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Hengniu: Fast Bearing and High Yielding Coconut Varieties

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Abstract

Benefits of coconut varieties that stakeholders want are early bearing, high yielding, short stems, and slow growth for height. Most local tall coconut palms in Indonesia have stem height above 20 m, making it increasingly difficult to climb to harvest fruit or tapping sap thereby making the harvesting cost high. To breed varieties of desired characters, an evaluation trial was initiated in 2014 with BYD x MTT-S4, RAD x MTT-S4, and KHINA-1 as a control. The crossing was done in 2012 and seedlings planted in January 2014 at Mapanget Experimental Garden, Indonesian Palma Crops Research Institute, North Sulawesi. The study used a Randomized Block Design (RBD) of three types of coconut hybrids, four replications with a plot size of 16 trees. Morphological observations were carried out on stem, crown and leaf characters, inflorescences and flowers, nut production, fruit components, copra, oil content, and fatty acid composition. The results of ANOVA analysis and statistical tests obtained those vegetative characters, such as stem circumference and number of leaf, generative characters namely the number of bunches, first flowering, and fruit production of these three crosses at the age of 4 years after planting, did not show a significant difference. The first initial flowering was in the coconut hybrid of RBD x MTT-S4, which is 26 months, followed by BYD x MTT-S4 in 32 months and KHINA-1 in 36 months after planting. The results of the analysis of fruit and copra production at the age of 5 years showed a significant increase between hybrid coconuts. The highest to lowest fruit production was obtained in BYD x MTT-S4 hybrid coconut, RBD x MTT-S4, KHINA-1, which were 64 nuts, 44 nuts and 26 nuts /palm respectively, or estimated copra production was 2.26 tons, 1.45 tons and 0.88 tons copra/ha. At 6 years old the harvest of fruits from the three hybrid coconuts is obtained sequentially 118 nuts, 99 nuts and 94 nuts/palm. While estimation of copra yield per hectare is found the highest in BYD x MTT-S4 hybrid coconut is 3.86 ton/ha/year and this yield differently significant compare with RBD x MTT-S4 is found 3.04 ton/ha/year, and control hybrid of KHINA-1, which is about 2.74 ton/ha/year. Based on the production potential, hence the estimated optimum production when aged over 10 years can reach more than 5 tons/ha/year. The hybrid coconut variety BYD x MTT-S4 is released in October 2019 under the name HENGNIU.

Key words: Coconut hybrid, early bearing, high yielding, short-trunked, oil content, fatty acid

Introduction

The results of various evaluation trials with hybrid coconuts conducted at Indonesian Palma Crops Research Institute (IPCRI) since the early 1980s resulted the release of four hybrids Tall x Tall hybrids viz., KB-1 (MTT-32 x MTT-32), KB 2 (MTT-32 x MTT-2), 3(MTT-32 x MTT-83), and 4 (MTT-32 x MTT-99) (Rompas et al., 1989); and five Dwarf x Tall hybrid viz., KHINA-1 (NYD x TAT), KHINA-2 (NYD x BIT), KHINA-3 (NYD x PUT), KHINA-4 (RBD x MTT), and KHINA-5 (BYD x MTT). Copra production of KHINA1, KHINA-2 and KHINA-3 hybrids is between 4-5 tons/ha /year (Novarianto et al., 1984), and for KHINA-4 and KHINA-5 is 3.5 tons/ha/year.

In 2005, the Minister of Agriculture of Indonesia released three Dwarf coconut varieties, which are high yielding fruits, and starting flowering from the age of 3 years. Compared to Tall varieties, Dwarf varieties are expected to be more homozygous because of self-pollination. Mapanget tall coconut is one of the superior coconut varieties in Indonesia (Anonymous, 1991).

Hybridization between inbred lines is expected to produce large heterosis (ref). The fourth generation selfed population of Mapanget Tall (MTT-S4) is found to be more homogeneous than the parental population MTT-S3 as seen with RAPD marker analysis (ref). The results of the hybridization between MTT-S4 and three Dwarfs are discussed in this paper.

Materials and Methods

The research activities on the Dwarf x-MTT-S4 coconut assembly have been carried out since 2012. The activity began with the selection of the parent trees of Bali Yellow Dwarf (BYD), Raja Brown Dwarf (RBD), and Tenga Tall (TAT) coconut in the Mapanget Experimental Garden, Nias Yellow Dwarf (NYD) was selected in the Paniki Experimental Garden, and coconut male parent trees in Mapanget generation selfing 4 (MTT-S4) in the Kima Atas Experimental Garden. The BYD, RBD, and NYD are used as female parents. The MTT-S4 and TAT coconut are used as male parents. The mature TAT and MTT-S4 coconut inflorescence are taken from selected male parent, then processed in the Breeding Laboratory, Indonesian Palma Crops Research Institute (IPCRI), Manado. The MTT-S4 and TAT coconut pollen, put in a plastic bottle, and stored in the freezer. Pollen processing techniques were used as per the standard manual at IPCRI (Ditjenbun, 2014). Hybridization of BYD x MTT-S4, RBD x MTT-S4, and NYD x TAT was carried out. KHINA-1 was used as the control. Hybridization was carried out in 2012 for 6 months, and continued with observing the fruit settings. In 2013 observations were made on the development of fruit setting, and harvested at the age of 11 months from pollination. Seednuts harvested were sown in nursery beds and on germination shifted on polybags. Planting was done in January 2014 at Mapanget Experimental Garden. Observation of vegetative growth of plants were recorded during 2014 to 2017 and reproductive characters and fruit production during 2017 to 2019.

The study used a Randomized Block Design (RBD). Spacing was 8.5 m x 8.5 m. The experimental design

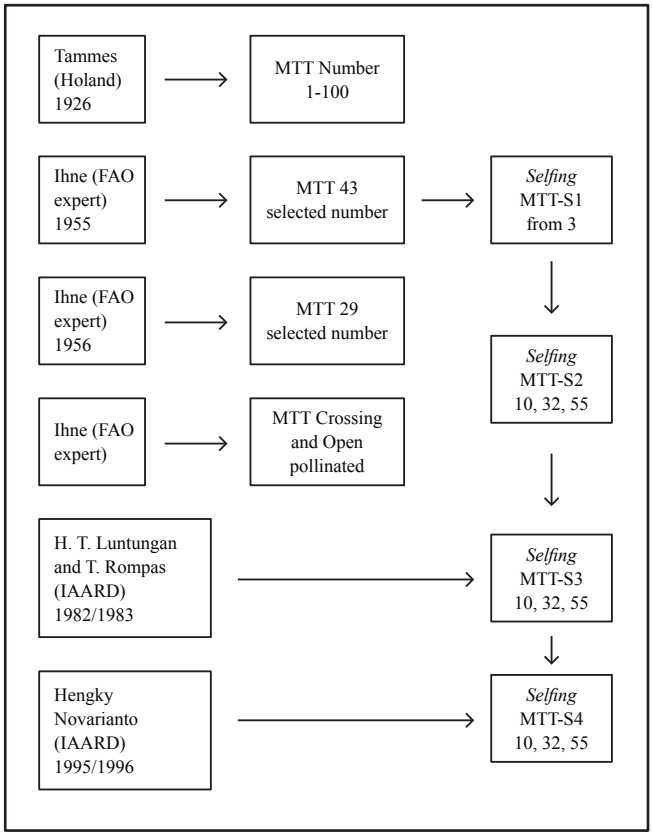

Figure 1. The origin of elders Mapanget tall coconut variety

uses four replications and each replication or plot consists of 16 palms. So, it has been planted 3 x 4 x 16 = 192 palms. Observations were made on morphological characters, such as stem character, crown and leaf, inflorescences and flowers, production, fruit components, copra, oil content, fatty acid content and composition, and resistance to Phytopthora palmivora disease.

Morphological, generative, and fruit production observations, and coconut fruit components, namely:

1. Stem: consists of a stem circumference at 20 cm, stem circumference at 1.5 m, length of stem with 11 leaf scars,
2. Leaf: crown shape, petiole color, number of leaf, rachis length, petiole length, petiole width, petiole thickness, number of leaflets, leaflets length, and leaflets width,
3. Inflorescence: number of bunches, length of peduncle, length of the central axis, thickness of peduncle, width of peduncle, number of spikelets and number of female flowers,
4. Fruit: number of fruit, fruit color, shape and size of whole fruit and shape and size of nut,
5. Fruit components: fruit weight, nut weight, weight split nut, shell weight, meat weight, and copra.

Other Supporting Data

a. Analysis of copra oil content *),
b. Analysis of coconut oil fatty acid composition and content *),
c. Analysis of macro and micronutrients in the experimental site **),
d. Analysis of macro and micronutrients in leaf number 14 hybrid coconut **),
e. Evaluation of Phytophthora palmivora disease attacks,
f. Financial Analysis of Hybrid Coconut.

Result

In the figure 1 can be seen the origin of Mapanget tall coconut by mass selection until individual selfing to get the homozygous genotype. The origin of Mapanget tall population selected by positive mass selection and get 100 best palms from population in Mapanget district, Minahasa region, North Sulawesi Province by Dr. Tammes in 1926. Dr. Ihne, who is FAO expert selected 43 number families by negative mass selection, and following by positive mass selection and got 29 number families as the best palms. Apart from that, selection has been carried out on the 3 best family numbers, namely numbers 10, 32, 55, and self-pollination has been carried out to obtain a population that is more homozygous. Self-pollination of these 3 family numbers was carried out until the 4th generation. This 4th generation population was chosen as the pollen source to be pollinated on Nias Yellow Maturity coconuts, and a HENGNIU hybrid was obtained.

Vegetative Character Growth and Development Age 1-4 years

Observation results of vegetative growth and development of hybrid coconut BYD x MTT-S4, RBD x MTT-S4, and KHINA-1, namely stem circumference and number of leaves are presented in Table 1. The ANOVA showed that characteristics of stem circumference at 1-4 years for these three hybrids coconut did not show any significative difference.

Number of Bunches and First Flowering Age 4 years

Observation of the character of the number of coconut bunches and the number of first flowering can be seen in Table 2. Observation of the number of coconut bunches and number of fruits until 4 years after planting obtained a number of bunches between 11.00-13.04 bunches/palm, and the number of fruits between 14.45-18.65 nuts /palm, but these two characters in the first year began to flower and fruiting is not yet significantly different among the hybrid coconuts.

Table 1. Vegetative character of stem circumference and number of leaf of three hybrid coconuts aged 1-4 years

No.	Hybrid coconuts	Stem circumference (cm) at aged (years)			
		1	2	3	4
1.	BYD x MTT-S4	17,62 a	51,70 a	138,03 a	151,72 a
2.	RBD x MTT-S4	16,21 a	43,22 a	131,32 a	134,12 a
3.	KHINA-1	18,55 a	53,96 a	140,55 a	157,61 a

No.	Hybrid coconuts	Number of leaf (leaf) at aged (years)			
		1	2	3	4
1.	BYD x MTT-S4	9,75 a	12,65 a	16,78 a	24,62 a
2.	RBD x MTT-S4	9,81 a	12,16 a	16,09 a	22,48 a
3.	KHINA-1	9,84 a	12,26 a	16,74 a	24,46 a

Table 2. Number of bunches and fruits of the three hybrid coconuts aged 4 years after planting

Characters/ hybrid coconuts	Parameter		
	Average	SD	CV (%)
BYD x MTT-S4	12,08 a	4,01	33,15
RBD x MTT-S4	13,04 a	2,85	21,89
KHINA-1	11,00 a	4,20	38,16
Number of fruits/palm (nuts)			
BYD x MTT-S4	17,83 a	12,67	71,07
RBD x MTT-S4	18,65 a	8,78	47,05
KHINA-1	14,45 a	10,80	74,75

Characteristics of Stem Morphology, Leaf and Inflorescence

Observations of stem morphology, leaf on the (?) coconut hybrid Bali Yellow Dwarf x Mapanget Tall-S4 (BYD x MTT-S4) are presented in Table 3. Observations at 6 years of age show the character of BYD x MTT-S4 hybrid coconut is generally spherical, or semi-spherical. The girth measurement at 20 cm above soil level is 148.33 cm and the girth measurement at 1.5 m above soil level is 84.43 cm. These results indicate that the lower stem circumference is greater than the upper stem circumference, meaning that the

Table 3. The average, standard deviation (SD), Coefficient of Variance (CV) of stem morphology, leaf and inflorescencia of BYD x MTT-S4 hybrid coconut

No.	Characters	Average	SD	CV (%)
1.	Shape of crown	*Spherical*	-	-
2.	Girth measurement at 20 cm above soil level (cm)	148.33	9.66	6.51
3.	Girth measurement at 1.5 m height (cm)	84.43	5.22	6.18
4.	Length (cm) of stem with 11 leaf scars	78.54	12.06	15.36
5.	Number of leaves	24.05	1.66	6.94
6.	Colour of petiole	Green-Yellow	-	-
7.	Petiole length (cm)	170.25	12.02	7.06
8.	Petiole thickness (cm)	3.19	0.19	5.96
9.	Petiole width (cm)	7.41	0.35	4.83
10.	Rachis length (cm)	417.30	17.32	4.15
11.	Number of leaflets	190.10	21.27	11.19
12.	Leaflet length (cm)	136.54	16.94	12.41
13.	Leaflet width (cm)	5.26	1.30	24.86
14.	Length of peduncle (cm)	61.70	5.24	8.49
15.	Thickness of peduncle (cm)	2.02	0.37	18.74
16.	Length of central axis (cm)	71.40	6.68	9.36
17.	Number of spikelets	34.45	4.78	13.88
18.	Number of spikelets with female flowers	23.05	5.80	25.19
19.	Length of first spikelet bearing female flower	45.20	6.37	14.11
20.	Number of female flowers	25.70	7.94	30.92
21.	Fruit polar circumference (cm)	55.00	2.20	4.00
22.	Shape of fruit (polar view)	*Round/Egg-shaped*	-	-
23.	Fruit equatorial circumference (cm)	50.00	3.35	6.70
24.	Shape of fruit (equatorial view)	Round	-	-
25.	Nut polar circumference (cm)	38.00	2.21	5.82
26.	Nut equatorial circumference (cm)	40.00	3.14	7.85
27.	Shape of husked nut	*Almost round*	-	-
28.	Fruit colour	*Green-Yellow*	-	-
29.	Fruit size	*Medium*	-	-

BYD x MTT-S4 hybrid coconut has a bole. Bole in coconut palms indicates including in the type of tall coconut and or type of hybrid coconut, but in general the type of tall coconut bole is larger than the bole of hybrid coconut or intermediate.

Fruit Production and Components

The results of analysis of fruit component weight and fruit and nut size of the three hybrid coconuts are presented in Table 4. The observation of fruit component data from the three hybrid coconuts showed that the biggest fruit weight was obtained in KHINA-1 hybrid coconut of 1,764 gr, followed by RBD x MTT-S4 of 1,518 gr and the lowest on BYD x MTT-S4 of 1,304 gr. The shape of the fruit can be seen from the size of the polar circumference and the equatorial circumference of almost all three for each size, which are classified as egg-shaped.

The results of observation of coconut fruit production until the age of 4 years were obtained from the three hybrid coconuts, respectively 18 nuts/palm, 19 nuts/palm and 14 nuts/palm have not shown statistically significant differences (Table 5). Likewise, if converted into copra, all three are 4.46 kg/palm, 4.74 kg/palm and 3.11 kg/palm. The estimated fruit production per hectare of these three hybrid coconuts is 2,484 nuts/ha, 2,622 nuts/ha and 1,932 nuts/ha at the age of 4 years after planting. Novarianto, et al. (2017) reported that the Lampanah tall coconut has a bunches number of 13.35 palm, the number of nuts 9.25/bunch, or an average of 138 nuts/palm/year.

Stem Height

The observation of stem height and length of stem with 11 leaf scars is shown in Table 6. The average height of hybrid coconut stems is not significantly different, where BYD x MTT-S4 hybrid coconut with 239 cm stem height, then RBD x MTT-S4 hybrid obtained 219 cm, and the comparison of 241 cm of KHINA-1. Furthermore, for the character of stem length with 11 leaf scars, it was shown that the RBD x MTT-S4 hybrid coconut was significantly different from the comparison of KHINA-1, which was on average 70 cm with 85 cm, whereas on the BYD x MTT-S4 hybrid coconut which had average length of stems 11 leaf scars is 78 cm, not significantly different from both. Shorter stems in BYD x MTT-S4 and RBD x MTT-S4 hybrids coconut show the effect of inbreeding which can cause the distance among leaf scars to be shorter to each other. Mahayu and Novarianto (2015) reported that the seedlings produced by BYD x MTT-S4 hybrid coconut were shorter than seedlings of KHINA-1.

Analysis of fat and fatty acid composition

The coconut meat samples of BYD x MTT-S4 hybrid coconut, RBD x MTT-S4 and KHINA-1 have 500 gr each, which are processed into copra with 5% moisture content. The copra yield obtained for the three hybrid coconuts was obtained at BYD x MTT-S4 of 58.08%, then hybrid RBD x MTT-S4 coconut was 55.33%, and hybrid KHINA-1 was 50.79%. Copra samples from each hybrid coconut are analyzed for oil content, fatty acid composition and fatty acid content. The results of analysis of fat, fatty acids content and fatty acid composition are presented in Table 7.

Discussion

In 2012 the MTT-S4 coconut was used as a source of pollen and was crossed with the Bali Yellow Dwarf (BYD) and Raja Brown Dwarf (RBD) coconut as a hybrid coconut testing material and compared to the control of hybrid coconut Nias Yellow Dwarf x Tenga Tall (KHINA-1). Until 2019 this MTT-S4 coconut from the three numbers, namely MTT-S4-10, MTT -S4-32 and MTT -S4-55 still survive as many as 150 palms and can be used as pollen sources. Mapanget Tall coconut (MTT) was released as one of the national superior varieties in 2014 with the Decree of the Minister of Agriculture of the Republic of Indonesia No.132/Kpts/SR.120/3/2004 (Department of Agriculture, 2004).

Table 4. The results of analysis of fruit component of BYD x MTT-S4, RBD x MTT-S4 and KHINA-1 hybrid coconuts

Characters		Hybrid coconuts		
		BYD x MTT-S4	RBD x MTT-S4	KHINA-1
Fruit weight (gr)	X	1.304	1.518	1.764
	SD	170	363	277
	CV (%)	13,10	23,90	15,69
Fruit polar circumference (cm)	X	55	57,25	60
	SD	2,20	4,23	3,36
	CV (%)	4,00	7,45	5,57
Fruit equatorial circumference (cm)	X	50	51	58
	SD	3,35	8,92	3,01
	CV (%)	6,74	17,49	5,17
Nut weight (gr)	X	991	1.175	1.359
	SD	132	298	247
	CV (%)	13,32	25,37	18,16
Nut polar circumference (cm)	X	38	41	43
	SD	2,21	3,03	1,80
	CV (%)	5,74	7,32	4,21
Nut equatorial circumference (cm)	X	40	42	45
	SD	3,14	4,00	2,55
	CV (%)	7,92	9,46	5,68
Weight of split nut (gr)	X	643	758	827
	SD	79	156	108
	CV (%)	12,33	20,57	13,06
Meat weight (gr)	X	436	532	584
	SD	45	113	73
	CV (%)	10,37	21,26	12,44
Endosperm thickness (cm)	X	1,09	1,10	1,20
	SD	0,12	0,11	0,13
	CV (%)	11,19	10,16	11,50
Copra weight (gr)	X	218	266	293
	SD	23	57	134
	CV (%)	10,36	21,49	16,32

Age 1 year after planting shows the stem circumference ranged from 16.21-18.55 cm, at the age of 2 years it increased to between 43.22-53.96 cm, then at the age of 3 years it became 131.32-140.55 cm, and after 4 years of age increases to between 134.12-157.61 cm. The addition of the largest stem circumference at the age of 2 years to 3 years old, which is increased by about 86.33-88.10 cm due to changes in the circumference of the pseudo-stem into the actual circumference of the stem. The character of the number of leaves on the coconut crown from the three hybrid coconuts based on the results of the diversity

Table 5. Average of meat weight, number of fruit and copra per palm, and estimated production per hectare on ages 4-6 years after planting

No.	Hybrid coconuts	Ages	Meat weight/ nut (gr)	Production/Palm		Production/ha*)	
				Fruit/year (nut)	Copra/year (kg)	Estimated fruit/ ha (nut)	Estimated copra/ ha (ton)
1.	BYD x MTT-S4	4 years	426,71 a	18 a	4,46	2.484	0,62
2.	RBD x MTT-S4		450,86 a	19 a	4,74	2.622	0,65
3.	KHINA-1		437,19 a	14 a	3,11	1.932	0,43
1.	BYD x MTT-S4	5 years	450,75 a	64 b	16,34 b	8.832 b	2,26 b
2.	RBD x MTT-S4		437,75 a	44 ab	10,51 ab	6.072 ab	1,45 ab
3.	KHINA-1		470,42 b	26 a	6,35 a	3.588 b	0,88 a
1.	BYD x MTT-S4	6 years	411,88 a	117,92 b	27,99 b	16.284 b	3,86 b
2.	RBD x MTT-S4		402,85 a	98,66 a	21,99 a	13.662 a	3,04 a
3.	KHINA-1		416,68 a	94,00 a	19,89 a	12.972 a	2,74 a

*) Planting distance 8.5 x 8.5 m square = 138 palms/ha.

Table 6. Average (X), standard deviation (SD) and Coefficient of variance (CV) of stem height and length of stem with 11 leaf scars on ages 5,5 years of hybrid coconut Dwarf x MTT-S4 and its control KHINA-1

No.	Hybrid coconuts	Height of stem (cm)			Length of stem with 11 leaf scars (cm)		
		X	SD	CV (%)	X	SD	CV (%)
1.	BYD x MTT-S4	239 a	28.67	12.01	78 ab	12.06	15.36
2.	RBD x MTT-S4	219 a	24.68	11.28	70 a	10.20	14.65
3.	KHINA-1	241 a	41.59	17.24	85 b	12.30	14.48

analysis did not show a significant difference in the number of leaves between BYD x MTT-S4 and GRA x DMT-S4 hybrids, against the comparison KHINA-1. The average number of leaves of the three hybrid coconuts at the age of 1-4 years in a row is between 9.81-9.84 strands; 12.16-12.65 strands; 16.09-16.8 leaf; and 22.48-24.62 leaf.

The results of the diversity coefficient analysis show the character of the number of bunches and the number of initial fruits of all hybrid coconuts is very diverse with the value of CV above 20%. The character of the number of coconut bunches was obtained between 21.89% and 38.16%. The character of the number of fruits produced was very diverse also in the three types of hybrid coconut with the value of CV between 47.05% to 74.75%. The first flowering is found in BYD x MTT-S4 hybrid coconut, i.e. 32 months after planting, RBD x MTT-S4 is earlier, i.e. 26 months, and comparison is KHINA-1, 36 months after planting. Jatmiko et al. (1990) reported that the development of a synthetic variety of coconut that flowering occurred as early as 2.5 years from field planting in two entries, BAYT x TAGT (2 palms) and WAT x TAGT (1 palm). At the age of 3.5 years, the hybrid WAT x RIT showed 50% flowering.

The length of stem with 11 leaf scars of the BYD x MTT-S4 hybrid coconut is around 78.54 cm, which indicates that this distance is quite tight between leaf scars. When compared with the male parent (Mapanget tall) which have 11 leaf scars of 113.90 cm (DMT-OP), 115.56 cm (DMT-S2), 100.45 (DMT-S3), 94.08 cm (DMT-S4) (6), and the female parent of the Bali Yellow Dwarf (BYD) coconut with 11 leaf scars as high as 43.77 cm, BYD x MTT-S4 hybrid coconut has 11 stem length leaf scars between the two parents or intermediate. The length of the stem with 11 leaf scars shows the high speed of the coconut stem. Therefore, the shorter the distance, the slower the coconut palm becomes higher. Coconut farmers want coconut trees that are short trunked so that the climber can easily harvest fruit and tapping sap to produce coconut sugar. Male parent (MTT-32 S4) which are the result of several generations of selfing show that the stem lengths of 11 leaf scars are shorter than those of Open Pollinated (OP), Selfing generation 2 (S2) and Selfing generation 3 (S3) of MTT-32 populations due to inbreeding depression (Pandin, 2010). The results of the analysis of the diversity of characters between trees show that the shape of the crown and characteristics of BYD x MTT-S4 hybrid coconut stems are quite uniform, where the diversity coefficient of variance (CV) of all characters are below 20%, between 6.18% to 14.73%. The BYD x MTT-S4 hybrid coconut has an average number of leaf petioles

Table 7. Fat content, composition and fatty acids content of BYD x MTT-S4, RBD x MTT-S4 and KHINA-1 hybrid coconuts

Parameter	Unit	BYD x MTT S-4	RBD x MTT-S4	KHINA-1	Analysis Method
Total fat	%	61.56	58.36	60.31	18-8-5/MU/SMM-SIG, Weilbul
Fatty acid composition					
Saturated fat	%	**91.89**	**91.74**	**89.96**	18-6-1/MU/SMM-SIG, GC
Butyrate (C4)	%	0.00	0.00	0.00	
Caproate (C6)	%	0.49	0.50	0.42	
Caprylate (C8)	%	6.39	5.69	5.19	
Caprate (C10)	%	5.23	4.71	4.26	
Undecanoate (C11)	%	0.01	0.02	0.02	
Laurate (C12)	%	**46.46**	**45.53**	**42.80**	
Tridecanoate (C13)	%	0.03	0.03	0.03	
Myristate (C14:0)	%	19.86	20.00	21.27	
Pentadecanoate (C15:0)	%	0.01	0.02	0.02	
Palmitate (C16:0)	%	10.35	10.66	11.82	
Heptadecanoate (C17:0)	%	0.01	0.02	0.02	
Stearate (C18:0)	%	2.93	4.37	3.96	
Arachidate (C20:0)	%	0.09	0.12	0.10	
Behenat (C22:0)	%	0.01	0.02	0.02	
Lignosefiber (C24:0)	%	0.02	0.05	0.03	
Unsaturated fat	%	8.10	8.25	10.02	18-6-1/MU/SMM-SIG, GC
Palmitoleate (16:1)	%	0.02	0.02	0.01	
Oleate (C18:1) (Omega 9)	%	6.76	6.88	8.42	
Linoleate (C18:2) (Omega 6)	%	1.29	1.30	1.56	
Linolenic acid (C18:3) (Omega 3)	%	0.00	0.02	0.01	
Eicosenoate (C20:1)	%	0.03	0.03	0.02	

of 24.05 strands with yellowish green leaf petiole color (Table 3). The petiole length is 170.25 cm, with petiole thickness and width of 3.19 cm and 7.41 cm respectively. The observation of rachis length was obtained at 417.30 cm, with the number of leaflets 190.10 leaflets. Furthermore, the character of the leaflet length is 136.54 cm, and the leaflet width is 5.26 cm. The results of the coefficient of variance analysis show that all leaf petiole characters have a fairly small diversity where the CV is below 20%, except for the leaflet width character with CV values of 24.86%.

Characteristics of inflorescences showed that the length peduncle of BYD x MTT-S4 hybrid coconut was 61.70 cm, with thickness of peduncle 2.02 cm, and length of central axis is about 71.40 cm. So that from the base of the peduncle to the end of the central axis has a length of about 133.10 cm. Spikelet is a part of a coconut bunch that is attached to male flowers, female flowers. The results of the observation showed that the average number of BYD x MTT-S4 hybrid coconut was 34.45 spikelets. Among them are the number of spikelets with female flowers of 23.05 pieces, with a spikelet length of 45.20 cm, and the number of female flowers in one fruit bunch is 25.70. Diversity analysis shows that generally the flower bunch character is quite uniform, except for the number of spikelet characters with female flowers and the number of female flowers that have CV is 25.19% and 30.92%, meaning that the diversity of these characters is quite large. Observation of BYD x MTT-S4 hybrid coconut was carried out on fruit and nut circumference of polar and equatorial. Fruit polar circumference is 55.00 cm, and the fruit equatorial circumference is 50.00 cm. Then for the nut polar circumference obtained 38.00 cm and nut

equatorial circumference is 40 cm. Comparison of polar and equatorial lengths shows that BYD x MTT-S4 hybrid coconut fruit is round to egg-shaped, while the nut shape is almost round. Fruit colour is yellowish green, and the size of the fruit are classified as medium. The nut weight is KHINA-1 the highest 1,359 gr and followed by RBD x MTT-S4 of 1,175 gr and the lowest on BYD x MTT-S4 of 991 gr. For the polar circumference of the nuts and equatorial circumference, the third hybrid is balanced in size, so it can be almost round. The thickness of the endosperm of the three hybrid coconuts is almost the same, which is around 1.09-1.20 cm. The most important component in coconut fruit is the meat weight.

The results of observations for the first fruit harvest obtained the highest meat weight on KHINA-1 hybrid coconut of 523 gr/nut, followed by RBD x MTT-S4 and BYD x MTT-S4, each weighing 463 gr /nut and 451 gr / nut. These three hybrid coconuts have a weight of meat above 400 gr/nut, already classified as one of the criteria of a good coconut. After being processed into copra, it was obtained in BYD x MTT-S4 hybrid coconut, RBD x MTT-S4, and KHINA-1, respectively copra weight was 262 gr/nut, 256 gr/nut and 266 gr/nut. Based on reports that in MAWA and MATAG hybrid coconut it was reported that it copra weighed 210 gr/nut and 250 gr/nut (UPB, 2015), while KHINA-1, KHINA-2, KHINA-3, KHINA-4 and KHINA-5 were consecutive also 253 gr /nut, 296 gr/nut, 254 gr/nut, 250 gr/nut and 245 gr/nut (Kadere et al., 2009). An evaluation trial conducted over 28 years on coconut hybrid combinations has resulted in identification of a superior, high yielding Dwarf x Tall hybrid, named as 'Kalpa Samrudhi' involving IND 058S as female parent and IND 069S as male parent. The results revealed that the hybrid is better performing over other hybrids and local control with higher fruit yield (117 fruits palm-1 year-1), high copra out turn (25.72 kg palm-1 year-1 or 4.5 t ha-1 year-1 copra) and estimated oil recovery of 3.04 tons ha-1 under rainfed conditions of Kerala (Kindangen et al., 1989).

The component weight of fruit meat, fruit production and copra per palm and estimated production per hectare at age 4, 5 and 6 years are presented in Table 5. Data in Table 5 shows that fruit production from BYD x MTT-S4 and RBD x MTT-S4 has fruit production that is consistently always higher than the control, namely KHINA-1. It can also be seen that the weight of fruit meat, fruit production and copra are the third hybrid coconut at the age of 4 years after planting, or the first harvest. The results of observing the weight of fruit components, especially the weight of fruit meat, showed that the three hybrid coconuts were equally heavy, namely hybrid BYD x MTT-S4, RBD x MTT-S4 and KHINA-1 comparison (Nias Yellow Dwarf x Tenga Tall) were 426.71 gr/nut, 450.86 gr/nut and 437.19 gr/nut.

The data observations of the components of the first year of production at the age of 5 years were analyzed for diversity and the real difference test using the Honest Significant Difference Test (HSD test), showed a significant difference in production. The average weight of coconut meat was highest in KHINA-1 hybrid coconut weighing 470.42 gr/nut, and this weight was significantly different from the weight of meat weight in BYD x MTT-S4 hybrid coconut and RBD x MTT-S4, respectively each 450.75 gr and 437, 75 gr/nut. Furthermore, the character of fruit production turned out to be the highest in BYD x MTT-S4 hybrids 64 nuts/palm, and the number of fruits was significantly different from the comparison of KHINA-1 hybrid coconut with an average yield of 26 nuts/palm for the first-year harvest when age of 5 years. Production of RBD x MTT-S4 hybrid coconut fruit, which is 44 nuts/palm, was not significantly different from BYD x MTT-S4 hybrid coconut and its control was KHINA-1. The results of the analysis of copra production from the three hybrid coconuts showed that BYD x MTT-S4 hybrid coconut obtained 16.34 kg/palm which was significantly different from the KHINA-1 comparison, which was around 6.35 kg/palm, while RBD x MTT-S4 hybrid coconut produce 10.51 kg copra/palm, which the statistical test results are not significantly different from BYD x MTT-S4 and KHINA-1 hybrid coconut. Estimates of copra production per hectare with spacing in this test 8.5 mx 8.5 m, or 138 trees per hectare obtained the highest copra production in BYD x MTT-S4 hybrid coconut as much as 2.26 tons/ha/year, followed by hybrid coconut RBD x MTT-S4 is 1.45 tons/ha/year, and the lowest is in KHINA-1 hybrid coconut as a comparison, which is 0.88 tons/ha/year. The production of RBD x MTT-S4 hybrid coconut copra is significantly different from KHINA-1 at the harvesting age of 5 years after planting.

Observation of coconut meat weight of three BYD x MTT-S4 hybrid coconuts, RBD x MTT-S4, and KHINA-1 at 6 years of age from planting obtained data of 411.88 gr/nut, 402.8 gr/nut and 416.68 gr/nut, respectively equally heavy and not significantly different from each other. Coconut fruit production until the age of 6 years was significantly different based on ANOVA and the HSD test, the highest was shown by BYD x MTT-S4 hybrid coconut as much as 117.92 nuts/palm and significantly different from hybrid coconut RBD x MTT-S4, and KHINA-1, each obtained 98.66 nuts/palm

and 94 nuts/palm. The results of copra analysis were found to be significantly different, namely in the hybrid BYD x MTT-S4 coconut as much as 27.99 kg/palm which was significantly different from hybrid coconut RBD x MTT-S4, and KHINA-1, which were 21.99 kg/palm, respectively and 19.89 kg/palm. Mahayu & Novarianto (2014) reported that the results of evaluations carried out on 10 coconut varieties at the United Plantation Berhad germplasm site, Malaysia, reported the number of fruits per bunch and per tree varied, and the highest in varieties in Tagnanan Tall from Philippines and West African Tall from Cote d'Ivoire.

Estimated copra production per hectare obtained the highest copra production in BYD x MTT-S4 hybrid coconut as much as 3.86 tons/ha/year, which was significantly different from RBD x MTT-S4 hybrid coconut as much as 3.04 tons/ha/year, and with KHINA-1 as a comparison, which is 2.74 tons/ha/year. Based on the results of previous hybrid coconut observations, namely KHINA (Mahayu & Novarianto, 2015; Mangindaan, 1987), increasing fruit and copra production will continue to increase until hybrid coconut is over 8-10 years after planting. KHINA-1 hybrid coconut is reported to produce copra 5 tons/ha at the age of 10 years (Anonymous, 2009; Dyanti et al., 2002). So based on the results of the previous hybrid coconut at the age of 10 years, BYD x MTT-S4 hybrid coconuts will be able to produce copra more than 5 tons/ha/year at the same age. The results of this study at the seedling level turned out to be in line with when the plants in the field until the age of 6 years after planting that the BYD x MTT-S4 and RBD x MTT-S4 hybrids were shorter in stem than KHINA-1. The results of the diversity analysis showed that the three hybrid coconuts were quite uniform in the stem height and stem length 11 leaf scars between palms in the same hybrid coconut, where the value of the Coefficient of Variance (CV) was below 20%. For stem height characters, it can be seen that BYD x MTT-S4 hybrid coconut obtained CV value 12.01%, RBD x MTT-S4 hybrid coconut with CV value of 11.28%, and its comparison (KHINA-1) with CV of 17.24%. The smaller CV values in the two hybrid coconuts compared to the comparison showed that the homogeneity level of male DMT-S4 parents after selfing up to the fourth generation was higher, so that hybrid coconuts were produced that were more uniform on the stem height character.

The results of the analysis of fat content of the three hybrid coconuts were highest in BYD x MTT-S4 hybrid coconut at 61.56%, then KHINA-1 comparison of 60.31% and RBD x MTT-S4 hybrid coconut at 58.36%. In general, the fat content of copra from coconut is around 58-65%, such as coconut of Mapanget tall 62.95%, Bali tall 65.52%, KHINA-1 60.78%, KHINA-2 60.61%, KHINA-3 62.46%, KHINA-4 60.00%, and KHINA-5 60.08% (Ditjenbun, 2014). Coconut oil consists of saturated fatty acids and unsaturated fatty acids. The results of the analysis showed that saturated fatty acids from the three BYD x MTT-S4 hybrid coconuts, RBD x MTT-S4 and KHINA-1 were 91.89%, 91.74% and 89.96%, and the remaining around 8-10% were unsaturated fatty acids. The composition of saturated fatty acids was detected as many as 14 kinds of fatty acids, ranging from Caproid acid (C6) to Licnoceric acid (C24). The highest saturated fatty acid levels were Lauric acid (C12), Miristic acid (C14), Caprylic acid (C8) and Capric acid (C10), which in BYD x MTT-S4 hybrid coconuts were 46.46%, respectively 19.86%, 6.39% and 5.23%. Total unsaturated fatty acids are 8.10%-10.02% in the three hybrid coconuts, consisting of five kinds of fatty acids, namely Palmitic acid (16:1), Oleat (18:1) or Omega 9 Acid, Linoleic (18:2) or Omega 6 Acid, Linolenic (18:3) or Omega 3 acid, and Eicosenoic acid (20:1). Among the five unsaturated fatty acids, the highest fat content is Oleic acid (Omega 9) as much as 6.76% in BYD x MTT-S4 hybrid coconut, then 6.88% in RBD x MTT-S4 and KHINA-1 hybrid coconut 8.42%. At this time coconut oil and various coconut products are consumed by more than 1 billion people and are a basic component of the best cuisine in the world. Coconut oil is one of the healthiest oils in the world. Although coconut oil is dominated by saturated fatty acids, most of it is Medium Chain Fatty Acid (C4-C12) or MCT oil (Medium Chain Triglyceride) as an energy source that is directly absorbed by the body without going through the process in the liver. The total content of medium chain saturated fatty acids in the three hybrid coconuts was obtained for BYD x MTT-S4 by 58.58%, then in RBD x MTT-S4 of 56.45%, and hybrid KHINA-1 as a comparison obtained 52.69%. The most important fatty acids of medium chain fatty acids are lauric acid (C12), and in the three hybrid coconuts obtained 46.46% respectively in BYD x MTT-S4, then 45.53 in RBD x MTT-S4 and comparison KHINA-1 hybrid coconut is 42.80%. One of the popular and expensive coconut products is Virgin Coconut Oil (VCO), and lauric acid is the important fatty acid of VCO.

The Hengniu coconut hybrid was released as a new coconut hybrid in October 2019 by Indonesian Republic Department of Agriculture. This coconut hybrid will be used as one plant materials for coconut development and replanting in Indonesia. References remaining around 8-10% were unsaturated fatty acids. The

composition of saturated fatty acids was detected as many as 14 kinds of fatty acids, ranging from Caproid acid (C6) to Licnoceric acid C24). The highest saturated fatty acid levels were Lauric acid (C12), Myristic acid (C14), Caprylic acid (C8) and Capric acid (C10), which in BYD x MTT-S4 hybrid coconuts were 46.46%, respectively 19.86%, 6.39% and 5.23%.

Conclusion

The Hengniu (BYD x MTT-S4) hybrid coconut begins to bear fruit at the age of 3 years, and at the age of 6 years has produced fruit 118 nuts/palm, and copra 3.86 tons /ha. The length of stem with 11 leaf scars is 78 cm. The oil content of copra 61.56%, medium chain saturated fatty acid (C6-C12) 58.58%, and lauric acid content (C12) 46.46%. The Hengniu coconut hybrid was released as a new coconut hybrid in October 2019 by Indonesian Republic Department of Agriculture.

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