Oak Timber Protection from Ambrosia Bark Beetles in FSC Certified Forests and its Integration within Logging Operations

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Abstract:
In FSC certified stands, oak timber protection from ambrosia beetles is restricted in insecticide application. Swarming of ambrosia bark beetles in the early months of winter and their continuous occurrence, interrupted only by few weeks of cold weather throughout the logging period, imposes high risk of damages on exposed oak timber. Phenology of ambrosia bark beetles, especially their period of active flight and search for suitable oak timber, generally coincides with the period of logging in Croatian oak stands. Typically this is the period of winter operations when best quality grades are yielded. Earliest species activity starts already in early January, culminating in March, with late species being active until September. Prolonged exposure of round oak timber on forest roads and forest storage areas increases the risk of ambrosia bark beetle infestation. Current grades of oak timber in European CEN/CENELC standard for oak round timber EN 1316-1 in quality grades Q-A, Q-B, Q-C do not allow any beetle holes in hardwood. Only the Q-C quality grade allows beetle holes in sapwood. Considering strict standards for oak round timber, protection is crucial, especially in favorable weather conditions which occur frequently in recent decades. From the economical point of view, ambrosia bark beetles can reduce oak round timber prices to third of its starting value (reaching 150 €/ m3). Recent field tests were conducted in conditions similar to operational logging during summer when at least five different ambrosia bark beetle species where active. Efficiency of Woodnet® was tested via a classical setup of treated (Woodnet® covered) logs versus control group of exposed oak round timber. Initial tests confirmed that commercial products for round timber protection, like BASF® Woodnet® (polymer reusable net with FSC compliant contact insecticide) can provide high rate of protection for exposed oak timber. Specialists and field workers in logging operations and forest protection are both, forced and encouraged, to establish new methods of integrated oak timber protection. Logging and oak round timber protection operations should become a coordinated part of logging in oak stands considering the high commercial value of oak timber.

Keywords: integrated protection, oak timber, ambrosia beetles, logging operations, FSC, EN-1316-1, polymer nets

1 Introduction

Timber pests, called in general the “ambrosia beetles”, belong to a group of xylomycetophagous insects from the order Coleoptera, family Curculionidae, subfamily Scolytinae among which some are highly important pests of oak timber (Baker 1963). Additionally, one species from the family Platypodidae is considered to be the most destructive technical pest of hardwoods within this group. Galleries, which they form during their life cycle within the timber and infest with staining “ambrosia” fungi, significantly decrease economical value of oak timber. Croatian state company ,,Hrvatske šume” LLC manages FSC (Forest Stewardship Council) certificated forests in which oak is represented with 14 % in overall timber mass. Methods of oak timber protection which in past were dominated by chemical sprayings are now banned according to FSC criteria. In these conditions it became a necessity to introduce novel methods of timber protection (Schleier et al. 2003, Tomiczek and Steyrer 2007, Tomiczek and Steyrer 2010). Newly available commercial products, insecticide treated polymer nets (Perny 2010, Kolšek 2012), were tested as means of integrated oak timber protection. The use of these in field conditions was tested. Initial trials in the oak forests in Croatia (Hrašovec and Franjević 2011, Franjević 2012) suggested the promising

potential of this approach. Good knowledge of phenology of ambrosia bark beetles and thorough understanding of forest logging operations and conditions that dominate in oak forests is crucial if methods applied are to be effective and taken at proper time. Recent experiments with semiochemicaly baited flight barrier traps (Franjević 2012) revealed that additional protection of some other mean is necessary in order to fully protect felled oak timber, presuming the fulfillment of strict nHRN and CENN (EN 1316-1) norms for oak timber classes of which do not allow any timber infestation in highest quality grades (Anon. 1995). High risk of infestation is present in the early months of spring for felled oak timber that is waiting for transport, typically due to organizational reasons. The rest of the season (April-August) oak timber is also threatened with active species of ambrosia bark beetles from genera *Trypodendron*, *Xyleborus* and *Xylosandrus* while in late spring/early summer the most destructive oak pinhole borer *Platypus cylindrus* (Fabricius 1792) begins to swarm. A newly developed method of targeted mechanical protection via the use of chemically treated polymer reusable net is envisioned as highly promising and economically feasible mean of protection. There are also strong indications that the method will be FSC approved in due time (BASF® pers. comm.) since the chemically treated polymer net already is WHO (World Health Organization) approved for human health protection against disease spreading insects in tropics.

2 Material and methods

Objective of the research was to evaluate effectiveness of polymer net in field conditions similar to standard logging operations conducted in early summer. Timber protection polymer net, under the preproduction name Woodnet® (now available under the commercial name Storanet®, produced by BASF®) was tested in the attempt to reduce or annihilate the ambrosia bark beetle infestation of felled oak timber. Test and control logs within the experiment were set up in a single day, immediately after felling of ten healthy oak trees (*Quercus robur* L.) on May 23rd 2012. On July 17th 2012, the trial ended. Polymer net was removed from protected logs and all logs were debarked for the purpose of evaluation of ambrosia beetle presence in timber. Location of the trial was in the central area of commercially managed forest, in the compartment No 33 of M.U. “Jastrebarski lugovi” near Jastrebarsko. Felled oaks were cut in logs of different sizes up to 5 meters in length and of slightly differing diameters) and covered with Woodnet® polymer net which was precut in 6×2 m sheets (Figure 1). Logs were scattered following the place of felling, but in general, each of the treatment log (protected by Woodnet® polymer net) had its control counterpart nearby. Under the treatment group of logs a synthetic canvas (6×2 m) was placed. The aim was to evaluate potential insecticidal effect of Woodnet® polymer net on non target (and target) forest arthropods that would get into contact with the net but fail to breach into the timber. The exposure of oak logs was in a period of high activity of at least six different species of ambrosia bark beetles that attack oak timber and decrease its commercial value (Franjević 2012). After the two months exposure, on July 17th logs were manually striped of bark with hand axes and ambrosia bark beetle holes were counted (Figure 2.). All the dead fauna that was found on the synthetic sheets under the treatment group of logs was collected and analyzed in the laboratory. Additionally, all logs were measured both in length and mean circumference for the purpose of assessment of active bark area available for swarming of ambrosia bark beetles, and calculating the number of holes per square meter of exposed timber.

Figure 1: One of the 5 pairs of control (near) and treatment (far) oak logs within the experimental site

Figure 2: Bark stripping and infestation assessments of one control log on July 17th at the end of the trial setup

3 Results

The results of the debarking and ambrosia bark beetle holes assessment with the relating active bark area are given in the Table 1. It is important to note that treatment logs (the ones protected by Woodnet® polymer net) had only been invaded by one of the smallest ambrosia bark beetle species - *Xyleborus saxesenii* (Ratzeburg 1837). The control group of oak logs, surprisingly, has not been attacked by this species at all (Table 2.). Control logs were heavily attacked by *Platypus cylindrus*. Closer inspection of *X. saxesenii* inborings on the treatment logs it was clearly observed that the beetles were dead and no frass was produced (inactive galleries). On the control group however, galleries of *P. cylindrus* were highly active, beetles alive, and sawdust produced even for prolonged period of one week an more after bark removal. The inspection of synthetic canvases beneath the treatment logs revealed some dead insects mixed with organic matter (predominantly leaf litter). In spite of the difficulties in taxonomic identification (partly, and sometimes completely destroyed bodies of arthropods) coleopteran species dominated. The most common were the representatives of Scolytinae (293 specimens) and Geotrupidae (17 specimens). Rhizophagidae, Silphidae and Staphylinidae were represented by less than 5 specimens each. Two of the ambrosia bark beetles species were present, namely 289 specimens of *X. saxesenii* and 4 specimens of *Xylosandrus germanus* (Blanford 1894). Statistical analysis (STATISTICA, by StatSoft, Inc. 2007) was performed on the datasets of entrance holes per square meter as dependent variable and log type as categorical predictor (P – protected or C – control). ANOVA test revealed significant differences between protected and control group of logs in general (Figure 3). For each of the entrance holes of the two detected ambrosia beetle species there were significant differences between *X. saxesenii* on protected and *P. cylindrus* on control group of logs (Figure 4).

Table 1: Active area of bark on protected and control logs and number of ambrosia bark beetle holes

Protected log	Number of holes	Log area [m^2]	N/m^2	Control log	Number of holes	Log area [m^2]	N/m^2
P1	54	3,26	17	C1	48	2,24	21
P2	18	3,10	6	C2	104	3,09	34
P3	5	3,54	1	C3	25	3,38	7
P4	16	2,59	6	C4	41	3,04	13
P5	2	3,52	1	C5	62	2,21	28
∑	95	16,00			280	13,95	

Table 2: Number of holes on logs by ambrosia beetle species

Protected log	Number of holes *X. saxesenii*	Number of holes *P. cylindrus*	Control log	Number of holes *X. saxesenii*	Number of holes *P. cylindrus*
P1	54	0	C1	0	48
P2	18	0	C2	0	104
P3	5	0	C3	0	25
P4	16	0	C4	0	41
P5	2	0	C5	0	62
∑	95	0		0	280

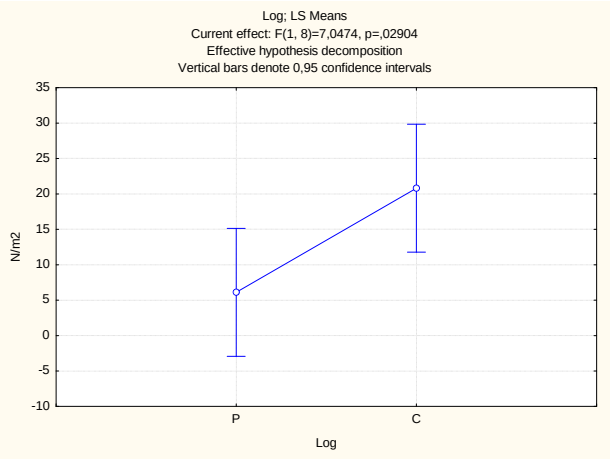

Figure 3: Overall ANOVA test for the two groups of logs (P- logs protected with net, C- control logs)

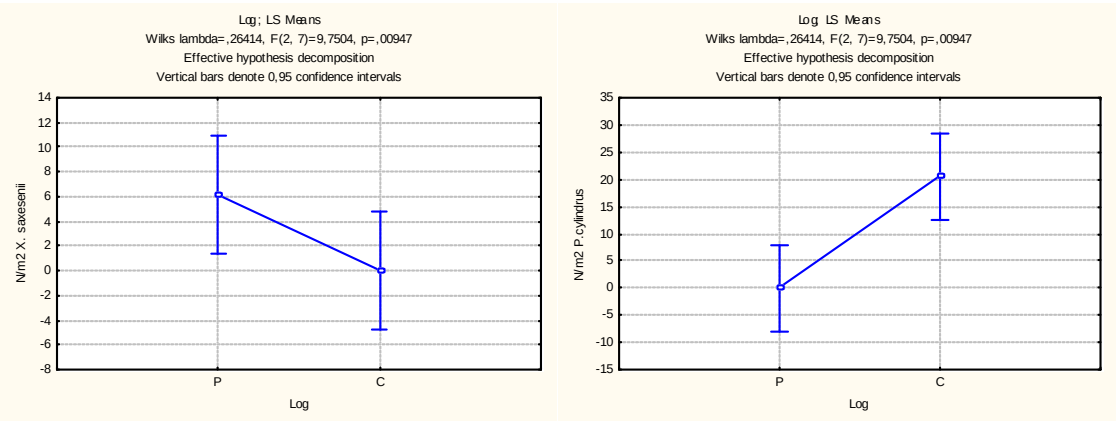

Figure 4: ANOVA test of the two groups of logs based on *X. saxesenii* (upper) and *P. cylindrus* (lower) entrance galleries (P- logs protected with net, C- control logs)

4 Discussion and conclusion

Woodnet® microencapsulated polymer net used in this trial demonstrated a significant ability to reduce the infestation of oak logs by ambrosia beetles. The net proved to be 100 % protective from the attack of larger ambrosia beetles like *P. cylindrus* but failed to completely stop the smaller species like *X. saxesenii*. Since all the *X. saxesenii* inboring beetles on the protected logs were found dead during debarking it is reasonable to assume that, due to their smaller dimensions (compared to other beetles and mesh size of the polymer net) they managed to squeeze themselves through the net but died quickly, in the beginning of the gallery formation. This would be due to the intoxication by insecticide released from the polymer surface. A similar effect seems to happen in the case of *Pityogenes chalcographus* (Linneaus 1761) which in some numbers succeeds penetrating insecticidal polymer net but dies soon afterwards, not even starting the formation of nuptial chamber. The unprotected, exposed group of control logs had been colonized only by *P. cylindrus* species, the activity of which begins in the late spring and continues until autumn. The outcome of the experiment, when neither a single *X. saxesenii* beetle gallery nor of any other ambrosia beetle gallery was found on the fully exposed control group of logs is quite confusing. Inversely, active *P. cylindrus* galleries were present only on the control logs, and this must have been the result of its unsuccessful penetration into the protected logs. As a result, a strong pheromonal aggregation effect could have directed in flying *P. cylindrus* beetles to the control logs. Could this semiochemically based infestation alter the infestation of other ambrosia beetles in the area remains unclear. It is common in nature that several species of ambrosia beetles invade the same log and *Xyleborus* and *Xylosandrus*

beetles were in the period of active timber search during the time of the experiment (Faccoli & Rukalski 2004, Franjević 2012). However, in this experiment, there was a clear separation of species (control versus treatment group). This needs to be researched further since it might open some new perspectives based on the potential of displacement strategies within the ambrosia beetle species. Findings of numerous dead *X. saxesenii* and 4 *X. germanus* on the synthetic canvas and not a single *P. cylindrus* cadaver could indicate the effect of secondary semiochemical aggregation of the first two on the protected logs. Short production of aggregation components by few beetles (95 to be precise) that penentrated the net barrier could have lured others that died on the surface of the net. Since no *P. cylindrus* succeeded penetrating the net there was no secondary attractiveness developing on the protected logs and this might be the cause that no cadaver of *P. cylindrus* was recovered from synthetic canvases. Partial successful penetration of tested Woodnet® polymer net implies some questions concerning stringent norms EN 1316-1 for oak round timber. Technical damage, even in the form of shortest and tiniest pin holes caused by ambrosia bark beetles like *X. saxesenii*, is still not tolerated and would reduce the value of protected timber. It is also necessary to evaluate this protective system in conditions of winter logging operations when larger ambrosia bark beetle species are swarming and their absolute numbers are potentially higher.

In spite of some confusing outcomes of the conducted trial, and seemingly a failure to reach a full protection from timber pests it is clearly evident that the use of microencapsulated polymer nets as a mean of oak timber protection against ambrosia beetles has great potential. This is especially true and needs further development in the case of certified forest production (such as the case of FSC certified forests in Croatia) where insecticidal applications in the form of log spraying are no longer allowed. Further field tests are planned, with the newly available Storanet® which will be tested on a larger scale and with some modifications fitting the common procedures in Croatian oak timber harvesting technology.

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