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EVALUATION OF INTERNATIONAL COCOA CLONES AT CRDC MADAI, SABAH

Aizat Japar[1], Nuraziawati Mat Yazik[2] and Haya Ramba[1]

[1]Upstream Technology Division, Malaysian Cocoa Board, CRDC Kota Samarahan, Lot 248 Block 14 Biotechnology Park, 94300 Kota Samarahan, Sarawak; [2]CRDC Bagan Datuk, Peti Surat 30, Jalan Sg. Dulang, 36307 Sungai Sumun, Perak
Corresponding author: *aizat@koko.gov.my*

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ABSTRACT - *Malaysian Cocoa Board (MCB) has been recognized as one of the centres for cocoa germplasm in the world with more than 1,500 cocoa clones collection. The ex-situ germplasm collection includes local selection from preceding research agencies such as Department of Agriculture (DOA) of Quoin Hill, Balong River Plantation, Borneo Abaca Limited, and MARDI, while the international cocoa clones are from Indonesia, Philippines, Costa Rica and Ecuador. Copious number of germplasm is preserved and evaluated at the MCB Cocoa Research and Development Centre of Madai, Sabah. The objectives of this study are to evaluate and assess the potential yield, vascular streak dieback disease tolerance and special characteristics of the international cocoa clones. Result obtained indicated that several international cocoa clones (ICS 95, UF 705 and AMAZON 3-2) show promising value of the study traits. This paper suggested that the potential clones could be used to develop new cocoa planting materials with specific traits and special characteristics.*

Keywords: germplasm, international clones

INTRODUCTION

Theobroma is a small genus belonging to the Malvaceae family. Brazil and Colombia can be considered as the main centers of diversity of the genus because both countries harbor the greatest number of indigenous species. This genus contains 22 species but only a few such as *T. cacao*, *T. grandiflorum* Willd. Ex Spreng., *T. bicolor* Humb. and Bonpl., and *T. angustifolium* Mocino and Sesse have economic value (Ronaldo *et al*., 2012). *T. cacao* or generally known as cocoa tree was widely cultivated in America, Asia and Africa to produce cocoa beans used for chocolate, confectionery and cosmetic industries (Motamayor *et al.*, 2013). Three main genetic types of cocoa have been traditionally recognized: Criollo, Forastero and Trinitario. The Criollo type is known for the high quality beans that can produce fine flavour chocolate; Forastero type is recognized to have high vigor and prolificacy; Trinitario genetic group is genetically considered to be a hybrid of Criollo and Forastero. Most of the commercial cocoa clones released by Malaysian Cocoa Board are from the Trinitario type.

Malaysian Cocoa Board (MCB) has been recognized as one of the centre for cocoa germplasm in the world with more than 1,500 cocoa clones collection. The ex-situ germplasm collection includes local selection from preceding research agencies such as DOA of Quoin Hill, Balong River Plantation, Borneo Abaca Limited, and MARDI, while the international cocoa clones are from Indonesia, Philippines, Costa Rica and Ecuador. Copious number of germplasm is preserved and evaluated at the MCB Cocoa Research and Development Centre of Madai, Sabah. The availability of genetic resources and the assessment of their diversity are very important in MCB cocoa breeding program. These genetic resources will be used to develop new and superior cocoa clones with high yield potential, good flavour, resistance to pest and disease. Therefore, trait assessment, as part of the selection process, is

one of the crucial stages in plant breeding and beneficial for the achievement of a breeding target. The objectives of this trial are to evaluate and assess the potential yield, vascular streak dieback disease tolerance and special characteristics of the international cocoa clones.

Materials and Methods

This study was conducted at the block F41, Cocoa Research and Development Centre (CRDC) Madai, Sabah with field planting was carried out in March 2007. Fourteen international clones (Figure 1) were included in this trial with PBC 123 and KKM 22 as control clones (Table 1).

Table 1: Clones name and their basic details.

CODE	CLONE	LOCATION	CODE	CLONE	LOCATION
T3	AMAZON 3-2	Peru	T28	ICS 95	Trinidad
T5	APA 4	Colombia	T30	KKM 22	Malaysia
T7	C 83-28	Trinidad	T32	MCMC 1	Costa Rica
T8	CATIE 1000B	Ghana	T34	PBC 123	Malaysia
T9	CCN 51	Ecuador	T37	SPEC 160-9	Colombia
T13	GA 57	Malaysia	T40	UF 668	Costa Rica
T14	GS 17B	Malaysia	T41	UF 705	Costa Rica

Figure 1: Clones CCN 51, APA 4 & PBC 123 (From left to right)

The site has an average monthly temperature of 25ºC, with a minimum of 20 ºC and a maximum of 35 ºC, monthly precipitation of 150.1mm and average relative humidity of 75%. The design adopted was randomized complete block design with three replications. Each replicate consisted of twenty trees planted in double rows with 3 m of spacing between both trees and plots. Forage tree legume (*Gliricidia sepium*) were planted for permanent shade at a spacing of 6 m x 6 m. Maintenance treatments were applied uniformly to each tree as follows: 4 x 270-300 g/tree per year 12N-12P-17K-TE fertilizer; canopy pruning for height; regular pruning for disease control, black pod control using metalaxyl fungicides during wet seasons, and weed control by a combination of herbicides and bush cutter.

Girths of the main trunk was measured twice a year (April and October) from 2008 until 2013 as one of the primary data from which growth analysis quantities were derived. Girth measurement was-measured at the same position marked with paint marker. Phenotypic data was recorded on a single tree basis and the number of mature pods was taken monthly over a 5-year period. The total number of pods harvested per year was evaluated as one of the main yield components. The dry cocoa beans were prepared according to normal procedure; fermentation of the raw beans for 4-5 days and sun-drying 5-7 days.

The characteristics measures included average bean weight, pod weight, husk content, and number of beans per pod for each hybrid. Pod value was expressed as the number of pods required to produce 1 kg of dried beans.

PV = [No of sampled/ Dry bean weight (g)] x 1000

Potential yield ($Kg{\cdot}ha^{-1}{\cdot}year^{-1}$) for each hybrid was estimated from pod production divided by pod value multiplied by 1,000 trees/ ha and a correction factor 0.83. The potential yield was recorded at maturity on 6-year old trees.

The extent of VSD disease symptom severity or damage is quantified by using a disease severity or damage scale.

Scale	Symptoms
0	Healthy
1	infected leaf, few or many
2	infected leaf, some or most of which showing chlorosis in progress
3	most of infected leaves showing chlorosis and necrotic, still remain attached
4	infected leaves began to abscise
5	most infected leaves have abscised, apparent cessation of first flush growth
6	near complete defoliation, dieback

The scale used is from 0-6 on progressive damage from chlorosis to defoliation to dieback. This method of measurement incorporates both the incidence and the extent of damage caused by the disease. This method applies for both the seedling and matures tree.

Table 2. Performance of selected cocoa clones for morphological and reproductive traits.

CLONE	NAME	GIRTH (cm)	No of Pods Per Tree	BNP	BCR (%)	ADBW (g)	PV	VSD Score	DBY (Kg/Tree/Year)	Potential Yield (Kg/Ha/Year)
T34	PBC 123	31.06	28.3	46.50	29.00	1.08	27.59	2.00	1.42	1421
T3	AMAZON 3-2	28.86	28.0	26.40	31.62	0.99	39.69	2.00	0.73	731
T28	ICS 95	21.69	27.5	33.67	30.05	0.83	33.28	2.33	0.60	606
T14	GS 17B	25.88	27.4	46.60	37.22	0.80	27.42	2.00	1.02	1021
T13	GA 57	27.59	23.7	31.33	24.13	0.93	37.11	2.00	0.80	803
T40	UF 668	23.4	21.7	39.00	27.21	0.82	35.34	2.00	0.69	693
T41	UF 705	20.07	21.6	41.45	33.56	0.70	34.69	2.17	0.62	626
T37	SPEC 160-9	23.31	20.8	35.40	29.75	0.86	34.65	2.00	0.63	633
T7	C 83-28	29.64	20.2	39.71	31.88	1.01	25.24	2.00	0.80	801
T8	CCN 51	22.26	19.9	30.00	28.77	0.85	46.34	2.17	0.50	507
T9	CATIE 1000B	21.26	19.8	35.40	29.75	0.86	34.65	2.00	0.60	602
T32	MCMC 1	25.16	19.4	30.75	33.73	1.14	31.21	2.50	0.68	680
T30	KKM 22	22.18	19.1	37.50	27.84	1.02	30.35	2.33	0.73	730
T5	APA 4	18.56	18.9	29.50	34.93	1.23	28.39	2.33	0.68	685
	MEAN	24.35	22.59	35.94	30.68	0.94	33.28	2.13	0.75	
	SD	3.78	3.63	6.22	3.42	0.14	5.57	0.17	0.22	
	SE	1.01	0.97	1.66	0.91	0.03	1.49	0.04	0.06	

RESULTS AND DISCUSSION

The girth data (Table 2) for all selected cocoa clones were collected from 2008; the first year which is the plot was established until the fifth year, 2013. Clone T5 recorded the lowest girth of 18.56 cm, while the highest value was recorded in the clone T34 with 31.06 cm. It was also observed that the stem girth increased correspondingly with plant height which indicated the vigour of the plant. In this study, control clone T34 or PBC 123 is one of the recommended commercial cocoa clones in Malaysia. This clone is one of the clones that are widely planted around Malaysia because of good potential yield and suitable with local environmental condition. The differences in tree girth are expected because the other clones except for T30 (KKM 22) are international clones that have yet been tested with local environmental condition.

Yield is the main selection criterion for most crops. The number of pods per tree in a year is the key factor determining the yield in cocoa and important traits to be considered for improvement. The number of pods harvested per tree showed significant variability among the cocoa clones (Table 2). The yield data displayed in Table 2 was the average of 5 years data from 2014 until 2019. Among the selected cocoa clones, T34 registered the highest number of pods per tree (28.3) followed by T3 (28) whereas, the clone T5 recorded the lowest number of pods per tree (18.56). The average number of beans seeds per pod is 35.94 while the average weight of dry bean is 0.94 g. With respect to the different potential yield, there is a large difference between T34 and the other selected cocoa clones. The highest potential yield in this trial is 1421 Kg/ha (T34) and the lowest is 507 Kg/ha (T8). The result of vascular streak dieback (VSD) disease assessment (Table 2) shows that the selected international cocoa clones possess VSD tolerance comparable to the local commercial clones

CONCLUSIONS

This study has revealed new and confirmed existing information for better understanding of the potential characteristics in Malaysian cocoa clones and international cocoa clones. The relationship between the girth of cocoa trees, pod yield, bean characteristics and potential yield has been demonstrated by the result of this work. Therefore, for the development of superior new cocoa clones, it is recommended to use those key characteristics as means of selection.

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