Effectiveness of pheromone traps for monitoring *Zeuzera* sp. (Lepidoptera: Cossidae) population on *Eucalyptus pellita* plantation

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Abstract. *Zeuzera* sp. (Lepidoptera: Cossidae) is a group of moths which the larvae is drilling holes into the stems and branches of tree. This study was conducted to record the population dynamic of *Zeuzera* sp. and to control the pest in *Eucalyptus pellita* plantation. The first damage of *Zeuzera* sp. was detected in 2017 at the *E. pellita* plantation block 4 (1 clone) owned by PT Korintiga Hutani in Central Kalimantan. It was found in 2 clones of block 5 in 2018, as well as in 3 clones of block 6 in 2019, and the tendency of the damage appeared widespread. The damage caused the broken top crown, swollen stem, and frass around the bottom part of the plant. Primary observation showed that there were several species of *Zeuzera*. The pest control was carried out by installing of delta trap + pheromone of *Zeuzera pyrina*. This pheromone trap was installed in 40 severely damaged locations. Each location had 1 trap installed. The results of monitoring with delta trap + pheromone showed that only 1 species of *Zeuzera* was found to be attracted by the pheromone. The density of captured adult varied depended on the clones and time of installation. The number of adult captured in May to July 2019 was 911. In conclusion, *Zeuzera* sp. damage in *E. pellita* plantation was gradually increased, and integrated pest management (silviculture, mechanical, biological, chemical) was required to prevent the damage.

1. Introduction

Recently, global demand for wood resources is continue to increase, while wood production in natural forest is decreasing. Forest plantation (HTI) is a solution to fulfill supply of forest product [1]. Until 2019, forest development in Indonesia has been mainly focused on industrial plantation forest [2]. The 2 species that widely used in HTI development programs are *Acacia* sp. and *Eucalyptus* sp. Both species are the most significant contributors to Indonesian pulp production [3]. While these afforestation projects have positive aspects that fulfill supply and demand for timber, they also have a negative impact on the development and maintenance of the plantation. Planting with monoculture provides an opportunity to enhance the population of pests and diseases, because of the availability of food sources is abundant [4]. One of the main pests in HTI companies is *Eucalyptus* borer (*Zeuzera* sp.)
Zeuzera sp. (Lepidoptera: Cossidae) is included in moth group which the larva stage would bore holes on the stem and branches of the host plant. The hole is in a circular ring-like pattern (hence, the pest commonly called ring borer), then they would bore through the top of the stem and branches. This pest attack may interrupt nutrients transport from the soil to the host plant [5]. Zeuzera sp. attack on plant would cause stunting, stem-swollen and in some cases the damaged top crown of stem would break and the main stem would grow some lateral branches. This would result in a poor quality of wood product, hence can not be used as lumber or plywood.

Pheromones are chemical substances released by an organism into its environment and enabling the organism to communicate intraspecifically among others. Pheromones are also useful in population monitoring and pest control [6]. Although, the use of pheromone trap for pest control in particular stages of insect pest (egg, larvae, nymph and pupa) is rather difficult, particularly for Zeuzera sp. Rohani and Samih stated that pheromone trap is used as an alternative to reduce the population of Z. pyrina in Iran. It is mainly due to the larva and pupa stages is a challenge to control with the pheromone trap technique [7].

Recently, Zeuzera sp. attack in PT KTH is still increasing. Thus, the monitoring and management of this pest are also still continue in the field to find the effective controlling strategy. Studies on the biology of Zeuzera sp. are still limited and several attempts to create artificial diet of the pest are still under development. A study by Navon showed that the development of artificial diet for Z. pyrina larvae requires 3-4 months [8]. In the meantime, the adult position is outside the tree, hence it is able to be monitored easily. Therefore, this study was focused more on adult control than the larvae stage. This study aimed to record the population dynamic of Zeuzera sp., as well as to control the pest in Eucalyptus pellita plantation.

2. Methods

2.1. Study area
The study was conducted at Eucalyptus pellita plantation owned by PT Korintiga Hutani (PT KTH), Central Kalimantan, from May to July 2019. PT KTH is a company that provide the source of raw material for pulpwood through industrial planting management. PT KTH has 4 camp units consist of Pellita Camp Unit, Indokayu Camp Unit, Talaweh Camp Unit and Tiger Camp Unit with the area of 438 ha, 3,786 ha, 345 ha and 23 ha, respectively. The forest is divided into 6 blocks with the total area of 94,384 ha. The main planting species was Eucalyptus pellita as this species was a fast-growing species suitable for pulp and paper industry [9].

Delta trap + pheromone of Zeuzera pyrina was installed in 40 locations at blocks 5th and 6th. The locations were picked based on the attack severity of the pest. Delta trap has standard uniform size of 26 x 20 cm in the base and 11 cm in height. A sticky sheet was put on the base of each trap. One pheromone lure (Pherobio Technology Co., Ltd) used to attract male of Zeuzera pyrina was hung under the center of the delta trap. The distance between the pheromone lure with the base should be at 1 - 2 cm. The location of pheromone trap installation and the damage distribution of Zeuzera sp. were marked on the map as the distribution of Zeuzera sp. in PT KTH.

2.2. Observation methods
Pheromone traps were monitored every week. In each installation location of delta trap + pheromone Z. pyrina, the number of captured adult was recorded and identified by species. The identification was based on the book of Borneo Family Cossidae. Monitoring was conducted every 2 wk which involved observation of 100 trees as samples in each location. The recorded data was consisted of the damage symptoms of Zeuzera sp. (stem-swollen, broken top crown, frass around the base of the stem), as well as the damage severity.
2.3. Data analysis
The monitoring data of accumulated captured adult and the growth of Zeuzera sp. population from each location were calculated. Then, they were presented in graphic.

![Map of the study sites located at PT KTH.](image)

3. Results and discussion

3.1. Observation of Zeuzera sp. attack at PT Korintiga Hutani

3.1.1. Early detection. It was conducted initially in 2017. The damage symptoms of Zeuzera sp. were detected in E. pellita plantation at PT KTH. The damage especially occurred in the northern part of the plantation area (Block 4th). The pest attacked E. pellita Clone ID 27. This situation would lead to the spread of Zeuzera sp attack to other plantation locations.

3.1.2. Second detection. The second attack of Zeuzera sp. was detected at Blok 5th in 2018. The pest specifically attacked E. pellita Clone ID 27 and 170.

3.1.3. Third detection. While, in early 2019, the third detection of Zeuzera sp. attack was reported occurred on E. pellita Clone ID 27, 63, and 30.

3.1.4. Monitoring and Zeuzera sp. damage symptoms. Based on the monitoring of E. pellita plantation, several species of Zeuzera were found attacked the plantation at PT KTH. The distribution of Zeuzera species in Borneo consisted of Zeuzera indica Herrich-Schaffer, Zeuzera caudata Joicey & Talbot, Zeuzera conferta Walker, Zeuzera Coffee Nietner, Zeuzera indica and Zeuzera borneana Roepeke [10]. Four dominant symptoms which were shown on the affected plant are asymmetric stem-swollen, frass around the stem base, and broken top crown. Further symptom development was the plant would respond by growing a fork-like branch stem (Fig 2). Yulianto stated that Zeuzera coffee attacked the longan tree in Tumanggung, Central Java, by boring into the cambium of the stem and the frass were found around the base of the stem [11].

3.2. Adult control of Zeuzera sp. with pheromone traps
The experiments using pheromone traps were succeeded to attract the adult of Zeuzera sp (Fig. 3). The daily monitoring was showed that only 1 species of Zeuzera sp. to be attracted to the installed pheromone traps. From all of the installation locations, only male adult of Zeuzera sp. attracted to the pheromone trap. The pheromones used in this experiment were a female insect sex pheromone. The
pheromone was released by female or male insect based on the function and behavior which indicated by the recipient as sex pheromones for mating process [12].

**Figure 2.** Damage symptoms of *Zeuzera* sp. consists of (a) asymmetric stem- swollen, (b) frass around the stem, (c) broken top crown, (d) fork-like branch stem.

**Figure 3.** The *Zeuzera* sp. captured on the pheromone traps.

Based on the accumulation data, the number of captured adult of *Zeuzera* sp. from May to July 2019 was 911 and the number would possibly increase higher. The adult captured depended on the *E. pellita* clones and the installation time of the trap. The highest number of adult captured in the field was Clone ID 170, followed with Clone ID 27. The rest of the clones were attacked as well. As the Clone ID 27 was the highest number of captured adult, they were more susceptible to *Zeuzera* sp. compared to others. Prat & Haneda stated that the tree suspected to be resistant, tolerant, and susceptible to *Z. coffeae* attack have a host palatability correlation with insects, both in terms of nutrition (chemical) and physical properties of wood. Micro-climatic conditions at the observation locations were affected by the intensity of rainfall, altitude and weeds growth [13]. There were clear differences in number of active holes per tree and number of broken olive shoot in the field, while
laboratory rearing experiments showed strong differences in suitability for larva of *Z. pyrina* development [14].

The accumulation of adult *Zeuzera* sp. using pheromone traps showed that the technique was quite effective because the pest population in the field could be reduced. Moreover, this technique also could monitor the population dynamic of *Zeuzera* sp. continuously. However, this technique has not been yet proven to be efficient because the performance of the pheromone was limited by time and ought to be refilled continuously. They were also expensive and these pheromones were rarely produced by *Zeuzera* sp. On the other hand, using a little amount of delta traps could capture fewer *Zeuzera* sp. The color of sticky sheet did not have any significant effect on the number of captured adult males, while the newly created trapezoid trap could capture twice as much of delta trap’s [15]. The accumulation result of *Zeuzera* sp. population was shown in Fig 4.

![Figure 4. Accumulation of Zeuzera sp. population.](image)

Based on the monitoring results, the number of captured *Zeuzera* sp. was thought to be correlated with the traps installation time in each week. The highest number of captured *Zeuzera* sp. was at the 2nd observation from 27 May to June 11 2019. Then, the population of *Zeuzera* sp. tended to decrease at the following weeks. It was suspected that the peak of *Zeuzera* sp. flights was from late May to early July. However, an observation of 1 year round should be conducted in order to understand the population trend of *Zeuzera* sp. A research by Hegazi *et al.* showed that the peak flight of *Z. pyrina* in olive orchard, Egypt, was from late April to October [16]. Meanwhile, *Z. pyrina* in walnut orchards, Iran, has the flight peak in May to July and August to September [8]. A study by Kutinkova *et al.* also showed that *Z. pyrina* has 2 flight peaks in Bulgaria [17]. The variation in population dynamics were allegedly due to the species differences of *Zeuzera* and geographical conditions. The population dynamics of *Zeuzera* sp. in *E. pellita* plantation at PT KTH was shown in Fig. 5.

The pheromone traps were successfully captured adult of *Zeuzera* sp. However, only 1 species was captured, while several other species found in the field were attacked *E. pellita* simultaneously. An integrated controlling plan was needed to control these pests effectively. Study showed that Integrated pest management (IPM) has resulted a significant reduction of *Z. Coffee* population in the walnut orchard, Pakistan [18]. Integrated pest management was made by collaborated several techniques based on several aspects, i.e silviculture, mechanical, biological, and chemical. This method was expected to reduce insecticide resistance and create sustainable pest control in the field as it was also stated by Damos *et al.* [19].

Some of the control methods based on the silviculture aspects were eradication and multi-specific planting. Saenger mentioned that *Sonneratia apetala* borer (*Z. conferta*) can be controlled with a
multi-specific planting system by mixing *Sonneratia* sp. and *Avicennia* sp. while also added a mechanical aspect (mating disruption technique) [20]. The control method of *Z. pyrina* using mating disruption technique was resulted good outcomes to protect apple orchards in Spain. While, *Z. pyrina* could also be controlled biologically by its natural enemies, such as *Sycanus* sp. [21]. Other natural enemies of *Z. pyrina* were insectary plants and entomopathogenic agents (*Beauveria bassiana*, *Cordyceps* sp. and nematodes) [22]. Ashtari mentioned that the application of entomopathogenic nematodes, *Steinernema carpocapsae*, in walnuts orchard, Iran, were able to infect 100% of *Z. pyrina* larvae [23]. Contol technique of *Z pyrina* using Destruxin from the *Metarhizium anisopliae* isolate was also proven to be effective [24]. Meanwhile, the application of fipronil was less effective than carbofuran in controlling *Z. coffee*, although fipronil insecticides with concentration of 0.2-04% could suppress the population of cacao fruit borer by 40.72 - 66.82% [25].

![Figure 5. The population dynamics of *Zeuzera* sp.](image)

### 4. Conclusion

The development of *Zeuzera* sp. damage in *E. pellita* plantation is keep increasing. Monitoring and control experiments with pheromone traps can capture only 1 species of *Zeuzera* in the period of May to July 2019 and the total accumulated *Zeuzera* sp. is 911. The highest population of *Zeuzera* sp. is at the 2nd observation (27 May - 11 June 2019). Integrated Pest Management (IPM) (silviculture, mechanical, biological and chemical) is necessary to prevent the damage of *Zeuzera* sp infestation.

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