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Infestation status of invasive coconut leaf beetle, *Brontispa longissima* (Coleoptera: Chrysomelidae) on coconut palms in three different locations in Malaysia

[Status infestasi lapangan *Brontispa longissima* (Coleoptera: Chrysomelidae), perosak daun kelapa invasif di tiga lokasi berbeza di Malaysia]

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Abstract

The coconut plant act as an essential role in the economy of many Asian countries including the Philippines and their economies are recently threatened due to a serious outbreak of the coconut leaf beetle, *Brontispa longissima* (Gestro). This study was conducted to record the number of populations of *B. longissima* (Gestro) and their interactions with three different locations, the variety of coconut plants and the weather for 12 months. Coconut leaf beetle infestations were observed in the field on different varieties of coconut palms such as the hybrid, Matag, the aromatic dwarf (locally known as pandan) and the exotic Tagnanan Tall in three locations viz., Parit Botak, Johor, Pasir Mas, Kelantan and Hilir Perak, Perak. Observations on infestations were recorded for one year from January to December 2016. Sampling was conducted based on the symptoms of coconut leaf damage by *B. longissima* on the coconut trees. A total of 50 to 100 trees of each variety were chosen at random for data collection. Leaves of each frond were examined for the number of larvae and adults of *B. longissima*. Data was recorded once a month for a period of one year. Data were transformed using the square root of x ($\sqrt{x}$) for normalisation before analysing using a 3-WAY ANOVA to determine the effect of months, varieties and stages of *B. longissima* on the extent of coconut leaves damaged. The mean number of coconut leaf beetles was higher and varied significantly (p <0.05) on the aromatic pandan variety compared to other varieties. The mean number of *B. longissima* larvae was found in larger numbers compared to their adults. Significant differences were seen in the mean number of *B. longissima* beetles recorded between months. Most beetle infestations were recorded in the middle and at the end of the year, i.e. between July and December 2016. The influence of weather changes on beetle populations is also discussed. We concluded that *B. longissima* is an economically important pest for the coconut palm industry in Malaysia.

Keywords: infestation, invasive, coconutleaf, beetle, *Brontispa longissima*

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Introduction

Coconut (*Cocos nucifera* L.) is a critical organic product tree in the world, particularly in tropical and subtropical districts (DebMandal and Mandal 2011). Every year, roughly 1 million tonnes of coconut is produced in Thailand at both juvenile and developed stages (Siriphanich et al. 2011; FAO 2014). In developing the natural product, the crisp portion is typically utilised for coconut drain creation, while the dry portion (copra) is mostly utilised as crude material for oil extraction. Coconut drain generation includes physically or mechanically destroying the coconut portion and crushing it with or without the expansion of water (de Leon and Delores 2004).

This plant is frequently found throughout the coastal areas and the interior of tropical countries like Malaysia, Thailand, Indonesia and The Philippines. In Malaysia, the coconut plantation industry is seen as a commodity crop that has great potential in the development of the national economy. Since 2007, the coconut industry has been positioned as one of the four strategic crops after oil palm, rubber and rice. Coconut crop acreage is estimated at 109,185 hectares with an estimated production of 571.3 million seeds. Sarawak, Johor, Sabah, Perak and Selangor are the main coconut-producing states in Malaysia (Department of Agriculture 2015). The total export value of Malaysia's trade for coconut and coconut products was more than RM430 million in 2010. The main export products were coconut oil, activated carbon, grated coconut and coconut milk or coconut powder.

Nevertheless, outbreaks of coconut pests were found to be among the factors capable of drastically affecting the coconut industry in Malaysia. One of the major insect pests of the coconut palm is the coconut leaf beetle, *Brontispa longissima* (Coleoptera: Chrysomelidae) (Rethinam and Singh 2005; Sankaran 2006; Nakamura et al. 2006). The beetles are native to the islands of Indonesia and Papua New Guinea (Nakamura et al. 2006, Konishi et al. 2007) and later spread to other countries such as Malaysia, Sri Lanka, Australia, Maldives, India, Myanmar, Bangladesh, Thailand, Vietnam and Southern China (Wilco and Chapman 2004; Liu et al. 2011) due to weakness and negligence in quarantine and controlling of coconut seeds from entering into the country (Goles 2003).

According to Guo (2007), *B. longissima* beetle outbreaks on coconut palms reduce yield as well as could potentially lead to the death of the palm tree if the population of the beetles is high and unregulated. This is because the tree is not capable of carrying out photosynthesis from leaves that have been perforated due to damage by larvae and adult beetles (Fenner 1996; Howard et al. 2001). In addition, the beetles were found to attack coconut palms of various age groups, particularly those that were planted in the dry areas and received low rainfall distribution (Hosang et al. 2004). According to Liebregts and Chapman (2004), Vietnam is the first Southeast Asian country to record the case of *B. longissima* beetles on coconut palms in the Mekong Delta region during the late '90s. Apart from coconut palms, these beetles also attack other palms such as Palma Sirih (*Areca catechu*), sago tree, rumbia, Palma Fan Mexican (*Washintonia robusta*), Palma Fans Chinese (*Livistonna chinensis*), Palma Nipah, Nipah fruition, Royal Palma (*Roystonea regia*), palm oil (*Elais guineensis*), Palma Nicobar (*Bentinckia nicobarica*) and palm Carpentaria (*Carpentaria acuminate*) (Rethinam and Singh 2005).

Although *B. longissima* is known to cause severe destruction to the coconut tree (Wilco and Chapman 2004; Sivapragasam 2007), studies on the extent and status of this pest infestation on coconut palms in Malaysia is still lacking. In addition, coconut plantations which are not well managed are also among the contributors to the increase in *B. longissima* beetle outbreaks throughout the country. As such, the main objective of

this study was to determine the population of *B. longissima* and its infestation rate on some varieties grown in coconut plantations in selected locations around Malaysia.

Materials and methods

Survey of B. longissima infestation in coconut palm plots

Survey of *B. longissima* outbreaks was carried out from January to December 2016 in coconut palm plots located at different areas of Parit Botak District (1° 43'37.7" N 103°05'48.4"E), Pasir Mas (5°59'45"N 102°3'47"E) and Hilir Perak (3.890722 N, 100.85845E). The area of each coconut palm plot was between 1 and 1.5 ha. Each plot was planted with three varieties namely, Matag, Pandan and Tagnanan. An experiment was conducted using Randomised Complete Block Design (RCBD). Sampling was done based on the symptoms of coconut leaves damaged by the beetles on the palm trees. A total of 50 to 100 trees of each variety were chosen at random for inspection (*Figure 1*). Young leaves of each frond (frond 1 to frond 3 from the ground) were examined for the number of all stages of larvae and adults of *B. longissima*. Data were recorded once a month for a period of one year. Data were transformed using the square root of x ($\sqrt{x}$) for normalisation before analysing by a 3-WAY ANOVA to determine the effect of months, varieties and stages of *B. longissima* on the extent of coconut leaves damaged. Tukey's test (at $p < 0.05$) was used to separate the means if the ANOVA results were significant. The age of the coconut palms was between 1 and 3 years.

Results

Survey of B longissima infestation in coconut palm plots

(a) Parit Botak, Johor

The results of the 3-WAY ANOVA showed that all three independent variables or factors (varieties, stage of beetle growth and month of infestation) as well as their interaction showed some significant differences ($p < 0.05$) on the number of larvae and adults of *B. longissima* present on the coconut palms at Parit Botak (*Table 1*). Compared to the other two varieties, Pandan variety was the most susceptible as it was infested by the highest number of beetles viz., 4.51 ± 0.15. This value was significantly different ($p < 0.05$) compared to Matag (3.06 ± 0.09) and Tagnanan (2.08 ± 0.08). The interaction between varieties and months ($F = 8.97$, df = 22 and 648, $p < 0.05$) or insect stages and months ($F = 6.82$, df = 11 and 648, $p < 0.05$) showed significant

*Figure 1. Larva (a) and adult (b) of **B. longissima** on coconut leaves*

Table 1. The number of larvae and adults of *B. longissima* on coconut trees in a plot at Parit Botak, Johor, Malaysia

Source	Df	ANOVA SS	F-value	*p*-value
Variety	2	714.11	213.53	<0.05
Stage	1	32.68	19.55	<0.05
Month	11	357.9	19.46	<0.05
Variety *Stage	2	11.51	0.45	0.636
Variety *Month	22	329.92	8.97	<0.05
Stage *Month	11	125.49	6.82	<0.05
Variety *Stage *Month	22	25.09	0.72	0.759
Error	648	1083.56		
Total	719			

effects to the mean number of beetles recorded. However, there were no significant interactions between the variety and stages as well as between all three factors. The attack on coconut trees in December had the highest mean of beetle infestation (4.2 ± 0.3) compared to other months. At the same time, the interaction between different varieties and month showed a significant difference (F = 8.97, df = 22.79 and p <0.05), which affected the mean number of beetles on the coconut trees.

Generally, Pandan had higher beetle infestation compared to other varieties in all months except in January. The highest mean number of beetle infestation on Pandan variety was recorded in October (6.67 ± 0.29) and this was significantly different (p <0.05) when compared to the other two varieties (*Figure 2*). Varieties of Matag recorded the highest mean beetle infestation in December viz., 4.6 ± 0.14 but did not differ significantly from Tagnanan varieties from June to August. On the other hand, in Tagnanan variety, the mean number of beetle infestation was lowest compared to all other months except for October, which was higher compared to Matag variety.

Results on the effect of stage of growth of the coconut leaf beetle at various months revealed that there is an interaction between these two factors (F = 6.82; df = 11.79; p <0.05) (*Table 1*). The larval stage had the highest mean number in November (4.97 ± 0.49) and was significantly different (p <0.05) than the adult stage (3.11 ± 0.23). A similar trend was recorded in January, April, May, June and August (*Figure 3*). The exception to this trend was seen only in the month of October where the mean number of the adults was higher but not significantly different p >0.05) compared to the larval stage of growth.

(b) Pasir Mas, Kelantan

Results of 3-WAY ANOVA test found that all the three independent variables or factors (variety, stage of beetle growth and month of infestation) as well as their interaction showed some significant difference (p <0.05) on the number of larvae and adults of *B. longissima* present on coconut palms at Pasir Mas, Kelantan (*Table 2*). Among the three coconut varieties studied, the Pandan variety listed the highest mean number of beetle infestation (5.2 ± 0.1) and was significantly different (p <0.05) compared to Matag (3.7 ± 0.1) and Tagnanan (2.3 ± 0.1) varieties. The highest infestation was observed by the adult *B. longissima* beetles (4.2 ± 0.1) which was significantly different (p <0.05) compared to the larval stage (3.3 ± 0.1). July recorded the highest mean of *B. longissima* beetle attack (4.5 ± 0.2) in the plot at Pasir Mas compared to other months. However, no significant interaction was observed between the month and the stage of beetles growth, and also between the three variables (*Table 2*).

Although all the three coconut varieties recorded a relatively greater number of adult beetles' infestations compared to the

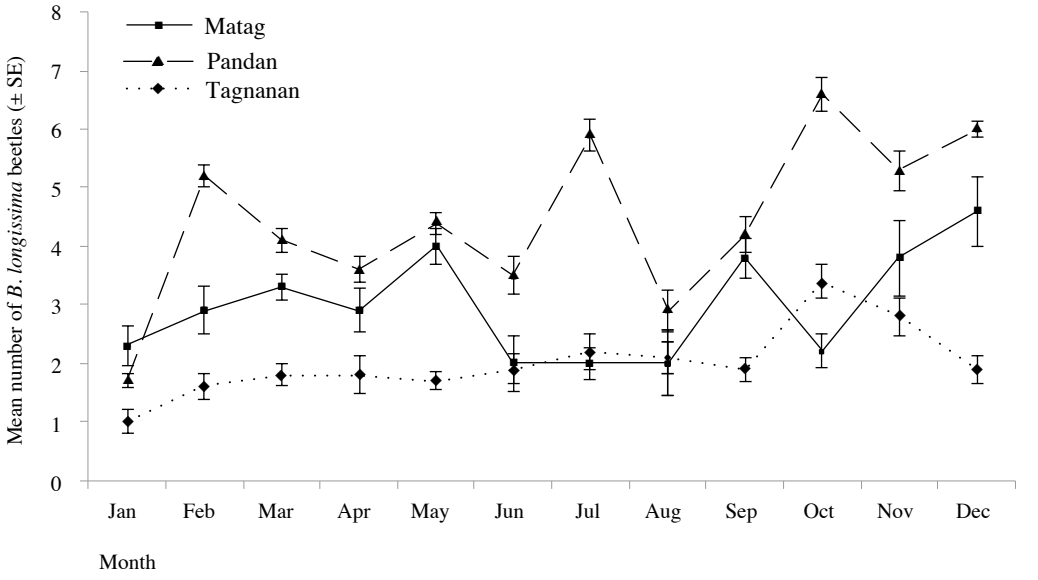

*Figure 2. Mean number of **B. longissima** beetles (± SE) infestation on three coconut palm varieties at monthly intervals*

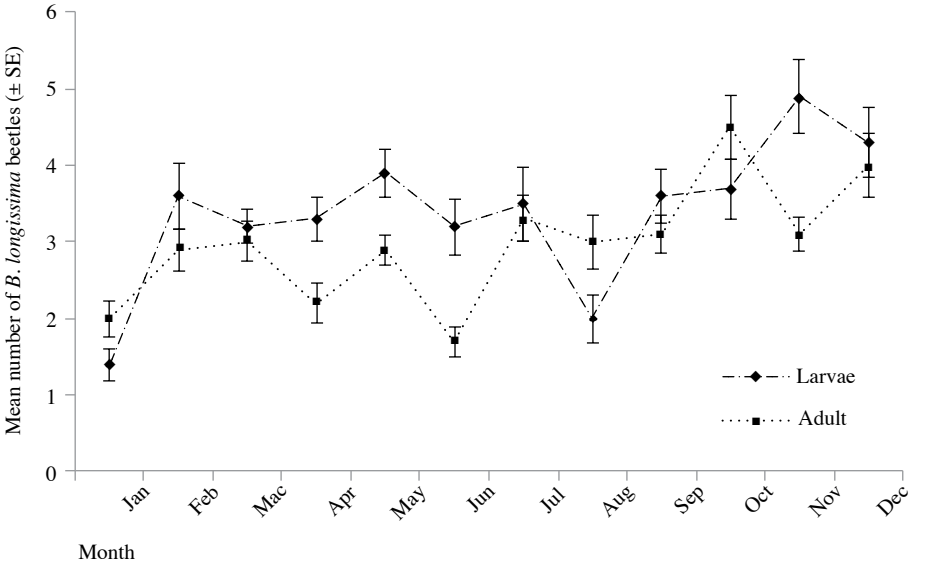

*Figure 3. The mean number of **B. longissima** beetles (± SE) at the adult and larval stage of growth at monthly intervals*

Table 2. Results of 3-WAY ANOVA on the number of larvae and adults of *B. longissima* on coconut trees in a plot at Pasir Mas, Kelantan

Source	Df	ANOVA SS	F-value	*p*-value
Variety	2	1006.15	342.3	<0.05
Stage	1	144.85	98.5	<0.05
Month	11	164.89	10.2	<0.05
Variety * Stage	2	49.48	16.8	<0.05
Variety * Month	22	298.33	9.23	<0.05
Stage * Month	11	135.01	0.49	0.15
Variety * Stage * Month	22	320.89	0.93	0.33
Error	648	952.20		
Total	719			

larval stage of growth, the infestation on the Pandan variety was the highest at the larval stage (4.4 ± 0.1) or as adults (6.0 ± 0.1) (*Figure 4*). This was followed by the Matag and Tagnanan varieties.

July and October recorded the highest mean number of beetles on the Pandan variety per month (6.9 ± 0.3) (*Figure 5*) while the mean number of beetles recorded in May and August were the same for the Pandan and Matag varieties (5.2 ± 0.2 and 3.9 ± 0.6 respectively). The same phenomenon was also observed in Matag and Tagnanan varieties which recorded the same mean number of beetles in June and October. The month of May recorded the highest mean of beetle infestation (5.2 ± 0.2) on the Matag variety but did not differ with the mean number of beetles infesting the Pandan variety. On the other hand, the mean of beetle infestation in June recorded the lowest number of infestation on the Matag variety at 2.4 ± 0.3 but did not differ significantly with the number of beetles infesting on the Tagnanan variety. The highest mean number of beetles recorded for the Tagnanan variety was during July (3.5 ± 0.3) and the lowest mean number of beetles was recorded in November (1.5 ± 0.3).

(c) Hilir Perak, Perak

The results of the 3-WAY ANOVA test found that all the three independent variables or factors (varieties, stage of beetle growth and month of infestation) as well as their interaction showed some significant difference (p <0.05) on the number of larvae and adults of *B. longissima* present on coconut palms at Hilir Perak, Perak (*Table 3*). The Pandan variety recorded the highest average mean number of beetle infestation at 2.7 ± 0.08 which was significantly different (p <0.05) compared to the Matag (2.0 ± 0.09) and Tagnanan (1.5 ± 0.07) varieties. In addition, the beetle growth stage exhibited significant differences (p <0.05) in the total number of beetles where the larvae recorded the highest average mean number of beetles at 2.3 ± 0.08 compared to the adult stage (1.8 ± 0.06). However, no significant interaction was observed between the variety and the stage of beetle growth, and also between the three variables. Meanwhile, there was a significant difference for the month variable (F = 131.41, df = 11.719; p <0.05) which affected the mean number of *B. longissima* beetles that attacked the coconut palms.

In November, the highest mean number of beetle infestation (3.66 ± 0.26) was recorded for the Matag variety compared to other months at Hilir Perak (*Figure 6*). The highest mean number of *B. longissima* beetles attacking the Pandan variety was recorded in December (4.2 ± 0.41) and was significantly different (p <0.05) compared to other varieties in the same month. The month of December also recorded the

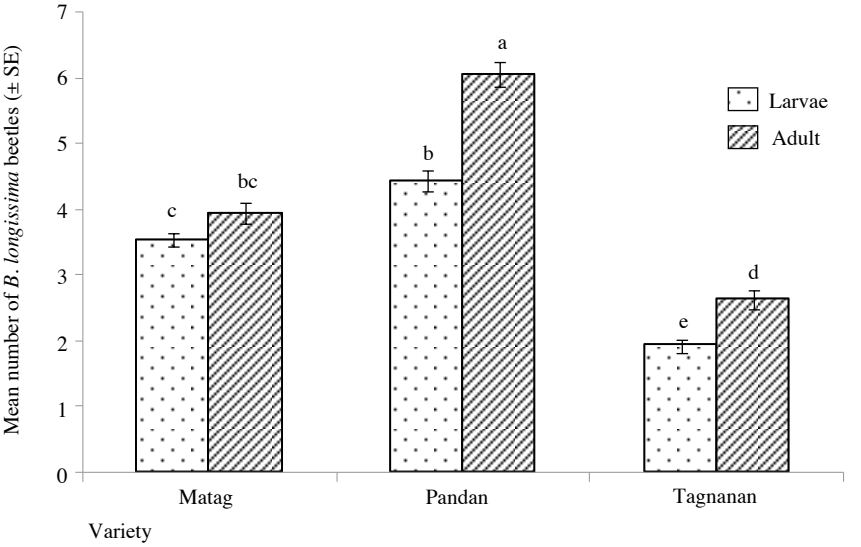

*Figure 4. The mean number of **B. longissima** beetles (± SE) in the adult and larval stage of growth infestating different coconut varieties*

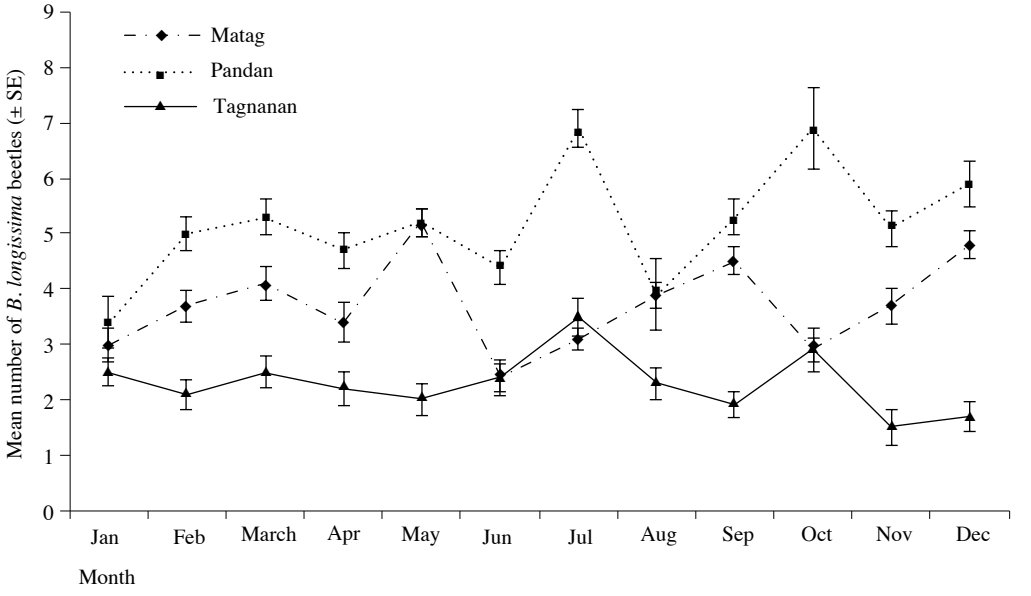

*Figure 5. Mean number of **B. longissima** beetles (± SE) infestation on three coconut palm varieties at monthly intervals*

Table 3. Results of 3-WAY ANOVA on the number of larvae and adults of *B. longissima* on coconut trees in a plot at Hilir Perak, Perak

Source	Df	ANOVA SS	F-value	*p*-value
Variety	2	175.61	83.25	<0.05
Stage	1	43.37	41.12	<0.05
Month	11	131.41	11.33	<0.05
Variety * Stage	2	33.24	0.52	0.78
Variety * Month	22	215.8	4.53	<0.05
Stage * Month	11	120.81	5.21	<0.05
Variety * Stage * Month	22	105.01	0.38	0.51
Error	648	683.45		
Total	719			

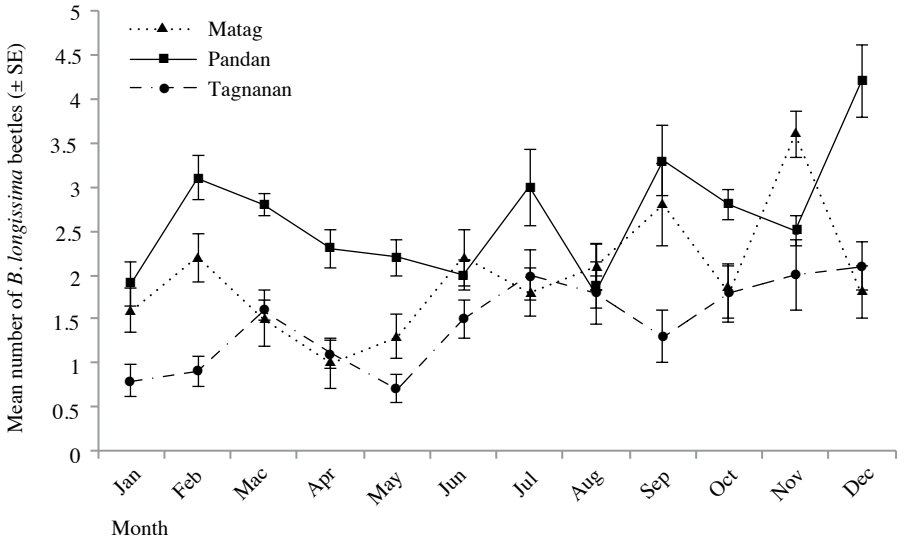

Figure 6. Mean number of ***B. longissima*** *beetles (± SE) infestation on three coconut palm varieties at monthly intervals*

highest mean number of *B. longissima* beetles on the Tagnanan variety (2.1 ± 0.2) compared to other months. November recorded the highest mean number of *B. longissima* beetles on the Matag variety (3.66 ± 0.26) and was significantly different (p <0.05) when compared to the Pandan and Tagnanan varieties.

The highest number of mean larvae was recorded in December (3.8 ± 0.32) and was significantly different (p <0.05) compared to the adults (1.6 ± 0.18) (*Figure 7*). On the other hand, the lowest mean number of larvae was recorded in May (1.0 ± 0.15), but the amount was lower than adults (1.9 ± 0.21) recorded in the same month. For adults, the highest mean number of beetles was recorded in November (2.48 ± 0.2) but the number was less than the mean number of larvae recorded in the same month. In July, the lowest mean of adult beetles (1.22 ± 0.16) was recorded and this value was significantly different (p <0.05) from the mean number of larvae (3.38 ± 0.25) in the same month.

Discussion

Our results revealed that the *B. longissima* beetle is one of the major insect pests on coconut palms as it can severely damage

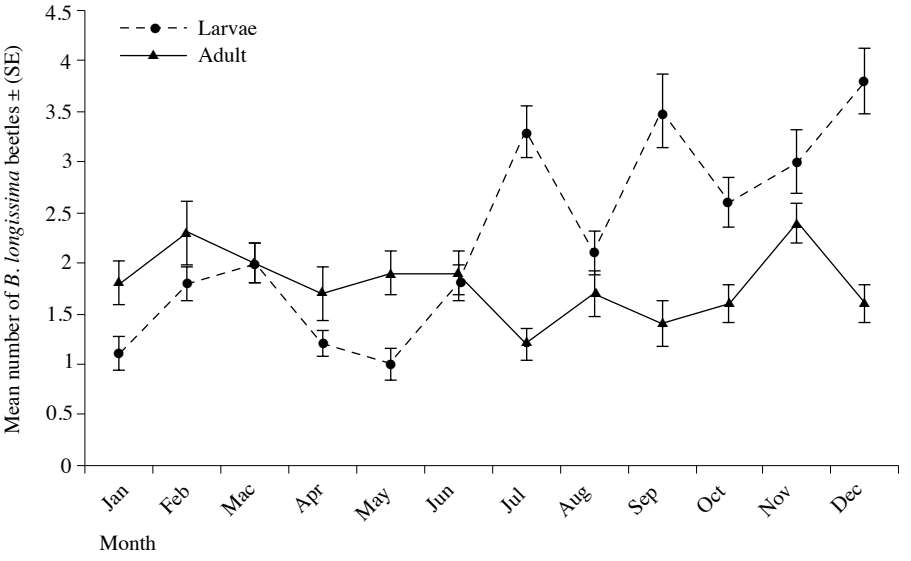

Figure 7. The mean number of ***B. longissima*** *beetles (± SE) at the adult and larva stage of growth at monthly intervals*

the leaves leading to not only the reduction in fruit yield but eventually the destruction of the trees. The beetles were found to attack all three coconut varieties (Pandan, Matag and Tagnanan) that were widely planted in Malaysia. According to Wilco and Chapman (2004), *B. longissima* has never been recorded to damage coconut trees in the Southeast Asian countries until the late 90s, when it was first detected in coconut palms at the Mekong Delta, Vietnam. In Malaysia, its infestation on the coconut palms was first detected and recorded in 2005 (Sivapragasam 2007).

Results of the survey on *B. longissima* beetles infestation on coconut palms in Parit Botak, Pasir Mas and Hilir Perak suggested that the type of variety can significantly affect the level of *B. longissima* beetle infestation. The Pandan variety was observed to have the highest number of *B. longissima* infestation followed by the Matag and Tagnanan varieties which was in agreement with the findings of Sivapragasam (2007) and Wan Khairul et al. (2010). This was due to the fact that the Pandan variety produced volatile chemical compounds (VOCs) that attracted the beetles as indicated by preliminary research carried out at MARDI's laboratories. However, comprehensive studies of the effects of VOCs as an attractant to the beetle population need to be verified. Novalisa et al. (2013) found that dwarf coconut varieties such as Pandan and Matag have a slower development period compared to the taller coconut varieties. This may encourage the *B. longissima* beetles to prefer dwarf varieties as flight path is shorter and requires less energy.

The results of the survey found that the stage of growth of the *B. Longissima* beetles also affected the total mean number of *B. longissima*. The mean number of beetle larvae recorded was generally significantly higher compared to the adult beetles as observed at Hilir Perak and Parit Botak. This result is in agreement with the findings of Hosang et al. (1996) in Indonesia. The complete life cycle of *B. longissima* takes about three months, of which two months belongs to the larva stage. Hence, the larva stage is considered more aggressive as it stays longer on the coconut tree, thereby causing more severe damage (Hean 2004). In conclusion, the better indicator of the

infestation rate should have been the number of larvae found and recorded at any particular sampling time.

For the time variable (months), results showed that the differences of the mean number of *B. longissima* recorded at various months was somewhat fluctuating throughout the year and relatively higher in July and December than in other months. The differences may be influenced by weather changes throughout the year. Fenner (1984) reported that insect pest populations generally increase markedly during the dry periods or droughts and begin to decline during the rainy season. Similarly, Gumbek (1999) found that *Promecotheca nuciferae* beetles abundance increased during prolonged droughts in Sarawak. Drought is an important contributing factor in increasing pest infestation against coconut palms as reported by Choo-Toh (1999) and Lerdau and Keller (1997). This may be due to the fact that during this period, normally there are low numbers of the natural enemy of the pest population.

Conclusion

The study revealed that the coconut, especially the dwarf variety, Pandan, was the most preferred and susceptible host to *B. longissima* compared to the other palms. As such, planting Pandan may have to be combined with effective control programmes such as intercropping with more tolerant coconut varieties as well as other crops that might have the repellent effect to the beetles to reduce the damage, especially in areas that have high incidences of coconut leaf damage in Malaysia. To achieve an effective control programme of this pest, further work on the field ecology and management aspects should be carried out.

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References

Choo Toh, G.T. (1999). An outbreak of *Plesispa reichei* Chapuis on palms in Singapore. In: *Proceedings of the 5th International conference on plant protection in the tropics*, (Sivapragasam et al., eds.), p. 390 – 393. Kuala Lumpur, Malaysia

DebMandal, M. and Mandal, S. (2011). Coconut (*Cocos nucifera* L.: Arecaceae): In: *Health promotion and disease prevention. Asian Pacific Journal of Tropical Medicine* 4: 241 – 247

de Leon, S.Y. and Delores, M.I. (2004). Coconut. In: *Processing fruits: Science and technology* 2nd ed. (Barrett, D.M., Somogyi, L. and Ramaswamy, H.S., eds.), p. 707 – 737. Florida: CRC Press

Department of Agriculture (2015). Statistik Tanaman Industri Malaysia, Putrjaya Malaysia. p. 88

FAO (2014). FAOSTAT. Food and Agriculture Organization of the United Nations, Rome, Italy. Web. http://faostat.fao.org/default.aspx

Fenner, T.L. (1984). Palm leaf beetle. Northern Territory of Australia: Department of Primary Production. *Agnote* 84: 16 – 18

—— (1996). Palm leaf beetle. Darwin, Northern Territory of Australia: Department of Primary Production. *Agnote* 371: 1 – 3

Goles, H.G. (2003). Integrated pest management practices for mango. *Proceedings of the 34th anniversary and annual scientific conference*, p. 32 – 39

Gumbek, M. (1999). Outbreak of coconut leaf miner, *Promecotheca nuciferae* in Sarawak. In: *Proceedings of the 5th International conference on plant protection in the tropics*, (Sivapragasam et al., eds.), p. 390 – 393

Guo, J. (2007). Coconut beetle management in Hainan Island, China: Assessment of issues, new developments and future plans. In: *Developing an Asia-Pacific strategy for forest invasive species: The coconut beetle problem – Bridging agriculture and forestry* (Appanah, S., Sim, H.C. and Sankaran, K.V., eds.), p. 15 – 20. Bangkok: RAP publication

Hean, V. (2004). Coconut hispid beetle (*Brontispa longissima*): A new threat to coconut palms in Cambodia. In: *Report of the expert consultation on coconut beetle outbreak in APPPC countries*, 26 – 27 Oct. 2004/29, p. 31 – 34, Food and Agricultural Organization of the United Nations Regional Office for Asia and the Pacific. Bangkok: RAP Publication

Hosang, M.L.A., Alouw, J.C. and Novarianto, H. (2004). Biological control of *Brontispa longissima* Gestro in Indonesia. In: *Report of the expert consultation on coconut beetle outbreak in APPPC member countries,* p. 10 – 15

Hosang, M.L.A., Sabbatoellah, S., Tumewan, F. and Alouw, J.C. (1996). Musuh alami hama *Brontispa longissima* Gestro. *Prosiding seminar regional hasil-hasil penelitian tanaman kelapa dan palma lain*, p. 30 – 38

Howard, F.W., Moore, D., Giblin-Davis, R.M. and Abad, R.G. (2001). Insects on palms. Wallingford: CABI Publishing

Konishi, K., Nakamura, S. and Takasu, K. (2007). Invasion of the coconut hispine beetle, *Brontispa longissima*: Current situation and control measures in Asia. In: *NIAES International symposium* 2007, *invasive alien species in monsoon Asia: Status and control*. Tsukuba, Japan

Lerdau, M. and Keller, M. (1997). Controls on isoprene emission from trees in a subtropical dry forest. *Plant Cell and Environment* 20: 569 – 578

Liebregts, W. and Chapman, K. (2004). Impact and control of the coconut hispine beetle, *Brontispa longissima* Gestro (Coleoptera: Chrysomelidae). In: *Report of the expert consultation coconut beetle outbreak in APPPC member countries,* p. 19 – 25. FAO Regional Office for Asia and The Pacific

Liu, Y.Q., Zhao, L., Yang, Y.L., Zhao, C.Y. and Liu, T.T. (2011). Evaluation of insecticidal activity of podophyllotoxin derivatives against *Brontispa longissima*. *Pesticide Biochemistry and Physiology* 99(1): 39 – 44

Nakamura, S., Konishi, K. and Takasu, K. (2006). "Invasion of the coconut Hispine beetle, *Brontispa longissima*: Current situation and control measures in Southeast Asia". In: *Crop production and environment division, JIRCAS*, p. 305 – 8686. Tsukuba, Ibaraki, Japan

Novalisa, L., Sri, K., Liliek, S. and Retno, D.P. (2013). The Demographic of *Brontispa longissima* Gestro (Coleoptera:Chrysomelidae) on Mapanget Tall Coconut and Brown Dwarf Coconut. *Journal of Agriculture and Veterinary Science* 6(2): 33 – 37

Rethinam, P. and Singh, S.P. (2005). Current status of the coconut beetle outbreaks in the Asia-Pacific region. In: *Developing an Asia-Pacific strategy for forest invasive species: the coconut beetle problem: bridging agriculture and forestry* (Appanah, S., Sim, H.C. and Sankaran, K.V., eds.), p. 1 – 12

Sankaran, K.V. (2006). Coconut leaf beetle *Brontispa longissima*. Newsletter of the Asia-pacific Forest Invasive Species Network (APFISN) 6: 1 – 4

Siriphanich, J., Saradhuldhat, P., Romphophak, T., Krisanapook, K., Pathaveerat, S. and Tongchitpakdee, S. (2011). Coconut (*Cocos nucifera* L.). In: *Postharvest biology and technology of tropical and subtropical fruits volume 3: Cocona to mango* (Yahia, E.M., ed.), p. 8 – 33. Cambridge: Woodhead Publishing Limited

Sivapragasam, A. (2007). "*Brontispa longissima*, its status and management in Malaysia". In: *Report of the APCC/FAO – RAP/APPPC consultative meeting of the IPM* of *Brontispa longissima*. Bangkok, Thailand

Wan Khairul Anuar, W.A., Sivapragasam, A. and Razali, B. (2010). *Brontispa longissima*: An invasive pest of coconut. *Proceedings of the National Coconut Conference 'Opportunities for a sunrise industry'*, p. 135 – 139

Wilco, L. and Chapman, K. (2004). "Impact and control of the coconut Hispine beetle, *Brontispa Longissima* Gestro (Coleoptera: Chrysomelidae)". In: *Report of the expert consultation on coconut beetle outbreak in APPPC member countries*. Bangkok, Thailand: FAO RAP Publication 2004/29

Abstrak

Tanaman kelapa memainkan peranan penting dalam ekonomi banyak negara Asia termasuk Filipina dan ekonomi mereka baru-baru ini terancam akibat wabak serius kumbang daun kelapa, *Brontispa longissima* (Gestro). Kajian ini dijalankan untuk merekodkan bilangan populasi *B. longissima* (Gestro) dan interaksi mereka dengan tiga lokasi berbeza, jenis tanaman kelapa dan cuaca selama 12 bulan. Pemerhatian terhadap kumbang daun kelapa, *B. longissima* (Gestro) telah dilakukan di ladang pada pelbagai jenis kelapa seperti hibrid Matag, Dwarf beraroma (pandan tempatan) dan eksotik Tagnanan Tall di tiga lokasi iaitu Parit Botak, Johor, Pasir Mas, Kelantan dan Hilir Perak, Perak. Pemerhatian terhadap serangan juga telah direkodkan selama satu tahun dari Januari hingga Disember 2016. Pensampelan dijalankan berdasarkan kerosakan daun yang diserang oleh *B. longissima* pada pokok kelapa. Sebanyak 50 hingga 100 pokok dari setiap varieti dipilih secara rawak untuk pengumpulan data. Setiap daun telah diperiksa untuk merekodkan jumlah larva dan dewasa *B. longissima*. Data direkod sekali sebulan untuk tempoh satu tahun. Data telah diubahsuai menggunakan 'square root' x ($\sqrt{x}$) untuk normalisasi sebelum dianalisis menggunakan ANOVA 3-HALA bagi menentukan kesan bulan, jenis dan peringkat *B. longissima* pada tahap kerosakan daun kelapa. Bilangan purata kumbang daun kelapa adalah lebih tinggi dan berbeza dengan ketara (p <0.05) pada varieti pandan aromatik berbanding dengan varieti lain. Bilangan purata larva *B. longissima* didapati lebih banyak berbanding dengan kumbang dewasa. Perbezaan yang signifikan didapati dalam bilangan purata *B. longissima* yang direkodkan antara bulan. Kebanyakan serangan kumbang telah direkodkan pada pertengahan dan akhir tahun, iaitu antara Julai hingga Disember 2016. Pengaruh perubahan cuaca pada populasi kumbang juga telah dibincangkan. Kesimpulannya, *B. longissima* adalah perosak ekonomi penting bagi industri kelapa di Malaysia.