

PHYTOPATHOLOGICAL MONITORING AND PROTECTION AGAINST FUNGAL DISEASES IN YOUNG PINE *PINUS SYLVESTRIS* L. STANDS IN LITHUANIA

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Abstract

*This work reports about the importance of phytopathological monitoring use for forest protection against fungal diseases and for its prognosis. Pure stands of young pines *Pinus sylvestris* L. were observed in south part of Lithuania in October 2012. Preliminary results of our observation showed that the most common fungal diseases in our research plots were *Lophodermium* sp. and *Armillaria* sp. Using monitoring methods we can observe the influence of treatment of pines with plant protection tolls.*

Key words: monitoring, pine stands, fungal diseases, protection

1. INTRODUCTION

Monitoring and assessments of the forest health require indicators of forest conditions and environmental stresses. Indicator selections depend on objectives and the strategy for data collection and analysis. Fungal diseases are the main forest health indicators in this paper.

The most common diseases on needles and shoots in pine plantations in Lithuania there are: *Lophodermium seditiosum* Minter, Staley & Millar, *Coleosporium* sp., *Gremmeniella abietina* (Lagerb.) Morelet, *Melampsora populnea* (Pers.) P. Karst. These pathogens are very dangerous to young pine trees. The fungus *Gremmeniella abietina* (Lagerb.) M. Morelet can cause devastating epidemics in pine forest in Europe, especially on Austrian pine (*Pinus nigra*), but also on Scots pine (*Pinus sylvestris* L.), mountain pine (*Pinus mugo* Turra) (Thomsen 2009). The example of huge losses because of *G. abietina* comes from Sweden, where it was estimated that more then 400.000 ha of forest was damaged in 2001 (Stenlid 2001; Wulff & Walheim 2002).

Favourable conditions for development of pathogenic ascomycete *Dothistroma septosporum* (Dorog.) Morelet (teleomorph *Mycosphaerella pini* E. Rostrup apud Munk) were detected in recent years in Lithuania. In 2002 *D. septosporum* was detected for the first time for the Baltic countries in Lithuania on *Pinus mugo* (Jovaišienė & Pavilionis 2005). Later this fungus was found widely spreaded on Scots pine in Lithuania at the end of September 2008 (Markovskaja & Treigienė 2009). This pathogen, known to cause red-band needle blight, damages the needles of pine, causes the defoliation and reduces the growth of pine trees significantly (Drenkhan & Hanso 2009). One year later, in 2009, *Lecanosticta acicola* (Thumen) A. Sydow, an anamorphic stage of pathogenic ascomycetous fungus *Mycosphaerella dearnessii* M.E. Barr, causing foliage disease of pines known as brown spot needle blight has been for the first time reported in Lithuania (Markovskaja, Kačergius & Treigienė 2011).

Very dangerous parasite in pine plantations is *Phacidium infestans* Karst. Needle blight caused by that fungus kills Scots pine trees in forest plantations and naturally regenerated areas all over the Nordic countries (Roll-Hansen et al. 1992). *P. infestans* develops under the snow, where temperature is often near 0° C, even then, if above the snow cover it is much lower (Roll-Hansen 1989). It has been one of the most serious diseases of Scots pine seedling Finish nurseries and had caused serious mortality in

reforestations there (Kurkela 1996). The disease conditions are favourable for the development in Lithuania, but the larger damages made by *P. infestans* in our country were not detected by far (Hanso 2000). Other dangerous fungal pathogens for young pines are root pathogens: *Heterobasidion annosum* (Fr.) Bref. and *Armillaria* sp. The first signs of *Heterobasidion annosum* damages can be detected on 15-20 years old pines (Vasiliauskas 2008). *Armillaria* sp. is very common pathogen on young (3-15 years) pines.

The quantity of plants damaged by diseases and intensity of the diseases varies each year depending on the type of infection, environmental conditions and plant health. The usage degree of plant protection tools depends on the intensity of the spread of plant diseases. In order to select effective plant protection tools to prevent epidemics and to minimize the damages made by diseases it is very important to make prognosis of infections outspread (Dabkevičius, Vasiliauskas & Žiogas 2006).

The aim of this study – to assess the distribution of fungal pathogens in the young stands of pine using monitoring methods and to select effective plant protection tools for reduction the damages made by fungal diseases.

2. MATERIALS AND METHODS

The object of research - fungal pathogens in Scots pine (*Pinus sylvestris*) stands (forested in 2005) in the southern part of Lithuania. Phytopathological monitoring was made in October 2012 in three research plots (Grūtas, Druskininkai, Latežeris). The main characteristics of observed pine stands are presented in Table 1. All pine stands were the same age (10 years old) and grew up in the same forest site (soils of normal humidity).

Table 1. Characteristics of the research plots

Research plot	Forest enterprise	Forest district	Forest block/plot	Age, years	Forest site
Grūtas	Druskininkų	Grūto	123/2	10	Na/Nc*
Druskininkai	Druskininkų	Druskininkų	371/10-11	10	Na/Nc*
Latežeris	Druskininkų	Latežerio	294/8	10	Na/Nc*

*(Na – soils of normal humidity, fertility very poor; Nc – soils of normal humidity, fertile).

Each research plot included 750 trees planted in 15 rows (50 trees in each row). Totally six research plots will be assessed. Three research plots will be treated with plant protection tools against fungal disease and other three plots will be without treatment (as control).

In each research plot measured indicators: 1) total number of pine trees; 2) number of stumps; 3) fungal pathogens; 4) efficiency of plant protection tools applied in research plots.

The total number of pine trees was estimated including healthy, damaged and newly replanted pines. Degree of damage and reason of damage were assessed. Damage degree was evaluated grouping trees to the categories: 0 – healthy trees without indications of damage; 1 – slightly damaged with individual spots on the needles, needles with brown tips; 2 – damaged on average (up to 50% of needles are desiccated); 3 – strongly damaged (more than 50% of needles are desiccated); 4 – fully desiccated. Reason of damage could be mentioned as: mechanical damage, fungal disease, pest damage, animal

damage. Mechanical, pests and animal affected damages make the main ways for the spread of fungal infection. Trees in research plots were labeled (Fig.1) with possibility to observe the same tree next year.

The stumps are included in the observations because it is the one of the main source for fungal infection spread (especially root pathogens). Four categories of stumps decay were assessed: I – started to decay, II – half decayed; III – fully decayed; IV – fully decayed with fungus fruiting bodies.



Fig. 1. Labeled pines in the research plot

Fungal pathogens were evaluated in more detail. Fungal pathogens were identified using identification keys and determined by morphological characteristic (fruiting bodies, spores). The samples of fungal pathogens were collected from pine needles, shoots, twigs, stems and root.

Efficiency of plant protection tools against fungal pathogens applied in research plots will be evaluated one - three years after treatment (2014-2016).

Phytopathological monitoring in pine stands is performed two times a year (in spring and autumn). All monitoring results are visualized on the schemes of the research plot. Healthy and damaged pine trees, stumps and potential fungal disease outbreaks are marked in the schemes of research plot. Such a scheme will be created each year – from 2013 to 2016. Comparing all schemes it will be possible to determine the spread direction and speed of fungal pathogen. Either efficiency of applied protection tools could be evaluated from created schemes.

3. RESULTS AND DISCUSSION

Phytopathological monitoring was made in three Scots pine stands (Grūtas, Druskininkai, Latežeris) in October 2012. It was estimated that about 50-76 % of pines were healthy (0 category) (Table 2).

Most healthy pines (75.9%) were detected in Latežeris stand where either most weakened (10.3 %) and desiccated (6 %) pines were observed. We could observe the pine trees damaged by animal (6 pines) in recent research plot (Table 2).

Table 2. Damaged trees in the research plots

No.	Pine trees	Number (%) of damaged trees in the research plots		
		Grūtas	Druskininkai	Latežeris
1	Healthy	456 (60.8)	327 (49.6)	569 (75.9)
2	No pine	216 (28.8)	348 (46.4)	45 (6.0)
3	Weakened pine	33 (4.4)	9 (1.2)	77 (10.3)
4	Fully desiccated pine	13 (1.7)	8 (1.1)	45 (6.0)
5	Other tree	12 (1.6)	7 (0.9)	3 (0.4)
6	<i>Armillaria</i> sp.	5 (0.7)	1 (0.1)	0
7	<i>Lophodermium</i> sp.	15 (2.0)	2 (0.3)	3 (0.4)
8	Animal damage	0	0	6 (0.8)
9	Stump	16	18	22

All results were transferred to the schemes of research plots where general view about pine stands condition was presented (Fig. 2).

Using these schemes we will have ability to follow the process of fungal infection spread after few years of our observations.

According primary results the main pathogens dominated on pine stands were *Armillaria* sp. (Fig. 3) and *Lophodermium* sp. (Fig. 4). *Armillaria* root pathogen lives on living and dead wood and infects a tree through its roots.

Lophodermium sp. is especially dangerous pathogen to young trees. After infection needles turn brown and die. The death does not kill the plant although the new shoots are visibly weakened and after frequency infection the plant desiccates.

The most pines damaged by *Armillaria* sp. (0.7%) were detected in Grūtas stand. It was noticed that pines damaged by root pathogen were located near desiccated trees or near the old stumps. During our observation we also noticed that the *Armillaria* root pathogen was the main reason of some pines death. It was clearly seen that this pathogen was the primary pathogen which killed the pines. First symptoms of root disease (rudimental fruitbodies of *Armillaria* sp.) we detected then the pine was still with green needles. Some months later the pines became fully desiccated, without needles and with mature fruitbodies of root disease (Fig. 5). These notices will be observed next year. Only one pine was damaged by *Armillaria* sp. in Druskininkai stand. Any damages made by *Armillaria* sp. were detected in Latežeris pine stand.

The most damaged pines by *Lophodermium* sp. (2 %) were detected in Grūtas plot where the small groups of damaged trees formatted. Infected trees were fully desiccated but needles with *Lophodermium* sp. symptoms were still on the tree. Only single pines were infected by this disease in other research plots (Druskininkai and Latežeris).

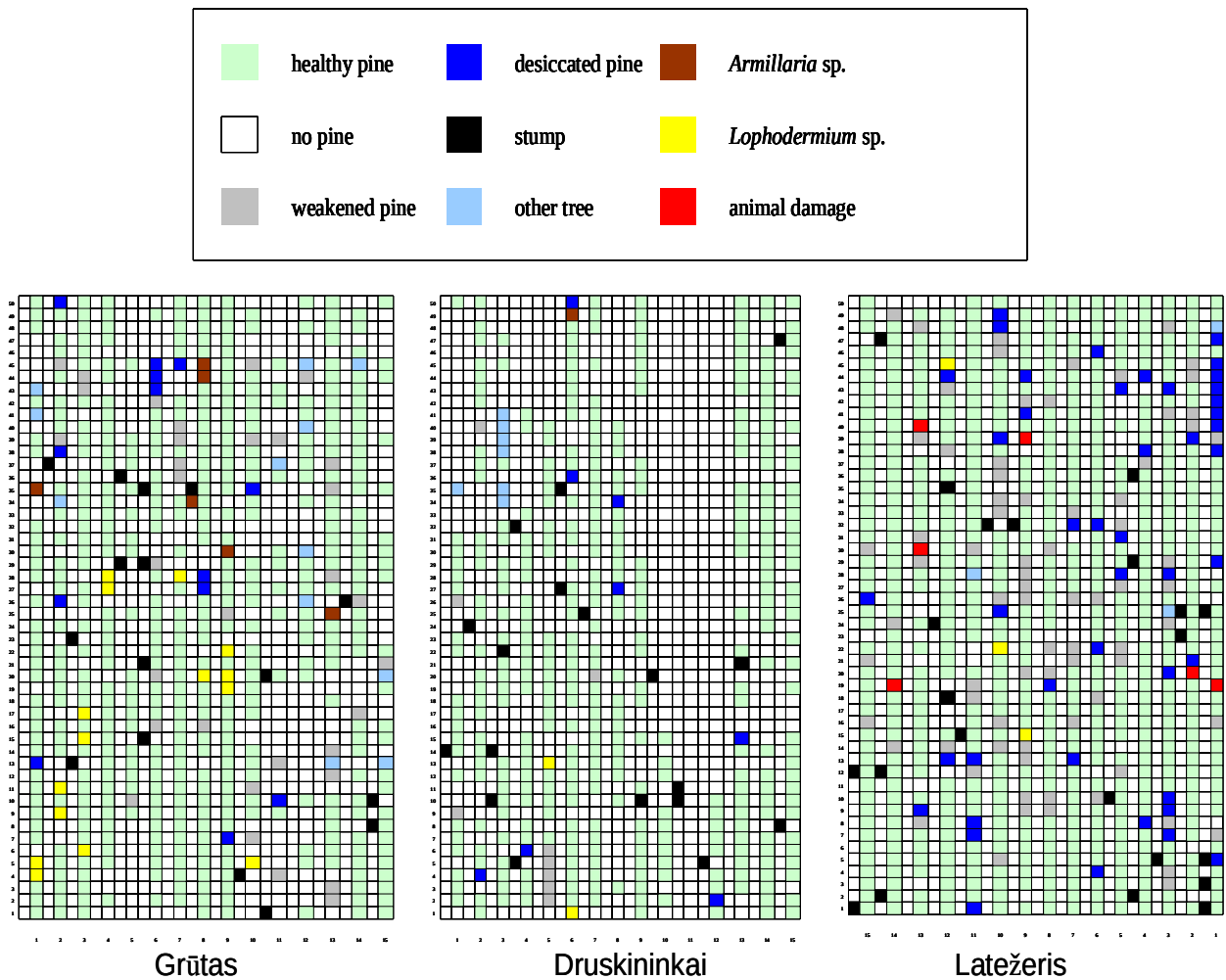


Fig. 2. Schemes of observed research plots



Fig. 3. *Armillaria mellea* fruitbody on *Pinus sylvestris*



Fig 4. *Lophodermium* sp. on *Pinus sylvestris* needles



Fig. 5. Pines damaged by *Armillaria* sp. (stages of infection from first symptoms to full desiccation)

The stumps of pine trees were observed in our research plots. The presence of stumps can serve as potential sources of roots borne fungal diseases. The most stumps left in the research plots were half decayed (II category) but no one was with fruitbodies of the fungi (IV category). Totally we have detected about 20 old (about 8 years old) stumps in the research plots.

According to the fungal pathogens observation results we are going to test few plant protection tools in our research plots. We are going to use systemic fungicide with active ingredient azoxystrobin to protect pines from the *Lophodermium* sp. diseases. This fungicide is best used as a protective treatment or during

early stages of disease establishment. All the pines located around damaged pines will be treated by fungicide. Armillaria root rot fungus will be controlled by removing infected tree, including the dead and alive trees with symptoms of disease. The ground will be watered with systemic fungicide after damaged pines removing.

It is known that infection of future plantation reduces the stump treatment with fungicide, stump bark removing and burning. Stumps remaining in the disease outbreaks could be debarked or burned that leads to development of saprophytic-antagonistic fungi: *Fomitopsis pinicola* (Sw.) P. Karst., *Gloeophyllum sepiarium* (Wulfen) P. Karst., *Phlebiopsis gigantea* (Fr.) Jülich. In young pine stands infected by Armillaria root rot it is recommended to unroot the damaged and desiccated pines. The grooves of 0.5 meters in width and 0.5 meters in depth should be made around the outbreaks of infected trees. It is important to know that infected trees with no visible symptoms of root diseases can be located 5-6 meters around the disease outbreak. Trees without visible symptoms should be monitored to determine their external signs of desiccation.

The airborne technologies are planned to use in our research plots. These technologies will help to make monitoring more easily and quickly. The research plots will be photographed from the air. Using aerial photography permits large areas of forest to be inspected rapidly for visibly affected trees, for quantifying effects, and for providing a record of fungal disease occurrence. Damaged trees and efficiency of treated protection tools will be visible on the photography made by airborne technologies.

4. CONCLUSIONS

One year after monitoring of our research plots made in young pine stands we conclude that: 50-76 % of pines were healthy (0 category); 1-10 % trees were weakened and about 1-6 % pines were fully desiccated (4 category). The main pathogens dominated on pine stands were *Armillaria* sp. and *Lophodermium* sp. It was noticed that pines damaged by Armillaria root rot were located near fully desiccated trees or near the old stumps. The most stumps left in the research plots were half decayed (II category) but no one was with fruitbodies of the fungi (IV category). According to the observation results we are going to test few plant protection tools in our research plots. Trees damaged by *Lophodermium* sp. will be treated with fungicide containing active ingredient azoxystrobin. Trees damaged by Armillaria root rot will be removed and remaining place watered with systemic fungicide.

ACKNOWLEDGEMENT

The paper presents research findings, which have been obtained through long-term research programme "Sustainable forestry and global changes" implemented by Lithuanian Research Centre for Agriculture and Forestry

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