SCREENING OF CPB DAMAGE ON PROGENY TRIAL IN CRDC MADAI, SABAH: EARLY RESULTS.

Navies Maisin[1], Aizat Jaafar[2], Mohd. Shakri Awang[1] and Haya Ramba[2]

[1]Malaysian Cocoa Board, Cocoa Research and Development Centre, Mile 10, Apas Road, Tawau P. O. Box 60237, 91012 Tawau, Sabah, Malaysia
[2]Malaysian Cocoa Board, Cocoa Research and Development Centre, Lot 248, Block 14, Biotechnology Park, Locked Bag 3131, Perdana Pending Road, 93250 Kuching, Sarawak, Malaysia.
Corresponding author: navie@koko.gov.my

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ABSTRACT - Cocoa pod borer (CPB), *Conopomorpha cramerella* (Snellen) (Lepidoptera: Gracillariidae), is a major cocoa pest in Malaysia and Southeast Asia including Papua New Guinea. CPB has been partly responsible in reduction of cocoa cultivation area in Malaysia. Methods to control CPB has been developed by Malaysian Cocoa Board (MCB), however other approach to manage this pest is still welcomed. Host resistance of cocoa has been considered as a long term alternative control for the CPB. Breeding programme has been conducted by MCB breeder to produce superior cocoa planting materials with emphasis on high yielding, good flavour quality and resistance to pests and diseases. The progeny trial was established at plot F 33 in MCB CRDC Madai that consisted nine crosses, (KW 30 X DRC 15), (ARDACIAR 10 X ARDACIAR 26), (DRC 15 X KW 264), (PBC 123 X LAFI 7), (QH 22 X NA 33), (PBC 123 X QH 22), (KKM 22 X LAFI 7), (UIT 1 X NA 33 (HP)), and (MCBC 3 X KKM 22). Screening for CPB damage and pod physical characteristics on that progeny trial is being carried out. Observations and data recording for ADSI and physical characteristics currently been conducted on each individual progeny tree in the plot. Such information is necessary to determine the degree of tolerance, one of resistance mechanism toward CPB infestation among progeny trees. It is expected that the data will be able to categories the progeny response toward CPB infestation into susceptible, moderate and tolerance. This paper will provide an overview of progress in screening CPB tolerance of cocoa progeny in plot F 33 at MCB CRDC, Madai for further utilization in breeding programs.

Keywords: Host Plant Resistance, Tolerance, Cocoa Pod Borer, *Conopomorpha cramerella*, cocoa

INTRODUCTION

The success in every crop is dependent on the availability of good if not excellent planting materials. This is the reason why breeding programme is one of the important components of agriculture. As a research institution custodian to cocoa industry in Malaysia, Malaysian Cocoa Board (MCB) has also prioritised the cocoa breeding programme. In order to create new cocoa planting materials that include the tolerance towards pests and diseases, other disciplines were also involve such as entomologist and pathologist.

It was known that the cocoa production in the Southeast Asia has greatly affected by the cocoa pod borer (CPB), *Conopomorpha cramerella* (Snellen) (Lepidoptera: Gracillariidae). Many studies have been done that leads towards creating a method to control it, however there is still have some constrains in their implementation. Cocoa planting materials that resistance to CPB pest have been though and attempted to study its possibility (Azhar and Lim, 1987; Azhar *et al*., 1995; Haya *et al*., 2007; Navies *et al*., 2012; and Navies and Shakri, 2018). Their studies however have focused on the readily available clones in the germplasm collections. Their findings have revealed that a few cocoa clones do show tolerance towards CPB. This information than provided to the cocoa breeder in MCB and ended into a breeding programme intended to include the creation of cocoa planting material that posse's tolerance towards CPB. Hence, the study was conducted in collaboration between cocoa breeder and entomologist.

MATERIALS AND METHODS

Progeny trial for development of superior cocoa planting materials was established at plot F 33 in CRDC Madai. This project not only to develop high yielding cocoa but also emphasis on pest and diseases resistance. List of progenies to be screened for CPB resistance was shown in Table 1.

In this project, several parameters were bserved and recorded. It included the pod physical characteristics and the damage due to CPB infestation. The observation period for this study was from Jul 2019 until Dec 2020.

Table 1: Progeny coding for the plot F 33, PPK Madai.

Code	Progeny	Tolerance to CPB
A	KW 30 X DRC 15	Unknown
B	ARDACIAR 10 X ARDACIAR 26	Unknown
C	DRC 15 X KW 264	Unknown
D	PBC 123 X LAFI 7	LAFI 7
E	QH 22 X NA 33	Both parent
F	PBC 123 X QH 22	QH 22
G	KKM 22 X LAFI 7	Both parent
H	UIT 1 X NA 33 (HP)	NA 33
I	MCBC 3 X KKM 22	KKM 22

Parameters that have been observed and recorded were ADSI, larva entry hole and exit hole, sclerotic layer thickness, pod thickness and pod hardness. Only observation data from July 2019 to March 2020 period were discussed in this paper. CPB tolerance by the progeny were investigated through dendrogram using average linkage Hierarchical Cluster Analysis using SPSS. This analysis is useful for exploratory purposes to subsequently indicate the appropriate number of groupings (Azhar *et al*., 1995). Bar chart was used to plot the pod physical characteristic of each progeny to investigate its trend.

RESULTS AND DISCUSSION

a. Physical characteristic

The results of nine crossing groups may not all be available. It was because during the observation period, some group fail to produce pod. This was the reasons that only progeny from five groups (A, B, D, E and F) displayed. The physical characteristic of the progeny on each groups are shown in Figure 1 to 3. According to Azhar and Lim, (1987); Azhar *et al*. (1995) and Haya *et al.*, (2007), these physical characteristic do contribute in resistance towards CPB. The characteristics that directly involve are the sclerotic layer thickness, pod thickness and pod hardness. The more of those parameters expressed, the more it contribute to the plant tolerance (a resistance mechanism) for CPB. The results as shown in Figure 1 to 3 can be summarised as in Table 2 to 4.

Through the observation, progeny in group E and F with at least one parent are tolerance to CPB have very thick sclerotic layer (Table 2). On the pod husk thickness, few trees in all progeny group except group E recorded thicker pod husks (Table 3). And on the pod hardness, one tree in progeny group A and five trees in progeny group E recorded the hardest pod (Table 4). Through correlation analysis (Table 5), it was shown that only sclerotic layer thickness and pod hardness found to have strong positive correlation (r = 0.72).

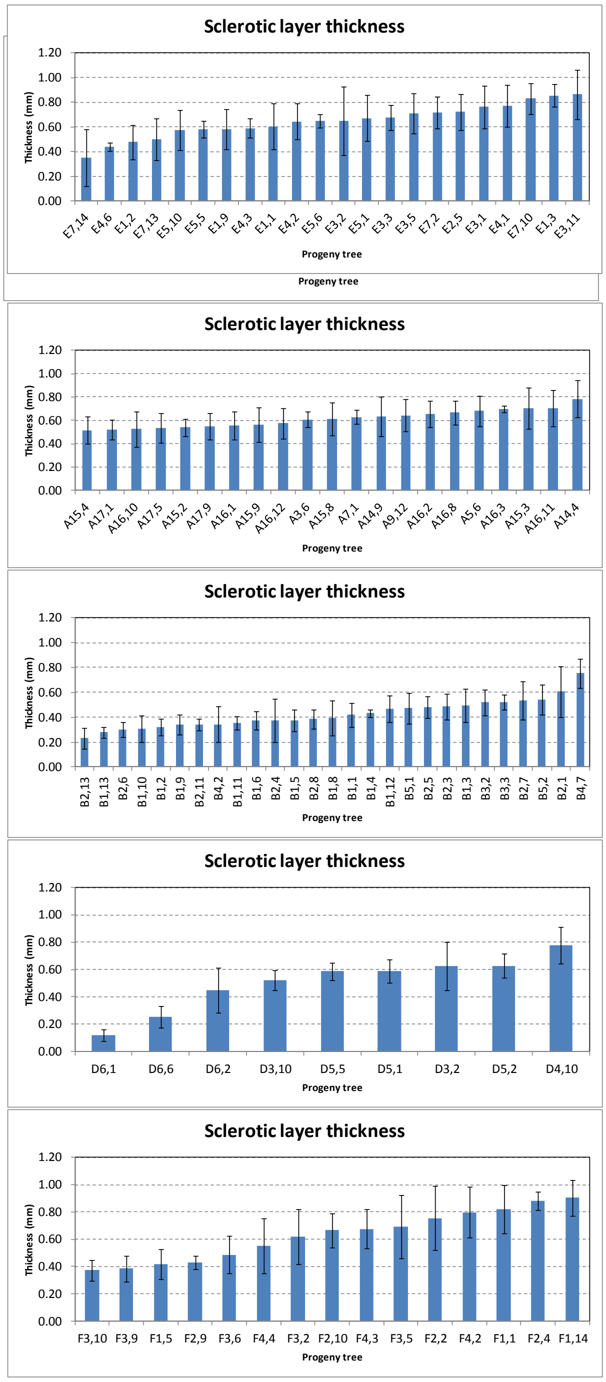

Figure 1: Sclerotic layer thickness of progeny tree.

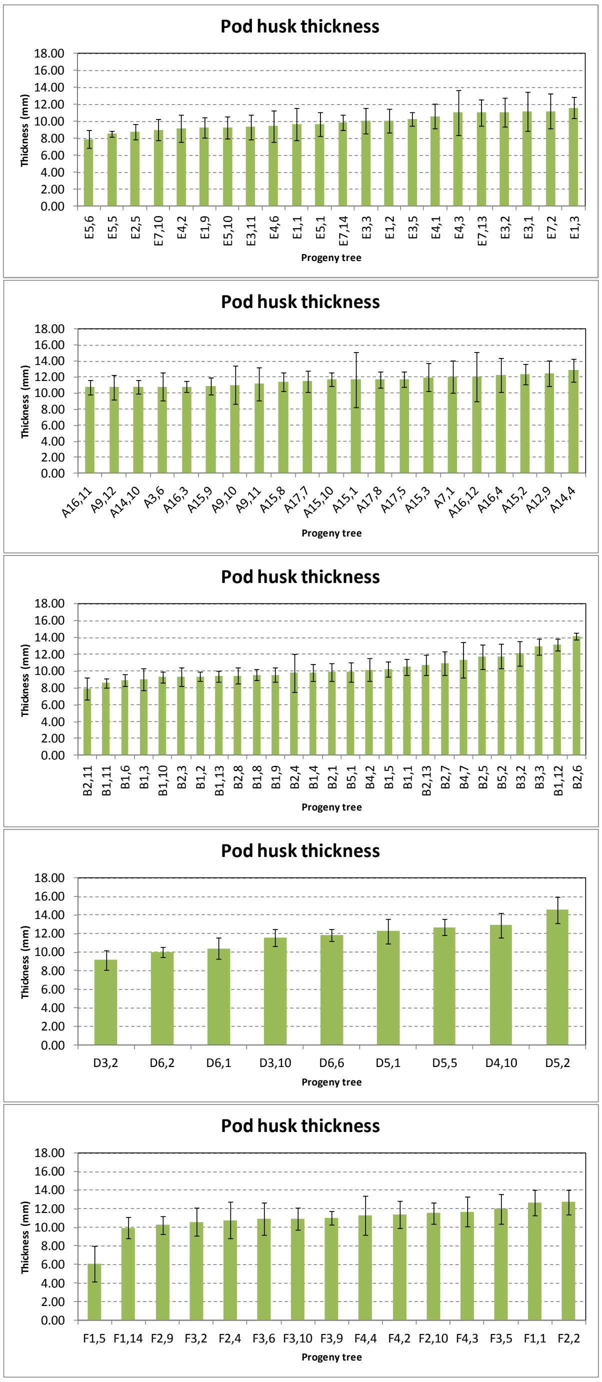

Figure 2: Pod husk thickness of progeny tree

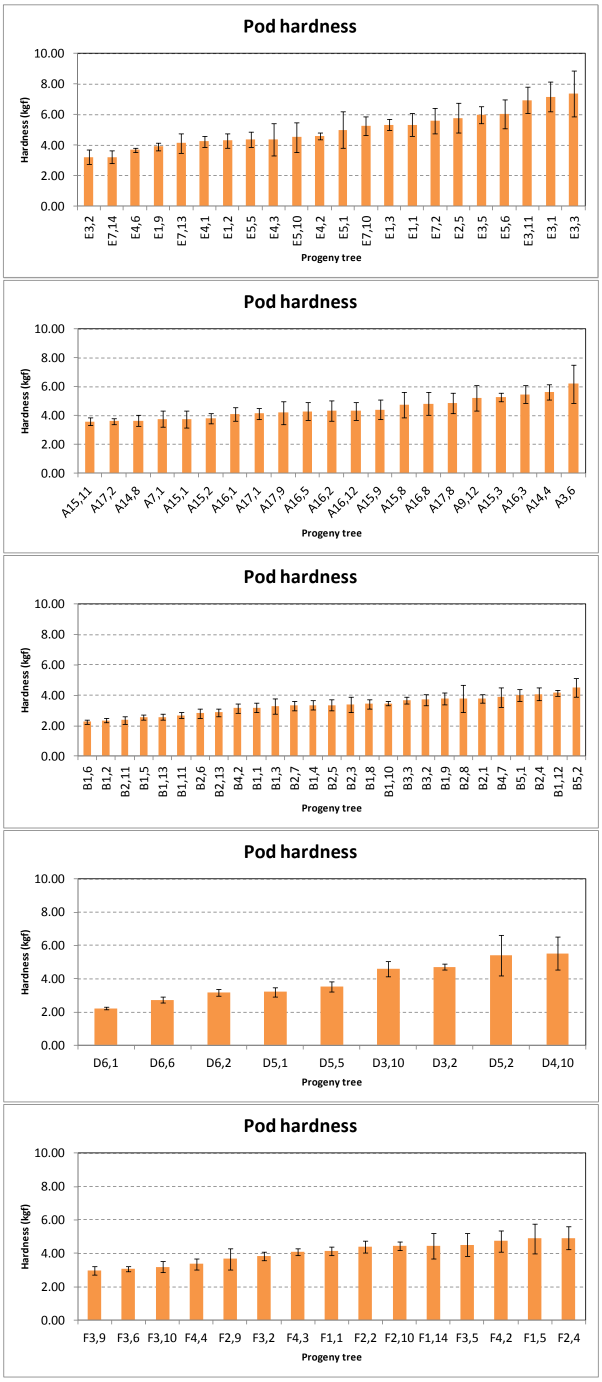

Figure 3: Pod hardness of progeny tree.

Table 2: Progeny tree with sclerotic thickness of 0.8 mm and over as in Figure 1.

Code	Progeny	Tree label with sclerotic thickness 0.8 mm and over	Literature record on Tolerance to CPB
A	KW 30 X DRC 15	None	Unknown
B	ARDACIAR 10 X ARDACIAR 26	None	Unknown
D	PBC 123 X LAFI 7	None	LAFI 7
E	QH 22 X NA 33	E1,3; E3,11; E7,10	Both parent
F	PBC 123 X QH 22	F1,1; F1,14; F2,4; F4,2	QH 22

Table 3: Progeny tree with pod husk thickness of 12.0 mm and over as in Figure 2.

Code	Progeny	Tree label with pod husk thickness 12.0 mm and over	Literature record on Tolerance to CPB
A	KW 30 X DRC 15	A7,1; A12,9; A14,4; A15,2; A16,4; A16,12	Unknown
B	ARDACIAR 10 X ARDACIAR 26	B1,12; B2,6; B3,2; B3,3	Unknown
D	PBC 123 X LAFI 7	D4,10; D5,1; D5,2; D5,5	LAFI 7
E	QH 22 X NA 33	None	Both parent
F	PBC 123 X QH 22	F1,1; F2,2; F3,5	QH 22

Table 4: Progeny tree with pod hardness of 6.0 kgf and over as in Figure 3.

Code	Progeny	Tree label with pod hardness 6.0 kgf and over	Literature record on Tolerance to CPB
A	KW 30 X DRC 15	A3,6	Unknown
B	ARDACIAR 10 X ARDACIAR 26	None	Unknown
D	PBC 123 X LAFI 7	None	LAFI 7
E	QH 22 X NA 33	E3,1; E3,3; E3,5; E3,11; E5,6	Both parent
F	PBC 123 X QH 22	None	QH 22

Table 5: Correlation analysis of pod physical parameters.

	Pod hardness	*Pod husk thickness*	*Sclerotic layer thickness*
Pod hardness	1.00		
Pod husk thickness	0.11	1.00	
Sclerotic layer thickness	**0.72**	0.21	1.00

b. Effect of CPB infestation

Plant tolerance to pests can be observed and quantified. Hence, average damage severity index (ADSI), larva entry and exit hole were the parameters that observed on each progeny trees for analysis. It is more meaningful when the tolerance can be categorised into three, tolerance, moderate and susceptible. Data used in this analysis were from 52 progeny trees that have ten and above cumulative pods during the observation period. The data obtained in this study were analysed with Hierarchical Cluster Analysis on SPSS. The dendrogram using average linkage was plotted as on Figure 4 to 6.

ADSI is a parameter that able to give a quick reference on cocoa tolerance to CPB. On Figure 4, three distinct groups at the distance of 6 observed on the dendrogram. The lower group with progeny tree B1,1 was alone in the group that considered being tolerance due to lowest in ADSI (2.0). Middle group, moderate tolerance consist of 6 progeny trees with ADSI range 2.5 to 2.9 and the susceptible group consist of 45 progeny trees with ADSI range 3.0 to 4.0.

Number of larva entry hole was related to the number of eggs oviposited by the CPB on the pod surface. This parameter is giving indication of pod attractiveness to CPB for egg laying. On Figure 5, at the distance of 8, three groups of cluster are observed. The lower group consist of 14 progeny trees, middle group with 9 progeny trees and top group with 29 progeny trees.

Number of exit hole was related to larva survival inside the pod. Less number of exit hole indicate the larva was not able to survive or at least unable to grow normally. Figure 6, at the distance of 8, again three groups of cluster are visible. The lower group consist of 2 progeny trees, middle group with single progeny tree and the top group consist of 49 progeny trees.

In all of the progeny trees, only progeny tree coded with B1,1 consistence to be in the lower cluster group. The parameters of CPB infestation for this single tree were, ADSI (2.0), entry hole per pod (2.6) and for exit hole per pod (1.0).

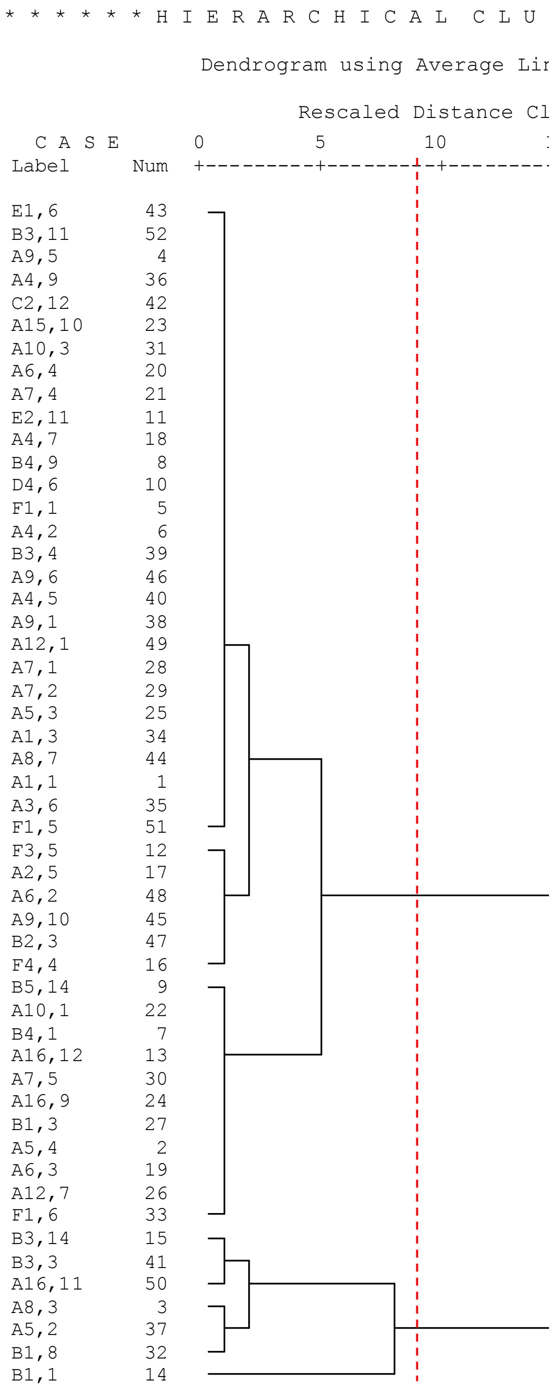

Figure 4: Hierarchical Cluster Analysis on ADSI of 52 progeny trees. Red dashed line denotes the distance cluster with three distinct cluster groups.

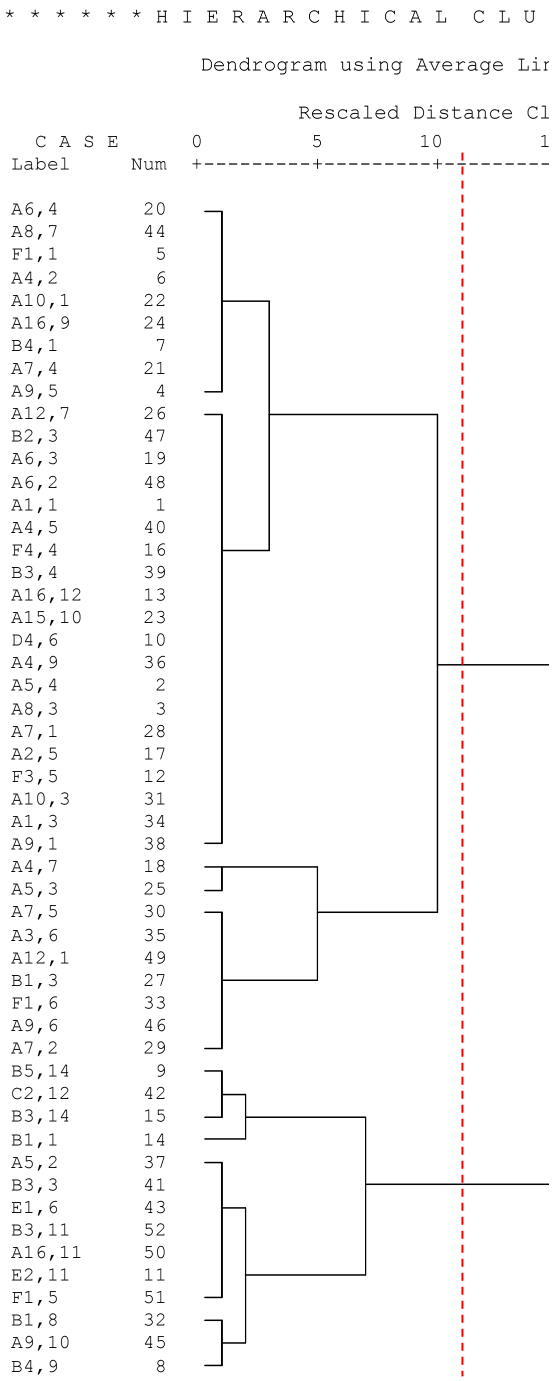

Figure 5: Hierarchical Cluster Analysis on larva entry holes per pods of 52 progeny trees. Red dashed line denotes the distance cluster with three distinct cluster groups.

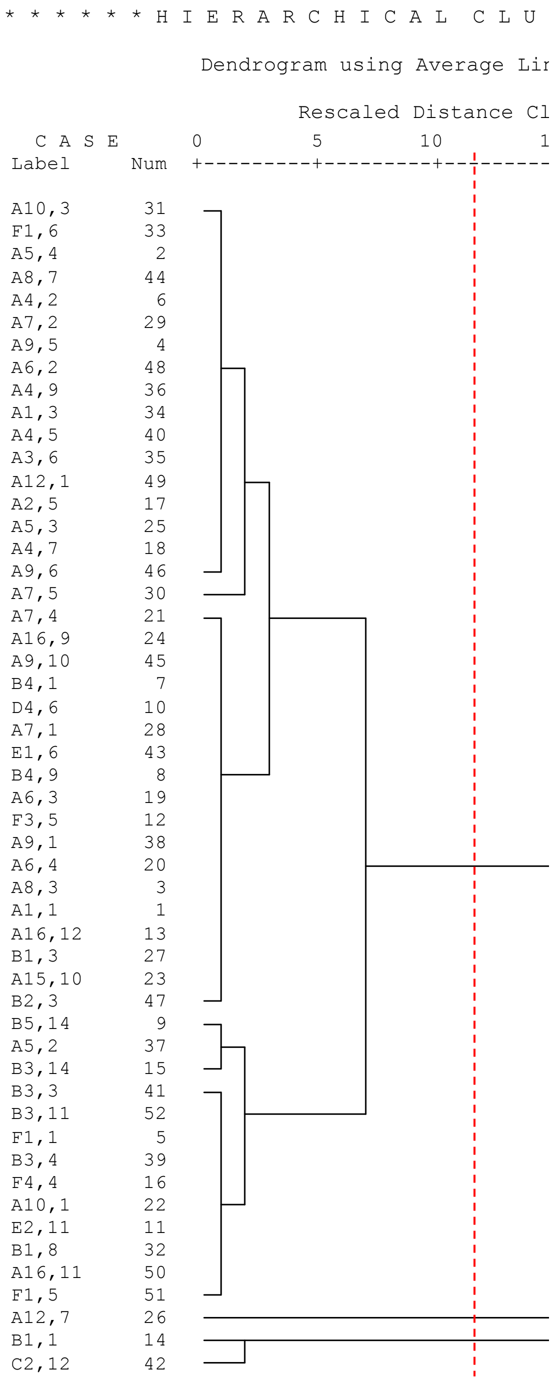

Figure 6: Hierarchical Cluster Analysis on larva exit holes per pods of 52 progeny trees. Red dashed line denotes the distance cluster with three distinct cluster groups.

CONCLUSION

As a conclusion, the physical characteristic even though has been considered to contribute in the resistance of the plant; at least in this study it was not able to provide conclusive evidence. The progeny tree coded B1,1 that identified to be tolerance to CPB using cluster analysis, was not found to exhibit extreme in the physical characteristics. Therefore, in screening for CPB tolerance study, it is recommended to focus only on parameters that involved CPB infestation. The finding in this study will be beneficial to the cocoa breeder in their future action to obtain new planting material that tolerance to CPB.

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