Artículo de investigación

Substantiation of the minimum size of the trial area when estimating the yield of chaga in birch plants of Perm Region

ОБОСНОВАНИЕ МИНИМАЛЬНОГО РАЗМЕРА ПРОБНОЙ ПЛОЩАДИ ПРИ ОЦЕНКЕ УРОЖАЙНОСТИ ЧАГИ В БЕРЕЗОВЫХ НАСАЖДЕНИЯХ ПЕРМСКОГО КРАЯ

Recibido: 5 de agosto del 2019 Aceptado: 28 de septiembre del 2019

Written by:
Tatiana Alekseevna Boiko[97]
ORCID 0000-0001-7705-5382
SPIN 5519-1539
Vitaliy Sergeevich Botalov[98]
ORCID 0000-0001-5242-8648
SPIN 5225-0003
Aleksandr Valerievich Romanov[99]
ORCID 0000-0002-3908-9765
SPIN 1885-7419

Abstract

The article discusses the results of mantle tinder (Inonotus obliquus) productivity studies in the birch plantings of Kizelovsky and Kungursky forestry in Perm Region. The aim of the study was to establish the optimal size of the trial plot laid in the plantation and providing representative data on the fungus production. Distances between infected trees exceed 100 meters. The minimum trial area should be 3 hectares. In the studied territories, chaga production was 0.5–2.7 kg / ha in fresh weight.

Keywords: Tinder fungus (chaga); trial plot; birch plantations; density of part of the growth; height of the location of the fungus on the trunk.

Аннотация

В статье обсуждаются итоги проведения исследований урожайности трутовика скошенного (*Inonotus obliquus)* в березовых насаждениях Кизеловского и Кунгурского лесничества Пермского края. Целью исследования являлось установление оптимального размера пробной площади, закладываемой в насаждении и обеспечивающей репрезентативные данные по урожайности гриба. Расстояния между зараженными деревьями превышают 100 метров. Минимальный размер пробной площади должен составлять 3 гектаров. На обследованных территориях урожайность чаги составила 0,5–2,7 кг/га в сыром весе.

Ключевые слова: трутовик скошенный (чага), пробная площадь, березовые насаждения, плотность части нароста, высота местоположения гриба на стволе.

[97] Ph. D. in Biological Sciences Associate Professor Head of Department of Forestry and Landscape Architecture Department of Forestry and Landscape Architecture Perm State Agro-Technological University named after Academician D.N. Pryanishnikov, Russia.
[98] Ph. D. in Biological Sciences Associate Professor Department of Forestry and Landscape Architecture Perm State Agro-Technological University named after Academician D.N. Pryanishnikov, Russia.
[99] Ph. D in Agricultural Sciences Associate Professor Associate Professor Department of Forestry and Landscape Architecture Perm State Agro-Technological University named after Academician D.N. Pryanishnikov, Russia.

Introduction

An increase in the profitability of forestry in the conditions of market relations can be achieved only on the basis of accounting and rational use of all types of forest resources, among which minor forest resources and secondary forest products occupy an important place. Obtaining information on the stocks of secondary forest resources and products of secondary forest management will not only streamline their use, but also give a full assessment of these resources, as well as clarify the damage caused by natural and man-made impacts.

One of the valuable forest resources is the sterile formations of the beveled tinder fungus associated with birch (chaga), which are intensively harvested by both the population and enterprises. Despite the long period in the study and the widespread use in official and traditional medicine of preparations based on the wood-destroying basidiomycete fungus Inonotus obliquus, universal methods for determining the yield of chaga have not yet been developed. This does not allow to correctly assess the resources of this raw material and complicates its export.

A detailed study of the biology and morphology of the fungus was carried out by O. P. Nizovskaya (1959), E. I. Slepyan (1961), K. Kalamees (1979), R. A. Blanchette (1982), G. Tyler (1984), M. A. Bondartseva (1986), E. Kh. Parmasto (1986), B. P. Churakov (1993), Dai Yu-Cheng (2010), M. E. Balandaykin (2013).

The relationships of the fungus and the host plant were studied by A. S. Bondartsev (1953, 1959), Yu. V. Sinadsky (1973), R. A. Blanchette (1982), M. A. Bondartseva (1986), B. P. Churakov (1993), M. E. Balandaykin (2013).

Materials and methods

The studies were conducted in the taiga on forest plots located in the 103rd quarter of Chikmansky precinct forestry of Kizelovskoye Lesnichestvo, Perm Region. Type of forest − Piceetum crenato-athyriosum (according to international classification). On this territory 2 sites were examined. A plot of 22 hectares was the main for the study. The second site (3 hectares) was a test trial area. The age of birches is 100 years. The same two test plots (each test plot is 3 hectares) were laid in the 2nd quarter of the Orda district forestry, State Institution "Kungur Forestry", Perm Region. Forest type − Piceetum oxalidoso-linnaeani-dryopteridosum. The age of birches is 65 years.

In the plots, each birch was examined for the presence of infection by chaga. The location of the detected infected tree was recorded by the GPS-navigator. The diameter of the trunk, the height of the tree, and the sanitary condition of the tree were measured. The height of the location of the fungus on the trunk, its size were measured too (using a special optical device). If the mushroom was at a height of up to 6.5 meters, it had been sawed off to determine weight and density.

Results

An examination of a 22-hectare site has showed a group distribution of birches infected with a mowed tinder. The distance between single trees and those located in groups exceeds 100 meters (Fig. 1).

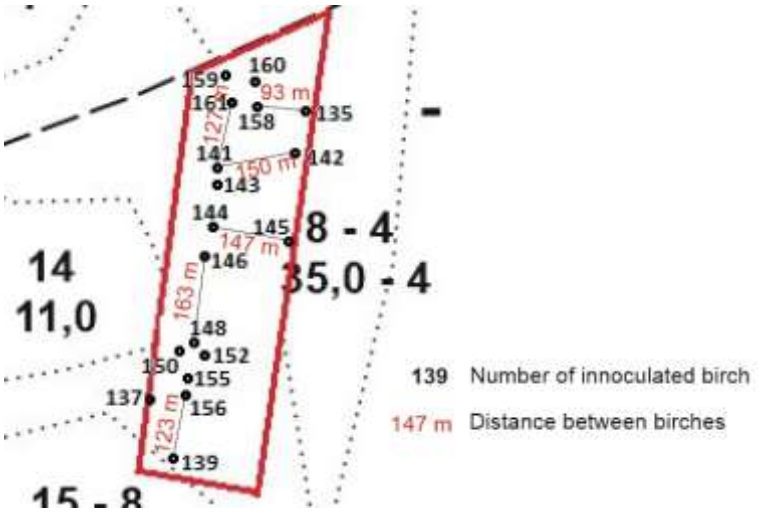

Figure 1. Distances between trees with chaga in the surveyed area of 22 hectares

ISSN 2322- 6307

Using the above research methods does not guarantee to establish the presence (or prove complete absence) of infected trees. Even a test area of 1 ha may be between the trees with the chaga. It was noted that the minimum distances between infected trees prevail in the meridional direction. Perhaps this is due to the fact that the infection of trees had been occurred under the influence of southerly winds. The presence of chaga in the lower part of the trunk (at a height of up to 2 meters) was noted in 2 cases. In these trees, the chaga is marked on the north side of the tree. Statistical indicators of trees with chaga are shown in Table 1.

Any tendencies for the growth of chaga on a part of the trunk that was definitely oriented to the cardinal points haven't been revealed. 28% of chaga's trees were not available for workpieces using a saw extended to 6 meters. 11% of trees showed that chaga could have been sawing off with a regular garden saw without lengthening it.

The volume and parameters of chaga obtained in stationary studies are shown in Table 2. The volume of growths for each of the tree was established by the calculation method, since when sawing off they have been cut into pieces.

The correspondence of the volume of a part of the growth to its weight was determined not for all parts. Next, the density of part of the growth was established. If several parts had been measured for one tree, then the density was taken as the average for the tree. Volume of trees with permanent parts of chaga growth was carried out according to the average density according to the results of all measurements.

On 22 hectares, 18 trees with chaga (0.8 trees / ha) were found. The total weight of tinder fungus outgrowths, including uncollected samples, was 25308 grams in fresh weight, and 13702 grams in dry weight. Productivity of chaga in fresh weight is 1150 g/ha, in the air dry— 623 g/ha.

Table 1. Statistical indicators of trees with chaga

Number trees sampled (№)	Tree height, m	Tree diameter, cm	Chaga placement height, m	Trunk's chaga placement side of the world	Sanitary condition, category number
135	21.5	42	5.6	East	3
137	20.5	27	4.5	North	3
139	18.0	23	4.0	North	3
141	17.0	24	6.5	North East	3
142	20.0	34	7.0	South West	3
143	23.0	43	7.0	South and East	3
144	22.0	32	11.0	South	3
145	14.5	34	2.5	West	3
146	19.0	25	5.6	South and East	3
148	20.0	35	7.8	South East	4
150	4.5	38	4.4	South West	6
152	19.0	23	4.7	South	3
155	23.0	28	1.0	North	3
156	23.5	29	6.5	South	3
158	12.0	32	5.8	North	3
159	20.0	40	9.0	South West	3
160	26.0	35	1.5–2.0	North	3
161	15.0	24	6.0	East	3

Table 2. Weight and volume of chaga collected from 22 ha

Number trees sampled (№)	Weight of chaga, g		Share of water, %	Density of chaga, g/ cm3	Volume of chaga before drying, cm^3
	raw	air dry			
135	664	369	44	0.98	678
137	1323	609	54	1.09	1214
139	2302	1229	47	1.17	1968
141	238	113	53	1.40	170
145	72	53	26	1.09	66
146	1907	953	50	1.04	1834
150	5658	3595	36	0.96	5894
152	1098	442	60	1.10	998
155	1920	899	53	1.09	1761
156	2479	1354	45	1.11	2233
158	1761	962	45	0.90	1957
160	432	200	54	1.09	396
161	658	382	42	1.13	582
Total	20512	11160	–	–	19751

In the second section (test plot), 3 trees with chaga were found. Thus, 1 infected tree with an average productivity of chaga 563 g/ ha accounts for 1 hectare of the surveyed area. As on a 22-hectare site, the only tree with a chaga at a height of up to 2 meters had a growth on the north side. Inspection of the test plots in the State Institution "Kungurskoye Lesnichestvo" showed that on the first test plot with the participation of birch as part of the planting of 8 units, 8 trees with chaga were found (mushroom productivity - 2.7 kg / ha). On the second test plot, only 2 infected trees were found (productivity - 0.9 kg / ha).

Discussion

In the studies of M. A. Bondartseva, E. Kh. Parmasto S. P. Arefyev Inonotus obliquus is represented as a multi-regional species of the fungal genus Inonotus, distributed in the European part of Russia, Western Siberia, the Far East, the North Caucasus and the Urals (Bondartseva, Parmasto, 1986; Arefyev, 2010). A. M. Zhukov, A. S. Bondartsev, L. Rivarden, Yu. Chen note that the species of the fungal genus Inonotus is also found outside the Russian Federation - in the CIS countries, Western Europe, North America, Canada, Australia, China and on the island of Ceylon (Bondartsev, 1953, 1959; Zhukov, 1978; Ryvarden, 1993; Yu-Cheng, 2010). A characteristic feature of the multiregional species of the fungal genus Inonotus is that it propagates by basidiospores. According to A. S. Bondartsev, S. P. Arefyev, mantle tinder is found on birch, alder, mountain ash, bird cherry, elm, maple, beech, apple tree trunks, as well as on old birch trees hanging and fluffy (Bondartsev, 1953, 1959; Arefyev, 2010).

O. P. Nizovskaya (1959), Yu. V. Sinadsky (1973), B. P. Churakov (1993) paid attention to the peculiarities of fungus growth on birch trunks and productivity. The effect on the distribution of chaga in various forest conditions, as well as the sanitary condition of trees, was studied by Yu. V. Sinadsky (1973), A. M. Zhukov (1978), T. N. Barsukova and O. V. Mamedova (2001), S. M. Music (2009), S. P. Arefyev (2010), M. E. Balandaykin (2013), Sh. Z. Nagumanov (2014). B. P. Churakov and M. E. Balandaykin used the method of dimensionless registration samples in their studies on trees infected with mowed mowing (Churakov, 1993; Balandaykin, 2013). On these samples, a continuous recount of trees was carried out according to the categorical principle. Two categories of trees stood out: healthy and affected trees. The degree of fungus spread was expressed in the number of trunks with chaga per 1000 examined trees. A number of authors consider it necessary to lay a trial plot so large that it includes at least 200 trees of forest-forming species (Stavishenko, 2008; 2015). H. Kauhanen, using the method of dimensionless registration samples, recommends using transects measuring 10 × 400 m, or laying test areas (10 × 10 m), performed every 100 metres of the territory examined along the route (Kauhanen, 2009). Sh. Z. Nagumanov in his studies used constant test plots of 20 × 20 meters in size, as well as one-time transects 0.2–0.7 km long and 4 meters wide (Nagumanov, 2014). At the same time, when conducting forest inventory works, taxis use 100 × 100 meters sample plots (Andreeva, 2002; Anuchin, 2004; Temporary working rules for field work, 2008). At these test sites, a complete recount of all forest-forming

trees is carried out with a description of their sizes for subsequent evaluation.

Conclusions

Tinder funnel (Inonotus obliquus) is a xylotroph that develops on trees of the genus Birch, Aspen, Alder, less often Mountain ash, Beech and some other hardwoods. Its sterile formations associated with birch (chaga) are used in folk medicine and can serve as goods not only in the domestic market of Russia, but also actively exported. The export of this product is hampered by the lack of assessment methods, starting with the assessment of chaga productivity in forest areas, and ending with the methodology for determining the value of goods for taxation during transportation across the border.
In summer of 2019, studies were conducted in Chikmansky district forestry of GKU "Kizelovskoye Lesnichestvo", and in Orda district forestry of GKU "Kungurskoye Lesnichestvo" in Perm Region. The aim of the research was to develop a methodology for taxation of the forest area to determine chaga productivity.

Based on the research results, the following conclusions can be drawn:

1. Birch trees infected with tinder funnel were not found in 30–40 year old stands. Only in stands of 60 years at least it makes sense to assess chaga productivity.
2. No difference was found in the number of trees with chaga in the stands with birch in the composition from 2 to 5 units (0.8–1 pcs / ha). An increase in the proportion of birch in the planting up to 8 units led to an increase in such trees by 3 times (3.2 pcs / ha).
3. Trees with chaga in the study area are found both in groups and singly. The distance between them exceeds 100 meters, which makes it inappropriate to lay up trial plots with sides 100 × 100 m. A survey of an area of 22 hectares showed the predominant placement of trees with chaga in the direction from South to North.
4. 11% of trees with chaga showed a growth located at a height of up to 2 meters, 28% − at a height of at least 7 meters. At the same time, the weight of chaga on such trees can exceed 1 kg in its raw form.
5. Chaga productivity in plantations with the participation of birch (2–5 units of composition) ranged from 563 to 1150 g / ha. In plantation, where birch occupied 8 units, productivity had been increasing by 2 times (2690 g / ha).
6. When drying, about 47% of chaga weight has been losting due to the evaporation of water. At the same time, when drying the parts of chaga (since large growths had been cut off in parts), a clear relationship between the size of the part of the growth and evaporation of water hasn't been established. The minimum humidity was 25.5%, the maximum was 66%.
7. The minimum size of the trial plot for assessing chaga productivity on birches should be 3 hectares. If the size of the allotment does not exceed 5 hectares, then it is most convenient to examine such an allotment completely. It is better to lay the trial area with sides 200 × 150 m. The long side of the trial area is located across the often blowing winds. Considering the size of the trial plot, its border might begin both from the boundary of the allotment and from the trail that runs along the allotment.

References

Andreeva, E. N. (2002). Methods of studying forest communities. Saint- Petersburg: Research Institute of Chemistry, St. Petersburg State University.
Anuchin, N. P. (2004). Forest taxation. Moscow: VNIILM.
Arefiev, S. P. (2010). System analysis of biota of wood-destroying fungi. Novosibirsk: Nauka.
Balandaykin, M. E. (2013). Bioecological features of the influence of Inonotus obliquus macromycete (Pers.: Fr.) Pil. on birch forest stands of Ulyanovsk Region. Extended abstract of dis... cand. biol. sciences. A cand. sci. dissertation in biology. Ulyanovsk: Ulyanovsk State University, 22.
Barsukova, T. N. and Mamedova, O. V. (2001). Xyloparasitic fungi in the territory of the Zvenigorod biological station. Proceedings of the Zvenigorod Biological Station. Vol. 3. Moscow: Logos, 100–105.
Blanchette, R. A. (1982). Progressive Stages of Discoloration and Decay Associated with the Canker-Rot Fungus, Inonotus obliquus, in Birch. Phytopathology, 72 (10), 1272–1277.
Bondartsev, A. S. (1953). Tinder mushrooms of the European part of the USSR and the Caucasus. Moscow: Leningrad: Publishing House of the Academy of Sciences of the USSR.

Bondartsev, A. S. (1959). Chaga and some of the most common tinder trees on a birch. Chaga and its therapeutic use in stage IV cancer. Leningrad: Medgiz, 23–31.

Bondartseva, M. A. and Parmasto, E. Kh. (2002). Key to mushrooms of the USSR. Aphyllophore order. Vol. 1. Families hymenochet, lahnokladievye, konioforovye, alkaline-green. Leningrad: Nauka.

Churakov, B. P. (1993). The relationship of pathogenic fungi with woody plants. Moscow: Publishing House of Moscow State University.

Dai, Y. C. (2010). Hymenochaetaceae (Basidiomycota) in China. Fungal Diversity, 45, 131–343.

Kalamees, K. (1979). The role of fungal groupings in the structure of ecosystems. Eesti NVS Teaduste Akadeemia Tiometised. Köide Bioloogia, 28 (3), 206–213.

Kauhanen, H. (2009). Coniferous forests of northern latitudes: from research to environmentally responsible forestry. Jyuväskylä: Kopijyvä.

Music, S. M. (2009). Macroscopic mushrooms in environmental monitoring of the northern regions of the Irkutsk region. Coniferous boreal zone, 1, 126–131.

Nagumanov, Sh. Z. (2014). Resources of medicinal mushrooms used in veterinary medicine. Scientific notes of Kazan State Academic Veterinary Medicine named after N. E. Bauman, 218 (2), 183–188.

Nizovskaya, O. P. (1959). To the biology of the pathogen chaga on a birch. Chaga and its therapeutic use in stage IV cancer. Leningrad: Medgiz, 32–35.

Ryvarden, L. (1993). European Polypores. Vol. 1: Abortiporus - Lindtneria. Oslo: Fungiflora.

Sinadsky, Yu. V. (1973) Birch. Its pests and diseases. Moscow: Science.

Slepyan, E. I. (1961). Features of pathological changes in the structure of the trunk of Betula verrucosa Ehrh. with the development of the fungus Inonotus obliquus (Pers.) Pil. Integrated study of physiologically active substances of lower plants. Moscow; Leningrad: Nauka, 18–32.

Specially Protected Natural Territories of Sverdlovsk Region: Monitoring of the State of the Environment (2015). Ed. I. A. Kuznetsova. Yekaterinburg: Publishing House Ural. University.

Stavishenko, I. V. (2008). Monitoring of communities of wood-destroying fungi of the Kondinsky Lakes Natural Park. Siberian Ecological Journal, 4, 645–654.

Temporary field work rules. Ministry of Agriculture (2008). FSUE "Roslesinforg".

Tyler, G. (1984). The impact of heavy metals pollution on forests: a case study of Gusum, Sweden. Ambio, 13 (1), 18−24.

Zhukov, A. M. (1978). Fungal diseases of Upper Ob forests. Novosibirsk: Nauka.

Zmitrovich, I. V. (2010) The middle taiga of the Karelian Isthmus: zonal, intrazonal and extrazonal phenomena. Bulletin of ecology, forest science and landscape science, 12, 54–76.