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Infestation of Coffee White Stem Borer *Xylotrechus quadripes* (Coleoptera: Cerambycidae) In Bolaven Plateau, Southern Laos

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Abstract

Xylotrechus quadripes (Chevrolat), the Coffee White Stem Borer, is a major pest of arabica coffee plantations (*Coffea arabica* L.) in southern Laos and some Asian countries. This study was conducted on an arabica coffee plantation in Bolaven Plateau, southern Laos, during January, March and June 2021. The study was undertaken to assess the number of adult beetles, larvae and their exit holes of the Coffee White Stem Borer, or *X. quadripes*, as well as their relationship. The result indicated that there was a significant difference in the number of adults depending on the collection date; moreover, the number of adults gradually increased from January to June. However, there was no significant difference between the number of larvae and exit holes for the collection date. On the whole, there was a relatively strong positive relationship between the number of adults and larvae versus the number of exit holes. This finding was the fundamental data to support the farmer in terms of properly controlling and managing their coffee plantations in the region.

Keywords: Bolaven Plateau, *Coffea arabica*, Infestation, Southern Laos, *Xylotrechus quadripes*.

1. Introduction

The Bolaven Plateau is located in the southern part of Laos, where the most exclusive cultivation is coffee. This Bolaven Plateau is of volcanic origin and covers approximately 1000 km^2. The altitude of this area varies from 300 to 1500 m above sea level. There are about 20,000 local families, based on 250 villages, which cultivate coffee in this area. However, most of the income of people who are living in this region is from coffee cultivation. Therefore, it is an important source of main income for many people in the area.

Coffee production is a main economic crop in many developing countries in Southwest Asia, including Laos (Venkatesha and Dinesh, 2012). Two species of coffee, namely arabica coffee (*Coffea arabica* L.) and robusta coffee (*Coffea canephora* Pierre) (Rubiaceae), are cultivated in Laos (ICO, 2011). *Xylotrechus quadripes* Chevrolat (Coleoptera: Cerambycidae), which is recognized commonly as a Coffee White Stem Borer, is the most significant insect pest of arabica coffee (*Coffea arabica* L) in southern Laos and Asian countries (Rajus et al., 2021). Each year, the farmers are usually facing insect pests with their coffee bushes being easily damaged or killed by the Coffee White Stem Borer, which results in a loss of income and alow price (Douangphachanh et al., 2021). As a matter of fact, the coffee white stem borer is the most threatening coffee insect pest in Laos, but reliable investigation of the actual number of beetle adults, larva, and their exit holes, as well as their relationship and interaction with each

other,are virtually nil. Even thoughmany reports of the field surveys suggest that the coffee white stem boreris more prevalent in highland than lowland arabica coffee plantations. However, some reports indicate that, even though altitude does influence the Coffee White Stem Borer, there may be other factors involved (Liebig et al., 2018; Pandey et al., 2022).

The Coffee White Stem Borer is one of the most widespread insects across Southeast Asian countries, including India (Liebig et al., 2018). Even though several techniques for control have been applied, the percentage of infestation is still increasing. The adult female Coffee White Stem Borer lays her eggs under the bark of the coffee tree at the stem. Three weeks later,the eggs hatch to produce cream-white, flattened larvae (Rutherford and Phiri, 2006). The larvae attack the stem and feed on it, forming a ring around it. After passing through a number of stages and the next instar becoming more yellow, it will continue its attack on the bark and move to the wood. This instar causes the most serious damage to the coffee tree. The adult Coffee White Stem Borer emerges from the coffee stem by cutting a small circular hole and will spread to another tree (Rutherford and Phiri, 2006).

To provide the fundamental right action for controlling and assessing the infestation of the coffee white stem borer for farmers, this study was conducted to examine the infestation of the coffee white stem borer beetle adult, larva, and exit hole in different months as well as their relationship. This study addresses the following questions: (a) Do the number of adults and the number of larvae of the Coffee White Stem Borer correlate with the number of exit holes? (b) Does the season affect the coffee white stem borer infestation?

2. Material and methods

2.1. Study area

The coffee white stem borer *X. quadripes* was sampled in a coffee arabica plantation located in Bolaven Plateau, Champassak province, southern Laos, which is about 30-35 km away from Pakse city, which is sited between the Annamite Mountain Range, along which runs Laos' eastern border with Vietnam, and the Mekong River to the west, at about 15°N 106°E. The study was conducted on an organic coffee plantation that belonged to the small business of a farmer; this organic plantation measures about one ha. The elevation of the region is 1313 m above sea level (15°08’39.1” N and 106°17’13.5” E), which receives the highest rainfall of 3810 mm annually and has a relatively cool climate, the rainy season starts from May to October, whereas the dry season starts from November to March. The average maximum of the yearly temperature is 31 °C, and the minimum is 19 °C.

Adult and larval beetles of *X. quadripes* were collected from a weak coffee tree that was damaged by *X. quadripes*. Such a weak coffee tree was cut and split open to show tunnels from the base (root) up to the top section to observe the adults and larvae of *X. quadripes* per tree. Before cutting, the number of exit holes per tree was counted. One coffee tree was designated as a sampling site. Each site was separated from other by a minimum of 30 m, and 10 such sampling sites were investigated in this study. The study was done three times, i.e., in January, March and June 2021 and took one day for each. The selection of only one coffee tree per a sampling site was based on the permission of the farmer (coffee plantation owner).

2.2. Statistical analysis

The number of adults, larvae, and their exit holes from each sampling site was pooled for analyses and compared among months. One-way ANOVA (non-parametric Kruskal-Wallis) was performed. The pearson correlation between adult beetles and exit holes and larvae versus exit holes was analyzed using R version 4.0.5 (R Core Team 2021).

3. Result

During the investigation, the population of Coffee White Stemborer, the number of adult beetles of *X. quadripes* (n = 32) belonging to the order Coleoptera, Cerambycidae family was collected for three collection months (January, March, and June) across an organic coffee arabica plantation in the Bolaven Plateau, southern Laos. A total of 54 larvae and 96 exit holes from 30 coffee trees were recorded. The number of adults, larvae, and exit holes peaked in June with 17, 26, and 42, followed by March with 10 adults, 14 larvae, and 27 exit holes. January had a relatively small number of adults, with 5 individuals, 14 larvae, and 27 exit holes.

In January, 5 adults, 14 larvae, and 27 exit holes (1b and 1b) were captured.For the number of adults when compared among months, it was found that the number of individuals gradually increased from the January to June period, though there was a significant difference between months, and a significantly higher number of adults was found in June compared to January and March (P = 0.011, Fig. 1a and 1b). However, larvae and the exit hole had a non-significant difference between months (P = 0.09; P = 0.13, Fig. 1a and 1b).

There was a positive relationship between the number of adults and exit holes recorded on the coffee tree (r = 0.69; P >0.0001; Fig. 4a), and the relationship between the number of larvae and the number of exit holes was revealed to be strongly significant on the coffee tree (r = 0.82; P >0.0001; Fig. 4a).

4. Discussions

The present study indicated that the infestation of the adult beetle Coffee White Stemborer of *X. quadripes* peaked in June (monsoon), when compared to January and March (pre-monsoon). In this case, it is possible that seasonal variation of temperature and rainfall were increasing the feeding rate and extending the activity of feeding and breeding in organic plantations (Mattson, 1980; Thapa and Lantinga, 2016). Moreover, the different climate conditions affected the adult beetle of *X. quadripes* in terms of distribution, where pre-monsoon to monsoon periods were more appropriate for the flight period of the adult beetle of *X. quadripes* (Sekhar, 1958 & Kung, 1977). However, the number of larvae was found to be less than the number of exit holes, due to which approximately 84% of adults emerge from the main stem, whereas 16% emerge from the roots (Visitpanich, 1994; Venkatesha & Dinesh, 2012). In addition, it may have been old exit holes, whose adults left before observation. The present study also mostly found the adults and larvae in the main stem and occasionally appeared in the root where it tunneled its way into the main root, which agreed with the report of Venkatesha and Dinesh (2012), which reported that the larvae produce galleries in the primary branch and the stem, including the main root.

The relationship between the number of adults and larvae versus the exit hole was strongly positive. This was due to the fact that the numbers of adults and larvae were relatively equivalent to the number of exit holes found. A previous study indicated the infestation of *X. quadripes* was found to show more preference for highland than lowland in arabica coffee plantations (Venkatesha and Dinesh, 2012), which supported the similarly found in the present study. The present study indicated that there was a relatively serious infestation of the coffee white stemborer *X. quadripes* in organic coffee plantations, especially during the monsoon. In addition, the relationship between adults and larvae versus those with an exit hole had a strongly positive correlation. This finding was fundamental data to support farmers in terms of proper control and management in the region.

5. Conclusion

In the conclusion, we indicate here some basic information about the Coffee White Stemborer (*Xylotrechus qua*) infestation of

coffee plantations in southern Laos. Our finding suggested that the population of the Coffee White Stumbler is increasing in the monsoon period, and all response variables, for example, the number of larvae, the number of exit holes, as well as the number of adults, are also strongly correlated with each other. Our finding is a step forward in supporting the farmer to develop and apply adaptation techniques to minimize the negative impacts not only on the coffee stump but perhaps for other insect pests. Of course, the coffee white stem borer is extremely difficult to control. Hence, the methodologies need improvement for an effective control of this pest. Even though intensive research has been attempted for many years, the coffee white worm (Stemborer) has been considered a serious pest to coffee plantations in several countries in Asia.

6. Conflict of Interest

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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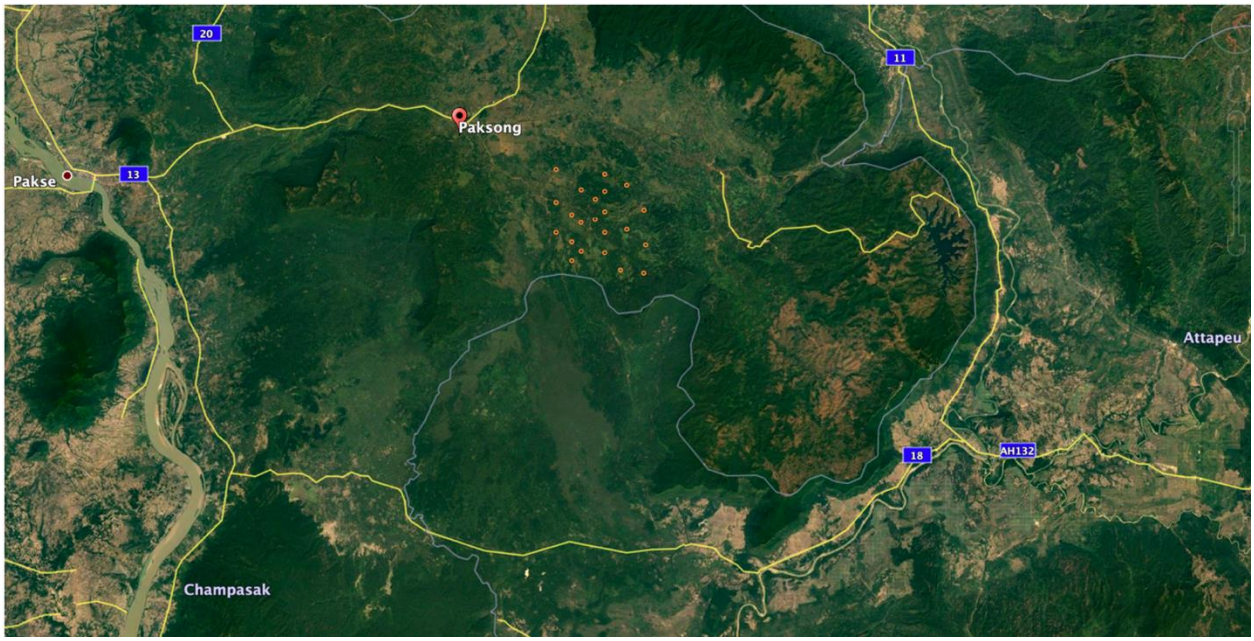

Fig. 1. Map showing the study area in Bolaven Plateau, Paksong District Champassak province, Southern Laos, during January, March and June, 2021. Dark brown cycles indicate distribution of the coffee plantations. (Courtesy: Google Earth).

Fig. 2. Incidence of *Xylotrechus quadripes* (coffee white stem borer) (Coleoptera: Cerambycidae) on *Coffea arabica.* (a) healthy coffee tree; (b) completely dead coffee tree, damaged by *X. quadripes;* (c) an adult beetle of *X. quadripes*; (d) larvae beetle of *X. quadripes*. Coffee white stem borer infested stem open to show borer tunnels, as well as, pupation chamber and borer exit holes (yellow circled).

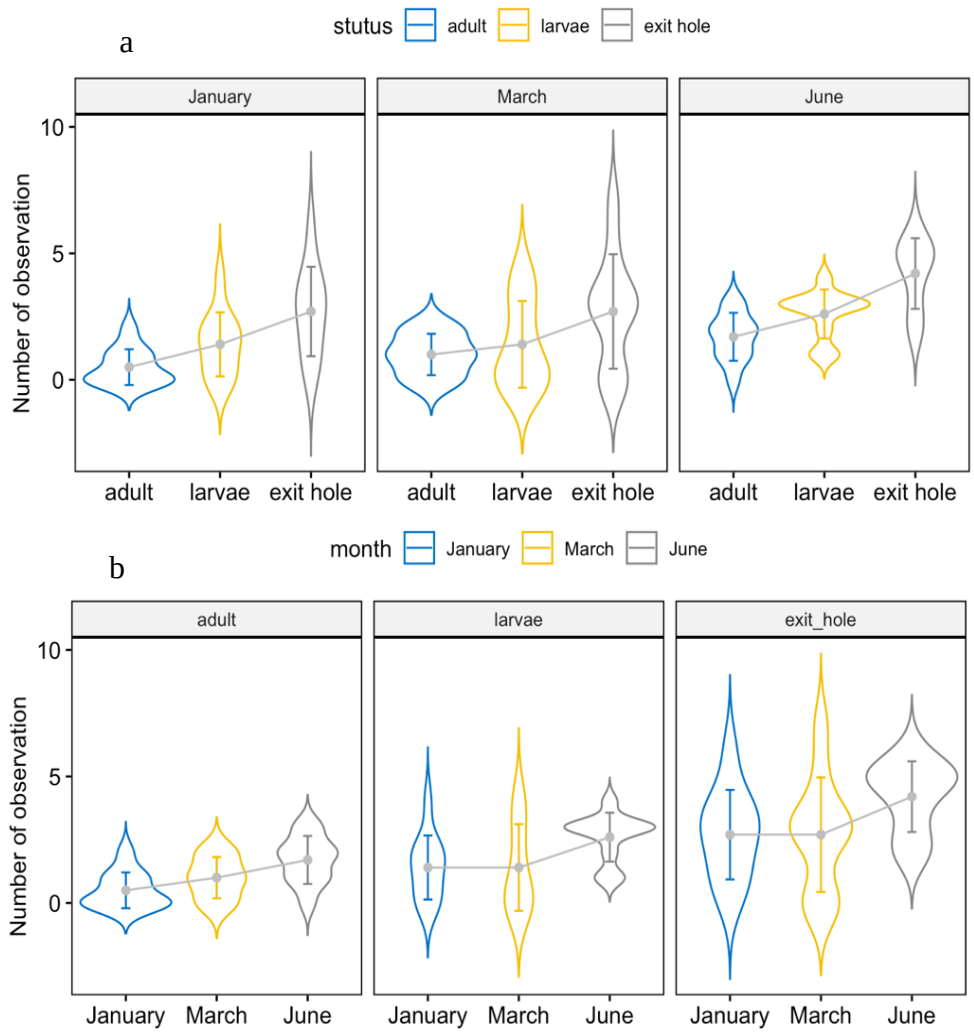

Fig. 3. Total number of adult beetles of *X. quadripes*, larvae and its exit hole found in *Coffea arabica* tree during January, March and June. Mean ± SE; *n*= 10 sampling sites.

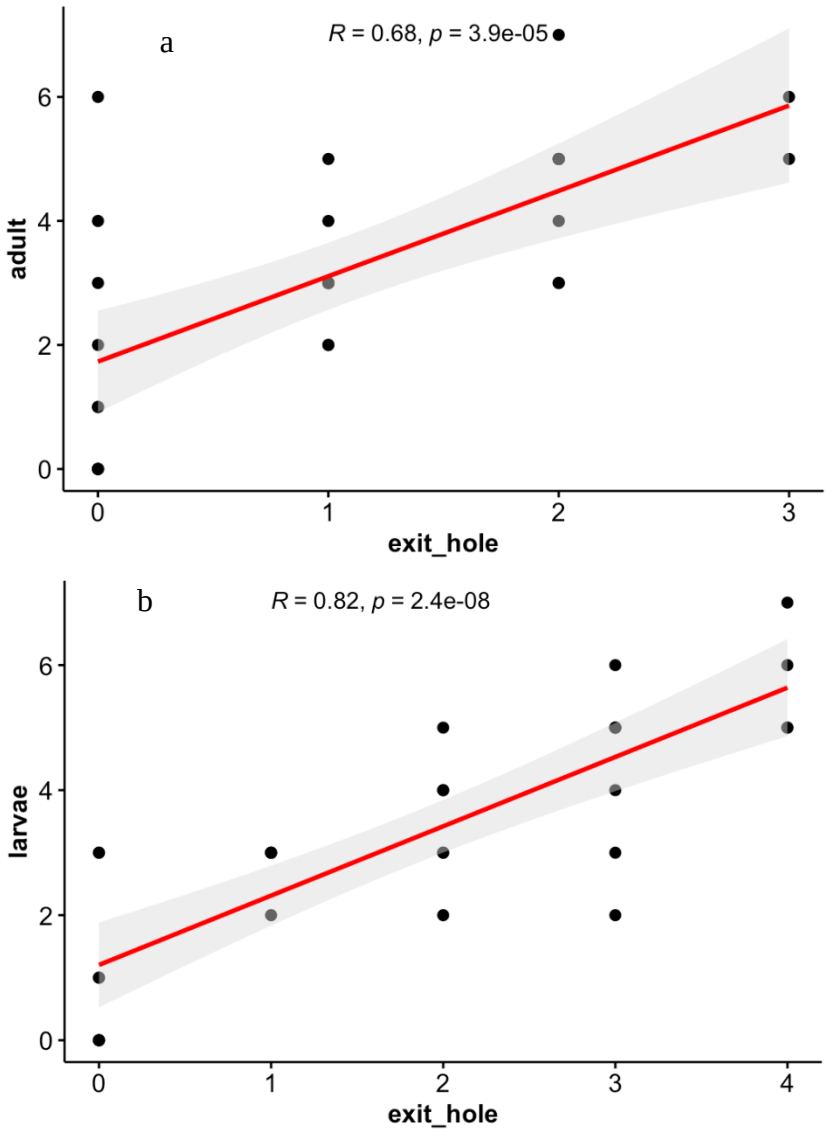

Fig. 4. Pearson correlation between adult beetle of *X. quadripes.* and its exit hole (a), the relationship between larvae and its exit hole (b).