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PHEROMONE DISPENSER ACUMIPROTECT FOR MASS TRAPPING OF THE SHARP-DENTATED BARK BEETLE, *IPS ACUMINATUS* (COLEOPTERA; CURCULIONIDAE)

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The sharp-dentated bark beetle (*Ips acuminatus* Glyl.) is one of the most aggressive European bark beetle species with the occurrence in pine. This communication discusses the experience with a new pheromone dispenser Acumiprotect from a practical point of view.

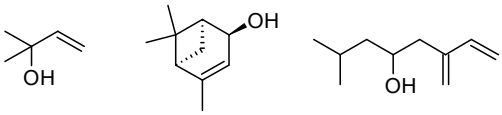
Keywords: sharp-dentated bark beetle, pine bark beetle, dispenser, Acumiprotect, Pheagr-IAC

The sharp-dentated bark beetle (*Ips acuminatus* Gyll., Fig. 1, ref.[1]) belongs to the order of Coleoptera, the family Curculionidae. It is one of the most aggressive European bark beetle species that infests various species of pines, especially black pine and Scots pine. It attacks primarily drought-stressed and wind-thrown trees as well as broken branches, but during outbreaks, even healthy pine stands are at risk[2,3].

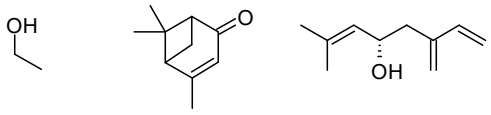
In Europe, the amount of wood damaged by this pest reaches several million m^3 per year[4,5]. In the Czech Republic, sanitation felling of infested trees is the only protective measure against the sharp dentated bark beetle. Pheromone traps (traps using aggregation pheromones to capture bark beetles) or trap-trees (freshly felled pine trees that are used to capture bark beetles) are rarely used, as accurate methodological procedures for their application are not available. Even so, several pheromone lures are available on the market, which can be used in pheromone traps to monitor population dynamics and to increase the attractivity of trap trees.

Chemical literature, which is very poor in the case of this pest, describes several pheromone components that include 2-methyl-3-buten-2-ol[6], (*S*)-*cis*-verbenol[6,7], (+/–)-ipsenol[7], and (*S*)-(+)-ipsdienol[6,7], verbenone[8], ethanol[9] and the Scots Pine Essential Oil – SPEO[9]. (*R*)-(–)-Ipsdienol, secreted by the pine bark beetle (*Ips sexdentatus*) reduced the attractiveness of the pheromones to the sharp-dentated bark beetle[10].

Fig. 1. The sharp-dentated bark beetle (*Ips acuminatus* Gyll., ref.[1])



2-methyl-3-buten-2-ol, (*S*)-*cis*-verbenol, (+/-)-ipsenol



ethanol, verbenone, (*S*)-(+)-ipsdienol

In the Czech Republic, commercially available pheromone lures against this pest include Acuwit[11], an Austrian product of the company Witasek Pflanzenschutz GmbH (Feldkirchen, Austria), and Pheagr-IAC (ref. [12]) produced since 2004 by the Czech company Scitech (Prague, Czech Republic). Of the two above named, Acuwit occurred only for a limited time but did not find a greater interest. Recently, the Spanish product Acumiprotect (SEDQ Healthy Crops, S.L., Barcelona, Spain)[13], was introduced to the market. This evaporator is interesting by its construction. It consists of a pocket of 9 × 8 cm from the multilayer aluminium foil (PET/Al/PE), into which a sealed polyethylene bag containing a cellulose porous insert. The insert is soaked in a pheromone mixture of approx. 275 mg (verbenol, ipsdienol, ipsenol, plus 2,6-di-*terc*-butyl-4-methylphenol, as a stabilizer; in this mixture there are only traces of 2-methyl-3-buten-2-ol). The aluminium foil packet has a central hole with a diameter of 3.5 cm on one side, which ensures pheromone evaporation. The dynamics of the evaporation differ considerably from the dynamics

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of the dispenser Pheagr-IAC, although the amounts of terpenes used per evaporator are approximately the same.

Minor deviations from the "smooth curve" in the curve showing the dynamics of the evaporation are caused by changes in the ambient temperature (Figs. 2, 3). While the first 50 days of pheromone loss is relatively comparable to the Pheagr-IAC, in the following weeks Acumiprotect releases smaller and smaller amounts of pheromone mixture. This may be due, among other things, that Acumiprotect does not contain 2-methyl-3-buten-2-ol, which has a boiling point of 99 °C and verbenol, ipsdienol, ipsenol have significantly higher boiling points, and therefore they evaporate more slowly. This, of course, also affects the efficiency of the pheromone evaporator. In the individual periods of its use, the insects are specifically sensitive to each component of the pheromone mixture.

To support direct parallels between the dynamics of evaporation in the laboratory and under the field conditions, slit traps were used and the results were summarized in the master thesis at the UCT Prague[14]. The all-season regular dispenser weighing (both laboratory and field data), as well as number of captured *Ips acuminatus*, were comparable.

Both the above-mentioned types of pheromone lures were used in 2021 in a field experiment at several locations in the Czech Republic. In all cases, the lures were installed in the Theysohn slit traps arranged in the line so that both tested products were present in three repetitions at each locality. The trapped insects were collected weekly and the pheromone baits replaced after 8 weeks. Acumipotect attracted also the six-toothed bark beetle (*Ips sexdentatus*), which was present in higher hundreds of individuals. The highest catches of the sharp-dentated bark beetle were recorded after installation, with a decline after about a month in both Acumiprotect and Pheagr-IAC (Figs. 4, 5), which is in accordance with the laboratory described rate of evaporation of attractive substances. However, the catches of the six-toothed bark beetle peaked during the second month of observation, which indicates that the field collected data reflect rather population dynamics of both bark beetle species than the evaporation dynamics of pheromones. The sharp-dentated bark beetle is a freeze-tolerant species that survives even sub-zero temperatures around –39 °C. Its swarming peaks in the spring, when temperatures exceed 14 °C (refs.[15,16]). Then the flight activity decreases until the daughter generation emerges in July and August. The end of the vegetation season and shortening of the day-length below the critical threshold induces diapause development and the catches are minimal[17]. On the other hand, the six-toothed bark beetle inhabits rather warm lowland areas and adults start to swarm at temperatures above 20 °C (ref.[18]), which explains the delay of peaks in catches compared to the sharp-dentated bark beetle. Thus, spring swarming in the sharp-dentated bark beetle occurred into the period, when both types of pheromone lures released the highest amount of attractive substances, while in the six-toothed bark beetle, the swarming peaked in the second half of the lifetime guaranteed by manufacturers. However, there were no catches of the six-toothed bark beetle in the Pheagr-IAC traps, so the data are not comparable. The completely different trends in the captures of the sharp-dentated bark beetles at the locations of Brandýs nad Labem and Třebíč can be explained by differences in precipitation in the summer months. The absence of a significant swarming peak of F1 generation at the Třebíč locality was probably caused by frequent rains that stopped the flight activity (Fig. 4). At the Brandýs locality, the swarming of F1 generation is clearly visible. Adults of F1 generation, that were caught in traps with Pheagr IAC at the end of vegetation season (Fig. 5), probably reacted to 2-methyl-3-buten-2-ol. Similar results were obtained by the previous authors[6], who mention the attractiveness of 2-methyl-3-buten-2-ol for the sharp-dentated bark beetle.

Recently, all commercially available pheromone dispensers against *Ips acuminatus* and some experimental

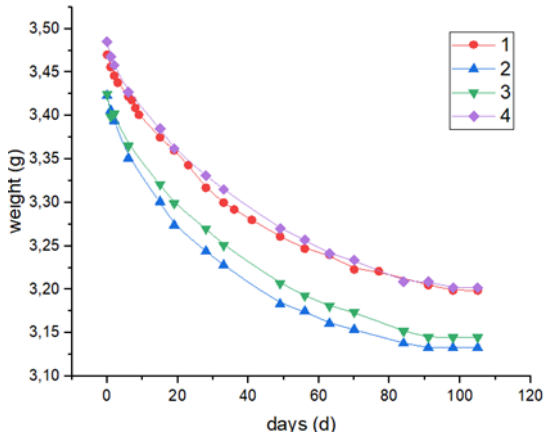

Fig. 2. **Acumiprotect dispenser weight loss, depending on time, curves 1–4 show the data on four randomly selected dispensers**

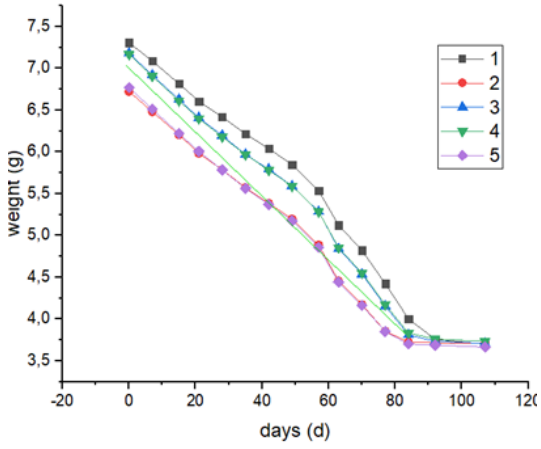

Fig. 3. **Pheagr-IAC dispenser weight loss, depending on time, curves 1–5 show the data on five randomly selected dispensers**

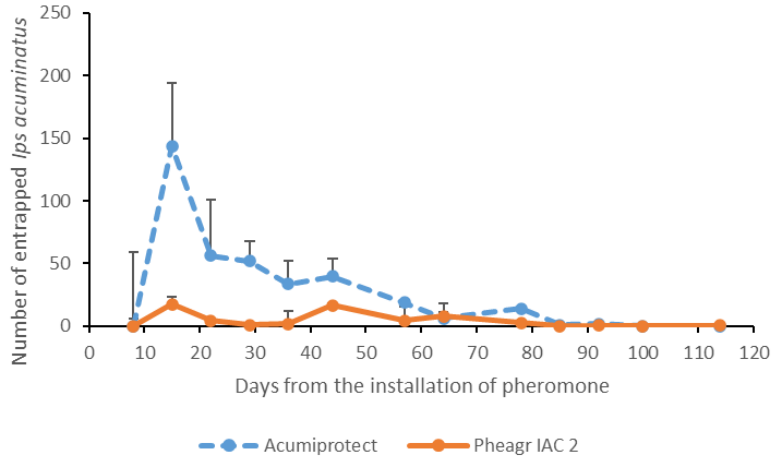

Fig. 4. **Average numbers (+ standard deviation) of the sharp-dentated bark beetles captured at locality Šemíkovice near Třebíč in 2021.** Three Theysohn pheromone traps with each type of dispenser were installed

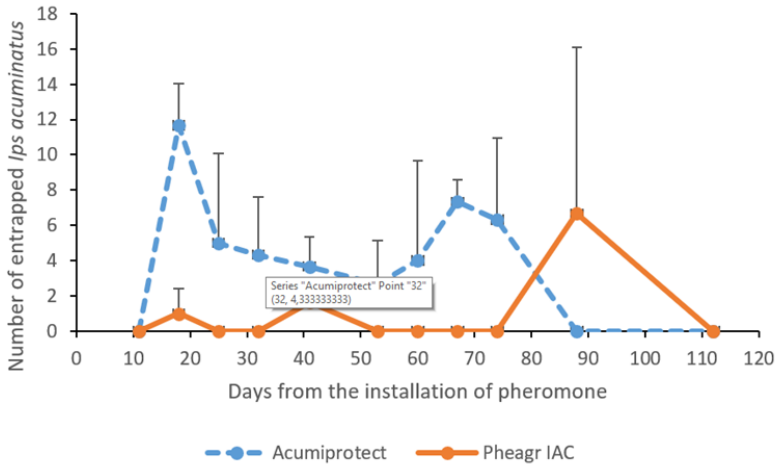

Fig. 5. **Average numbers (+ standard deviation) of the sharp-dentated bark beetles captured at a locality near Brandýs nad Labem in 2021.** Three Theysohn pheromone traps with each type of dispenser were installed

prototypes were tested in Poland and the results were published in the journal Agricultural and Forest Entomology[9]. The highest catches were recorded in the traps with Acumiprotect. In 2017 and 2018, the number of entrapped beetles peaked in May, i.e. after the installation of new evaporators. In 2019, on the other hand, cold weather delayed the spring swarming, and thus the number of caught beetles during the first and second half of the dispensers' lifetime was the same. Such observation confirms the above hypothesis that the number of captured beetles corresponds rather to the population dynamics of *Ips acuminatus*. It is also worth mentioning that the Austrian Acuvit dispenser proved to be the least convenient of all tested products.

At the existing level of knowledge[9,12,19], commercially available pheromone-based products against the sharp-dentated bark beetle represent rather a tool for monitoring its flight activity than a way to reduce its population density. However, the higher success of new and experimental products compared to traditional brands suggests that the chemical composition is appropriate. However, the sharp dentated bark beetle attacks the upper parts of pines and branches, which may substantially limit the performance of traps placed 2 m above the ground[12]. Future experiments should therefore concentrate on the methodology and timing of trap installation.

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