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Identification and Analysis of Relationship Several Local Promising Clones Cocoa (*Theobroma cacao* L.) based on morphological Characters in South Sulawesi

R P Lembang¹, K Mustari², L Asrul²

¹Agrotechnology, Faculty of Agriculture, Hasanuddin University, Jalan Perintis Kemerdekaan KM 10, Makassar, 90245, South Sulawesi, Indonesia.

²Faculty of Agriculture, Hasanuddin University, Jalan Perintis Kemerdekaan KM 10, Makassar, 90245, South Sulawesi, Indonesia.

E-mail: putryanirl.agro@gmail.com

Abstract. Cacao (*Theobroma cacao* L.) is one of the agricultural products that have an important role in achieving reliable and agricultural development programs. This study aimed to identify morphological characters and phylogenetic relationship of seven local cocoa clones expectations developed in Luwu Timur, Pinrang, and Bantaeng. Seven clones of cocoa were observed Clones: (1) PBC 123, (2) BR 25 (3) 45 (4) M 01, (5) M 04, (6) M 06, and (7) GTB. This study used the survey method. Observation of morphological characters is presented in the form of descriptions, images, and scoring then analyzed using a 2:02 version NYSys program (Numerical Taxonomy and Multivariate Analysis systems) and clustering using the UPGMA method (Unweighted Pair-Group Method with arithmetic averaging). The results showed similarity coefficient ranged from 0.17 to 0.68. The highest similarity coefficient is owned by a combination of BR clone 25 and clone 45 which is 0.68 (68%) or the nearest genetic distance of 0.32 (32%), while the lowest is owned by a combination of PBC Clone 123 and Clone AD 04, namely 0.17 (17 %) or farthest genetic distance of 0.83 (83%). While the average index of similarity of all clones was 0.41 (41%) is relatively low. Kinship patterns on dendrogram form two main groups on the genetic similarity of 0.46 is the group A consisting of five clones (PBC 123, BR 25, 45, M 06, and GTB), and group B consists of two clones (M 01 and M 04). 32 (32%), while the lowest is owned by a combination of PBC Clone 123 and Clone AD 04 that is 0.17 (17%) or farthest genetic distance of 0.83 (83%). While the average index of similarity of all clones was 0.41 (41%) is relatively low. Kinship patterns on dendrogram form two main groups on the genetic similarity of 0.46 is the group A consisting of five clones (PBC 123, BR 25, 45, M 06, and GTB), and group B consists of two clones (M 01 and M 04). 32 (32%), while the lowest is owned by a combination of PBC Clone 123 and Clone AD 04 that is 0.17 (17%) or farthest genetic distance of 0.83 (83%). While the average index of similarity of all clones was 0.41 (41%) is relatively low. Kinship patterns on dendrogram form two main groups on the genetic similarity of 0.46 is the group A consisting of five clones (PBC 123, BR 25, 45, M 06, and GTB), and group B consists of two clones (M 01 and M 04).

1. Introduction

Cocoa plant (*Theobroma cacao* L.) is an agricultural commodity that has a good prospect at the moment because as one source of foreign exchange from the non-oil sector. Besides, it is the cocoa plant export crops which have high economic value and have good marketing prospects as an industrial raw material of food, beverage, and cosmetics favored by the people. Cocoa cultivation today in terms of additional acreage in Indonesia, especially cocoa folk very rapidly.



According to BPS data in 2017, cocoa production in Indonesia in 2016 reached 656 817 tonnes with a total area reaches 1,701,351 ha and about 36% of the volume of cocoa production in Indonesia contributed from Sulawesi, about 95% of cocoa production that comes from smallholders [1].

South Sulawesi is one of the major producers of cocoa Indonesia, followed by Central Sulawesi, Southeast Sulawesi, and West Sulawesi. However, within the past five years since 2013, it seems the production and productivity of cocoa annually decreasing. Production and productivity of cocoa in 2013 amounting to 116 650 tonnes and 871 kg/ha. Then in 2017, both production and productivity decreased respectively to 102 696 tonnes distributed in 21 districts mainly Luwu Timur, Luwu Utara, Soppeng, Pinrang, Wajo, Sinjai, Bantaeng and Bulukumba [2].

Declining production and productivity of cocoa is generally caused by several factors, such as the age of the older plants, the use of plant material that is not qualified, the intensity of pests and disease, and lack of maintenance gardens by farmers [3].

Therefore, the use of total quality seeds to be one effective alternative in addressing cocoa productivity. To get quality seeds is very dependent on the availability of accurate information about the diversity of the cocoa plant varieties [4].

In South Sulawesi, there are several clones that have been in the collection by farmers such as Sulawesi clone 1, clone Sulawesi 2, clone 45, clone M 01, and many other clones scattered farmers. Clones potentially high yield, resistance/tolerance to pests/diseases like cocoa major cocoa pod borer (CPB), fruit rot disease, and Vascular Streak Dieback.

To support the assembly of new varieties of cocoa plants need to identify or characterize the cocoa morphological characters that can be used as a basis for grouping plants. Characterization based on morphological characters can determine the use of plants in the characterization. And [5] states that the morphological characters are characters that are easily seen and not a hidden character, so that the variation can be assessed quickly when compared to the other characters. It can facilitate the farmers in conducting cross between clones to produce a new clone with superior properties.

However, a cross between cocoa clones that have a close kinship relationship if done continuously, it can cause a decrease in nature, to varieties or clones that have a close genetic relationship is not recommended to be crossed. This is done to avoid the appearance of properties inbreeding in offspring that can be fertile offspring [6]. One way to determine the phylogenetic relationship between species is one with the other is to see the resemblance characterize the morphology [7].

Research on kinship is important because in terms of the benefit is to facilitate the search for varieties of replacement (varieties substitution) when crop varieties have constraints in the process of cultivation [8] and look for varieties of replacement if there is one variety that extinction [9]. Several studies on morphological characterization aim to continue the repair and collection of germplasm as in teak [10]

It is not known how the kinship between local cocoa clones expectancy in South Sulawesi when assessed based on their morphological characters. Kinship between cocoa clones can provide information about the characteristic of the character of each group of clones formed, therefore the need for kinship analysis based on morphological characters. Therefore it is necessary for the identification and analysis of local cocoa clones kinship hope scattered farmers so that clones that could potentially be utilized more widely superior. This study aims to determine the morphological characters, and phylogenetic relationship of local cocoa clones of hope scattered farmers in South Sulawesi.

2. Materials and Methods

This study was conducted in Luwu Timur, Pinrang, and Bantaeng as cocoa development centers in the province of South Sulawesi, which lasts from October to December 2017.

Materials used in this research is the cocoa plant of the type clones (PBC 123, BR 25, 45, M 01, M 04, M 06, and GTB). The tools used in this study is an analytical balance, calipers, ruler/tape measure, plastic samples, shears, knife/cutter, paper labels, stationery, cameras, recorder, and computer (laptop).

This research was conducted in the form of survey with observation methods to samples intentionally (purposive sampling), the plants were observed cocoa crop from farmers.

Identification carried out against 19 characters, both quantitative and qualitative observations. Characterization of cocoa descriptor refers to a script prepared by the [11,12], to observe the character of the leaf (1 character), fruit (12 characters), seeds (5 characters), and flowers (1 character). Characterization is done by observing and measuring the direct object of research.

2.1. Data analysis

Data analysis included descriptive data analysis with genetic method. The data were obtained by morphological characters are quantitative and qualitative, then with each clone was given a score of votes with the number 1 if the character were observed owned by such clones, and 0 if it is not owned by the clones. Then the data from each clone compared with searching for genetic similarity coefficient or coefficient of genetic distance clone combination.

Genetic similarity calculation using the formula Dice genetic similarity [13]. To calculate the distance coefficient, the data is converted to the formula $(d) = 1 - S_b$, where d is the distance, and S_b is a similarity coefficient, with the following formula: $S_b S_b$

$$S_b = \frac{2a}{(n_i + n_j)} \times 100\%$$

S_b = Coefficient of genetic similarity Dice

a = Total characteristic (value 1), which is owned by the accession of the i -th and j -th

n_i dan n_j = Total value of 1 of the i -th column and j -th

Under the condition [14]:

S_b = ≥ 0.75 : Very close
 0.50 to 0.75 : Close
 0.25 to 0.50 : Far
 ≤ 0.25 : Very far

In this study, all the parameters of the observations will be analyzed. Relationships are based on the analysis frenetic with technical hierarchy [14] using the UPGMA method [15]. The results of these analyses will form dendrogram that describes the kinship of a combination of clones.

3. Results and Discussion

3.1. Morphological Characteristics Cocoa Clones

The observation of morphological characters of seven local cocoa clones expectancy in South Sulawesi indicates that there is a cacao fruit morphological diversity in each area based clones were planted. Cocoa fruit morphological characters can be seen in Table 1.

In the observation table (Table 1) note that PBC Clone 123, BR 25, 45, and M 06 has a red flush, while clones M 01, M 04, and GTB has a reddish brown flush. When viewed from the color of shoots, type clones included in the type of cocoa lindak. The color of the leaves on the young cocoa plants vary considerably depending on the species or varieties of plants, which began to pale green, reddish to dark red. It is also by [16] which states that the irregularities pointed out by the advent of color diversity flush most easily identified visually.

Furthermore, it is known that clones GTB has the character of fruit obovate shape without the bottleneck and the blunt end of the fruit. Fruits like these tend to be rounded is a form of stimulant that is released by the host insect. It seems that the insects do not have a sense of love towards the fruit as a morphologic appearance unsuitable for feeding and nesting. This is by the opinion of [17] that the host has resistance mechanisms to deter insect colonization, called antivenoms. Such a mechanism could be the morphological characteristics of plants that are disliked by insects. This is by the opinion [18] which states that the morphological appearance of cocoa pods resistant and susceptible EAPs have some differences. Whereas susceptible plants generally have more varied forms of fruit. Another opinion expressed by [19] which states that there is a possibility cocoa fruit character or physical properties that affect the behavior and physiology of the cocoa PBK so tolerant.

On the surface texture of the characters, Clones BR 25, 45, M 01, M 04 and M 06 has a slightly rough texture of very rough and grooved to shallow to deep. When compared with PBC Clones and Clones 123 GTB which has a smooth texture and grooved shallow. Based on visual observations in the field, the character of the fruit with the skin surface smooth and grooved superficially, it seems difficult to pest infestation and occupied by PBK in laying eggs. Eggs are laid on the surface of the skin smooth and grooved shallow will more easily fall if exposed to rain or wind. In contrast to the fruit skin surface rough and grooved in for eggs laid can withstand exposure to rain or wind. This is in accordance with opinions [20] and [21] mentions that the fruits rough skin surface is more preferred by CPB insect to lay eggs. Meanwhile, according to [22] that the skin of fruit that has a groove in a more preferred PBK for

facilitating the laying eggs on fruit groove. This character is also similar to that found, that the clone LW4 and pest-resistant LW5 PBK has a subtle fruit (slippery) and grooved shallow.

Table 1. Morphological characters Clones Local Cocoa Hope in South Sulawesi

CHARACTER	CLONE						
	PBC 123	BR 25	45	M 01	M 04	M 06	GTB
Leaf							
Color Flush	Red	Red	Red	Red shale	Red Shale	Red	Red shale
Fruit							
Fruit size	Moderate	Moderate	Big	Big	Big	Big	Moderate
Fruit Length (cm)	19.46	20.32	20.12	21.18	21.35	23.05	20.49
Fruit diameter (cm)	9.21	10.13	10.46	10.57	10.24	10.45	10.34
Fruit shape	Ellipse	Ellipse	Obovate	Oblong	Obovate	Ellipse	Ellipse
Fruit tip	Very pointed	Pointed	Pointed	spinning	Pointed	Very pointed	Blunt
Bottleneck	No	No	Clear	No	Vague	No	No
Texture Fruit	Smooth	Rather rough	Rather rough	Very rough	Very rough	Rather rough	Smooth
Fruit groove	Shallow	In	In	In	In	Shallow	Shallow
Colors Fruit Young	Red	Red	Red	Green	Green	Red	Red
Colors Fruit Cook	Dark red	Yellowish red	Yellowish red	Yellowish green	Yellowish green	Yellowish red	Red greenery-yellowish
Fruit Leather Thickness (cm)	1.25	1.11	1.22	1.4	1.72	1.59	1.31
Fruit Sclerotic thick (cm)	0.51	0.24	0.35	0.48	0.54	0.55	0.32
Seed							
Seed Shape	Ellipse	Oval	Ellipse	Oblong	Oblong	Oblong	Ellipse
Number of seeds	32	43	45	46	25	35	28
Heavy Wet seeds/ fruit (gr)	115.5	156.1	199.3	249.2	110.5	161.1	68.3
Weight Dry seeds/fruit (gr)	30.2	62.1	101.5	105.1	55.6	52.9	39.5
Weight per Seed Dry (g)	0.94	1.29	2.25	2.28	2,22	1.51	1.41
Flower							
Stems Flower Color	Redness	Redness	Redness	Greenness	Greenness	Reddish green	Reddish green

Furthermore, fruit on PBC clones 123, BR 25, 45, M 06, and GTB when young have the same colors namely red but show some differences when it is ripe. While the fruit Clones M 01 and M 04 when young green and yellowish green to yellow when the fruit is ripe. Fruit with bright color (PBC Clone 123, 45, BR 25, M 06, and GTB) can impair vision PBK pests so that clones are not well liked. [23] suggested that the color of the fruit can provide visual stimuli to insects. The ability of vision, sensitivity to touch and presence of the chemical compound is determined by a stimulus which is owned by the host plant. Stimulation released by the host plant and responded by insects through sight, touch, and chemical response.

Then on the observation of flower characteristics showed the character of each clone (PBC 123, BR 25, 45, M 01, M 04, M 06, and GTB) despite having some differences but also about similarities in the color of the flower stalk observation parameter. Clones PBC at 123, 45, BR 25, M 06, and GTB, colored red and green flower stalks reddish. As for clone M, 01 and M 06 has a greenish color of the flower stalk. The color difference becomes distinctive flower stalks on each clone. It is appropriate that the cocoa flower color between different types, then these differences can be used as one of the parameters determination of cacao varieties.

In observation of the thickness of thick rind and fruit sclerotic, the visible difference on each clone. When compared to clone M 04 which has a thick rind of 1.72 cm highest reach among other clones and

clones M 06 has a thickness of fruit skerotik highest of 0.54 cm. Nonetheless, clone M 04 included in the vulnerable category. This is because the clone M 04 has a very rough surface of the skin and not hard (soft) so very easy CPB pests to lay eggs. This is in accordance with the opinion of [24] that stimulation of vision refers to the difference in the color of leaves, fruits, flowers, hardness, thickness of the tissue, as well as lignifies or defense structures, others such as their feathers, spikes or wax coating affect the response of insects on oviposition and response to eating. It is also appropriate [25] that the thickness of the sclerotic is a variable that represents the character of cocoa resistance to pests PBK. Further stated that the process lignifies (buildup lignin) in the sclerotic layer that inhibits the entry of CPB larvae into cocoa pods not yet known whether physical or chemical.

In observation of the average number of seeds per fruit that has the highest average is the Clones BR 25, 45, M 01. But who has the highest number on the parameters of the average observation of wet seed weight, the average weight of dry beans, average the highest dry weight per seed is in Clone AD 01. this is because the clone M 01 has a length and diameter of large fruit. It's the kind described [26], that the results of experiments the influence of CPB attack on the quality of cocoa beans that CPB pest attacks affect the number of seeds in one fruit.

[27] explains that the greater the length of the fruit will increase significantly the character of the greater weight of the fruit and fruit weight will significantly improve the dry weight per seed is good. Furthermore, regarding the weight of seeds as finding [28], that there are differences in the number of cocoa beans resistant and not resistant. Average weight per resistant cocoa beans D1, D2 respectively of 1.20 grams and 1.17 grams (Donggala), in Toli-Toli T1 and T2 respectively 1.18 grams and 1.14 grams. While on cocoa vulnerable (D3 and T3) the average weight per seed is 0.93 and 0.97.

The development of the cocoa plant to support its existence in an ecosystem, not in spite of the existence of such insect pests that eat them PBK. Facing the insect pressure, cocoa plants develop self-defense system that can reduce the success of insects in the use of these plants. These systems can be either physical or chemical properties in a long time in nature will form pressure-resistant cocoa plants of the insect. [29] states that the plant resistance is the nature of plants can reduce insect success in utilizing the plant because the insects do not grow and reproduce on resistant plants, the damage they cause is not severe, and there are results that can be harvested.

3.2. Similarity Measurement and Analysis of Kinship based Characters Morphology

Calculation results of resemblance or similarity index are done by using program NTSYS Version 2.02 the Dice coefficient formula. The measurement results obtained in the form of a Similarity similarity matrix and are presented in Table 2.

The similarity matrix (Table 2) indicate that there are 21 combinations of pairs with similarity coefficient values range between 0.17 to 0.68 or genetic distance values between 0.32 to 0.83. According, the genetic distance of 0.52 to 0.85 is good enough to use to generate F1 that has a high level of genetic diversity.

The result showed that the genetic similarity highest value obtained partner with Clone Clones BR 25 45 0.68 (68%) or the nearest genetic distance of 0.32 (32%), while the lowest value of genetic similarity obtained by a combination of PBC 123 couples with Clones clone M 04 0.17 (17%) or farthest genetic distance is 0.83 (83%). This suggests that if the degree of similarity that is owned by a couple of individuals the genetic distance that owned the closer that has a level of diversity is low, conversely if the similarity possessed individual pairs the lower the genetic distance that you have will get increase far that has a level of diversity high. In *Diosphyros celebica* genetic distance and mating system can be measurement with molecular breeding [30]. This is by the opinion [31], which says that the cocoa clones which are known to have the highest similarity score are to have high genetic proximity to have a low genetic distance. By contrast, cocoa clones which are known to have the lowest similarity value mean it has low genetic proximity to have a high genetic distance.

If the views of the average value of the similarity index of all couples clone, then this similarity can be categorized as low, of 0.41 (41%). This is because of the average value of similarity to below 50%. In accordance with the opinion of [32] which states that the similarity between populations based on the average value can be generally categorized into two lower if less than 50% and high if above 50%. For more similarities we can categorize the similarity is very high if above 75% and above 95% identical when morphologically.

Table 2. The similarity matrix value Clones Local Cocoa Hope in South Sulawesi

Clone	PBC 123	BR 25	45	M 01	M 04	M 06	GTB
PBC 123							
BR-25	0.49						
45	0.43	0.68					
M-01	0.22	0.27	0.38				
M-04	0.17	0.32	0.54	0.61			
M-06	0.49	0.63	0.47	0.22	0.32		
GTB	0.43	0.53	0.42	0.32	0.32	0.47	

Table 3. Grouping Combination Clones Local Cocoa Expectations Based Similarity Index Up Smallest Largest

No.	Combination Clones	Value Similarity	Information
1	BR 25 and 45	0.68	Close kinship
2	BR 25 and M 06	0.63	Close kinship
3	M 01 and M 04	0.61	Close kinship
4	45 and M 04	0.54	Close kinship
5	BR 25 and GTB	0.53	Close kinship
6	PBC 123 and BR 25	0.49	Far kinship
7	PBC 123 and M 06	0.49	Far kinship
8	45 and M 06	0.47	Far kinship
9	M 06 and GTB	0.47	Far kinship
10	PBC 123 and 45	0.43	Far kinship
11	PBC 123 and GTB	0.43	Far kinship
12	45 and GTB	0.42	Far kinship
13	45 and M 01	0.38	Far kinship
14	BR 25 and M 04	0.32	Far kinship
15	M 01 and GTB	0.32	Far kinship
16	M 04 and M 06	0.32	Far kinship
17	M 04 and GTB	0.32	Far kinship
18	BR 25 and M 01	0.27	Far kinship
19	PBC 123 and M 01	0.22	Kinship Very Much
20	M 01 and M 06	0.22	Kinship Very Much
21	PBC 123 and M 04	0.17	Kinship Very Much

The result of the combination grouping several local cocoa clones expectations based on the similarity matrix (Table 2) is presented in Table 3. The similarity matrix shows that there are three levels of kinship categories in grouping combinations of clones that close kinship, kinship distant and very distant kinship which is based on the value of similarity largest to smallest.

The first category shows a close kinship obtained from five combinations with similarity coefficient value of 0.68 (68%) up to the value of similarity coefficient of 0.53 (53%) or the genetic distance between 0.32 to 0.47. This value is obtained from a large number of the same characteristics in each organ observed between the five combinations of these clones was a combination Clones BR 25 and clone 45, clone BR 25 and Clone AD 06, clone M 01 and Clone AD 04, clone 45 and clone M 04 , BR clone 25 and clone GTB.

For the second category is the category distant kinship with similarity values between 0.49 (49%) to 0.27 (27%) or the genetic distance between 0.57 to 0.73, contained in 13 pairs combination of the Clones PBC clone 123 and clone BR 25 clones PBC 123 and Clone AD 06, clone 45 and clone M 06, clone M 06 and Clones GTB, Clones PBC 123 and clone 45, clone PBC 123 and Clones GTB, clone 45 and clone GTB, clone 45 and clone M 01, BR 25 and Clones Clones M 04, M 01 and Clones Clones GTB, Clones Clones M 04 and M 06, M 04 and Clones Clones GTB, and Clones Clones BR 25 and M 01.

The third category of kinship is very distant kinship with similarity values between 0.22 (22%) to 0.17 (17%) or the genetic distance between 0.78 to 0.83, obtained in three combinations of clones consisting of the Clones PBC 123 and clones M 01, M 01 and clones clones M 06, as well as PBC clone 123 and clone AD 04. Combination clones PBC 123 and M 04 is a combination of clones with the most distant kinship level because it has little in common trait. The characteristic equation that is owned by a combination of PBC Clone 123 and Clone AD 04 perhaps on the length of the fruit, thick sclerotic fruit and wet seed weight/fruit.

The dendrogram (Figure 1) shows that the lower limit is the similarity index by 31% and the upper limit of 68%. The smaller the percentage indeks shows the level of kinship between individuals getting a much higher percentage individual similarity index showed a close kinship.

Results of grouping on dendrogram showed that the degree of genetic similarity of 0.31 (31%) is divided into two main groups. Group A consists of three (3) sub-groups in which there are five types of clones, and group B consists of two types of clones.

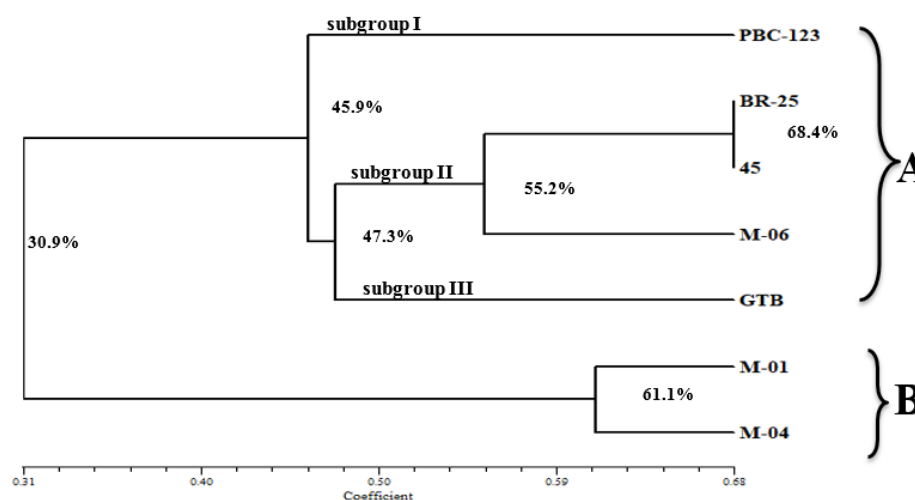


Figure 1. Seven Clones Kinship Dendrogram Local Cocoa Hope in South Sulawesi

Crop Group A consisting of five clones are clones PBC 123, BR 25, 45, M 06, and GTB are split with the group B consisting of the Clones M 01 and Clone AD 04, because of differences in the characteristics of the color flush, fruit size, fruit shape, the bottleneck, the tip of the fruit, the texture of the fruit, the flow of fruit, the color of the young fruit, the color of ripe fruit, the color of the flower stalk, form of seeds, fruit length, fruit diameter, thick sclerotic fruit, seed number, seed weight wet / fruit, heavy dry seeds / fruit and seed weight per dry. The morphological characters that distinguish significantly between PBC Clone 123 and Clone AD 04.

Grouping and similarity frenetic all clones were analyzed based on the similarity index. The fenetik similarity in group A showed that clones formed a group based on the similarity of their morphological characteristics. By the opinion of [33], which states that the more common the characteristics that the greater the similarity value means the closer kinship between the groups being compared Otus. Conversely, the more differences in the characteristics that the smaller the value of similarity means that the more distant family links between the groups being compared Otus.

Plants group B consisting of the Clones M 01 and Clone AD 04, is a plant that is frenetic relatively similar, especially on the organ pieces, so that clones based on the results of the morphological analysis can be used as plant hope in the future to serve as a source of germplasm. This is by the opinion [34]

which says that the development of the cocoa crop in the future can be done through graft and tissue culture by utilizing the nuftah plasma source.

In the opinion of [35], a good parent plant used is a plant that has a higher genetic distance from other genotypes. Four combinations of the Clones (PBC 123 x M 04, M 01 x M 06, the PBC 123 x M 01 and BR 25 x M 01) have the highest genetic distance ≥ 0.70 (Table 3). The more distantly related an organism, the greater the possibility of differences in the number, shape and arrangement of the individual chromosomes [36] and will produce high genetic diversity in progenies [37].

4. Conclusions

Based on the identification of morphological characters on each clone cocoa and cocoa clones kinship between, then the whole can be summed up as follows:

From seven clones of cocoa have been found, found 19 differences in morphological characters of the color flush, fruit size, fruit shape, the end of the fruit, the bottleneck, the texture of the fruit, the flow of fruit, the color of the young fruit, the color of ripe fruit, the color of the flower stalk, seed shape, fruit length, fruit diameter, thickness of the skin of the fruit, fruit sclerotic thickness, number of seeds, wet seed weight/fruit, dried seed weight / fruit and seed weight per day.

From the results of the similarity index and grouping based dendrogram it is known that the combination of BR clone 25 and clone 45 has the closest kinship with the highest genetic similarity coefficient of 0.68 (68%) or the nearest genetic distance of 0.32 (32%), while the PBC clone 123 and clone M 04 has the most distant kinship with the smallest genetic similarity coefficient of 0.17 (17%) or farthest genetic distance of 0.83 (83%).

References

- [1] Directorate General of Plantation 2018 Cocoa, Statistics Plantation, Plantation General (Jakarta : Directorate Ministry of Agriculture) p 90
- [2] Department of Plantation 2017 Statistics South Sulawesi Province South Sulawesi Plantation Office Makassar
- [3] Sahardi and Djufry F 2015 Diversity of Morphological Characteristics And agronomist Germplasm Local Cocoa Clones Hope South Sulawesi *J. Littri*. **21** p 145-152
- [4] Rubiyo 2009 Study of Resistance Genetics Plant Cocoa (*Theobroma cacao* L.) Against Fruit Rot Disease (*Phytophthora palmivora* Butl.) In Indonesia Dissertation Bogor Agricultural University p 67-83
- [5] Rahayu SE and Handayani 2008 Morphology and Anatomy Pandanus Diversity (Pandanaceae) in West Java *Vis. Vitalis*. **1** 29-44
- [6] Sari NK 2015 Kinship Analysis of Plant Varieties Cassava (*Manihot utilissima*) Based on Morphological Characters In Area Nganjuk Thesis University of Nusantara PGRI Kediri p 69
- [7] Fatimah S 2013 Morphological analysis and Kinship Eleven Plant type Salak (*Salacca zalacca* (Gertner) Voss) Bangkalan *Agrovigor* **6** 5-9
- [8] Prabawanti YW, Hamida and Soedarti T 2012 Plant Diversity Biosistemika Sugarcane (*Saccharum officinarum*) Using Morphological Approach Department of Biology Airlangga University Surabaya p 88
- [9] Farusha F 2014 Member Kinship analysis portulacaceae Based on Structure Morphology and Anatomy For Education Poster Education Department of Biology Faculty of Teaching and Education University Teachers Association Nusantara Indonesia Kediri p 8-10
- [10] Larekeng., S.H., Gusmiaty, Restu M, Arsyad M A and Dermawan R 2019. Morphophysiological analyses on Teak (*Tectona grandis* Linn.f) from three provenances. IOP Conf. Series: *Earth and Environmental Science* **235** 1-12.
- [11] UPOV 2011 Guidelines For The Conduct of Tests For Distinctness Uniformity and Stability International Union For The Protection Of New Varieties Of Plants Geneva p 7-10
- [12] Engels J, Bartley B and Enriquez C 1980 Cacao Descriptors Their States and Modus Operandi (Turrialba Costa Rica: CATIE) p 8-10
- [13] Fuentes JL, Escobar F, Alvarez A, Gallego G, Duque MC, Ferrer M, Enrique J and Tohme JM 1999 Analyzes of the genetic diversity in Cuban rice varieties using isozyme, RAPD, and AFLP markers *Euphytica* **109** 107-115

- [14] Hasanuddin and Fitriana 2014 Species Kinship 12 Members Familia Asteraceae *EduBio Journal of Tropical* **2** 187-250
- [15] Beer SC, Goffreda J, Philips TD and Sorrells ME 1993 Assessment of genetic variation in *Avena sterilis* using morphological traits, isozymes, and RFLPs *Crop Sci.* **33** 1386-1393
- [16] Abd et al., 2012 Research Report: Characterization Morphology and Plant Tissue Fruit Cocoa Cocoa Cocoa Fruit Borer Resistant Hope (*Conopomorpha cramerella* Snell.). Hasanuddin University Makassar p 78-80
- [17] Randriani E, Dani and Sulistiyorini I 2014 Performance of Plant Cocoa (*Theobroma cacao* L.) Somatic Embryos Propagation Results In Experiment Garden Pakuwon *SIRINOV* **2** 199-206
- [18] Dent D 2000 Host plant resistance United Kingdom p 123-179
- [19] Anshary A 2000 Study of Morphology, Anatomy and Histology Fruit Cocoa (*Theobroma cacao* L.) resistant cocoa pod borer National Seminar Papers Biological Sciences and the Congress of the Association of Indonesia (Bogor:Institut of Technology) p 10
- [20] Lim GT 1992 Biology, ecology, and control of cocoa podborer *Conophomorpha cramerella* (Snellen) *Ninth International Cocoa Research Conference Togo.* 539-542
- [21] Azhar I 2000 Measuring ovipositional preference of the cacao pod borer, *Conopomorpha cramerella* (Lepidoptera: Gracillariidae) to various cocoa clones Proceedeings of Incoped 3rd *International Seminar Malaysian Cacao Board* p 57-59
- [22] Flood, Guest JD, Holmes KA, Keane P, Rice B and Sulistyowati E 2004 Cacao under attack In: J. Flood 7 R. Murphy (Eds.) *Cocoa Futures: A Source Book of Some Important Issues Confronting the Cocoa Industry CABI Comodities Colombia* p 33-35
- [23] Limbongan J 2011 The morphological and anatomical characteristics clones borer resistant cocoa as a source of planting materials. *Journal of Agricultural Research and Development* **31** 18
- [24] Panda N and Khush GS 1995 Host Plant Resistance to Insect CAB International Published Accosiation with the IRRI Philippines p 207-231
- [25] Susilo AW 2010 Characteristics Study of Resistance of Plant Cocoa (*Theobroma cacao* L.) against pests Cocoa Fruit Borer (*Conopomorpha cramerella* Snell.) Dissertation Graduate Faculty of Agriculture (Yogyakarta: Gadjah Mada University) p 165
- [26] Sulistyowati E 2002 Exploration and Genotype Testing Against Resistant Cocoa Cocoa Fruit Borer p 9
- [27] Anita-Sari I and Susilo AW 2013 Investigation of different characters of stomata on three cocoa clones with resistance levels difference to VSD (Vascular Streak Dieback) disease *J. of Agricultural Science and Technology* **3** 703-710
- [28] Anshary A 2002 Characteristics of Plants Resistant to Cocoa Cocoa Fruit Borer ((MSc Dissertation is not published) Hasanuddin University Makassar) p 69-70
- [29] Morgan FD 1979 Host-Arthropod Relationships p 231-237. In: A: F. Brown (ed.) *A. Plant Protection Course Manual Australian Vice Choncellors' Committee.*
- [30] Restu, M., Gusmiaty, dan Larekeng, S.H. 2017. High Outcrossing Rate And Pollen Dispersal Distance of *Diospyros celebica* Bakh. (Ebenaceae), an Endemic Tree Species In Sulawesi Island, Indonesia. *Biotropia*, **24** 173 – 181
- [31] Rubiyo 2013 Cocoa Planting Material Improvement in Indonesia *Bul. RISTRI* **4** 199-413
- [32] Supaman 2014 Research Journal Cassava (*Manihot esculenta*) On the island of Ternate Based on Morphological Characters Laboratorium Biology FKIP Khairun University North Maluku **2** 249-255
- [33] Socal RH and Sneath PA 1963 Principle of Numerical Taxonomy WH Freeman and Co. (SanFrancisco) p 291-303
- [34] Abd L 2006 Selection and Analysis of Plant Genetic Diversity of Cocoa (*Theobroma cacao* L.) Hold Hope Cocoa Fruit Borer (*Conopomorpha cramerella* Snell) S3 Dissertation Agricultural Sciences The Graduate School of the University of Hasanuddin p 90-99
- [35] Tarin R 2016 Analysis of Genetic Diversity of Ecuador Cacao (*Theobroma cacao* L.) Based on SSR Markers Essay Department of Biochemistry Faculty of Mathematics and Natural Sciences Bogor Agricultural University (Bogor : Institut Pertanian Bogor)pp 5-10
- [36] Ville CA 1976 VG Dethier Biological principles and processes 2nd edition Seattle ((US): Sounders Company) pp 6-9

- [37] Sudarsono, Setiawan A, Purwantara A and Sukamto SS 2009 Kurniasih molecular techniques and plant breeding to accelerate the assembly of superior cultivars of cacao (*Theobroma cacao* L.) resistant to fruit rot disease (*Phytophthora palmivora* Butl.) Lap Penel KKP3T (unpublished) p 208