

# AGRICULTURAL SCIENCES

## MELIORATIVE CHARACTERISTICS OF FOREST LITTER OF PROTECTIVE PLANTATIONS ON RECULTIVATED DUMPS OF YURKIV BROWN COAL QUARRY

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### Abstract

The study of forest litter of plantations on reclaimed brown coal dumps revealed its greatest capacity in pure pine stands, and the capacity of litter is higher in rows and lower in between rows. It's found out the presence of a two-layer structure of litter in the rows of plantations of common oak and red oak, which is due to the acceleration of mineralization processes, a significant amount of soft litter of associated species and more moisture due to the trunk accumulation of precipitation. Analysis of litter stocks showed that intensive accumulation of litter is observed in stands of Scots pine due to the long period of its decomposition. In the total stock of litter a large share falls on the branches and crumbs, which is in the conifer and deciduous plantations about 65 and 55%, respectively. The largest share of crumb was found in the plantations of common oak with hornbeam and sharp-leaved maple, which indicates the activation of litter mineralization and soil formation. Also in plantations with a predominance of common oak and red oak, a high percentage of fruits, the share of which is 16.6 and 18.3%, respectively, which in the long run will provide natural regeneration on reclaimed lands.

**Keywords:** fractional composition, branches, bark, fruits, crumbs, mineralization

**INTRODUCTION.** An important role in the functioning of the forest ecosystem is played by forest litter, which is allocated to a special biogeocenotic component [5, 7]. Forest litter is formed due to forest fall, which includes leaves or needles, twigs, bark, seeds, cones and other dead parts of woody plants. In addition, the waste includes dead terrestrial parts of herbaceous plants, roots, as well as dead representatives of the mesofauna and microorganisms. The relationship between the stocks of different components of the litter is important for understanding the processes of dynamics of its decomposition [5].

Artificial plantations were created on the reclaimed lands of the Yurkiv brown coal quarry after its production in the 70s and 80s of the last century. Currently, they are in the reproductive phase of the formation of natural regeneration, the success of which depends on the mineralized state of forest litter, which contributes to the creation of conditions for the emergence and development of undergrowth and undergrowth. The aim of the study was to determine the fractional composition of litter in pine plantations and its reclamation impact on the formation of conditions for plant growth on reclaimed lands.

**Material and research methods.** The object of the study is protective forest plantations of IV-V classes

of age on the reclaimed lands of the Yurkiv brown coal quarry. To perform the research, trial plots (TP) were selected, which characterize pure and mixed (with an admixture of six units in the composition) pine stands - TP 1 and 2, respectively, as well as mixed plantings of common oak and red oak, which are represented respectively TP 3 and 4.

Sampling of forest litter was carried out during August-October 2018 at the accounting sites with an area of 0.5 m<sup>2</sup> (0.5 x 1 m), which were placed both in the middle between the rows and in rows. At the accounting site, the litter was cut off with a knife and poured on burlap, and in the laboratory were disassembled into fractions, which were weighed on electronic scales. Morphological characteristics of forest litter were determined according to the method of Yu. Chornobay [6]. At the same time, its structure, thickness, connection of the litter with the soil, linkage, the degree of soil coverage was evaluated. Samples of forest litter were dried in thermostats to an air-dry state and after removal of mineral particles were disassembled into fractional groups: branches, bark, leaves, needles, fruits, and crumbs.

**Results and discussion.** The results of the study of morphological features of forest litter of plantations on the object of reclamation are given in Table 1.

### 1. The main morphological characteristics of forest litter

| Type and composition*)<br>of plantings, age, trial<br>plot                   | Place of meas-<br>urement | Indexes          |              |                     |  |                            |
|--|---------------------------|------------------|--------------|---------------------|--|----------------------------|
|  |                           | thickness,<br>cm | structure    | linkage             | strength of con-<br>nection with the<br>soil | degree of soil<br>coverage |
| Pine-birch plantation<br>6Ps4Bp+Pc;<br>age – 38 years; TP № 1                | in a row                  | 2,4±0,58         | single layer | weakly<br>connected | relative solid                               | continuous                 |
|  | in between rows           | 2,1±0,34         | single layer | not related         | solid  | continuous                 |
| Pine plantation<br>10Ps+Bp; age – 42<br>years; TP № 2                        | in a row                  | 3,3±0,69         | single layer | weakly<br>connected | relative solid                               | continuous                 |
|  | in between rows           | 2,9±0,55         | single layer | friable             | solid  | patchy                     |
| Mixed planting of com-<br>mon oak<br>6Qr3Cb1Ap+Qr; age –<br>40 years; TP № 3 | in a row                  | 1,3±0,31         | two-layer    | friable             | relative solid                               | continuous                 |
|  | in between rows           | 1,1±0,12         | single layer | friable             | relative solid                               | patchy                     |
| Mixed planting of red<br>oak 9Qr1Qrb; age – 49<br>years; TP № 4              | in a row                  | 2,2±0,34         | two-layer a  | friable             | relative solid                               | continuous                 |
|  | in between rows           | 2,3±0,27         | single layer | friable             | relative solid                               | continuous                 |

\*) Ps – Pinus sylvestris; Bp – Betula pendula; Pc – Pinus crimea; Qr – Quercus robur; Qrb – Quercus rubra; Cb – Carpinus betulus; Ap – Acer platanoides.

Data of Table 1 shows that the greatest thickness is the litter of pure pine plantations, located on the upper part of the slope of the southern exposure with a speed of 120. It can be defined as medium thickness. The presence of two layers in the litter of plantations of common oak and red oak in rows is due to the acceleration of mineralization processes, a significant amount of soft litter of associated species and more moisture due to the accumulation of liquid precipitation.

In pine stands, the thickness of the litter is higher in the rows and lower in the rows. This is confirmed by studies of Voron et al. [6], who studied the planting of Scots pine in Rivne Polissya. According to their data, the largest volumes of litter were registered near the tree trunk, and they decreased with increasing distance from it.

Litter in pine stands decomposes slowly and the rate of mineralization slows down with age, as evidenced by studies by Çömez et al. [1], Corter [2], Voron et al. [6] and others. The accelerated process of litter mineralization is observed in the plantations of common oak with an admixture of concomitant species -

hornbeam and maple, which cannot be said about the litter of red oak plantations. Here the process of litter mineralization slows down due to the lack of specific mycorrhizal fungi that occur in the forests of North America [3, 4].

The linkage with the soil is relatively strong, which also indicates the definiteness of the humification layer. The degree of soil cover with litter in plantations on reclaimed lands is generally continuous, but varies slightly depending on the type of planting. Thus, in the rows of pure pine and mixed oak plantations with accompanying species there are small gaps, the reason for which is the blowing of litter from between rows.

The fractional composition of forest litter of protective plantations on reclaimed lands is given in table. 2. It is known that the increase in litter capacity in forest stands is due to the receipt of dead plant remains during the extinction of aboveground plant phytomass. Decomposition and movement of litter material in the lower soil horizons reduces the capacity of the litter, which depends on the ratio of forest fall and removal of mineralization products in the lower soil horizons [7].

### 2. Stocks and fractional composition of litter in plantations on reclaimed dumps

| Type and composition of plantings, age, trial<br>plot                | Litter<br>stocks,<br>ts/ha | Litter fractions, ts/ha |                      |           |           |          |
|--|----------------------------|-------------------------|----------------------|-----------|-----------|----------|
|  |                            | branches                | leaves, nee-<br>dles | fruits    | crumbs    | bark     |
| Pine-birch plantation 6Ps4Bp+Pc;<br>age – 38 years; TP № 1           | 58,8                       | 24,6±4,66               | 7,5±1,26             | 5,1±0,96  | 13,5±2,98 | 8,1±0,98 |
| Pine plantation<br>10Ps+Bp; age – 42 years; TP № 2                   | 64,5                       | 26,0±5,01               | 8,1±3,05             | 6,7±1,39  | 15,4±3,04 | 8,3±1,78 |
| Mixed planting of common oak<br>6Qr3Cb1Ap+Qr; age – 40 years; TP № 3 | 77,1                       | 17,4±3,87               | 15,2±5,18            | 12,4±2,41 | 27,5±5,18 | 4,6±0,83 |
| Mixed planting of red oak 9Qr1Qrb; age – 49<br>years; TP № 4         | 62,4                       | 16,6±4,13               | 17,6±5,54            | 11,7±2,69 | 13,5±3,24 | 3,0±0,69 |

Analysis of litter reserves showed that intensive accumulation of litter is observed in stands of Scots pine due to the long period of its decomposition and ranges from 58.8 to 64.5 ts/ha. The litter of red oak plantations also decomposes poorly, forming a dense

upper cover.

In the total stock of litter a large share falls on branches and crumbs, which is in the conifer and deciduous plantations about 65 and 55%, respectively, as illustrated in Fig. 1.

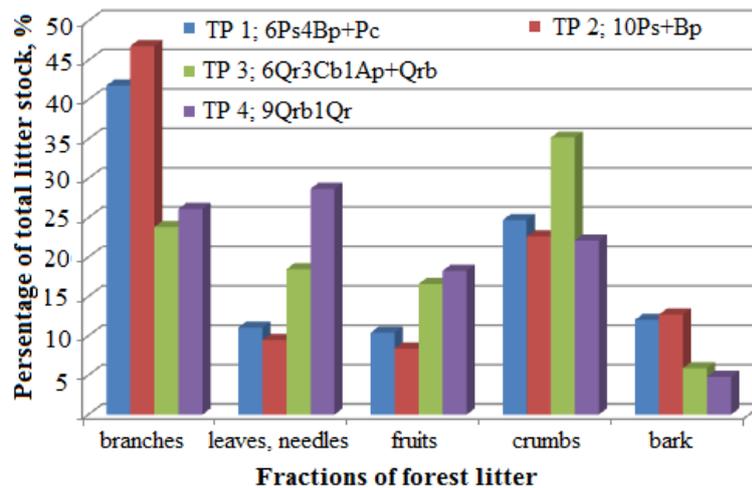


Fig. 1. Fractional composition of litter of protective plantings on reclaimed lands

Weakening of pine plantations on reclaimed lands is manifested in an increase in the fraction of branches in conifer plantations compared to deciduous stands. Thus, the share of the fraction of pine branches is almost twice as high as that of oak plantations. This ratio is 46.8: 23.8%. This confirms the fact of slowing down the growth and weakening of the development of pines, starting from the IV class of age. At the same time, the fraction of branches in mixed and pure pine stands is 41.8 and 46.8%, which indicates a more intensive process of mortmass formation in pure pine plantations.

The largest share of crumbs, which is 35.2%, was found in the plantation of common oak with hornbeam and sharp-leaved maple. This is evidence of intensification of litter mineralization and soil formation. Also in plantations with a predominance of common oak and red oak, a high percentage of fruits, the share of which is 16.6 and 18.3%, respectively, which in the long run will provide natural regeneration on reclaimed lands. It should be noted that the fruits, along with leaves and crumbs are an active part of the litter.

In the total composition of the litter, a much smaller share is accounted for by the bark fraction. The share of bark in pin plantations is more than twice that of deciduous stands. In pure and mixed pine stands, the share of bark is

12.0 and 12.7%, respectively. Its lowest value in red oak plantations (4.8%) indicate the intensity of growth and prospects for the use of this tree species on reclaimed lands.

Analysis of the fractional composition of forest litter of red oak plantations shows that a significant contribution to its formation is made by the following fractions in descending order of participation: leaves - 28.7%, branches - 26.1%, crumbs - 22.1% and fruits - 18.3%. As mentioned above, the bark fraction is only 4.8% of the total stock of litter, which indicates a satisfactory state of development of all tree and shrub species in the planting of red oak.

In the plantations of conifer the main part of the litter reserves is created due to the fractions of the branch and crumb, which is 41.8 and 24.7%, respectively. This indicates an intensive process of tree differentiation and increase in natural waste of trees of IV and V categories of Kraft in terms of growth and development [5].

It is known that the rate of decomposition of organic matter of forest litter depends on the ratio of its active and inactive parts. The active part of the litter includes leaves, fruits, crumbs, and the inactive - branches and barks. Stocks of active and inactive parts of forest litter of plantations on reclaimed lands by the studied types of protective plantings are given in Table 3.

### 3. Stocks of active and inactive litter in plantations on reclaimed dumps

| Type and composition of plantings, age, trial plot                | Litter stocks, ts/ha | Parts of the litter |      |          |      |
|---|----------------------|---------------------|------|----------|------|
|   |                      | active              |      | inactive |      |
|   |                      | ts/ha               | %    | ts/ha    | %    |
| Pine-birch plantation 6Ps4Bp+Pc; age – 38 years; TP № 1           | 58,8                 | 27,2                | 46,3 | 31,6     | 53,7 |
| Pine plantation 10Ps+Bp; age – 42 years; TP № 2                   | 64,5                 | 26,1                | 40,5 | 38,4     | 59,5 |
| Mixed planting of common oak 6Qr3Cb1Ap+Qr; age – 40 years; TP № 3 | 77,1                 | 54,2                | 70,3 | 22,9     | 29,7 |
| Mixed planting of red oak 9Qr1Qrb; age – 49 years; TP № 4         | 62,4                 | 43,1                | 69,1 | 19,3     | 30,9 |

The analysis of the obtained experimental data showed that the main part of the forest litter reserves of mixed pine-birch plantations is the inactive part - 31.6 ts/ha, or 53.7%. The active part of the forest litter in this plantation accounts for 46.3% of its total reserves, or 27.2 ts/ha. In pure pine plantation, the percentage of inactive litter reaches 59.5% due to the increase of the branch fraction.

Another pattern is inherent in the forest litter of oak plantations. Both the stands of common oak and red oak are dominated by the active part of the litter, the values of

which are 70.3 and 69.1% or 54.2 and 43.1 ts/ha, respectively. This indicates the onset of a period of intensive growth and development of woody and shrubby plants, high microbiological activity of the forest litter.

**Conclusions.** The study of forest litter of reclaimed plantations revealed its greatest capacity in pure pine stands, and the thickness of litter is higher in rows and lowers in rows. The presence of a two-layer structure of litter in a number of plantations of common oak and red oak, which is due to the acceleration of mineralization pro-

cesses, a significant amount of soft litter of associated species and more moisture due to the accumulation of liquid precipitation.

Litter in pine stands decomposes slowly and the rate of its mineralization slows down with age. Accelerated litter mineralization process is observed in plantations of common oak with an admixture of related species - hornbeam and maple. In red oak plantations, the process of litter mineralization slows down due to the lack of specific mycorrhizal fungi that occur in the forests of North America.

Analysis of litter reserves showed that intensive accumulation of litter is observed in stands of Scots pine due to the long period of its decomposition and ranges from 58.8 to 64.5 ts/ha. In the total stock of litter a large share falls on the branches and crumbs, which is in the pin and deciduous plantations about 65 and 55%, respectively.

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