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Efficacy of different pheromone trap design in monitoring of the box tree moth, *Cydalima perspectalis* in the northern forests of Iran

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RESEARCH ARTICLE

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ABSTRACT

The box tree moth, *Cydalima perspectalis*, is the most important pest of the box tree in the world. The use of pheromone is expected to reduce use of chemical pesticides in *C. perspectalis*. In this study, the efficiency of three different types of traps including funnel, wing and delta traps at two installation heights (2 and 4 m above the ground) and also dynamic activity of *C. perspectalis* at different elevations above sea level was investigated in Mazandaran province (Iran) in 2018 and 2019 seasons. The results showed that funnel traps in comparison with the other two types of traps (delta and wing) captured significantly more *C. perspectalis*. However, trap height had no effect on trapping. *C. perspectalis* was active in the box reservoir at different elevations above sea level.

KEYWORDS

pheromone trap, trap design, *Cydalima perspectalis*, box tree, capture

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INTRODUCTION

The box tree moth, *Cydalima perspectalis* (Walker, 1859) (Lep.: Crambidae), is native to East Asia (China, Japan, Taiwan, Korea, parts of eastern Russia and India), its first report from Europe was in 2007 from Switzerland (Billen, 2007) and since then, the spread of the pest has gradually widened, so that was reported from many European countries including Germany (Kruger, 2008), the Netherlands (Muus et al., 2009), Britain and Ireland (Mitchell, 2009), Austria (van der Straten and Muus, 2010), Italy (Bella, 2013), Romania (Székely et al., 2011) and the European part of Turkey near Istanbul (Hizal et al., 2012). Also, this pest was reported for the first time in 2015 from northern forests of Iran, wherever the Hyrcanian box tree, *Buxus hyrcana*, is one of the major and endemic evergreen trees (Ahangaran, 2016; Farahani et al., 2016). Larvae cause severe damage by feeding on the leaves of box tree and leave the tree completely leafless and then feed on barks. Three families including Aquifoliaceae (*Ilex purpurea* Hasskarl), Buxaceae (different species of the genus Buxus) and Celastraceae (*Euonymus japonicus* Thunberg and (*E. alatus* Thunberg) are the main hosts of this insect (Wan et al., 2014).

Székely et al. (2011) attributed the spread of this pest both naturally (migration) and by importing infected plants. Newly hatched eggs and larvae are very small and this is a very good factor for moving to new places. Also, adult insects are strong fliers and migrate naturally about 5–10 km per year (van der Straten and Muus, 2010).

The females of BTM produce sex pheromone that comprise of the two aldehyde compounds, (*Z*)-11-hexadecenal (Z11-16: Ald) and (*E*)-11-hexadecenal (E11-16: Ald) in a ratio of roughly 4: 1 (Kawazu et al., 2007). Kim and Park (2013) carried out similar studies in Korea and proposed ratios of 5:1 and 7:1. Pheromone traps can be used to determine the distribution of BTM in new areas and also control in the form of integrated pest management (Santi et al., 2015). The goal of this research was to study the efficacy of different types of pheromone traps for trapping of BTM and determination population activity in different elevations above sea in the northern forests of Iran.

MATERIAL AND METHODS

All assays were carried out in the Mazandaran province of Iran, is mostly covered by *Buxus hyrcana* (Pojark.), and to a lesser extent with *Parrotia persica* Mey, *Quercus brantii* Lindl., *Carpinus betulus* L., *C. orientalis* Mill., *Acer pseudoplatanus* L.

The traps were provided by Zistbani Paya Company (Iran) and were prepared using rubber septum lures (Trifolio M Co., Germany) containing (*Z*)-11 hexadecenal (Z11-16: Ald) at 0.48 mg and (*E*)-11 hexadecenal (E11-16: Ald) at 0.12 mg (with 98% min. purity). The distance between traps was 50 m. The blocks were 500 m apart. The traps were checked at regular intervals (every 7 days) to collect trapped BTM and the dispensers were changed every 4 weeks.

In assay 1, efficacy of 3 different types of traps (delta trap, wing trap, and funnel with transparent body and yellow lid) at three replicates was investigated from July 14 to October 15, 2018, at Varaky region, Mazandaran province (ca. 372 m, 53°10′ 45.228″ N, 36°17′ 57.678″ E). The traps were placed around the box tree approximately at 2 and 4 m above ground.

In assay 2, comparison of flight activity of BTM in different elevation above sea level was carried out from June 16 to September 20, 2019 at Mescopa (ca. 593 m, 53°18′ 26.242″ N, 36°12′

42.733″ E), Afrachal (ca. 711 m, 53°18′ 49.725″ N, 36°12′ 42.733″ E) and Sangdeh (ca. 1,178 m, 53°11′ 30.959″ N, 36°5′ 28.608″ E) that are located in Mazandaran Province forests. Based on the results of the assay 1, funnel traps were used. Three traps were placed at 2 m above the ground in each elevation.

Statistical analysis

Data were analyzed using procedures of MINITAB™ 16. The number of captured moth (χ) was transformed to ln (χ +1) and analyzed by parametric ANOVA. Means were compared using the Tukey–test (α = 0.05).

RESULTS

The best installation height and type of pheromone trap

The ANOVA results of traps' total catch of assay 1, indicated that there was significant difference among trap types ($F_{(2,\ 95)}$ = 128.17; P < 0.001). The type of traps influenced the captures, so that the funnel traps captured more BTM than delta and wing traps. But, trap height had no effect on trapping. The efficiency of traps placed in 2 and 4 m was equivalent (Fig. 1).

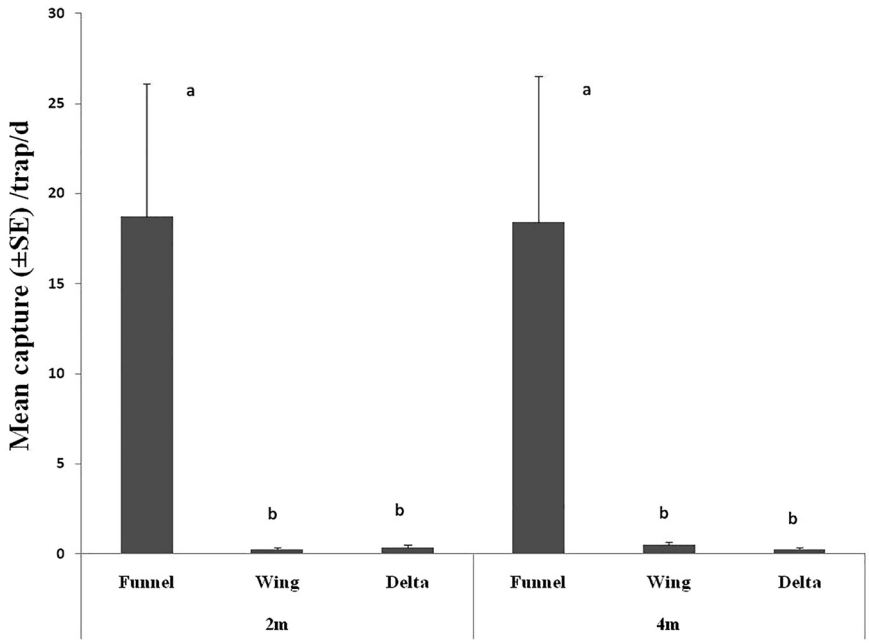

Fig. 1. Mean (±SE) capture of *C. perspectalis* by different types of pheromone traps placed in 2 and 4 m above ground at Varaky (Mazandaran province, Iran) in 2018

Flight activity of BTM at different elevation above sea level

The ANOVA results of traps' total catch of assay 2, indicated that there was significant difference among treatments ($F_{(2,\ 8)} = 76.04$, $P < 0.004$). Results showed that traps placed at elevation more than 1,000 m above sea level had the most capture comparison to elevation 500–1,000 m above sea level (Fig. 2).

DISCUSSION

The results showed that funnel traps captured more BTM (60 and 50 folds) in comparison with delta and wing traps, respectively. The openings in wing and delta traps are small for entering male of BTM and on the other hand, due to the large size of the BTM, the sticky surface of these traps is covered by the captured BTM after a short time, and the next attracted BTM do not stick to the adhesive surface and escaped. Conversely, voluminosity of funnel traps was big enough for keeping attracted BTM. Kim and Park (2013) tested various traps and indicated that a uni-trap was more effective in catching BTM than delta and wing traps. Study on the efficacy of sex pheromone traps in Italy showed that the funnel traps baited with sex pheromone were useful in capturing BTM males (Santi et al., 2015). Our finding indicated that trap height had no effect on trapping of BTM so that traps placed at 2 and 4 m had equal capture. Kazerani et al. (2019) also showed that there was no significant

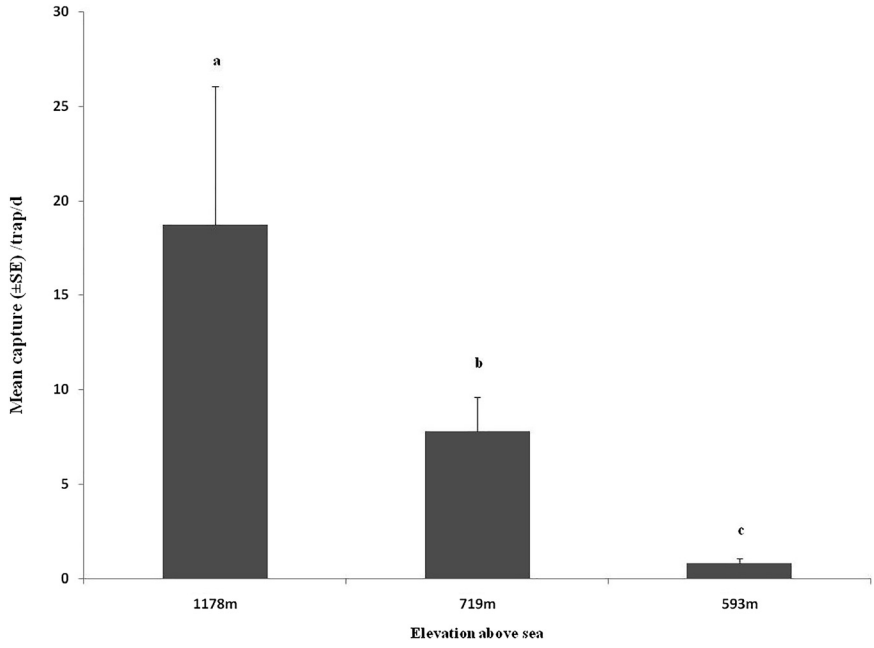

Fig. 2. Mean (±SE) capture of *C. perspectalis* at different elevation above sea in 2019 at Mescopa (ca. 593 m), Afrachal (ca. 711 m) and Sangdeh (ca. 1178 m), Mazandaran province, Iran

difference among traps that were fixed at 3 different heights above the ground (1–1.30 m, 1.30–1.60 m and 1.60–2 m).

Based on the present research, BTM was active in the box trees at different elevation above sea level (0 to more than 1,000 m) so that at different elevations BTM was captured in the pheromone traps, but captured moths at elevation of over 1,000 m were more than other elevations above sea level (593 and 719 m). The high population density of BTM caused severe damage thanks to the larval feeding on the leaves as well as on the bark of box trees during three years after its outbreak in 2016. So that in 2018, only dry box trees reservoirs were exist at lower elevations above sea level. Therefore, it seems that in order to survive, this species was gradually moved to higher elevation to find box tree reservoirs.

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