УДК 630.174:630*524

A. O. Luferov
Belarusian State Technological University

FEATURES OF NATURAL REGENERATION UNDER THE CANOPY OF POLYTRIC PINE FORESTS OF BELARUSIAN POLESIE

In article results of study of natural regeneration under a cover of Polytric pine forests on the territory of Belarusian Polesie. 10 indicator plots have been laid under the canopy of middle-aged, ripening and mature pine stands on the territory of GLHU "Miloshevichsky forestry enterprise", GLHU "Petrikov forestry enterprise" and GOLHU "Mozyr experimental forestry enterprise". Produced enumeration of undergrowth on survey sites with subsequent transfer of the accounting amount to 1 hectare. The ages, heights and conditions of each plant with groups to their viability have been determined. Undergrowth of birch, oak and pine prevalence under the canopy of pine stands. The largest number of young growth noted in the stand density of the parent stand between 0.7–0.8. The absence of relationship between the amount of undergrowth and density of the pine stand have been identified. The structure and density of underbrush has been studied. Prevalence of buckthorn brittle was evaluated. The underbrush is sparse and doesn't make any influence on the growth of undergrowth under these conditions. Mosses occupy up to 85% of the total projective cover field layer in the plots. It was noted that a small fraction of the pine regrowth due to the high density of the coating with moses (*Polytrichum commune* L.), which prevents the rooting of pine seedlings.

Key words: pine, underbrush, undergrowth, indicator plot, field layer, stand density, vitality, overwetting.

Introduction. Currently, in the forests of the Republic of Belarus Pine formation takes more than 50% of the forest area, making it the most common in our country. However, pine forests, in spite of the widespread and intensive anthropogenic impacts have been less studied than many other forest formations. The typological structure, regularities in the formation and growth of the forest types, their geography, as well as features of the natural regeneration of the forest is not enough investigated [1]. Negative trends reproduction pine plantations in recent years has also caused the selection of pine forests as a research object [7].

Obviously, overwetting types of pine forests, which include the polytric pine forests (occupying 4.5% of the total area of pine formations in the territory of the Republic of Belarus [2]), studied even less. According to the existing regulatory base [3, 4], polytric pine forests are inaccessible part of the operational forest fund, i.e. on the timber harvested in these habitat conditions allowed, if necessary, reduce tax costs by 20%.

The landing of plantations on the pine cuttings in conditions of overwetting of soils isn't possible, and inaccessibility of certain sites impugns a possibility of carrying out measures of assistance to natural forest regeneration by the mechanized methods. Therefore, studying of features of natural forest regeneration in such conditions is quite important task.

The research area of this work is the Belarusian Polesie (territory of the Gomel GLHU) having the unique hydrological regime, geomorphology and typological features. The Central Polesie and Southern Polesie are characterized by the greatest distribution of the pine forests, which occupy more than 60% of the forestcovered area. Pine mossy forests (42.3%), pine bilberry forests (23.2%) and pine heather forests (11.0%) are prevailed in the territory of the Belarusian Polesie. The share of polytric pine forests on this area reaches 5.3%. The pine woods on a waterless valley occupy 93.5% of the pine woods total area, at the swamp – 6.5% [2].

The polytric pine forests growing in the conditions of crude pine forests on the peaty mineral soils of oligotrophic bogging, in the territory of the Gomel GLHU forest fund are presented non-uniformly, with the share increasing from the northeast to the southwest of the area. They occupy the space equals to 35,164 hectares, which about 70% (24,411 hectares) make polytric pine forests of Petrikov forestry enterprise (4.5%), Oktyabrski forestry enterprise (5.0%), Elsk forestry enterprise (5.8%), Lelchitsy forestry enterprise (about 8.9%), Zhitkovichy forestry enterprise (10.1%) and Miloshevichy forestry enterprise (10.6%) in forest fund of Gomel GLHU.

According to the researchers, which wanted to detect the features of natural regeneration under a canopy of pine forests of the upland forest types [1, 5–7], a dominance of pine undergrowth height is noted, and the most optimal conditions are noted in the medium-density plantings. It is also found that reforestation in the pine forests proceed with the change of pines with other tree species with the increasing of wealth and moisture of soils.

So, according to Labokha K. V., Shiman D. V. [7], in the Bugsko-Polessky geobotanical district in rather rich forest vegetation conditions, the spruce undergrowth gives way to an oak and other deciduous tree that is caused by a natural area of its distribution. Pine is revived in the greatest part of lichen,

heather and cowberry pine forests, and with the increasing of wealth and moisture of soils, pine is revived by oak and other tree species in pine forests in the territory of the Polesie and pre-Dnieper geobotanical district. On average in Belarus under a canopy of pine forests on the poor and moderate humidity soils undergrowth of a pine meets only by 9.3% of total area; 26.6% are renewed with change of pine by other wood types. The richest specific structure of undergrowth is marked out in the Oxalis and the Fern pine forests, rare – in bilberry pine forests. The presence of economically valuable tree species undergrowth under the canopy of ripening and mature pine forest stands, its quantity and form define the main use of appointed felling in these forest stands therefore detection of these characteristics is necessary.

Main part. The purpose of this research is the analysis of natural forest regeneration under the canopy of polytric pine forests. The researches were conducted in the territory of GLHU "Miloshevichy forestry enterprise", GLHU "Petrikov forestry enterprise" and GOLHU "Mazyr experimental forestry enterprise" by laying of indicator plot. Formation of new planting directly depends on initial forest vegetation conditions and condition of the parental forest stand; the space characteristic of forest stand is caused by its forestry and taxation indexes prior to carrying out ecomeasures, structure of undergrowth and underbrush, a specific variety and abundance of a field layer, a microrelief. These indexes are considered during this research.

Researches of undergrowth were conducted by continuous enumeration method on the indicator plots with the subsequent transfer of registration quantity to thousands of pieces per 1 hectare. The round form indicator plots were put. The area of one plot was accepted in dependence on the undergrowth density: sparse undergrowth (to 2 thousand pieces per hectare) – 20 m^2; average dense of undergrowth (2–8 thousand pieces per hectare) – 10 m^2; dense undergrowth (8–13 thousand pieces per hectare) – 4–5 m^2; very dense (more than 13 thousand pieces per hectare) – 1–2 m^2 [8]. Density of natural regeneration for determination of the area of the plots was defined at a glance.

At laying of indicator plots the following radiuses of a circle in dependence of the indicator plots area were accepted: at the area of 1 m^2 the radius of a circle was 0.56 m; at the area of 2 m^2 – 0.80 m; at the area of 4 m^2 – 1.13 m; at the area of 5 m^2 – 1.26 m; at the area of 10 m^2 – 1.79 m; at the area of 20 m^2 – 2.53 m. The number of indicator plots by this method depends on the area of the examinee area and in our case, it was 10 pieces for each section.

Thus, undergrowth was investigated on 10 indicator plots (IP) of the middle-aged, ripening and mature pine plantings. At the accounting of undergrowth, the age, height and a form of each plant with their reference to groups of viability (healthy, defective, oppressed, dead undergrowth) are defined. Quality control of reliability of undergrowth is made. Quality control of natural forest regeneration was carried out according to TKP 047-2009 (02080).

Undergrowth was considered on categories of fineness: small (height of 0.1–0.5 m), average (height of 0.5–1.5 m), large (more than 1.5 m) [8].

The cover field layer was also studied by laying of registrated plots (1 m^2 sized) on the indicator plots.

Plots were put in number of 20 pieces by the parallel courses (in the form of a grid) on equal removal from each other. Degree of a projective cover field layer of one species of a plant was determined as a percentage at a glance.

The total area of a projective cover on the indicator plot was calculated by toting of a projective cover of separate species of plants [9].

During this research the total absence of undergrowth in middle-aged plantings (IP no. 1 and IP no. 2), and also in the ripening planting (IP no. 3), even despite rather low average completeness and, as a result, good light intensity under a cover of the forest (Table 1) was revealed. On other plots the undergrowth of different degree of viability is noted. The characteristic of the indicator plots is shown in Table 2.

The greatest number of undergrowth is noted on the IP no. 6 (8.4 thousand pieces per hectare) where it is presented by a birch, and also on the IP no. 7 (2.0 thousand pieces per hectare) where besides a birch there is an impurity of a pine (Table 2).

These are the only explored plots with reliable undergrowth. The undergrowth on these plots is created under the canopy of the clear pine forest stands with the density corresponding to 0.7–0.79. In general, birch undergrowth occupies 44.3% on the explored plots. Vitality of birch undergrowth reaches 79%.

According to N. E. Dekatov researches, a characteristic feature of the resumption of polytric pine cutting plots is the fact that this process occurs in the first 2–3 years after felling until mosses (*Polytricum commune*) covering of relatively small power and does not interfere with pine settlement.

In the absence of pre-renewal and pine insemination polytric pine lumbering, as a rule, are renewed with birch. Thus, the birch plays a positive role in these conditions.

These data can be projected also on the explored areas of the mixed and clear pine forest stands – at most of them after final harvest subsequently will be created birch forests. In a favor of this assumption testify high fitness of a birch to conditions of the increased moisture, undemanding to the soil wealth and high competitiveness.

Table 1

Characteristic of pine forest stands at the indicator plots

Number of IP	Area, ha	Age, years	Composition	Height, m	Diameter, cm	Stand density	Site class
1	0.5	40	7P3B	10.9	13.6	0.47	III
2	0.5	45	8P1B1As	14.2	15.7	0.60	II
3	0.5	60	10P	18.0	21.8	0.66	II
4	1.0	60	8P2B	19.0	20.0	0.90	II
5	1.0	80	10P+B+O	18.0	24.0	0.50	II
6	0.5	75	10P	18.0	22.0	0.70	III
7	1.0	85	10P	18.3	20.0	0.79	III
8	0.5	95	6P3B1Al	23.3	29.0	0.64	II
9	1.0	115	10P+B+Al+O	27.1	28.3	0.54	II
10	1.0	115	10P	26.0	35.9	0.56	II

The least number of undergrowth is noted on indicator plots no. 4 (0.1 thousand pieces per hectare) and no. 8 (0.7 thousand pieces per hectare).

The birch occupies the considerable part in here, however on the IP no. 8 is noted a dominance of oak which is not able to grow normally in the overwetting conditions, and also in a shadowing from other trees and will not create adult planting in these conditions. At the same time on the explored areas under a cover of pine forests oak undergrowth occupies 27.1%.

Undergrowth under the canopy of pine forests on indicator plots no. 4 and 8 also differs in the greatest variety: a birch – 50%, an oak – 30%, a pine and a spruce – on 10%. High density of parental planting on the IP no. 4 caused the slight number of undergrowth owing to high degree of opacity. The low number of undergrowth is noted also on the IP no. 5 (0.8 thousand pieces per hectare). As a part of a forest stand there are individual trees of an oak from which there as a renewing process. A similar situation with the IP of no. 9 where the oak undergrowth occupies 80%. Viable oak undergrowth on the explored areas is not noted therefore actually in pine forests on the explored areas in these silvicultural conditions it carries out a role of the undertrush. Pine undergrowth is presented only on IP no. 5 and 10 to mixes with an oak.

As for high-rise structure of undergrowth on the explored areas – the undergrowth of average height (1.3 m) prevails; on IP no. 9 and 10 large undergrowth of an oak is noted. Average and large undergrowth to a lesser extent experiences depressing from other plant tiers in comparison with small undergrowth, however it not so quickly adapts to changes on environmental conditions. Pine undergrowth on the indicator plots makes only 25.7%. Its viability reaches 53%. Small individual share of a pine undergrowth is caused by the plentiful cover of mosses, especially *Polytrichum commune*, the percentage of which presents the vegetation of seeds and rooting of pine shoots. In general, the moss and lichen tier of an alive ground cover on the indicator plots is presented by mosses (about 85% of the common projective covering). Grass-subshrub group is presented by a marsh tea (*Ledum palustre*), sedge (*Carex hirta* L.*, Carex capillaris* L.), horsetails (*Equisetum palustre, Equisetum fluviatile*), common heather ordinary (*Calluna vulgaris*), small reed (*Calamagrostis lanceolata*), matgrass (*Nardus stricta*), bilberry (*Vaccinium myrtillus*), blueberry (*Vaccinium uliginosum*). Among the underbrush, the alder buckthorn (*Frangula alnus*) represents 90% of the underbrush thickness. The existence of a mountain ash (*Sorbus aucuparia*) and a willow (*Salix viminalis* L.*, Salix alba* L.) is also noted. The underbrush, in general, is of average thickness sparse, it has no significant effect on the undergrowth in these conditions.

Table 2

Characteristic of undergrowth under the canopy of polytric pine forests

Number of IP	The characteristic of undergrowth				
	Notal, pcs./ha	Height, m	A_{avg}, years	Composition	Mark
1	Missing				
2	Missing				
3	Missing				
4	0.1	1.2	3	6B2P2O	Unreliable
5	0.8	1.0	5	8P2O	Unreliable
6	8.4	1.0	5	10B	Reliable
7	2.0	1.5	15	9B1P	Reliable
8	0.7	1.5	10	4O2S4B	Unreliable
9	1.2	5.0	20	8O2B	Unreliable
10	1.0	2.0	5	7P3O	Unreliable

As for dependence of number of undergrowth under cover of the wood from the density of the parental stand, the consistent pattern was not revealed during this research. The greatest number of undergrowth was noted at density 0.7–0.8, the least – at density 0.6 and 0.9. Thus, it is possible to make a conclusion that the greater influence on quantify and quality of undergrowth in this case renders not the state of a parental stand, but growth conditions, especially soil conditions – overwetting of the soil. Reliability of the presented results can't be considered exhaustive (in connection with a trace amount of the indicator plots), the carrying out of additional researches on this direction is required. However, even the amount of provided

material is enough to detect the consistent patterns and features of natural regeneration under the canopy of Polytric pine forests in Belarusian Polesie.

Conslusion. During this research, it was revealed that under the canopy of Polytric pine forests the birch (44.3%), oak (27.1%) and pine undergrowth (25.7%) is prevailed. As a part of undergrowth healthy trees (40%) prevail. The greatest number of undergrowth is noted at density 0.7–0.8, however there wasn't revealed dependence between the number of undergrowth under a canopy of the forest and density of pine planting. The greater influence in these conditions on rooting and further formation of undergrowth is rendered with the owerwetting soil.

Rather small share of objective pine undergrowth is caused by high thickness of a covering an alive ground cover (to 90%), especially *Polytrichum commune* L., which hinders the rooting of pine shoots.

References

1. Yurkevich I. D., Lovchiy N. F. *Sosnovye lesa Belorussii* [Pine forests of Belarus]. Minsk, Nauka Publ., 1984. 123 p.

2. Lovchiy N. F. *Kadastr tipov sosnovykh lesov Belorusskogo Poles'ya* [Type cadaster of pine forests of Belarusian Polesie]. Minsk, NAN Belarusi Publ., 2012. 221 p.

3. The procedure of referring of commercial forests to arduous categories. Order of Forestry Department of Republic of Belarus, no. 191. Minsk, 2001. 16 p. (In Russian).

4. TKP 143-2008 (02080). Rules of fellings in the Republic of Belarus. Minsk, Forestry Department Publ., 2008. 99 p. (In Russian).

5. Yurkevich I. D. *Estestvennoe vozobnovlenie v vodookhrannykh lesakh BSSR* [Natural regeneration in water-conservancy forests in BSSR]. Minsk, GIZ BSSR Publ., 1939. 68 p.

6. Yurkevich I. D., Golod D. S. Natural regeneration and estimation of it's success. *Spravochnik rabotnika lesnogo khozyaystva* [Forestry worker's manual]. Minsk, Nauka i tekhnika Publ., 1987, pp. 83–94 (In Russian).

7. Labokha K. V., Shiman D. V. *Postepennye rubki v sosnyakakh Belarusi* [Shelterwood in pine forests of Belarus]. Minsk, BGTU Publ., 2013. 284 p.

8. TKP 047-2009 (02080). Sustainable forest management and exploitation. The manual for reforestation and afforestation in the Republic of Belarus. Minsk, Forestry Department Publ., 2009. 105 p. (In Russian).

9. Dylis N. V. *Programma i metodika biogeotsenoticheskikh issledovaniy* [Program and methodology of biogeocenotic research]. Moscow, Nauka Publ., 1974. 311 p.

Information about the author

Luferov Anton Olegovich – PhD student, the Department of Silviculture. Belarusian State Technological University (13a, Sverdlova str., 220006, Minsk, Republic of Belarus). Engineer appraiser. RDLUP "Gomellesproect" (35, Pervaya Vstrechnaya str., 246027, Gomel, Republic of Belarus). E-mail: anluferov@rambler.ru

Received 16.02.2016