3}$) than in rows (1.4–1.5 $g \cdot cm^{-3}$) and in the following years – develops inter-row space as the nearby and more distant rows. Inclusion loams and clays that occur in the surface layer of sand, sucking pine roots branching, then continued growth in the upper 30-cm layer of sand. Reaching number of alder, pine permeates its roots rhizosphere space and nodules. In this case, the mechanical penetration in pine roots and root nodules of alder, as described in the literature A.V. Zarubenko [7], A. Titov [17] for poplar and alder ashen alder communities, growing in zonal soils were observed, indicating a possible redistribution of mineral nutrients in the rhizosphere of these species through soil-absorbing complex. Acacia white, introduced in pine and alder culture (p. 5), pine grows in height (17 %) and alder (29 %). With this combination of woody plants inhibited acacia alder and left in the stands as an impurity. In a culture created by blending 6rPine1rAld scheme (p. 6), alder behind (34 %) of the growth in height of pine and fell under its canopy, dried peaks (15 % of trees).

2. Forestry-evaluation characteristic of 16-year-old pine and alder stands that grow on sandy soils, formed by the extraction of ilmenite
(west of the village Rolls, Volodar-Volyn region, locating planting beds - 2,5 x0, 5m)

N	Placing plantings beds	Compo-sition	Element of forest	Average		Site index	Den-sity	Per 1 ha	
				height, m	diameter, cm			trees	stock, m^3
7	4rPine 1rAld	7Pine 3Ald	Pine Ald	3,4 4,5	3,1 4,4	IV	0,36 0,11	4600 780	10 4
8	3rPine 1rAld +Betula	9Pine 1Betula +Ald	Pine Ald Betula	7,9 7,5 8,1	8,1 6,1 5,7	I^a	0,62 0,05 0,05	3400 450 550	78 5 7
9	4rPine 1rAld	7Ald 3Pine	Ald Pine	11,6 5,1	13,7 5,5	I^d	0,44 0,43	571 3828	53 27
10	5rPine 1rAld	6Ald 4Pine	Ald Pine	11,4 5,0	14,5 4,9	I^d	0,40 0,58	444 4884	49 32

However, the worst water and chemical mode power generated on the sands, including in the mining of mineral deposits washed silt fraction. It is from these sands, formed in sandy soils teases method for extraction of ilmenite in Irshansk Mining, Zhytomyr region. Growth and biological stability of pine and alder stands on these sands primarily depends on their water content.

In areas where groundwater is occurring at a depth of 2 m (Table 2), pine and alder stands growing under IV class of productivity (p. 7). Under these conditions, growth is slow accumulation of forest floor, underbrush and undergrowth, usually absent, and the grass cover only a few settled mosses and grasses. Almost 10 % of pine and alder trees observed shrinkage and seed production, indicating that the premature aging of plants. In the desert, where the top layer contains up to 10 % of impurities with loam or clay, and ground water lying at a depth of 1.5–2.0 m, pine and alder stands growing under I^a class of productivity (p. 8). In plantations established under the scheme mixing 3rPine1rAld + Betula, alder, stunted height of pine (5 %) and birch (8 %), thus forming the composition phytocenoses 9Pine1Betula + Ald. It should also be noted that the sand soils black alder occupies a dominant position only in plantations that grow on sand with groundwater at a depth of 0.7–1.0 m in such areas alder grows by I^d class of productivity and grows by 56 % tallest pine (paragraphs 9, 10). Despite the fact that only one row of alder combined with 4–5 rows of pine trees of 16–year-old alder dominated cultures, and its share in the total stock of wood is 6–7 receiver units. Pine-alder plantations formed on these sands characteristic – self-seeding isolated undergrowth of oak up to 0.3 meters, liquid undergrowth of mountain ash (*Sorbus aucuparia* L.) and cherry (*Padus serotina* Ehrh.) height of 0.9 m and herbs cover of medium thickness, consisting of grasses (*Gramineae*) and single impurity horsetail (*Equisetum arvense* L.) and conventional andromeda (*Tussilago farfara* L.).

In sandy soils formed from the sands of continental origin, pine and alder grow crops for class II–I^a growth class (Table 3). However, the most productive stands are formed when planting scheme with mixing 3rP+Bet 1rAld + Bet (items 11). Elder red by mixing in the ranks of the chain (1–3 plants) after closed crowns falls under the

canopy of pine and not withstanding shade falls from stands. Shrunken elderberry bushes that survived to the survey, reached a height of 7.3 m, and in the bushes there were 3 shafts , which were at the root collar diameter up to 9.2 cm on slopes with northern exposure steep slopes $8–10^0$ pine and alder growing by I class of productivity (p. 12). They are characterized by high completeness (0.97 units) and the presence rare regrowth (self-seeding of oak, elm turn pages , pears normal, Birch and mountain ash) and undergrowth (laburnum Rus) up to 0.5 m from the data shows that the impact of interactions between woody plants depends on the micro-relief, which contributes to the redistribution of moisture, light and heat and clearly seen in pine-birch- alder stands set up at the same mixing schemes and farming on the plateau-like area with bumpy terrain.

3. Forestry-evaluation characteristic of 23-year-old pine and alder stands that grow on sandy soils in Irshansk Mining

(Shershnivsk forestry, bl. 41, un. 3, placing planting beds - 2.5 x 0.5-1.0 m)

N	Placing plantings beds	Compo-sition	Element of forest	Average		Site index	Den-sity	Per 1 ha	
				height, m	diameter, cm			trees	stock, m^3
11*	3rPine+Bet 1rAld+Bet	9Pine 1Ald +Bet	Pine Ald Bet Smb	11,0 7,8 9,0 7,3	13,6 9,1 8,3 9,2	I^a	0,88 0,08 0,01	1782 327 72	151 10 2
12	4rPine 2rAld	8Pine 2Ald	Pine Ald	9,4 8,1	10,4 9,8	I	0,77 0,20	2060 679	85 24
13	4rPine 2rAld+Bet	9Pine 1Ald +Bet	Pine Ald Bet	7,3 6,9 8,3	9,4 6,2 6,7	II	0,86 0,05 0,05	2594 315 267	98 6 5
14	4rPine 2rAld+Bet	7Pine 3Ald +Bet	Pine Ald Bet	8,2 10,1 10,2	11,6 10,7 9,6	II	0,68 0,24 0,04	1513 641 154	77 31 6

Notes: Samples 11 - founded in bl.39, un. 6.

In micro upper places (p. 13) pine alder grows in height (6 %) and inferior in growth in height coast (14 %), resulting in stands formed with the composition 9Pine1Ald + Bet, while micro lower places (h. 14), where pine gives way to grow up alder (23 %) and the birch (24 %), are formed with pine stands of composition (7Pine3Ald + Betula).

Conclusions

1. On sandy soils interactions between black alder and Scotch pine depends on complex environmental factors, among which are the presence or absence of silt loam and factions within the rhizosphere and the level of groundwater and micro-relief features.

2. In pine-alder cultures, founded on sands with groundwater at a depth of 0.7–1.0 m alder dominates over pine, while the occurrence at a depth of 2.0 m – dominant position belongs pine.

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