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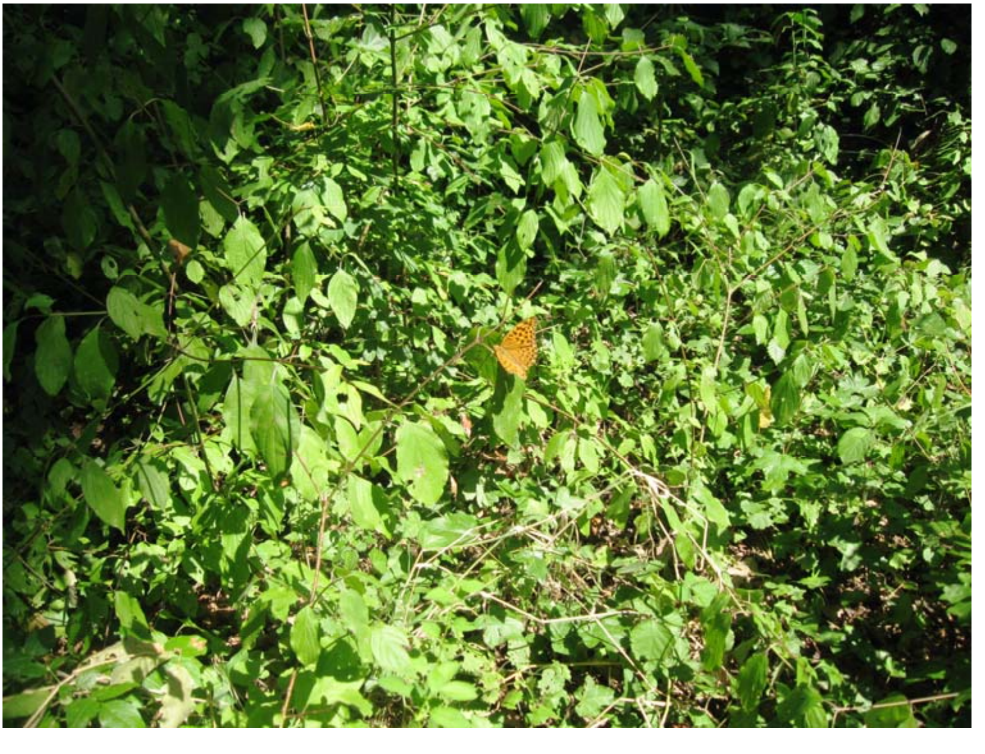

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SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
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UDK 630*453 Lymantria dispar L+630*443.2 Pollacia elegans (Vuill.) Fabr.]:228.7 Poplar spp.=111
Original scientific paper

SENSITIVITY OF SEVEN CLONES OF POPLAR TO THE ATTACK BY CATERPILLARS OF GYPSY MOTH (*Lymantria dispar* L.) AND FUNGUS *Pollacia elegans* (Vuill.) Fabr.

Slobodan MILANOVIĆ[1], Zlatan RADULOVIĆ[1], Milorad VESELINOVIĆ[1], Suzana MITROVIĆ[1], Katarina MLADENOVIĆ[1]

Abstract: *Presence of herbivorous insects, Lymantria dipar (L.) caterpillars and pathogen Pollacia elegans (Vuill.) Fabr. on seven poplar clones was estimated on a short rotation plantation which was established near Junkovac (MB Kolubara).*
The highest percentage of trees with Gypsy moth caterpillars present was found in clones "Panonija" and "I214", although the percent is twice lower in the latter clone. In clones produced by hybridization of Populus nigra and P. maximowicziii and "Koltay", the number of trees with Gypsy moth caterpillars varied between 1% and 2.5%, and the lowest value was recorded in clone "Muhle Larsen". The fungus Pollacia elegans was mostly present in clones produced by hybridization of Populus nigra and P. maximowicziii "Max 1", "Max 2", "Max 3", while its presence was significantly lower in clones "Koltay"and "Panonia". The presence of this pathogen was recorded in less than 5% of plants in clones "I214" and "Muhle Larsen".

Key words: Poplar clones, Short rotation plantation, *Lymantria dispar*, *Pollacia elegans*, preference

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OSTELJIVOST SEDAM KLONOVA TOPOLE NA NAPAD GUBARA (*Lymantria dispar* L.) I GLJIVE *Pollacia elegans* (Vuill.) Fabr.

Izvod: *U plantaži sa kratkom ophodnjom koja je osnovana u blizini Junkovca (RB Kolubara) istraživano je prisutvo gusenica gubara Lymantria dipar (L.) i patogena Pollacia elegans (Vuill.) Fabr. na sadnicama sedam klonova topole. Najviši procenat stabala sa prisutnim gusenicama gubara nalazimo kod klona „Panonija“ i „I 214“, mada je taj procenat kod drugog klona duplo niži. Kod klonova nastalih hibridizacijom Populus nigra i P. maximowicziii i „Koltay“, broj stabala sa gusenicama gubara je varirao od 1 do 2,5% a njanižu vrednost beležimo kod klona „Muhle Larsen“. Gljiva Pollacia elegans je najprisutnija kod kolonova nastalih hibridizacijom Populus nigra i P. maximowicziii, „Max 1“, „Max 2“, „Max 4“, dok je značajno manje prisutna kod klona „Koltay“ i „Panonia“. Prisustvo ovog patogena beležimo na manje od 5% biljaka kod klonova „I214“ i „Muhle Larsen“.*

Ključne reči: Klonovi topole, plantaže kratke ophodnje, *Lymantria dipar*, *Pollacia elegans*, preferenca

1. INTRODUCTION

Under the Kyoto protocol, Serbia same as European countries has to reach the target of a 20% share of the energy mix by renewable energy sources by the year 2020. In order to meet that obligation, at the tailings ponds of Kolubara open pit mine, where recultivation by afforestation has been carried out for more than 40 years (Veselinović, 2006), intensive research is conducted on opportunities for the production of biomass for energy purposes (Drazic et al. 2005, 2006, 2007, 2011, Mitrović et al., 2011). Short rotation coppices (SRC) will be one of the solutions. SCR is established with the primary goal of producing biomass for energy. The technology of the SRC is more like agriculture than forestry. Harvesting of wood stands would be every 2-10 years (rotation cycle), and depending of tree species, trees can be cultivated over a period of 30 years or more. Biomass product is wood chips which can be utilized for energy production. Raw material can be utilized for briquette or pellet production. Poplar is one of the species with high rate of biomass production, are appealing as short-rotation woody crops (Coyle et al., 2006).

The production of biomass in poplar plantations may be compromised by numerous abiotic and biotic factors. Among the abiotic factors, the greatest damage may be caused by low or high air temperatures as well as lack of humidity in the soil. Among the biotic factors, great damages to poplar plantations may be caused by numerous species of insects (Mihajlović, 2008) and plant diseases (Karadžić, 2010) specific for this genus of trees, but also certain polyphagous species such as Gypsy moth. The negative effect of abiotic factors may be avoided by proper selection of the habitat on which a plantation is to be established. In the establishment of plantations the selection of species should depend on their production characteristics as well as their sensitivity to the most significant diseases and pests. *Populus* species are among the types of trees on which Gypsy moth likes to feed (which may cause major damage and even jeopardize their survival if defoliation should recur for several years in a row). However, different species of the same genus of host may differ significantly in preferences and performances of Gypsy moth caterpillars (Milanović, 2010). We therefore took the opportunity to determine the feeding preference of Gypsy moth caterpillars on seven various poplar clones in a spontaneously infected experimental plantation so that in the future we could recommend the ones least preferred by the Gypsy moth.

In the experimental plantation symptoms of disease caused by the fungus *Pollaccia elegans* Servazzi were noted. The perfect stadium of this fungus is known as *Venturia populina* (Vuill.) L. Fabricius. This species occurs on black poplars (sections *Aigeiros, Tacamahaca*) and causes spring loss of leaves in poplars. It is most damaging in nurseries and young cultures. It attacks leaves and young branches of poplars, where in the early stages of the disease the edges of leaves turn first yellow and then black. Necrosis usually spreads over one-third of the area of the leaf, which warps and eventually falls offs. The falling off commences in early spring, which is why the disease was named "spring loss of leaves". The fungus simultaneously attacks the branches and the buds, whose tissue darkens, the branch wilts, breaks and falls off. Spreading of the disease is facilitated by rainy spring and temperatures between 15 and 25^0 C. In spring, the infected leaves and branches become hosts for development of pseudothecia, and in them of asci with ascospores that carry out the primary infection. Following the primary infection through ascospores, a conidian form develops on the leaves and conidia continue spreading the disease. Since the sensitivity to pathogens of different species of the genus *Populus* may vary (Hsiang and van der Kamp, 1985; Pinon, 1992), we wanted to determine the frequency of symptoms of *P. elegans* on different clones in this experimental plantation.

2. MATERIAL AND METHODS

In the experiment for researching the opportunities for production of biomass on degraded areas of REIK Kolubara, in March 2012 an experimental plantation of willow, alder, birch and various poplar clones was established on locality Junkovac. The experimental plantation was set up between two windbreak belts dominated by coniferous tree species. The subject of our research was the presence of caterpillars of Gypsy moth (*Lymantria dispar* L.) and spring loss of leaves caused by the fungus *Pollacia elegans* on seedlings of various poplar clones. There was a total of 7 poplar clones on the plantation, as follows: "Max 1", "Max 2" and "Max 4" (*Populus nigra* × *P. maximowiczii*), "I 214", "Panonija" and "Koltay" (*Populus nigra* × *P . deltoides*) and then clone "Muhle Larsen" (*Populus trichocarpa*).

The inspection conducted in late May determined the number of trees with present Gypsy moth caterpillars, the number of trees with the symptoms of the fungus *Pollacia elegans,* and the total number of trees in a single row. As the take of the plants was incomplete, the number of seedlings with the Gypsy moth or with symptoms of *Pollacia elegans* was expressed in percentages. The number of inspected rows varied from 12 to 24 per a researched poplar clone, and the number of seedlings per row was 23, with four rows per one plot.

Statistical data processing included the analysis of covariance (ANCOVA) with the type of clone as the variable and the distance of the plot from the edge of the forest as the covariance. The intention of the analysis was to take into consideration the effect of the distance of the experimental plot from the edge of the forest as a potential source of infection on the number of trees with Gypsy moth caterpillars and with the fungus *Pollacia elagans*. The significance of differences between the observed poplar clones in the number of trees with Gypsy moth or fungus *Pollacia elegans* was determined by means of Tukey HSD test (α=0,05).

3. RESULTS OF THE RESEARCH

Table 1 presents the results of the analysis of covariance (ANCOVA) for the number of trees with Gypsy moths and symptoms of fungus *P. elegans* in a plantation of different poplar clones. The distance of the experimental plots from the windbreak belt did not have any statistically significant impact on differences in the number of trees with the presence of Gypsy moths and symptoms of *P. elegans.* The results of ANCOVA have shown that the type of clone had significantly impacted the observed parameters.

Table 1. *Analysis of covariance ANCOVA for observed parameters*

Effect		*Lymantria dispar*				*Pollacia elegans*			
	d.f.	**SS**	**MS**	**F**	**p**	**SS**	**MS**	**F**	**p**
Intercept	1	360,83	360,83	4,45	0,0369	5644,87	5644,87	55,25	0,0000
Clon	6	**5622,02**	**937,00**	**11,55**	**0,0000**	**13925,86**	**2320,98**	**22,72**	**0,0000**
Distance	1	61,14	61,14	0,75	0,3869	315,53	315,53	3,09	0,0813
Error	123	9974,73	81,10			12565,83	102,16		
Total	130	15598,81				27394,25			

Table 2 presents the mean values and standard errors for the observed parameters. The highest percentage of trees with present Gypsy moth caterpillars was found in the clones "Panonija" and "I214", although that percent is twice lower in the latter clone. In clones produced by hybridization of *Populus nigra* and *P. maximowicziii "*Max 1", "Max 2", "Max 4" and "Koltay", the number of trees with Gypsy moth caterpillars varied between 1% and 2.5%, with the lowest value noted in the clone "Muhle Larsen".

Table 2. *Number of repetitions, Mean value and Standard errors (Mean ± SE) for observed parameters*

Clone		*Lymantria dispar*	*Pollacia elegans*
	N	**Mean±SE**	**Mean±SE**
Panonia	24	18,00±2,877**c**	9,59±1,439**ab**
I 214	23	9,65±3,094**b**	3,05±1,382**a**
Max I	12	2,54±1,130**ab**	23,50±3,542**cd**
Max II	12	1,09±0,568**ab**	35,02±4,682**d**
Max IV	12	1,09±0,780**ab**	28,80±2,194**d**
Koltay	24	1,63±0,574**a**	17,57±2,800**bc**
Muhle Larsen	24	0,91±0,522**a**	4,89±1,511**a**

Mean values within column with same letter are not significantly different (Tukey HSD test, α=0,05)

The fungus Pollacia elegans is most present in clones produced by hybridization of *Populus nigra* and *P. maximowicziii* "Max 1", "Max 2", "Max 4", while its presence is significantly lower in clones "Koltay" and "Panonia". The presence of this pathogen is noted in less than 5% of plants in the clones "I214" and "Muhle Larsen".

4. DISCUSSION

In Gypsy moths, newly hatched caterpillars are responsible for the dispersion and selection of the host, when they may travel great distances carried by the wind, depending on the wind speed and the height from which they were moved, where this passive movement may be repeated multiple times until the larva lands on a suitable host and commences feeding (Mason & McManus, 1981). Second-stage larvae easily cross the filaments with which they get attached to the branches of the host plant and can also move to a new host with the help of wind (Leonard, 1967), so those may also be used for testing the suitability of the host. Acceptance of a plant as the primary host is a complex process that depends on physiological features (Lazarević, 1994; Lazarević et al, 1994; Milanović et al, 2008) and the genotype (Lazarević, 2000; Lazarević *et al*., 2002) of the herbivore itself, as well as on physical and chemical properties of the potential host (Foss & Rieske, 2003).

Caterpillars use various physical and chemical characteristics of their host plant in order to locate them (Schoonhoven, 1973). Their sense of sight differentiates colors, and in the search for food they prefer green to brown color (Smitley *et al*., 1993). Among different nuances of green they choose lighter shades. This may be linked to aging of the leaves, where the content of tannin increases during vegetation (Feeny, 1970) and the leaves turn darker. Gypsy moth caterpillars are more attracted to a darker than a lighter trunk, and to trunks that are wider in diameter, which was determined by using plastic modules for trunk simulation (Roden *et al*.,1992). Although the sense of sight helps caterpillars locate the trees or herbaceous plants, it is still not developed enough to have a crucial role in recognition of plants, which is supported by the fact that the process is carried out in complete darkness (Schoonhoven, 1973). Chemical senses, which are well-developed in insects, not only lead the monophagous organisms to their specific feed but also help the polyphagous species, such as Gypsy moth, differentiate between various types of plants. Chemoreceptors included in the process of finding a host plant are located on the antennae and parts of the mouth apparatus of the herbivore, so that they test the suitability of food by tasting it. Since the analysis of covariance showed that the position of the plot on which a certain clone was planted had no effect on the number of trees with Gypsy moth, it may be concluded that stay on a host and commencement of feeding was conditioned by the chemical content of leaves and their physical characteristics. This claim is supported by the findings by Gruppe *et al*. (1999) who mention the increased content of defense matter in the leaf of the clone "Muhle Larsen", whose leaves was, according to our results, least frequently chosen as feed by the Gypsy moth caterpillars. The increased content of defense matter certainly impacts the resistance of plants to diseases, and thus this clone also demonstrated high resistance to infections by the fungus *P. elegnas*.

In British Columbia, *P. trichocarpa, P. balsamifera* and many of the T x D hybrids are susceptible. Other hybrids in section *Tacamahaca* are less susceptible. Some commercially utilized T x D clones such as 49–177 and T x M hybrids are known to be resistant; in the latter case the resistance is conferred by the *P. maximowiczii* parent. Elsewhere in North America, disease incidence records are from poplars in section *Tacamahaca*, while in Europe and India, poplars in *Aigeiros* are also reported as hosts (Newcombe & van Oosten, 1997).

Heavy levels of disease in hybrid T x D plantations on Vancouver Island and the lower Columbia River have necessitated the replacement of susceptible clones by more resistant ones (Newcombe &van Oosten, 1997).

In Europe, according to Karadžić (2010), clone I214 demonstrates high resistance to this fungus.

5. CONCLUSIONS

Based on the obtained results, it may be concluded that among the tested clones there are difference in susceptibility to the pathogen *P.elegans* and preferences of Gypsy moth caterpillars.

The found differences are not random and do not depend on the potential source of infection.

Clones "Max 1", "Max 2", "Max 4" are least frequently selected for feeding by Gypsy moth caterpillars, besides the clones "Muhle Larsen" and "Koltay". On the other hand, all these clones, with the exception of "Muhle Larsen", register a much higher presence of the pathogen *Pollacia elegans* compared to the clones u odnosu na klonove "I214" and "Panonija".

In our research, resistance to attack by the pathogen *Pollacia elegans* is expressed in the following order: "Muhle Larsen" > "I214" > "Panonija" > "Koltay" > "Max 1" > "Max 4" > "Max 2".

The general conclusion is that the clone "Muhle Larsen" is the least susceptible to browsing by Gypsy moth caterpillars and to the attack by the pathogen *Pollacia elegans,* and as such may be recommended for establishment of energy plantations.

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SENSITIVITY OF SEVEN CLONES OF POPLAR TO THE ATTACK BY CATERPILLARS OF GYPSY MOTH (*Lymantria dispar* L.) AND FUNGUS *Pollacia elegans* (Vuill.) Fabr.

Slobodan MILANOVIĆ, Zlatan RADULOVIĆ, Milorad VESELINOVIĆ, Suzana MITROVIĆ, Katarina MLADENOVIĆ

Summary

Presence of herbivorous insects, Lymantria dipar (L.) caterpillars and pathogen Pollacia elegans (Vuill.) Fabr. on seven poplar clones was estimated on a short rotation plantation which was established near Junkovac (MB Kolubara).

The present study was carried out in the first year of the first rotation period after establishing of plantation. The highest percentage of trees with Gypsy moth caterpillars present was found in clones “Panonija” and “I214”, although the percent is twice lower in the latter clone. In clones produced by hybridization of Populus nigra and P. maximowicziii “Max 1”, “Max 2”, “Max 4” and “Koltay”, the number of trees with Gypsy moth caterpillars varied between 1 and 2.5%, and the lowest value was recorded in clone “Muhle Larsen”. The fungus Pollacia elegans was mostly present in clones produced by hybridization of Populus nigra and P. maximowicziii “Max 1”, “Max 2”, “Max 3”, while its presence was significantly lower in clones “Koltay”and “Panonia”. The presence of this pathogen was recorded in less than 5% of plants in clones “I214” and “Muhle Larsen”.

The obtained results lead to the conclusion that there are differences between the tested clones related to the sensitivity to the pathogen Pollacia elegans and the preference of Gypsy moth caterpillars. The found differences were not random and did not depend on the distance from the potential source of infection. The general conclusion is that the clone

"Muhle Larsen" is least sensitive to browsing by Gypsy moth caterpillars and to attack of the pathogen Pollacia elegans and that as such it can be recommended for establishment of energy plantations.

OSTELJIVOST SEDAM KLONOVA TOPOLE NA NAPAD GUBARA (*Lymantria dispar* L.) I GLJIVE *Pollacia elegans* (Vuill.) Fabr

Slobodan MILANOVIĆ, Zlatan RADULOVIĆ, Milorad VESELINOVIĆ, Suzana MITROVIĆ, Katarina MLADENOVIĆ

Rezime

U plantaži sa kratkom ophodnjom određeno je prisutvo gubara *Lymantria dipar* (L.) i patogena *Pollacia elegans* (Vuill.) Fabr. Na sedam klonova topole. Istraživanje je vršeno tokom prve godine, prve ophodnje nakon podizanja plantaže. Najviši procenat stabala sa prisutnim gusenicama gubara nalazimo kod klona „Panonija" i „I 214", mada je taj procenat kod drugog klona duplo niži. Kod klonova nastalih hibridizacijom *Populus nigra* i *P. maximowicziii* „Max 1", „Max 2", „Max 4" i „Koltay", broj stabala sa gusenicama gubara je varirao od 1 do 2,5% a njanižu vrednost beležimo kod klona „Muhle Larsen". Gljiva Pollacia elegans je najprisutnija kod kolonova nastalih hibridizacijom *Populus nigra* i *P. maximowicziii*, „Max 1", „Max 2", „Max 4", dok je značajno manje prisutna kod klona „Koltay" i „Panonia". Prisustvo ovog patogena beležimo na manje od 5% biljaka kod klonova „I214" i „Muhle Larsen".

Na osnovu dobijenih rezultata može se zaključiti da među testiranim klonovima postoje razlike u osetljivosti prema patogenu *Pollacia elegans* i prefernci gusenica gubara.

Ustanovljne razlike nisu slucajne i ne zavise od distance potencijalnog izvora zaraze.

Na osnovu dobijenih rezultata se može zaključiti da postoje razlike među testiranim klonovima u odnosu na njihovu osetljivost prema patogenu Pollacia elegans i prefreniji gusenica gubara. Ustanovljene razlike nisu slučajne i ne zavise od udaljenosti potencijalnog izvora zaraze. Generalni zaključak je da klon „ Muhle Larsen" najmanje podložan brstu gusenica gubara i napadu patogena *Pollacia elegans* i kao takav se može preporučiti za podizanje energentskih plantaža