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Research Article

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Chemical controlled strategy of ant occupied coconut tree (*Iridomyrmex cordatus*) (Hymenoptera: Formicidae) as the vector of cocoa pod rot disease(*Phytophthora palmivora*)

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ABSTRACT

The purpose of this research was to evaluate the effectiveness of several types of chemical compound insecticide combined with food bait to Iridomyrmex cordatus population as the agent of pod rot disease, Phytophthora palmivora, in the cocoa plant. The research is expected to find out better insecticide trial in pressing ant population. This research was conducted in Muktisari region (North Luwu district). Research design consisted of 5 trials (5 replications per trial) and to analyze data, regression analysis was used. Ant populations were measured based on scoring referred to Way and Khoo (1989) method; score 1= less than 50 population, score 2= 50 – 200 population, score 3= 200 – 500 population and score 4= more than 500 population observed. The average of ant population reached the highest score in the treatment of Fenvalerate with score 3.0 (about 350 population), meanwhile the lowest score was in the treatment of Chlorpyrifos reaching score 2.1 (about 200 population). All trials seemed to reduce population of I. cordatus. However, a noticeable reduction of ant population was shown in Chlorpyrifos trial (A2) and Carbaryl (A4).

Keywords: *Iridomyrmex cordatus*, insecticide, cocoa plant, *Phytophthora palmivora*

INTRODUCTION

Cocoa (*Theobroma cacao* L.) is one of many estate crops having high economic value and therefore this commodity has become a leading sector in boosting the income of cocoa farmers, governments and cocoa stakeholders and in helping development of agricultural business and agro industries.

According to data of Biro Pusat Statistik (BPS) in 1982-1986, cocoa export has been increasing from year to year [23]. In the past, unfortunately, the national export of cocoa beans reaching at 260,000 tonnes experienced $100 penalty per ton in London due to poor quality affecting to lost national income [2].

One of main factors is pests and diseases infected in cocoa farm and storage. Cocoa pod borer (*Conopomorpha cramerella*) and pod sucker (*Helopeltis* sp.) are major pests in cocoa plantation and vascular streak dieback (VSD) caused by *Ceratobasidium theobramae* and *ramicola* [21], cocoa pod rot disease and stem cancer influenced by *P. palmivora* are main cocoa diseases [15]. As [15] reports, cocoa diseases caused by fungal *P. palmivora* in Kar Kar island in Papua reduced to 63% of cocoa production and killed 10% of the trees otherwise the diseases were controlled. As [11] point out, fungal Phytophthora lost yield from 30% to 90% annually. Cocoa pod rot disease in Trinidad and Tobago reduced cocoa yield about 70%. In Indonesia particularly South Sulawesi, cocoa diseases has spread broadly in main cocoa producer regions such as Majene, Bulukumba, Bone, Soppeng, Sinjai, Wajo, Pinrang, Mamuju, and Palopo incurring 60% of severity damage [4]. Several infected ways, splashing rain surface ground, rain drop, touching between heath and infected pods and transferred by ant activities. [5] argues that rain splash played a crucial role because of carrying massively source of inoculums and ant activities such as foraging and nest building were vulnerable to spreading the cocoa pod rot disease. As [16] points out, ant contributed to 24% of dispersal of pathogen *P. palmivora* in the field, there was 70% caused by rain, and another dispersal made up other factors was 6%. The ant is successful agent in over spreading to the disease as its behaviors to build up their nest below ground and to bring inoculum sources of cocoa pod rot disease to stem or main branches. In Papua Nugini, it has been reported that types of ant species such as *Iridomyrmex* spp., *Crematogaster difformis*, and *Solenopsis* sp. are admittedly to over spread the pathogen of *P. palmivora* [22]. On the laboratory, the study of [20] identified *P. palmivora* carried by *Iridomyrmex cordatus* and the body of *I. cordatus* was embedded into surface healthy pod resulted in necrosis (black spotted) of cocoa pod rot disease. In addition, [13] recorded that there were a strong correlation between the severity damage of *P. palmivora* and *I. cordatus* which the highest pathogen infestation was assessed in cocoa trees. The trees occupied with a high ant population of *I. cordatus* (about 200 population) posed much more infected cocoa pod rot disease reaching 60 % of pod damage than unoccupied trees (control) was just 20 %.

The article is mainly focused on a strategy of *Iridomyrmex* spp. management by using lethal food bait and spray with systemic insecticide [12]. The spray with systemic insecticide is in effective as a queen of ant population is not killed regenerating large numbers of workers [8,17].

The control of *Iridomyrmex* spp. by using lethal trap may be more effective. The lethal food bait will be carried to their nest by the workers (trophallaxis) and to feed their larva and a queen [9,17,19]. The lethal trap consists of insecticide and attractant [9]. Sugar is very important attractant as the ant attracts highly [18] as well as dried fish, chicken intestine, shrimp, the body of grasshopper and cicada [1,10].

EXPERIMENTAL SECTION

The study was carried out in the Village of Muktisari, Sub-district of Bone-Bone District of North Luwu. The trees chosen purposively were to have tunnel of ant *Iridomyrmex cordatus* in the branches and stem. Among the trees distance was rather far.

1. Preliminary study

In this trial, the choice of artificial diets such as dried fish, chicken intestine, the body of grasshopper and cicada where were put together in the trees. Artificial diets were given without insecticide trial. Preliminary study was aimed to obtain food preference of *I. cordatus* and therefore they were made as a food attractant dissolved by insecticide. Food trial was laid into same place in cocoa trees and fed in the morning, food residual would be measured its weight prior to the next observation. The preliminary observation and test were carried out a week and every two days were accounted the remains of food in the place. The food trap visited mostly by *I. cordatus* was anchovies, 4.18 g of weight average before the body of grasshopper with 3.05 g, and intestine chicken 2.13 g.

2. Trap design

Every 0.1 mL of beta-cyfluthrin, Chlorpyrifos and Carbaryl per 100 mL of water was used while another trial of insecticide with 0.5 gr Carbaryl per 100 mL of water was implemented. Anchovies were soaked to every insecticide trial for ±10 minutes, dried and laid into a medium in cocoa tree. The trial was aimed to prevent the treatments and dropped water remained at the medium.

3. Research design

Design of study was carried out 5 replications per trial and 7 times observations by using regression analyses following;

A1. *β*-cyfluthrin
A2. Chlorpyrifos
A3. Fenvalerate
A4. Carbaryl
A5. Control

4. Observation

The toxicity test was conducted a day after the trap containing varied insecticides laid into the medium in the tree which every observation was done weekly. The next trap would be done once a two day. Parameter of observation used was ant colony appearance in the tree after trial given. Ant colony measurement was categorized based on [27] (Table 1).

Tabel 1.Ant colony measurement was categorized based on Way and Khoo (1989)

Score	Category	Number of ant population in the tree observed
1	few population	Ant colony was seen in the main branch and stem cocoa tree less than 50 colony
2	Some population	Ant population had more than 200 colony
3	Many population	about 201-500 colony of ant population were seen in the main branch and stem
4	Abundant population	There were over 500 colony of ant and overspread on the tree

RESULTS AND DISCUSSION

Figure 1 and 2 represented as an entire study and in line with regression analysis, there has been showed score average of ant population *Iridomyrmex cordatus* observed in the cocoa trees.

Figure 1 showed that in the first week observation, the average of ant population *I. cordatus* in the whole treatments and control has decreased. The ant population that has still stabilized was due to emerging generation and a number of eggs immediately emerged to every colony and thus the number of ant population killed was not significantly, compared to the number of ant population growing. Meanwhile, in control there was not change in population instead because they were fed without insecticidal trial. In food bait, ant workers were foraging and fed their colonies. However, prior to carry amount of food to their nest, they sufferred severely and dead immediately throughout foraging with the trial whose rapid knocked down effect and therefore the colonies in the nest avoided from lethal food given. As [26] state, the control of *Iridomyrmex* spp. colony by using both bait of feeding and spray was determined further how far distance to spray and how big nest size to be aimed. The increase of ant population might be led by the number of young generation emigrated and in the same time their eggs were readily emerging.

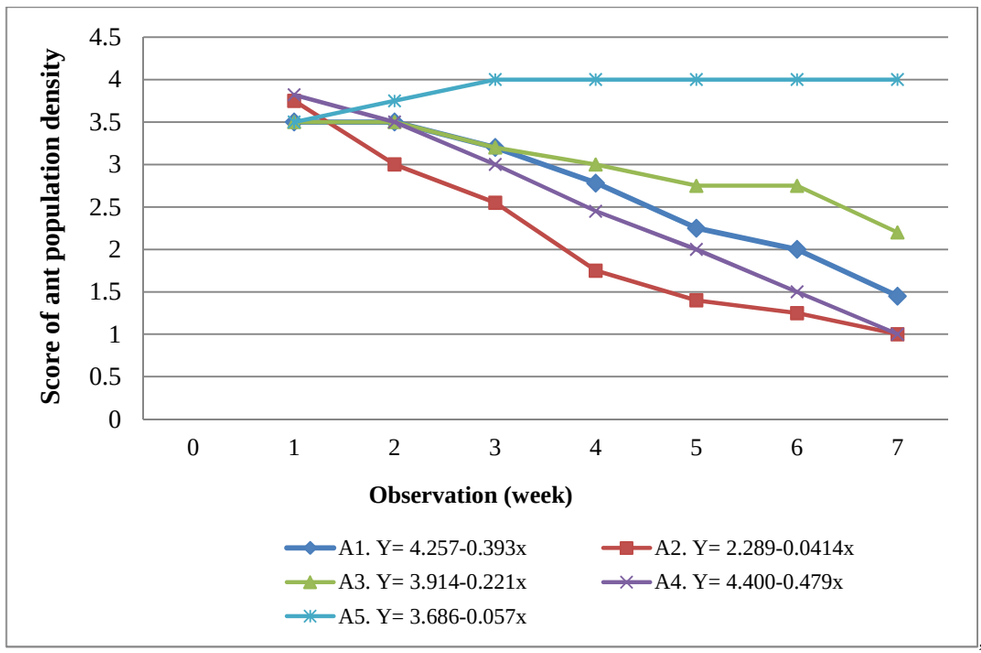

Figure 1. Relationship between decline of *Iridomyrmex cordatus* population and trials of weekly observation

A1. β-cyfluthrin
A2. Chlorpyrifos
A3. Fenvalerat
A4. Carbaryl
A5. Control

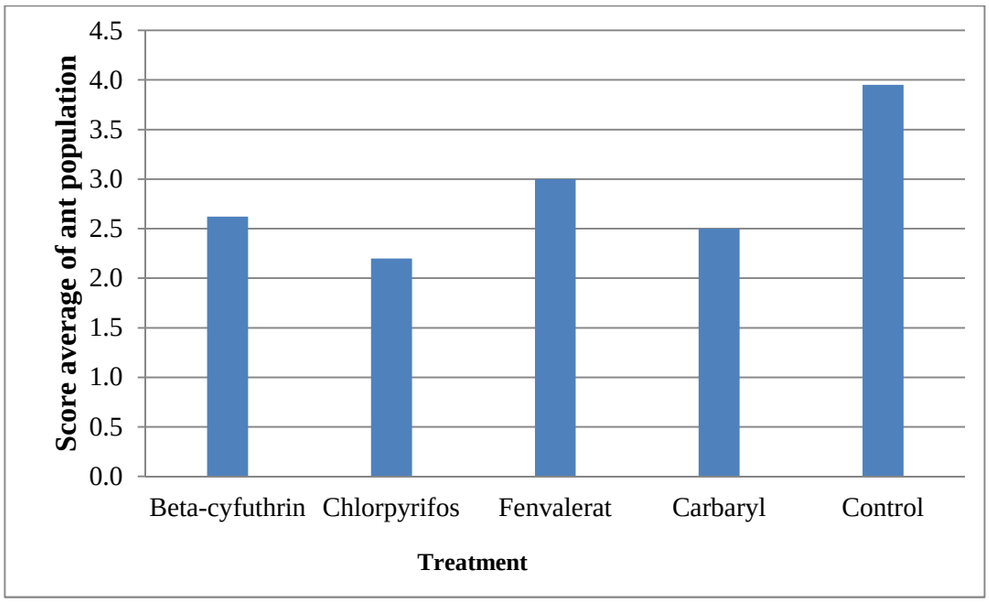

Figure 2. The score average of population *Iridomyrmex cordatus* throughout 7 week-observation

As a consequence, the trials of artificial diet without insecticide could be indeed developed properly and the environmental effect was not significantly to influence their population. [14] argues that *Iridomyrmex* spp. with possessing high ability to grow due to number of queens in every colony increasing their population. Moreover, [25] states that an organism that has powerful ability to develop could regenerate and maximize their colony based on their genetic ability and when there are the number of appropriate diet availability to their generation and favorable environmental support. In Figure 1, the trial of Chlorpyrifos shows that the average of ant colony of *I. cordatus.* was lower population than other trials following Figure 2. That is, because approximately population of *I. cordatus* to this trial of Chlorpyrifos seemed like to be due to effect of Chlorpyrifos that is categorized into lethal insecticide of organophosphate. [25] claims that group of organophosphate has high toxicity to group of insects, contiguity and broad-spectrum and devastates intestine system. A type of contact poison is such a rapid knocked down effect with killing ant population rapidly. When the workers are foraging and carry the lethal food bait, they are not able to reach at their nest. Meanwhile, in contrast to contact poison, a typical stomach poison does not kill rapidly and the ant colony has a bit time longer to live. Therefore, such workers along with food could still reach to their nest afterwards being killed. All generation in the nest and a queen can be killed as well. Mode of action of Organophosphate is to destroy cholinesterase in the cell as a consequence of cell nerve transmitted to acetylcholine ending up in the central nerve [9]. The effect on distraction to acetyl- cholinesterase system leads to accumulation of acetylcholine damaging a nerve transmission system so that the function of nerve system is not workable to transmit to muscles of insect and therefore insect become paralysis and death [25]. Comparison among trials of Carbaryl, β-cyfluthrin and Fenvalerat to ant colony indicated that ant population *I. cordatus* in the trial by using Carbaryl was lower than other trials. Reduction of ant population in trial of Carbaryl may be due to a group of Carbamate having a rapid knocked down effect to their colony. Moreover, Carbaryl is not longer remaining in insect exoskeletons even though this insecticide has ability to poison *Iridomyrmex* spp. Carbaryl is relatively stable in environment due to effects on the acid reaction and light exposure. Carbaryl is a type of insecticide that rapidly responds to organisms

and has a very short residual [3]. On the other trials, β-cyfluthrin and Fenvalerat, the average of *I. cordatus* population was higher that the trial by using the Chlorpyrifos and Carbaryl (Figure 2). An increase of *I. cordatus* population on the trials of β-cyfluthrin and Fenvalerat (group of synthetic Pyrethroid) was affected by characteristic insecticides due to knocked down effect, posing rapid death of insect. this type of insecticide is generally known as contact poison.. In addition, synthetic Pyrethroid can also cause the ant aimed to recovery from chemical exposure. Synthetic Pyrethroid easily evaporates when radiates ultraviolet exposure. [24] argues that type of synthetic Pyrethroid insecticide has a positive side effect due to having *knocked down* effect to kill quickly the ant aimed. Although a very low dosage disseminated to the ant colony targeted, it still rapidly devastates, and its residual in environment shortly remains due to a daily ultraviolet degradation factor and therefore the trial is rather saved from pollution.

CONCLUSION

Based on the result above, the highest average of *Iridomyrmex cordatus* population occurred in control (score 4; over 500 colonies) followed by the trial of Fenvalerat reaching at score 3.0 (more or less 350 colonies). Other trials, meanwhile, the average of *I. cordatus* population was low in the trial of Chlorpyrifos, reaching at score 2.1 (more or less 200 colony). The trial of Chlorpyrifos (A2) and Carbaryl (A4) combined with bait made from artificial diet showed the most effectiveness in reducing ant population.

Suggestion

To manage *I. cordatus* in the cocoa trees, Chlorpyrifos or Carbaryl either combined with bait of artificial diet should be disseminated due to effective reduction of *I. cordatus* population as well as benefit for economical use.

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