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Black Ant (*Dolichoderus thoracicus*): Artificial Diet and Nest Prospects in Controlling Cocoa Pod Borer (*Conopomorpha cramerella* Sn.)

Ahdin Gassa*, Fatahuddin, Tamrin Abdullah, and Muhammad Junaid.

Department of Plant Protection, Faculty of Agriculture, The University of Hasanuddin, Makassar-South Sulawesi, 90245, Indonesia.

ABSTRACT

It is undeniable that abundant black ant population along within cocoa treescan significantly benefit for controlling cocoa pod borer(CPB) and therefore most of efforts to establish ant colony have been focused. One of tactics is to manipulate food and nest built. The research objectives were first to understand how ant colony spread with in the trees and preyed on CPB once the colony prefered artificial nest made from organic matter and granule organic food trigger, second to know feasibility of artificial diet and nest (easily applied) built in order to optimize abundant population. The trials designed by following randomized block design consisting of five (5) trials with six (6) replications. The trias consisted of leaves of cocoa, coconut, coconut and bambo mixed and banana attached on the sieve tube bamboo. all trials were tie up in the cocoa (4 m range from ant colony). The ant distribution was observed and measured distance (m) from where the ant released and then mapping distribution and population abundance was drawn up. Predation ability was measured with the number of larvae, prepupa and pupae of CPB prayed everyday for 8 hours-observation.The results revealed that initial observation was relatively score 1 and 2 (from less than 50 to 200 colonies). In the final observation, ant built the nest (200 colonies in average) in only the trial of banana leaf attached on sieve tube bamboo and coconut and bamboo leaves mixed. Unlikely the ant tended to not pray eggs, 80.32 percent of larvae were prayed followed by prepupa (68.25%) and pupa (62.45 %) respectively. CPB infestation on pods in the trials showed a very slightly damage level. By contrast, the field without ant indicated heavy damage level of pods harvested.

Keywords: *Dolichoderus thoracicus*, artificial diet and nest formulation, *Conopomorpha cramerella* Sn.

**Corresponding author*

INTRODUCTION

Majority of Sulawesi cocoa farmers still relies heavily upon chemical usage in insect pest control. Despite the farmers gain benefits from hazardous chemical substances, unconsciously, the costs of control increase and health and environmental issues as another consequence must be paid as well. [16] pointed out that chemical tactic to control main cocoa pest was unsuccesfull. He assumed that a broadly wide range of CPB infestation these days is perhaps due massively to chemical control usage in the field. Once the farmers massively apply insecticide, CPB then will avoid against insectice spread (as behaviorous resistant mechanism to sustain the generation) by moving out around the trees untreated. the new infestation has begun. Indeed, resistant phenomenon arised and paid high attention of plant protection expertices in Malaysia. Group of Pyrethroid massively was often applied in normal dosage, in spite of killing CPB [12].

By looking at insect cocoa pod borer (CPB) as main pest whenever cocoa grows, there is serious threat in reducing the incomes of cocoa actors. Many efforts designed to control the main pest of cocoa, but then non significant controled package is trully applicable - when the control package is applied in field. For instance, one of pest control effors, using pod sleeving but the tactic therefore was refused by many of farmers with various reasons. In spite of the fact that the tactic of pest control was unpplicable and uneconomical as well as non efficient platform after examined, the need for effective and efficient pest control has to be explored.

In the nature, every single insect pest has at least a group of enemies that will affect to its development and behavior, no exception of insect cocoa pod borer. The natural enemy might be from parasitoid, predator or parasite. Of many general enemies, predator is potentially to be focused in this area. Previous study indicated that seven ant species were investigated to dominate cocoa farm. However, after examining the species which is potential to be developed as biocontrol for insect CPB, the only three ant species actively forage and colonize the tree day and night [1]. Furthermore, in contrast to without ant in the tree, a significant correlation between the tree occupied by ant (trial) and lack of pod damages harvested was assessed-most of pods was CPB infestation free but not in the control [2,6]. [3] examined the range of *O. smaragdina* foraging and number of nest development increased after providing artificial diet and therefore reduction of CPB infestation was significantly in the tree colonized.

Interaction between group of ant in particular black ant and mealybugs has been widely known in plant protection expertices as symbiotic-mutualism. Remarkable mechanism is when the ant colony receives honeydew and any other secresion liquors given by mealybugs while mealybugs earn a protection against the enemies. The honeydew released becomes a main source of food for black ant [8]. A group of mealybugs generally consists of *Planococcus liliacinus* and *Pseudococcus citri*.

By looking at limited amount of honeydew released, a critical issue arised when provision of honeydew is in appropriate in order to maintain enourmous ant colony (if expected in developing successful and effective biocontrol agent in the nature). Although a successful biocontrol achieved due to ant colonization the tree supported by the number of mealybugs nice the same tree, establishing in any different host-tree artificially may not be successful [7]. The group of mealybugs is often arise of serious problem in crop cultivation as damaging leaves and incurring fruit dwarf. The worthwhile idea arises investigating a potential combination between black ant colony (*Dolichoderus thoracicus*) and the mealybugs adopted in the cocoa whithout incurring negative impact. Study therefore was undertaken to design alternative food (artificially) to the ant in order to change the role of mealybugs in providing honeydew. By designing the trials to limit CPB infestation under economic threshold, using artificial diet, feeding stimulation by using artificial diet combined with artificial nest was expected to be applicable.

MATERIALS AND METHODS

Artificial Diet Preparation

Food bait made from waste of shrimp and chicken intestine was milled as flour. The flour was mixed to produce paste with composition : 0.25 (100 g shrimp) : 1.0 (400 g white sugar) : 0.5 (200 g flour). Testing durability of paste in the store, plant active ingredient was added as an antimicrobial role. In the end, the paste was performed in 1 g pellet before 5 minutes heated.

Ant Population Development

The objective was to produce abundant ant population and expected to be biological control active against major pest (CPB) in the tree. Ant population was measured as following [10] (Table 1).

Table 1. Categorizing ant colony based on [10]

Scoring of population	Category	Ant population occupied tree
1	Slight	Less than 50 ant population occupied in the branch and stem. No nest developed
2	Mild	50 - 200 ant population occupied and an initial nest developed
3	many	Up to 500 ant population occupied the branch and main stem and a proper nest developed
4	Abundant	More than 500 ant population occupied the tree and moved to colonyze tree surrounding

Development of Black Ant (*Dolichoderus thoracicus*) Stimulated With a Combination Between Artificial Diet and Nest

At the beginning of developing and releasing ant population, there was in a nearby tree and nest, followed by application of artificial diet. This was meant to allow an initial adaptation of ant population to grow and develop nest. Artificial nest developed within trials consisted of three (3) plots and each plot consisted of five (5) artificial nest trials. Artificial nest was made from a 45 cm (lenght) and 7 cm (diameter) bamboo. Every trial (dry leaves of coconut, banana and cocoa) was attached onto sieve tube bamboo. The other trials (without bamboo) were dry leaves of coconut leaf and cocoa only. Stimulation of artificial diet made from prown steamed was applied in each trial (artificial nest). In each artificial nest per observation plot, the trial was repeated six (6) times using 30 trees. Once the aritificial nest inhabited by ant colony and eggs developed, the artificial nest was transffered into observation plot. Every week was investigated followed by artifical food and sugarcane liquid given.

Ant Preadation Measurement

In the observation of egg, larvae and pupae predation, technique used was tocalculateaccording to egg, larvae and pupae exisisting in the pods and tree occuppied by black ant colony as following;

$$P = (n/N) \times 100\ \%$$

P = number of predation of egg, larvae and pupae
n = number of larvae or pupae prayed
N = Total of larvae and pupae in the sample tree

Severity Damage of CPB

Severity damage caused by CPB was begun to undertake when pod was ready to be harvested in all trials and control. Severity damage was calculated following:

$$Is = \frac{(Ri \times 0{,}093) + (Se \times 0{,}2970) + Be}{JB} \times 100\%$$

IS : severity damage of pod (%)
So : health
Ri : slight (1 % - < 10 % bean damage), easy to separate among beans and pulps
Se : mild (10 % - < 50 % bean damage), difficut to separte among beans and pulps
Be : heavy (> 50 % bean damage), very difficult to separate among beans and pulps
JB : Total of pods observed

RESULTS AND DISCUSSION

Black ant colony development (*Dolichoderus thoracicus*) with artificial nest

In Table 2, black ant population *D. thoracicus* was performed every trial. The Table indicated that ant population at the beginning of observation was relatively less population; from *score* 1, (<50 population) to score 2 (up to 200 population). However, in the end, artificial nest in different trial was inhabited. Ant population occupied bamboo attached leaves of banana showed score 1.6 (less than 200 population), coconut leaves only was score 1.5, <200 population), and bamboo attached leaves of coconut was (score 1.4, <200 population). Unlikely, leaves of cocoa and attaching in sieve bamboo were significant inhabitants, from score 0 to score 0.4 (<10 population). In the nature, nest of black ant often is laid into the ground, organic matters such as dried cocoa and coconut leaves fallen and a shaded and humid place near food source [17]. A natural selection occurs in occupying the cocoa tree. A competition among ant predators often faces and affects to a limited factor of growing colony and developing nest of certain ant. The only one single species colony of ant occupies and dominate as nice-tree unless different insect species will compite to be superior. A weaker ant colony will be refused to forange food around the nice. Therefore, the need for maintenance of ant population was necessary by introducing honewdew produced by mealybug within the cocoa. Nevertheless, if mealybug population unequals to ant population within the plot, insufficience of food for black ant population incurs and will result in a harmful effect for future generation of ant. The consequence is cocoa pod protection from CPB was less significant. It is likely dilemma as once mealybug population (source of honeydew) is higher than ant colony, mealybug colonises and suck pod and leaf layers impacting to dwarf pods and leaves and leaf roll and leaf disease caused by fungi. The activity of mealybug colonizing pods and leaves will interfere directly pothosyntesis pathway [14]. In many cases, mealybug is major pest associated with ant species. Therefore, regarding negative effects resulted from mealybug, an alternative diet was necessary to be developed.

Table 2. Black ant population (*Dolichoderus thoracicus*) performed in the trials triggered with alternative food.

Trial	Scoring ant population/ observation(day)											
	1	2	3	4	5	6	7	8	9	10	Total	average
Cocoa leaf	0.0	0.0	2.4	0.0	0.0	1.0	0.0	0.0	0.0	1.0	4.4	0.4^{a}
Coconut leaf	0.0	1.0	1.0	1.0	1.0	2.0	2.3	3.0	2.7	1.0	15.0	1.5^{b}
Bamboo + cocoa leaf	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0^{a}
Bamboo + coconut leaf	1.0	0.0	1.4	0.0	1.0	1.0	2.0	2.0	3.0	2.7	14.1	1.4^{b}
Bamboo + banana leaf	1.0	1.0	2.6	1.0	2.4	1.3	1.4	1.5	1.4	2.5	16.1	1.6^{b}

Note: number in the same column followed by same words is non-significant difference on 5% level of DMRT test.

The only bamboo attached dry cocoa was not preferred black ant colony to live. In the beginning, most of trials builtwas not fully accepted in the plot. Black ant colony had a tendence of accepting a new adaptation of habitat. However, in general black ant colony attracted and preferred bait of artificial diet mixed with sugarcane liquid given. This finding emphazised that, in the nature, black ant colony associates with mealybug producing honeydew as main source of food [11]. In addition, black ant attracted to artificial nest built (sieve bamboo attached dry coconut leaf). It was clearly seen that lot of ant population adapted and inhabited the artificial nest. Likely bamboo attached dry coconut leaf, ant population could grow in the dry banana and coconut leaves around the tree. [9] found ant colony nesting under the shaded branches of cocoa and coconut, dry coconut leaf and bamboo and tip of coconut. [10] added that black ant colony develop the nest under decayed leaves of cocoa and coconut fallen in the ground.

Predation ability

In this series observation, assessing ant ability of predation to larve and pupe was undertaken. Collecting all insect stadium (trial purposed) were carried out and then placed in the tree that was provided an artificial nest and also colonized by ant. The number of predation (%) would be known by measuring number of egg, larve, prepupa and pupae preyed (Table 3).

Tabel 3. Number of predation (%) to egg, larvae, prepupa and pupa by black ant.

Observation	Total stadium of CPB provided				Number of predation (%)			
	Egg	Larvae	Prepupa	Pupa	Egg	Larve	Prepupa	Pupa
I	2	25	4	6	1	80.0	75.0	66.6
II	1	23	14	3	0	80.0	71.4	66.6
III	1	9	3	2	0	88.0	66.6	50.0
IV	1	15	5	3	0	73.3	60.0	66.6
Average					1	80.32	68.25	62.45

In the Table 3, despite the ant colony tended not to prey egg in the field, the other insect stadium were successfully preyed; 80.32% of larvae, 68.25% of prepupa and 62.45% pupa respectively. Ant activity in the nature indicated aggressiveness behaviour to attack larvae and prepupa of CPB. In general, black ant (*Dolichoderus thoracicus*) is defined as predator [9]. Black ant (*D. thoracicus*) colonising the tree can benefit for insect pest protection such as fruit sucker *Helopeltis* spp., and CPB. Two mechanism offers in using black ant colony. Black ant colony can cover pod surface so that it can repeal the fruit sucker to land the pod for food and laying eggs. Black ant also can prey every single eggs, nymph of fruit sucker *Helopeltis* [17]. In 1908, experiment of using nest transformed to the cocoa field in Kediri allowed the tree to grow properly due mainly to CPB free infestation. [13] idetified that ant species obviously prey larvae and pupa CPB was *Iridomyrmex* spp., *Crematogaster* spp., *Myrmicaria brunnea*, *Oecophylla smaragdina*, *Odontoponera transversa*, and *Dolichoderus thoracicus.* In addition, the study conducted by [13] revealed 80% mortality of larvae and pupae *Conopomorpha cramerella* in the tree caused by different ant species. This finding, ant species has potential use in pest control of CPB.

Severity damage of pods caused by CPB

In Table 4, slight and mild severity damage caused by CPB were investigated. There was a shine and health pod appearance as indication. In contrast to plot control, most of pods harvested indicated heavy severy damage (Table 5). The pressured impact of black ant population in pods surrounding was significantly seen to beak off CPB female in egg laying on the surface. [9] pointed out that black ant species (*Dolichoderus thoracicus*) is a general predator. [15] added that based on experiment, of 36 tree samples, severity damage caused by fruit sucker *H. antonii* was less significant damage (only 1,04%) meanwhile pod damage in the control (no black ant activity) was 27,86%. Due mainly to ant activities such as foraging, nesting and colony development in the tree, the tree avoids from insect pest infestation-laying eggs [5]. The more *Dolichoderus thoracicus* population colonizes pods and tree, the less significant severity damage of pods incurs. If only partly tree such as branch or shoot is colonized, several pod damage incurs as *H. antonii* attacks other unoccupied pods [4].

Tabel 4. Severity damage caused by CPB in the trial plot (with *Dolichoderus thoracicus*)

Observation	Damage level (%)				Total pod
	Health	Slight	Middle	Heavy	
I	10	6	4	0	20
II	0	9	1	1	11
III	3	7	0	0	10
IV	5	3	5	0	13
V	0	6	3	1	10
VI	4	6	0	0	10
VII	8	0	3	0	11
VIII	7	0	4	0	11
IX	5	0	2	0	7
X	7	0	3	0	10

Tabel 5. Severity damage caused by CPB in the trial plot (without *Dolichoderus thoracicus*)

Observation	Damage level (%)				Total pod
	Health	Slight	Middle	Heavy	
I	0	4	12	4	18
II	0	1	12	2	15
III	3	6	15	2	26
IV	0	4	7	4	15
V	0	0	11	4	15
VI	0	6	11	3	20
VII	0	7	14	2	23
VIII	0	3	22	2	27
IX	0	3	15	2	20
X	0	3	12	0	15
XI	0	1	13	1	15
XII	0	10	15	0	25
XIII	0	2	23	0	25
XIV	0	2	24	0	26
XV	4	0	18	2	24

Note:
Health (0, no CPB infestation)
Slight (< 12 % bean damage), easy to spread among beans and pulp
Middle (> 34 % bean damage), harder to spread among beans and pulp
Heavy (> 54 % bean damage), solidifying among beans and pulp

CONCLUSION

Black ant colony, *Dolichoderus thoracicus,* at the beginning was less significant population, from score 1 (<50 population) to score 2 (up to 200 population). However, the population turned up and colonized artificial nestgiven in particular dry banana leaf attached in the sieve tube bamboo (score 1.6, <200 population), dry coconut leaf (score 1.5, <200 population) and dry coconut leaf attached in the sieve tube bamboo (score 1.4, <200 population). A significant heavy pod damage caused by CPB inccured in the control while in the trialsalmost pods harvested were health. Although black ant colony had a tendency, not to prey the eggs, predation value of larvae was higher (80.32%) followed by prepupa (68.25%) and pupae(62.45%) respectively.

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