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The influence of evaporated pheromone upon the trapping of the spruce bark beetle – *Ips typographus* (L.) (Coleoptera: Curculionidae: Scolytinae) – Short communication

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Abstract

Zahradníková M., Zahradník P. (2017): The influence of evaporated pheromone upon the trapping of the spruce bark beetle – *Ips typographus* (L.) (Coleoptera: Curculionidae: Scolytinae) – Short communication. J. For. Sci., 63: 149–152.

This article examines the relative efficacy of releasing a larger pheromone plume volume and the relative efficacy of the number of pheromone dispensers within baited traps in trapping the spruce bark beetle. Pheromone plume is released from a standard pheromone dispenser, and a higher volume of pheromone was provided by an increased number of pheromone dispensers. A field trial with 30 pheromone baited traps was conducted in 2013 that used three dispenser variants over ten replications. Ten traps were baited with one pheromone dispenser, ten with two dispensers and ten with three dispensers. The pheromone dispensers were placed according to EPPO standard PP1/152(4) in a fully randomized design. The highest trapping was achieved by the variant using three pheromone dispensers, and the lowest trapping was achieved by the two pheromone dispenser variant. There was no statistically significant difference between the three variants. The results suggest that the efficacy of pheromone traps cannot be increased solely through an increase in the number of pheromone dispensers.

Keywords: pheromone trap; pheromone dispenser; increased efficacy; forest protection

The spruce bark beetle (*Ips typographus* Linnaeus) is a major pest in European spruce forests (Skuhravý 2002; Grégoire, Evans 2004), especially in Central Europe (Liška et al. 1991; Zahradník 2008; Kunca et al. 2015; Vakula et al. 2015). Following the identification and synthesis of the aggregation pheromone (Vité et al. 1972; Bakke 1976; Bakke et al. 1977), aggregation pheromones have been artificially produced and used in combination with pheromone traps in forest protection systems for both monitoring and direct defence, even though the role of all of the pheromone constituents produced by *I. typographus* is not yet known (Birgersson et al. 1984). Two basic problems need to be overcome when developing functional and effective pheromone dispensers – the amount of released pheromone components needed to lure *I. typographus* and the ability to release a steady, predetermined amount of the required pheromone. Related research on this topic, however, was limited and what little there was by the companies offering pheromone dispensers that were available on the market and this led to the gradual development of a number of different types of pheromone dispensers with various means of evaporation (through the wall,

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through the wick) and with different volume of active substances, many of which are still being used (Zahradník, Zahradníková 2014). The aim of the experiment was to determine whether a permanent and long-term increase in the evaporation of active ingredients of the aggregation pheromone of *I. typographus* would lead to an increase in its capture. A higher volume of pheromone was obtained by using more pheromone dispensers (Franklin, Grégoire 2001).

MATERIAL AND METHODS

The experiment started in March 2013 in central Bohemia in the Obecnice forest district (Military Forests and Farms, s.e. – Hořovice Division), altitude 690 m a.s.l., 49°41'36''N, 13°53'30''E. Norway spruce (*Picea abies* /Linnaeus/ H. Karsten) with interspersed larch (*Larix decidua* Miller) represent almost 100% of the surrounding forests. The forest stand was about 80–90 years old. A total of 30 slit type pheromone traps (THEYSOHN Kunststoff GmbH, Germany) were installed at a distance of about 15 m from the stand edge with a spacing of about 15–20 m. These traps were gradually baited with one, two and three Pheagr IT pheromone dispensers (SciTech, spol. s r.o., Czech Republic), the active ingredient was 3–4.3% (*S*)-*cis*-verbenol (Zahradníková, Zahradník 2014). The number of dispensers in individual traps was completely randomized following EPPO PP1/152(4) (EPPO 2012). Traps Nos. 1, 4, 9, 12, 13, 16, 21, 24, 25 and 28 contained one dispenser each; traps Nos. 2, 6, 8, 10, 14, 18, 20, 22, 26 and 30 contained two dispensers each; and traps Nos. 3, 5, 7, 11, 15, 17, 19, 23, 27 and 29 contained three dispensers each. The traps were checked in regular 7 days intervals. The caught beetles were counted, and a measuring cylinder (1 ml = 35 beetles after removing needles, another insect species etc.) (Zahradník 2006) was used in cases of higher catches. The experiment was finished on the 2nd September, 2013.

The statistical evaluation was done using NCSS 10 (Version 10.0.6, 2015) with a Kruskal-Wallis one-way ANOVA, and the factor for assessing the statistical significance was the number of dispensers in pheromone trap. The null hypothesis H0: The pheromone plume volume (number of pheromone dispensers) has no effect on the amount of trapped imagoes of spruce bark beetle. The alternative hypothesis is H1: The pheromone plume volume (number of pheromone dispensers) affects the amount of trapped imagoes of spruce bark beetle. A higher amount of released substance was achieved by using more pheromone dispensers. The basic characteristics of catches representing the traps with the same number of pheromone dispensers in a box plot are shown in STATISTICA (Version 12SP2, 2013).

RESULTS

A total of 22,536 beetles were caught in traps with one pheromone dispenser, 19,989 beetles were caught in traps with two dispensers and 26,031 beetles were caught in traps with three dispensers. The mean value (median ± SD) (Fig. 1) by the trap catches with one dispenser $s = 421 \pm 1{,}721.96$, with two dispensers $s = 287 \pm 1{,}609.69$ and with three dispensers $s = 430 \pm 1{,}971.37$.

Statistical analysis by means of Kruskal-Wallis one-way ANOVA provided the following result: the probability $P = 0.36386 > \alpha = 0.05$. Thus, the null hypothesis H0 is confirmed and with 95% statistical certainty we can claim that the number of dispensers in the trap does not affect the number of trapped imagoes of *I. typographus*. Our study shows that an increase in the evaporated pheromone solution does not mean an increase in the total number of beetles caught. Traps with two dispensers had the lowest median value, but the statistical difference is not significant in comparison with the traps that contained one or three dispensers.

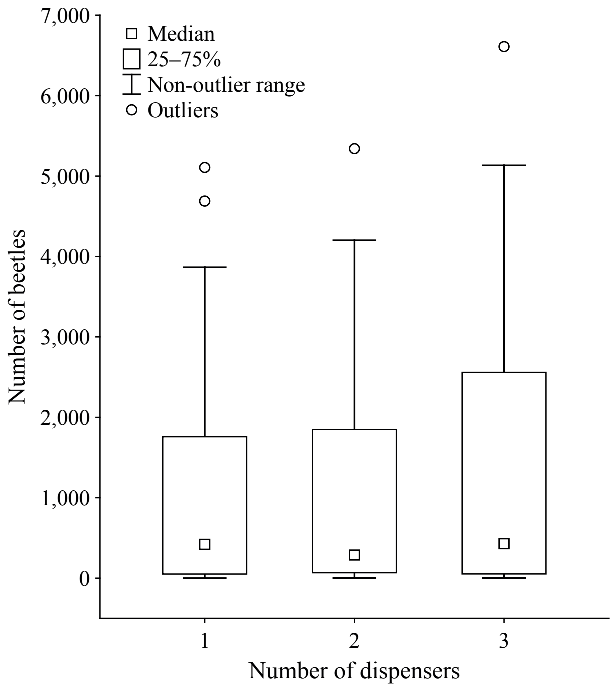

Fig. 1. Total trapping of spruce bark beetles in traps baited with one, two and three pheromone dispensers

DISCUSSION

The quantity of released pheromone substances of *I. typographus* varies during an attack on a tree, particularly during the development of galleries. The highest amount of basic compounds of *I. typographus* pheromone, i.e. methylbutenol and (*S*)-*cis*-verbenol, is produced during the fourth and the third phase. The third phase is characterized by the finishing of a nuptial chamber and the male presence. The females are also present during the fourth phase, but the egg laying has not taken place yet. The amount of released pheromones affects the attack of *I. typographus* onto trees, with the highest number of attacks onto trees coinciding with the highest production of 2-methyl-3-buten-ol (Birgersson et al. 1984).

Thus it is obvious that the amount of released substance affects the intensity of the *I. typographus* attack, particularly in relation to the number of beetles involved. Producers of pheromone dispensers regulate the pheromone release rates through the use of wicks or semipermeable walls, and the volume of substance at the dispenser influences the time of efficacy. Although the amount of evaporated substance in the dispenser decreases over time (Lie 1984), Zahradník and Zahradníková (2014) demonstrated that the resulting catches are not lower.

Byers (1989) wrote that the males release 2-methyl-3-buten-ol and *cis*-verbenol which attract both sexes, but after contact with high concentrations of pheromone the males become less precise than females in close-range orientation and are more likely to land in adjacent areas as a result.

The volume of evaporated substance in pheromone dispensers over time decreases, so the capture of *I. typographus* can be influenced. The attractiveness of pheromone dispensers is increased by 45% in 2–4 weeks and about 60% in 6–8 weeks (Lie 1984). The rate of evaporation has an impact on the length of the effectiveness of some types of pheromone dispensers (Zahradník, Zahradníková 2014). Therefore, the efficacy of an increased pheromone plume of *I. typographus* on the amount of its capture was studied.

Schlyter and Löfqvist (1986) tested trappings by varying the release rate of 2-methyl-3-buten-2-ol and (4*S*)-*cis*-verbenol. The highest number of beetles was captured in traps with the highest release rates. Beetles were caught via a triangle trap group (blank, low, medium and high). There was a significant increase in the catch on the blank in accordance with a decrease in the triangle size.

Many studies comparing *I. typographus* trapping at different levels of evaporation intensity are not concerned with the intensity increase for a rise in catches, but the dose of pheromone is reduced with the aim to influence the spatial orientation of *I. typographus* flights as little as possible and to map it accurately. With the higher release rate, trap catches decreased with increasing distance, whereas with the lower release rate, trap catches rose between 50 and 100 m and then decreased with increasing distance (Franklin et al. 2000). Franklin and Grégoire (2001) compared the dose-response of beetles to Pheroprax and low release rate pheromones. Trap catches increased with increasing release rates.

CONCLUSIONS

The highest trappings were recorded in traps with three dispensers, the lowest trappings were recorded in traps with two dispensers. The results of a Kruskal-Wallis ANOVA did not confirm a statistically significant difference between the three variants of the experiment (traps with 1, 2 and 3 dispensers). No significant increase in the trappings of spruce bark beetles resulted from an increase in the number of dispensers in pheromone traps. Increasing the volume of vaporized pheromone did not significantly increase the effectiveness of pheromone traps.

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