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Pest Monitoring Technology for Predicting Pest Attack Intensity *Hypothenemus hampei* Ferr. (Coleoptera: Scolytidae) of Arabica Coffee Plantation in Enrekang, South Sulawesi

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Abstract. Coffee Berry Borer (*Hypothenemus hampei* Ferr.) is one of the most severe pests, causing up to 80% yield losses in coffee. It mainly attacks arabica coffee varieties in Indonesia because they are cultivated more widely than robust. As a result, *H. hampei* spread throughout Indonesia and became an endemic pest. Population monitoring techniques to reduce pest invasion spread and attack are among the pest management approaches. The study was carried out to forecast attacks during the harvest season by monitoring the population of H. *hampei* in the Enrekang district, which had not been done earlier. The study was conducted in Enrekang Regency using the weekly observation technique and identifying the sample plants that used a line transect. Approximately 30 trees were sampled along transects every 4 meters. The study indicates that pest monitoring technology could determine attack levels in post-peak cropping conditions (high season), with the highest attack intensity of 6.14% at the beginning of the observation and the lowest at 0.54% at the end. CBB pests attack based on fruit color, with unripe green fruit getting its most attention compared to red, with a total of 209 green fruits attacked out of 264 fruits. *H. hampei* will begin its first attack on young fruit whose endosperm has hardened and dark green fruit (stage 3 fruit development) aged one month, which is the most sensitive. The soft tissue of the dark green fruits supports the movement of CBB larvae. Direct monitoring on infection rates will improve decision-making for control measures to reduce population and spread. The crop attack rate will be decreased with monitoring techniques and management systems.

INTRODUCTION

Coffee is a planting plant with an important role in the Indonesian economy. Coffee plants have contributed significantly to the currency of the country. South Sulawesi Province is one of the provinces in eastern Indonesia that has the potential to cultivate coffee, a fairly large planting area indicates this and very supportive agro-climatological conditions [1].

Enrekang Regency, South Sulawesi Province, is one of the largest coffee-producing zones in South Sulawesi. Coffee production in South Sulawesi was 33,394 tons in 2019 and 34,059 tons in 2020 [2]. The productivity of coffee plants has problems, namely the presence of pests and diseases. Based on the survey results, it is known that one type of pest that is troubling Enrekang farmers is the coffee berry borer (*H. hampei* Ferr.) (Coleoptera: Scolytidae).

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Symptoms of *H. hampei* attack have the characteristics of a hole in the navel of the fruit. The color of the fruit changes to yellowish red; this pest attacks the fruit that is still young until the fruit is ripe. Enrekang Regency, South Sulawesi Province, is one of the largest coffee-producing areas in South Sulawesi. Coffee production in South Sulawesi was 33,394 tons in 2019 and 34,059 tons in 2020. The productivity of coffee plants has problems, pests and diseases. Based on the survey results, it is known that one type of pest that is troubling Enrekang farmers is the coffee berry borer (*H.hampei* Ferr.) (Coleoptera: Scolytidae). Symptoms of *H. hampei* attack have the characteristics of a hole in the navel of the fruit. The color of the fruit changes to yellowish red, this pest attacks the fruit that is still young until the fruit is ripe.

The productivity of coffee plants has problems, namely the presence of pests and diseases. Based on the survey results, it is known that one type of pest that is troubling Enrekang farmers is the coffee berry borer (*H.hampei* Ferr.) (Coleoptera: Scolytidae). Symptoms of *H. hampei* attack have the characteristics of a hole in the navel of the fruit. The color of the fruit changes to yellowish-red; this pest attacks the fruit that is still young until the fruit is ripe. The average attack rate in Indonesia is estimated to be more than 20% resulting in yield losses of more than 10%, so it will significantly affect the yields that will be obtained [3]. There are two types of damage caused by *H. hampei*, fruit drop and yield loss in quality and quantity. CBB that attacks fruit that is still soft will cause the fruit not to develop and fall, while *H. hampei* attacks fruit that has hard endosperm will cause the seeds to become hollow so that it affects the sugar and caffeine content in coffee cherries resulting in a decrease in quality [4].

An observation with farmers in Benteng Alla Utara Village obtained information that currently, the coffee berry borer *H. hampei* is very troubling to farmers in the area. Information related to the magnitude of the *H. hampei* attack in Enrekang has never been reported thus it is necessary to have accurate data regarding the level of *H. hampei* attack in the area. This is important to determine the control techniques that can reduce the level of losses. This research is expected to provide benefits for coffee farmers in controlling H. hampei pests that are troubling at this time. This study aimed to determine the intensity of attacks on *H. hampei* in Enrekang Regency, South-Sulawesi Province. This research is expected to be used as an information and reference material regarding the coffee berry-borer attack level. It can also be used as an initial approach in determining control techniques that can be used for the government and farming communities in the Province of South Sulawesi.

METHODOLOGY

Sample Plot

Determination of samples on coffee plantations using the line transect method every 4 meters. The total number of sample plants was 67 trees and used as an observation unit as many as 30 trees on a land area of 1 ha (Fig. 1).

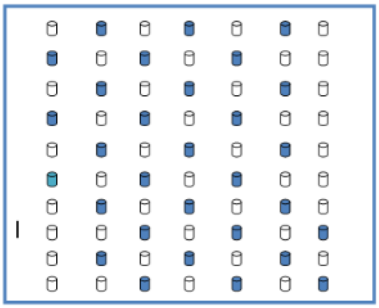

FIGURE 1. Plant sample plot design.

The tree samples were divided into six subsamples based on the cardinal directions (North, East, South, and West). The cardinal directions are determined using GPS by deriving two plant branches per cardinal direction. Coffee cherry samples were collected from sub-sample branches, and the fruit sample was counted based on the number of fruits on the branches and counting the number of fruits affected by *H. hampei* pests. Observation parameters include fruit that has been attacked by the *H. hampei* pest, which occurs when the fruit has holes. The infected fruits were taken from

the field to dissect and observe under a microscope used the observation parameter to see the intensity of the *H. hampei* pest attack [5].

$$Sb = n/Nb \times 100\% \quad (1)$$

Where:
Sb = Intensity of pest attack (%)
n = Number of coffee cherries affected on each branch of observation
Nb = Total fruit on each branch.

The intensity of pest attack was classified as follows: mild (25%), moderate (25%-50%), severe (50%-90%), and puso (>90%).

Data Analysis

The collected data was then analyzed quantitatively using Microsoft Office Excel.

RESULTS AND DISCUSSION

The Intensity of The Coffee Fruit Borer (*H. hampei*)

H. hampei is one of the pests that are very troubling for farmers in Baroko Enrekang Regency due to the pest attack, which significantly affects the yields to be obtained. The severity of *H. hampei* attack in Fig. 2.

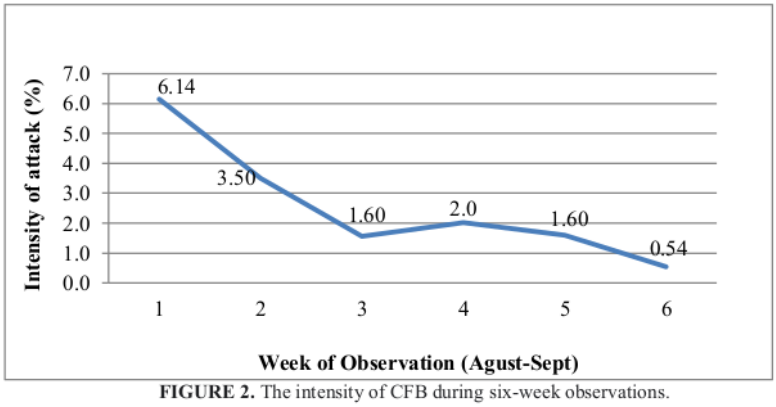

FIGURE 2. The intensity of CFB during six-week observations.

The observations made for 6 weeks of observation showed the highest attack intensity in the first observation was 6.14%, the attack category was in the low attack category, the low attack rate occurred because farmers often were pruning which helped to suppress the intensity of *H. hampei* attacks. Population fluctuations occur due to the availability of food sources. Figure 2 shows that demographic fluctuations occurred with each observation, decreasing attack intensity. This is because the fruit that has attack symptoms is plundered to suppress *H. hampei* development. In addition, the fewer coffee cherries in the fields caused the population of *H. hampei* to decrease so that the intensity of attacks also decreased. The influence of moisture levels influences the change in CBB and becomes a limiting factor on the dynamics and distribution of the *H. hampei* population [6]. Due to the protection from sunlight provided by CBB on coffee branches, the activity of *H. hampei* imago increased because the shaded branch became a resting place for *H. hampei* imago and would attack fruit around the shaded branch. Thus, pruning plants causes light to penetrate the coffee plantation, and air circulation in the coffee garden will be better and create conditions that CBB does not favor.

Monitoring the color of fruit attacked by the coffee berry borer, *H. hampei* attacks coffee cherries whose endosperm has hardened, both young and old. The results showed that the color of the fruit attacked by *H. hampei* greatly affected the intensity of the attack Fig. 3.

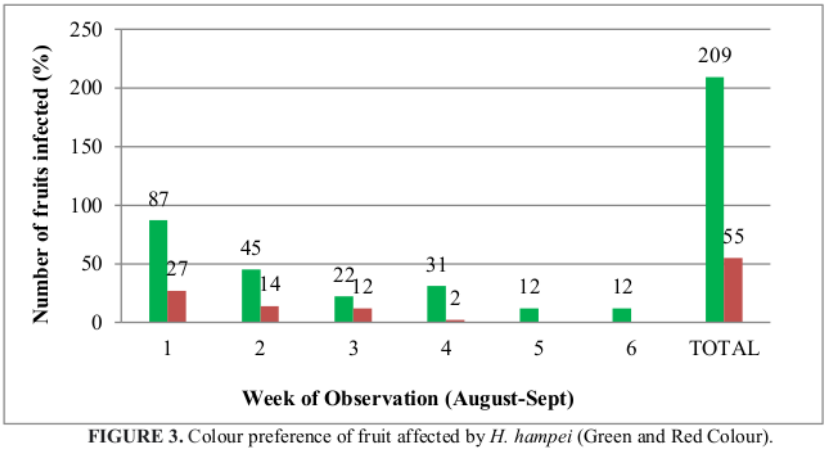

FIGURE 3. Colour preference of fruit affected by *H. hampei* (Green and Red Colour).

Coffeeberry that are attacked by *H. hampei* based on the color of the fruit when the split is shown in Fig. 4. The fruit attacked by *H. hampei* has a symptom of a hole at the bottom of the fruit. The fruit does not develop and will change color to reddish yellow, which causes the fruit to fall.

FIGURE 4. Green coffee berry affected by CBB.

This showed that the green fruit was mostly attacked by *H hampei*, which happened because *H hampei* would attack the young fruit, whose endosperm had not yet hardened so that the dark green fruit that was one month old was the most attacked. Dark green fruits have soft flesh that helps *H. hampei* carry out attacks. Observations were done after the peak of the harvest so that the fruits at the observation site were leftover fruits after harvesting and generally, the fruits were still dark green (Stage 3).

Monitoring Population and *H. hampei* stadia at the stage of development in Coffee Fruit

Coffee Borer pests undergo a complete metamorphosis of eggs, larvae, pupae, and imago that damage coffee cherries. On the damaged fruit, pest monitoring revealed egg, larva, pupa, and imago stages. The first observation the initial observation discovered pests throughout all phases of development (Fig. 5).

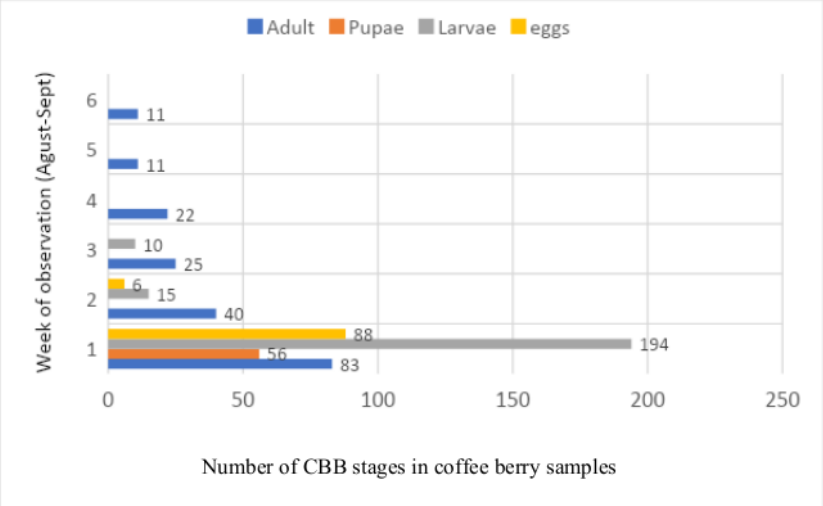

FIGURE 5. Stage of the coffee borer infecting the fruit of the coffee.

In the first observation, the population of all developmental stages of H. hampei was found in large numbers and the highest compared to other observations. This occurred because, at the time of the field observation of the immature fruit, there were still a large number of imagos of H. hampei, making reproduction in the field simple. During the 3rd to 6th week of observation, the stadia found were generally imago. This was due to the 3rd to 6th week of observation that the fruit was ripe (stage 4) with a hardened endosperm layer *H. hampei* imago could not be detected. Lay eggs, and what develops is the pre-adult stage from the previous stage, namely at the 1st to 2nd-week observation. Another influencing factor is that symptomatic fruits are taken from the field to interrupt the development of larvae into imago.

The survey results of coffee farmers showed that generally, the control techniques carried out by local farmers used pruning techniques and the use of pesticides. The most widely used control was pruning, with a percentage of 83.30%. Farmers generally use pruning techniques compared to other control techniques, which suppress the moisture level of the fruit site.

DISCUSSION

The intensity of the coffee berry borer attack in Fig. 4 shows that the highest intensity was found in the first observation of 6.14%, this category was included in the low category. The low intensity of attacks occurs because farmers often size and have passed the crop's peak. According to Baker et al., (1992), which indicates that *H. Hampei* attacks will increase when approaching the peak of harvest [7]. During the height of the harvest, the population of *H. Hampei* is very abundant in the field, then after the harvest ends, the population of *H. Hemp* will decline.

Fluctuations in *H. hampei* occur because feed sources influence it. Fig. 2 shows that the decrease in attack intensity at each observation was due to the coffee cherries being attacked and the sample was observed by taking fruit or harvesting so that at each subsequent observation, the number of coffeeberries in the field would continue to cause *H. hampei* also to decrease. The reduced *H. hampei* feed in the field caused the *H. hampei* population to decrease so that the intensity of the attack would decrease. According to Lauziere et al., (2000), insect population fluctuations occur because available feed sources and the controls influence them applied [6]. The availability of sufficient food is very influential on the survival and proliferation of *H. hampei*. In this case, if the fruit is symptomatic taken from the field, it will cause the fruit to decrease so that it will affect the population of *H. hampei* because taking the fruit can help decide the development of *H. hampei* stadia. A prominent dead female is under the white powdery patch on the berry's apex. The borer emerges from the hardened endosperm and excavates irregular tunnels and galleries where she lays

clusters of eggs. The 50 eggs can develop into adults within 25-60 days, depending on the temperature and endosperm consistency. Lauziere et al., (2000) reported that the female leaves the brood to start a new brood in another berry [6].

Pruning techniques that are routinely carried out are one factor in the low intensity of attacks. Control by pruning can reduce humidity and environmental temperature to create conditions that are not suitable for the development of *H. hampei*. On branches of coffee plants protected by sunlight, the activity of *H. hampei* imago is high because the shaded branches become a resting place for *H. hampei* imago, then *H. hampei* will attack the fruits around the humid branches [8]. According to Vega et al., (2009), pruning can facilitate the entry of sunlight on the entire leaf surface to cause the spread of pests to be inhibited [9]. The pruning coffee plants affect the attack rate of *H. hampei*. The function of pruning is to reduce the humidity that supports the development of *H. hampei*. *I*t can also reduce host sources from tree branches that have been attacked by *H. hampei*.

The factors that can attract CBB to attack coffee cherries are the shape, intensity of fruit colour, the fruit disc width, and aroma of coffee berries so that it affects differences in the intensity of *H hampei* attacks. The color of the green fruit is the fruit most attacked by *H. hampei*. The attack of *H. hampei* causes the fruit not to develop, and the color will turn reddish-yellow, and damage will occur in the seeds, as shown in Fig. 6. According to Silva et al., (2012) stated that the *H. hampei* pest carried out its first attack on young fruit with conditions [10]. The flesh of the fruit is still soft and colorful, but the coffee fruit that is still soft is generally only picked up to get food will then be left behind.

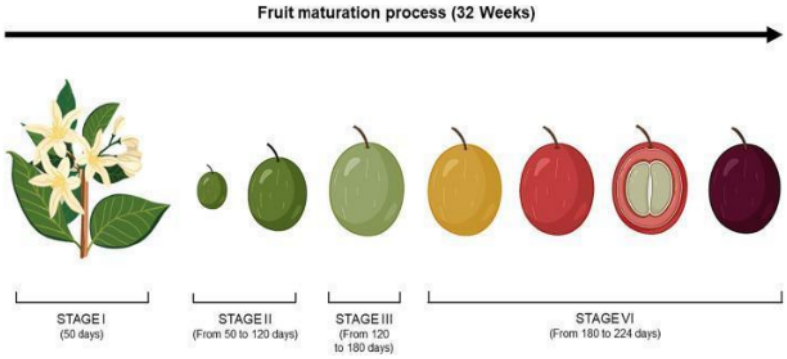

FIGURE 6. Level of maturation of coffee berries.

H. hampei made its first attacked young, dark green fruit (Stage 3) with hardened endosperm. The female imago breeds on young coffee cherries before maturity at 1 month. This is because the soft flesh of the fruit makes it easier for *H. hampei* to carry out hoisting, then *H. hampei* will lay eggs. Development from egg to imago takes place in the fruit. The developmental stage of *H. hampei* in plant samples showed that the first week of observation of the population of the pre-adult stage was the highest compared to other observations (Fig. 5). Many developmental stadia/phases of *H. hampei* found in the first observation occurred because there were still many young fruits in the field at the time of observation, so the image of *H. hampei* was easy to find a niche (fruit) for laying eggs. The decrease in the number of stadia/phases of pest development in subsequent observations occurred because symptomatic fruits were taken to be observed to break the development phase of the next stadia.

The eggs of *H. hampei* were clear, transparent, and very small in size, and the larval stage had a paler color. The color of the *H. hampei* pupa was milky white. The image of *H. hampei* was brownish-black, related to stated Baker et al., (1994), that the borer was coffee cherries are completely metamorphosed (Holometabola) with transparent eggs, C-shaped larvae and yellowish-white, milky white pupae, and black-brown imago [12]. The pruning technique is a technique that is often used the observation site (Fig. 6). The pruning technique is carried out because it is more cost-effective and effective in reducing the spread of the coffee berry borer. Pruning is done once a week and some farmers do pruning once two weeks. According to Hamilton et al., (2019), regular sanitation or pruning can reduce the spread of pests because pruning can regulate light temperature, and air circulation as conditions, which is less favored by the coffee berry borer [12]. The existence of farmer groups in Benteng Alla Utara Village that implements and provide counseling to nearby farmers regarding the negative impact of using pesticides is the cause of the lack of farmers using pesticides in control techniques.

CONCLUSION

The intensity of the *H. hampei* attack on coffee plantations in Benteng Alla Utara Village, Baroko District, Enrekang Regency was 6.14%, classified as low attack intensity. Fruit preference for CBB attack prefers green fruit to ripe red fruit.

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