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Postharvest management of cocoa pod borer

(Pengurusan lepas tuai pengorek buah koko)

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Key words: cocoa pod borer, cultural practice, insecticide, integrated pest management

Abstrak

Kawasan-kawasan koko yang diserang oleh pengorek buah koko (PBK), *Conopomorpha cramerella* (Snellen), terus mengalami kerugian hasil walaupun berbagai-bagai usaha pengawalannya telah dilakukan. Keadaan ini berlaku mungkin disebabkan pengekalan generasi melalui larva-larva yang keluar selepas buah dipetik dan dibelah. Satu kajian telah dijalankan untuk mengkaji corak pengeluaran larva selepas buah dipetik dan dibelah. Usaha-usaha membungkus serta menyembur kulit buah telah dibuat untuk menyekat larva-larva tersebut daripada terus hidup. Lebih kurang 80% atau purata 231.2 larva/100 biji buah keluar sebelum buah dipetik, manakala 20% atau purata 58.7 larva/100 biji buah keluar selepas buah dipetik. Jangka masa larva-larva ini keluar berbeza di antara 11–21 hari bagi buah yang dibelah dan tidak dibelah. Telah direkod bahawa purata yang melebihi 85% dan lebih kurang 58% daripada larva telah keluar daripada buah-buah yang telah dibelah dan tidak dibelah dalam minggu pertama selepas buah dipetik. Membungkus kulit buah menyebabkan 100% larva yang keluar itu mati dalam masa 5 hari. Pembungkusan juga mempercepat kulit buah menjadi reput yang mungkin disebabkan oleh suhu dan kelembapan yang tinggi di dalam karung bungkusan. Semburan racun serangga pada kulit buah menyebabkan 89% kematian larva yang keluar selepas buah dibelah. Peranan dan keutamaan pembungkusan dan penyemburan racun serangga pada kulit buah untuk mengawal pengeluaran larva selepas buah dipetik dan dibelah serta keseluruhan program pengurusan perosak bersepadu dibincangkan.

Abstract

Cocoa pod borer (CPB), *Conopomorpha cramerella* (Snellen), continued to inflict yield loss in the infested areas although various control efforts were instituted. The reason for this phenomenon might be because of the continued survival of generation through postharvest larval emergence. An investigation was carried out to examine the postharvest larval emergence pattern, and the bagging of split pod husks and insecticide spraying on pod husks as means to suppress their survival. Nearly 80% or an average of 231.2 larvae/100 pods emerged before the pods were harvested, while the other 20% or an average of 58.7 larvae/100 pods emerged after the pods were harvested. The duration of emergence varied from 11–21 days for the split and unsplit pods. An average of more than 85% and about 58% larval emergence were recorded from split and unsplit pods during the first week after harvesting. Bagging of pod husks

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ensured a 100% mortality to the emerging larvae within 5 days and enhanced husk rot probably through increased temperature and relative humidity inside the bags. The spraying of insecticide caused an average of about 89% mortality to the postharvest larval emergence. The significance of bagging and insecticide spraying in the management of postharvest larval emergence and the overall CPB integrated pest management programme are discussed.

Introduction

Cocoa pod borer (CPB), *Conopomorpha cramerella* (Snellen), is the most serious pest of cocoa in Malaysia. The pest may cause total yield loss if left untreated. Since its first discovery in Malaysia at Tawau district in the state of Sabah in late 1980, various methods were developed to manage the pest (Azhar 1986a,b; Ooi et al. 1987). Growers used both chemical and non-chemical methods to control the pest during the earlier half of the 1980s. However, the growers currently rely totally on heavy pesticide used for control. Twenty four applications at a bi-weekly interval are common among the growers although two or three spraying programmes (during the two ascending peak cropping periods and another optional spraying during the trough period) of 5–6 sprayings at a 10-day interval were recommended per year (Azhar 1986a, b; Azhar and Sabudin 1988; Sidhu et al. 1987). Since pyrethroids were heavily used, secondary outbreaks of mealybugs and mites have been reported in a number of plantations especially in those without shade (Azhar and Sabudin 1988).

Despite repeated insecticide treatments, CPB continues to cause unacceptable level of damage. Development of resistance in CPB populations may have rendered the chemicals as ineffective although Sim (1986) reported no evidence of resistance in her study. The ineffectiveness of the chemicals may also be attributed to deficient application techniques, timing, failure to reach targets, or formulation. Improper cultural practices may also contribute to this persistent pest problem. The practice of delayed harvesting allows CPB larvae to emerge and survive before pod harvesting and splitting. The random placement of split pod husks within the field is also thought to promote the continued CPB problem in cocoa. The split pod husks may still harbour residual number of mature larvae and have the potential in inflicting future damage if emerged and survived. Because of this widespread practice and the unavailability of alternative practical method of harvesting and management procedures, a study was conducted to quantify the residual larval populations and to find ways to manage them.

Table 1. Determination of larval emergence pattern from different harvesting processes

Harvesting process	Block	Pods/heap	No. of heaps
Split	2	100	5
	14	100	5
Unsplit	14	100	5

Materials and methods

The study was conducted in 1988 at the Cocoa Research Station, about 35 km north-east of Tawau. Pods used in the study were harvested from Block 2, which was planted with more than 50 F_0 clones (a clone at each row) in early 60s, and Block 14, which comprised mainly of hybrids cocoa planted in late 60s.

Larval emergence

The emergence pattern of mature larvae from the split and unsplit pods were studied as shown in *Table 1*.

The ripe pods were harvested and

separated into five groups in Block 2 and 10 groups in Block 14, with 100 pods in each group. In Block 2, the pods from different clones were mixed after harvesting. Larval emergence holes were then counted and recorded from each pod in all the groups. The pods from five groups from each block were split on the same day immediately after harvesting while another five groups of pods from Block 14 were left unsplit. The beans were extracted from the split pods using the normal plantation practice where the heavily clumped beans were left unrecovered. The wooden spoons were also used to extricate the recoverable less clumped beans. The pods from each of the unsplit groups and the husks from each of the split pod groups were then heaped onto a clear plastic and placed randomly within each block with used sump oil poured around the heaps to avoid encroachments of predators such as ants. All the heaps were covered with dried leaves that served as preferred pupation site for the emerging mature larvae. The larvae that emerged every day were collected and their pupation sites (either on leaves/plastic or on pods) recorded.

Bagging of pod husks

Ripe pods were harvested from Block 14 and separated into 16 groups of 50 pods each. The pods were then cross-sectionally split and beans extracted according to the normal plantation practice described above. The husks were returned to their respective groups with each group eventually made up of 100 split husks. Six groups of the husks were bagged using used fertilizer sacks while the other 10-husk groups were heaped onto clear plastics and placed randomly within the block.

To determine the duration that bagging should be carried out, several factors should be considered among which were the larval mortality rate and the rate of pod husk rotting. Ten newly emerged larvae were directly and randomly placed inside the sacks to determine the effect of bagging on the larval mortality rate and their causal factors. The number of larvae alive and the cause of mortality were recorded daily until all the larvae were dead. At the same time, the temperature within the sacks (measured by placing the thermometer inside the sack through a small hole) and under the cocoa canopies were recorded at three time-intervals (6.30 a.m., 12.00 p.m. and 6.00 p.m.) to compare their differentials and assess if temperature might be one of the important larval mortality factors. The rates of husk rotting in each group (bagged and unbagged) were also compared by recording the number of husks that, at least 50%, have blackened every day.

Spraying of insecticide

Another set of ripe pods were harvested in Block 14 and separated into 10 groups with each group consisted of 100 pods. Larval emergence holes were counted and recorded on each pod before splitting and the husks were heaped onto clear plastics according to each specified group. The used sump oil was poured around the heaps to avoid encroachments of predators. Two different treatments were applied. The first five groups of husks were sprayed with deltamethrin insecticide using pneumatic sprayer (Solo Model 423, capacity 10 L) at a rate of 20 L/ha immediately after splitting, while the other five groups were sprayed on the third day after splitting. The larval emergence, their mortality rate and the mortality factors were monitored and recorded every day.

Results

Larval emergence

The results of the CPB larval emergence pattern from pods harvested from Block 2 and Block 14 are shown in *Table 2* and *Table 3*. A total of 4 349 or a mean of

Table 2. Total number of larvae that emerged from 1 500 harvested pods

Block[1]	Emergence[2]		Pupation sites[3]		Predated[3]	
	Before	After	Leaf/plas	Pods	Leaf/plas	Pods
14US	913	272	211	32	26	3
	(77.1)	(22.9)	(77.6)	(11.2)	(9.6)	(1.1)
14S	1 288	270	214	36	9	11
	(82.7)	(17.3)	(79.3)	(13.3)	(3.3)	(4.1)
2S	1 267	339	221	79	11	28
	(78.9)	(21.1)	(65.2)	(23.3)	(3.2)	(8.3)
Total	3 468	881	646	147	46	42
Av.	1 156	293.7	215.3	49	15.3	14
%	79.7	20.3	73.3	16.7	5.2	4.8

[1]US = unsplit pods; S = split pods
[2]Numbers in brackets indicate the percentage of larval emergence before and after harvesting
[3]Plas = plastic Numbers in brackets indicate the % of postharvest larval emergence that pupated and predated on various collecting sites

Table 3. Consecutive daily mean number of CPB larval emergence per 100 pods[1]

Day	Block 14(US)			Block 14(S)			Block 2(S)		
	Mean	SD	%	Mean	SD	%	Mean	SD	%
0	182.6	20.91	77.05	257.6	52.49	82.67	253.4	94.64	78.89
1	2.4	1.14	1.01	10.8	3.56	3.47	13.2	6.76	4.11
2	5.4	2.51	2.28	8.6	2.40	2.76	6.8	4.15	2.12
3	3.2	1.30	1.35	8.2	2.17	2.63	8.8	5.26	2.74
4	6.0	3.16	2.53	6.8	4.55	2.18	8.2	3.63	2.55
5	4.2	0.84	1.77	6.0	3.67	1.93	7.8	2.86	2.43
6	6.6	6.84	2.78	5.2	2.95	1.67	5.8	3.56	1.81
7	4.0	2.34	1.69	3.0	2.12	0.96	4.0	2.24	1.25
8	3.8	4.38	1.60	2.6	2.07	0.83	7.0	3.46	2.18
9	3.6	2.07	1.52	2.0	2.35	0.64	2.4	1.34	0.75
10	3.4	2.88	1.43	0.6	1.34	0.19	1.6	1.34	0.50
11	2.8	1.30	1.18	0.2	0.45	0.06	1.2	1.10	0.37
12	2.4	2.88	1.01				1.0	1.00	0.31
13	2.2	1.92	0.93						
14	1.2	1.30	0.51						
15	1.2	1.78	0.51						
16	0.2	0.45	0.08						
17	0.4	0.55	0.17						
18	0.4	0.55	0.17						
19	0.4	0.55	0.17						
20	0.4	0.55	0.17						
21	0.2	0.45	0.08						

[1]US = unsplit pods; S = split pods; SD = standard deviation

289.9 larvae/100 pods emerged from 1 500 pods harvested (*Table 2*). Nearly 80% or an average of 231.2 larvae/100 pods emerged before the pods were harvested. The other 20% or an average of 58.7 larvae/100 pods emerged after the pods had been harvested. Most of the larvae that emerged (about 78.5%) were collected spinning their cocoons on leaves or plastic rather than on the pods as dried

leaves and plastic provided greater number of curvatures and crevices that facilitated cocoon spinning by the mature larvae. A total of 10% of the larvae that emerged were predated, presumably by ants (about 5.2% and 4.8% on dried leaves/plastics and pods, respectively). The mean number of larvae that emerged per 100 pods (before and after harvest) were comparatively higher in Block 2 (321.2) than Block 14 (split pods = 311.6; unsplit pods = 237) (*Table 2*). This similar pattern was also shown when the pre and post-harvest larval emergence were compared between the two blocks. The differences in clonal composition and management practices between the two blocks might be the reasons. Clonal materials in Block 2 consisted of both susceptible and resistant materials while Block 14 were planted with Amelonado and selected hybrids of proven performance. Block 2 had never received any management treatment while Block 14 had been frequently released of egg parasite at weekly interval. There was no significant difference ($p > 0.05$) between the mean number of postharvest larval emergence of the split (18 larvae/100 pods) and unsplit (18.1 larvae/100 pods) pods in Block 14.

The maximum duration of emergence is 11 and 21 days for the split pods and unsplit pods, respectively (*Table 3*). Most of the larvae from split pods (an average of more than 85%) appeared to emerge during the first week after harvesting and lasted before the end of the second week. On the other hand, the larval emergence from unsplit pods extended for a period of 21 days with only about 58% emergence occurred during the first week after harvesting.

Bagging of pod husks

The rate of rotting for bagged and unbagged husks are shown in *Figure 1*. Bagged husks showed a faster rate of rotting than those unbagged attaining 50% rotting within a week compared to nearly 10 days for unbagged husks. Unlike the bagged husks, in which rotting rate rises sharply after 3 days, there was a gradual rise in rotting rate for unbagged husks initially, only to increase gently after nearly 6 days. Maximum rotting for

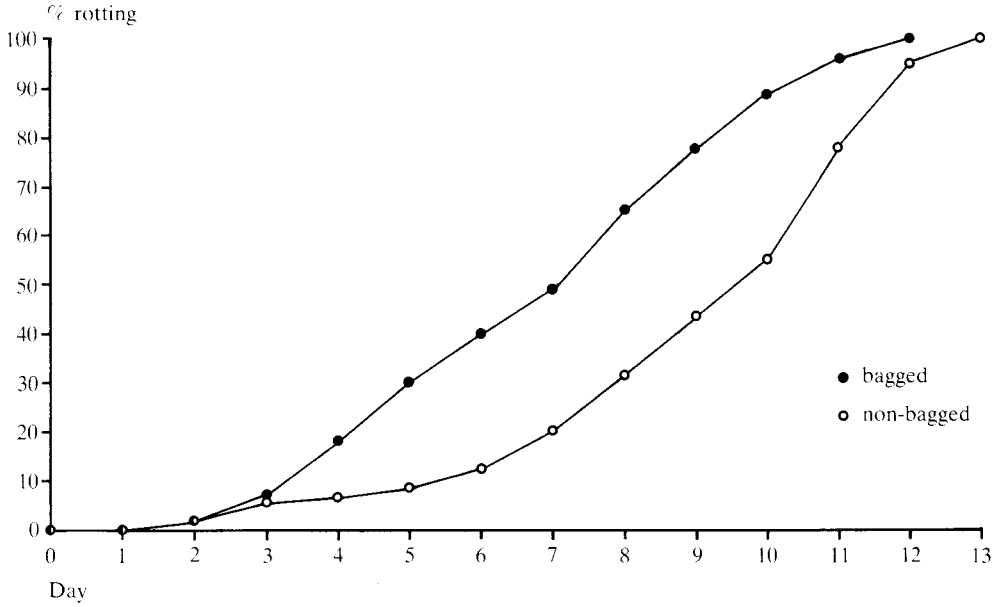

Figure 1. Rate of rotting for bagged and unbagged husks

Table 4. Mean daily mortality of larvae within the sacks[1]

Day	No. alive[2]	Mortality		
		Ants	Others	(%)
0	10.00	2.75	0.50	32.50
1	6.75	6.25	0	92.59
2	0.50	0	0	0
3	0.50	0	0	0
4	0.50	0	0.25	50.00
5	0.25	0.25	0	100.00

[1]Day 0 means the day the larvae were placed inside the bags.
[2]Indicates mean number of larvae per bag that are still alive in the morning.
Total number of larvae directly placed within 5 bags were 50

Table 5. Temperature variations within and outside the bags at different times of the day

Time	Temperature (°C)	
	Inside	Outside
6.30 a.m	26.30a	24.48b
12.00 p.m	30.05a	28.92b
6.00 p.m	29.06a	27.23b

Means between column followed by the same letter are not significantly different (p <0.05) (Fisher's LSD). N = 7 but only 6 readings were used for calculating means at 6.00 p.m. as it rained during one of the afternoons

both treatments was completed within less than 2 weeks (12 days and 13 days for bagged and unbagged husks).

All larvae placed inside the bags were dead by the fifth day after their placement (*Table 4*). Mortality was high during the first 2 days after placement reaching about 95% out of which more than 94% were due to predation by ants. Other mortality was presumed to be due to high temperature within the bag with slight variation from morning to evening (*Table 5*). The average temperature within the bag was 28.47 °C with an average difference of 1.59 °C to the outside temperature (*Table 5*).

Spraying of insecticide

The spraying of insecticide onto the heaps of split pod husks showed significant effect on larval mortality but the timing of spraying seemed to have little effect on the larval emergence pattern and their mortality (*Table 6* and *Table 7*). A total of 93.5% of the larvae that emerged from the heaps sprayed immediately after pod splitting were dead and failed to spin their cocoons while those sprayed on the second day after splitting suffered only a total of 53.3% mortality. However, low larval mortality due to insecticide was compensated by the higher number of larvae (29.4%) that spin the cocoons but did not pupate or pupated but did not emerge (*Table 7*). The failure to pupate or to emerge might be attributed to the residual effect of insecticide which was sprayed a couple of days after spinning the cocoons or after pupation.

The spraying of insecticide caused an average of 89% mortality while 13% suffered predation. Predation, mostly by ants, was only recorded in heaps sprayed on the second day after splitting and only during the first 3 days before insecticide was sprayed. The insecticide sprayed immediately after pod splitting might have deterred the ants from foraging in the heaps or might have killed them. A 100% mortality resulting from insecticide was inflicted on the larvae that emerged on the sixth day after pod splitting and subsequent emergence in all the heaps (*Table 6* and *Table 7*). Survival rate (adult emergence) was low in both treatments with 5.4% and 4.4% in heaps sprayed immediately and on the second day after

Table 6. The effects of insecticide sprayed immediately after pod splitting on larval emergence and their mortality for every 100 pods[1]

Day	CE	%	TE	%	DI	%	DC	%	S	%
0	146.0	81.3								
1	154.0	85.7	8.0	23.8	7.6	95.0	0	0	0.4	5.0
2	161.8	90.1	7.8	23.2	7.2	92.3	0	0	0.6	7.7
3	167.0	93.0	5.2	15.5	4.8	92.3	0.2	3.8	0.2	3.8
4	170.0	94.7	3.0	8.9	2.4	80.0	0	0	0.6	20.0
5	171.8	95.7	1.8	5.4	1.6	88.9	0.2	11.1	0	0
6	174.2	97.0	2.4	7.1	2.4	100	0	0	0	0
7	174.8	97.3	0.6	1.8	0.6	100	0	0	0	0
8	176.8	98.4	2.0	6.0	2.0	100	0	0	0	0
9	177.6	98.9	0.8	2.4	0.8	100	0	0	0	0
10	179.0	99.7	1.4	4.2	1.4	100	0	0	0	0
11	179.6	100	0.6	1.8	0.6	100	0	0	0	0
Total	179.6		33.6		31.4	93.5	0.4	1.2	1.8	5.4

[1]CE = Cumulative emergence; TE = Number of larval emergence after pod splitting; DI = Number of larvae that failed to spin the cocoons and died due to insecticide; DC = Number of larvae that pupate within the cocoons but died after insecticide spraying; P = Predation mostly by ants; S = Number of larvae that survived to adults. Percentage are to that number of larvae that emerged during each day after pod splitting except TE percentages that refer to that of the total number of larvae emerging after pod splitting. No predation was recorded and therefore not included in the table

Table 7. The effect of insecticide sprayed on the 2nd day after pod splitting on larval emergence and their mortality for every 100 pods[1]

Day	CE	%	TE	%	DI	%	DC	%	P	%	S	%
0	134.6	78.8										
1	141.6	83.0	7.0	19.4	0	0	4.8	68.5	1.6	22.9	0.6	8.6
2	150.6	88.2	9.0	25.0	0	0	5.4	60.0	3.0	33.3	0.6	6.7
3	155.4	91.0	4.8	13.3	4.6	95.8	0.2	0	0	0	0	0
4	161.2	94.4	5.8	16.1	5.4	93.1	0	0	0	0	0.4	6.9
5	165.0	96.7	3.8	10.5	3.6	94.7	0.2	5.3	0	0	0	0
6	165.6	97.0	0.6	1.7	0.6	100	0	0	0	0	0	0
7	167.4	98.1	1.8	5.0	1.8	100	0	0	0	0	0	0
8	169.2	99.1	1.8	5.0	1.8	100	0	0	0	0	0	0
9	169.4	99.2	0.2	0.6	0.2	100	0	0	0	0	0	0
10	170.2	99.7	0.8	2.2	0.8	100	0	0	0	0	0	0
11	170.4	99.8	0.2	0.6	0.2	100	0	0	0	0	0	0
12	170.6	100	0.2	0.6	0.2	100	0	0	0	0	0	0
Total	170.6		36		19.2	53.3	10.6	29.4	4.6	12.7	1.6	4.4

[1]Refer to Table 5

splitting. Larval emergence continued until the 11th and 12th day after splitting in the heaps sprayed immediately and on the second day after pod splitting (*Table 6* and *Table 7*). The heaps sprayed on the second day after pod splitting recorded a lower larval emergence (85.7%) during the first week than those sprayed on the

second day after splitting (91.1%). However, an average of more than 97% of the larvae infesting the pods had emerged in the first week from heaps receiving both treatments.

Discussion

It is a common practice by the growers to protect the developing pods from CPB adult moth oviposition through scheduled sprayings, but they are not encouraged to spray when pods are about to ripe (2–3 weeks before ripening) because the larvae hatching from these eggs do not cause serious damage. These beans inside these pods have fully developed and the mucilage has turned fleshy, and further, these late sprayings may cause insecticide contamination during pod splitting and bean extraction. It is during this short unsprayed period that allows the moths, which have been restrained from ovipositing on sprayed pods, to oviposit and the larvae hatched develop until after pod harvesting and splitting. The larvae have very important economic bearing as they will pupate and emerge as adults to continue reinfesting the healthy pods, hence, the continuation of the pest problems.

The results of this study support this empirical phenomenon where more than 20% of total larvae within pods still emerged after they were harvested and split (*Table 2*, *Table 6* and Table 7). These larvae may have developed from oviposition that took place during the 2–3 weeks before the pods ripen. Higher percentage of oviposition took place on pods of more than 2–3 weeks before ripening which resulted in higher percentage (79.8%) of larval emergence before harvesting (*Table 2*, *Table 6* and *Table 7*). Similar results were reported by Day (1983) that pods within a week after yellowing still contained 65% of larvae that would emerge during the pods lifetime, while 20% remained after the third week of ripening. Since harvestings were carried out at specific interval (normally every 2 weeks) by many plantations and the synchronous pattern of ripening of cocoa pods, a substantial percentage of larvae may have emerged and survived to adults for continuation of the generation.

Various approaches have been practised to manage the larval emergence, with the objective of breaking the pest generation cycle, which include bagging of pods and their husks, frequent harvesting, insecticide drenching, and burning of the husks (Day 1983; Azhar 1986a; Mumford 1986; Tay 1987; Wood 1987). These approaches had resulted in varying successes, where logistics, labour shortage and initial pest population density and tree physical conditions have been quoted as among the constraints to achieve efficient control. This study showed that efficient and effective control of the emerging larvae could be achieved through bagging where a 100% larval mortality has been recorded (*Table 4*). At the same time, bagging enhances the rate of rotting of the husks and thus, faster return of nutrition and colonization by the cocoa pollinators *Forcipomyia* spp. (Diptera: Ceratopogonidae) as breeding substrates (Azhar and Wahi 1986; Azhar 1989). The results on the rate of husk rot, larval mortality inside the bags and the duration of larval emergence after pod harvest and splitting further justified the currently recommended duration of husk bagging of 14 days.

Bagging of the unsplit pods seemed to be the most practical management approach especially in places where growers practise pod storage for pulp preconditioning to produce good flavoured beans (Mamot et al. 1988) as the larvae emerging from the storage pods would be killed resulting from high temperatures and observed high moisture development inside the bags (*Table 5*). In this case, storage duration may be reduced to lesser than the recommended

duration of 7–10 days (Mamot et al. 1988) but not less than 5 days to accommodate for increased temperature and humidity effect on the pulp and duration to achieve complete mortality of the emerging larvae. On the other hand, delaying of harvesting as a mean of pulp preconditioning suggested by Lewis and Lee (1985) may not be practical in CPB infested areas because it prolonged the duration of larval emergence which may lead to higher proportion of larval emergence and survival. This study demonstrates that the larvae continued to emerge up to 21 days in unsplit pods after they were harvested (*Table 3*).

Spraying of insecticide onto the split husks can also be an alternative means of managing the postharvest larval emergence. A plantation has been reported to use this method where harvested pods were brought out of the field and split at the road side followed by drenching of the husks with insecticide (Sidhu et al. 1987). This method, however, does not ensure a 100% mortality to the postharvest larval emergence as observed in this study where an average of nearly 5% larval emergence survived regardless whether spraying was carried out immediately or later (*Table 6* and *Table 7*). This survival, although small, will ensure the continued pod infestations over the next cropping season. Besides, the spraying of insecticide may be detrimental to the predators, mostly ant activities, where they generally caused a high percentage of predation to the emerging larvae (Lim and Pan 1986). More than 20% larval mortality due to ant predation took place as early as the first night after pod splitting (*Table 4* and *Table 7*). Insecticide spraying may also be detrimental to other beneficials especially the ceratopogonid pollinators which utilized the rotten pod husks as one of their breeding substrates (Azhar and Wahi 1986; Azhar 1989).

Frequently harvesting the pods at 7–10 days interval may also reduce the problem of pest population built-up over the next generation (Azhar 1986a; Sidhu et al. 1987). Although this practice may require additional labour cost especially during the trough periods, it is still cost-benefit if considered in the long term. Burning of pod husks is another approach to manage the emerging larvae. It is commonly practised by a number of smallholders who brought the harvested pods and split them near the fermentary instead of breaking them in the field. This approach is not quite efficient as burning is normally not carried out immediately after splitting causing a likely chance for the emerging larvae to pupate and survived. The method also increases the opportunity for the pest to spread to the new infestation-free areas with the point of pods splitting serving as the inoculum center. The spread of CPB through this method has been observed in the outbreak of the pest in one of the plantations in Johor Tenggara.

Generally, management of the postharvest or postripening emerging larvae is as crucial as the management of CPB moths or protection of developing pods against oviposition by the pest and is reemphasized and justified by the results demonstrated in this study. Among these, bagging of pod husks, spraying of the husks with insecticide and frequent harvesting offer effective management approach and together may provide total mortality to the emerging larvae. Coupled with the selective application of insecticide and other cultural practices, such as proper pruning and pod sleeving of developing pods, the integration may reduce the potential built-up of the pest temporally and spatially and provides least disturbance to the environment. With proper supervision, the intensive use of IPM has resulted in the containment and effective reduction of the outbreak in the Peninsula (Anon. 1988).

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