Identification of morphological characters and kinship of coconut genotypes (*Cocos nucifera* L.) in Aceh Tamiang District, Aceh

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**Abstract.** Coconut productivity in Indonesia was relatively low, whereas the potential for coconut production can reach 3–5 tons of copra/ha/yr. Collection of genetic material or sources of genetic diversity of coconuts that are indispensable to plant breeders. This research was conducted using a descriptive survey method based on books IPGRI (International Plant Genetic Resources Institute) coconut descriptor guide with sampling technique by accidental sampling. Cultivation of coconuts in Tenggulun, Seruway and Rantau Districts consists of land and yard coconut with monoculture or polyculture cropping patterns. The research conducted on 27 genotypes of coconut, which research showed that all of the genotype coconut identified were genotypes of coconut Dwarf. Morphological characterization results were found for canopy shape (round, half round, X-shaped silhouette, V-shaped), flowers (normal and still covered with leaf sheaths), fruit (ovoid, oblate, angled, round), shell (pointed, ovate almost spherical, oblate). From the 27 genotypes, there are genotypes that are good as a source of parents, namely AS26 with the character of heavy and thick flesh and AS4 with a large number of fruits.

1. **Introduction**

Coconut plants are widely available in tropical climates. Coconut is estimated to be found in more than 80 countries. Indonesia is an agricultural country which ranks third after the Philippines and India, as the largest coconut producer in the world [1].

Coconut (*Cocos nucifera* L.) is known as the tree of "life". The pulp is covered with a thin skin, protected by a hard shell, thick coir and a smooth outer skin. According to the Directorate General of Plantation, Indonesia [2], the area of the coconut plantations in Indonesia which is widely distributed in Sumatra (34.5%), Java (23.2%), Sulawesi (19.6%), Bali, NTB, NTT (8%), Borneo (7.5%), Maluku and Papua (7.5%). National coconut production reaches 3.29 million tons/yr. Coconut cultivation also opens job opportunities from the various derivative and by-product processing activities. Most (98%) of the total coconut plantation area in Indonesia are smallholder plantations, and the rest are state plantations and private plantations.

Coconut productivity in Indonesia was relatively low, which was an average of 1.0 tons of copra/ha/year or 4,500 grains/ha/year, whereas the potential for coconut production can reach 3–5 tons of copra/ha/yr.

Coconut is a tree that has various uses and potentials and is easily found in the Philippines, Malaysia and Indonesia. Coconut water is used for drinks and nata de coco. Coconut meat is processed
for the extraction of coconut milk and is used for cooking. Coconut is also processed into grated coconut, coconut powder, cosmetics and for medical ingredients [3].

Coconut (Cocos nucifera) is a type of palm plant that has large enough fruit. Coconut tree trunks generally stand upright and do not branch, and can reach 10-14 m or more. The leaves can reach 3-4 m in length with fins that support each strand. The fruit is wrapped in fibers and shells that are strong enough so that to get a coconut you have to peel it first. A large and fertile coconut can produce 2-10 coconuts per stem [4].

The coconut plant is used almost all of its parts by humans so that it is considered a versatile plant, especially for coastal communities. Coconut plants can be used for both food and non-food purposes. Every part of the coconut plant can be used for human benefit. Therefore, the coconut tree is nicknamed The Tree of Life (the tree of life), therefore this plant has high economic value [5].

2. Materials and methods

The materials used in this study were 27 coconut genotypes belonging to farmers in Tenggulun, Seruwai and Rantau sub-districts of Aceh Tamiang district. The tools used in this study is a camera to document the results of the study, a GPS to determine the coordinates of sampling point. Tape measure, callipers and scales were used to measure quantitative characters of plants, measuring cup was used to measure the volume of coconut water, labels for marking of samples, banners, questionnaires, data books and stationery to record the data obtained.

Determining the research location with purposive sampling method, namely the sampling technique based on certain considerations with the aim of obtaining a sampling unit that has the desired characteristics. The research location is determined based on extensive data of crops and coconut production data from the Central Statistics Agency (BPS) [6], then conducted searches research sites in accidental sampling. Qualitative and quantitative data were scored and processed using the SPSS 21 program with cluster analysis to determine the level of kinship between genotypes. Cluster analysis produces a dendrogram that is used to assess patterns of diversity from survey data.

Data collection was carried out by observing samples based on the International Plant Genetic Resources Institute (IPGRI) [7]. The observed variables were: 1) plant morphology: crown shape, stem circumference at 20 cm, stem circumference at 1.5 m from the ground surface, tree height, stem growth pattern, 2) leaf morphology: petiole colour, petiole length, thickness of petiole, width of petiole, length of rachis, number of leaflets, length of leaflets, width of leaflets, 3) flower morphology: flowering type, flower stem colour, female flower colour, male flower colour, flower stalk length, flower stalk thickness, number of spikelets with female flowers, number of spikelets without female flowers, number of female flowers in one bouquet, diameter of female flowers, 4) fruit morphology: number of bunches per tree, number of fruit per bunch, fruit colour, fruit shape, shape polar fruit, equatorial fruit shape, shell shape, fruit weight, coir weight, shell weight, fruit flesh weight, pulp thickness, coconut water weight.

3. Results and discussion

The results of a survey indicated that coconut plant accessions were scattered in several villages. The following is the name of the village and the coconut plant accessions found in the area showed in table 1a and 1b.

Table 1a. Research location and condition of coconut plants.

| Sub-District   | Village        | Genotype Code | Altitude (m) | Coordinate Point        |
|---------------|----------------|---------------|--------------|-------------------------|
| Tenggulun     | Adil Makmur I  | AS 1          | 24           | N 41'31.1952" E 97 59'49.4556 |
|               |                | AS 2          | 28           | N 41'38.4348" E 97 59'47.7276 |
|               |                | AS 3          | 35           | N 41'50.4948" E 97 59'54.69" |
Table 1b. Research location and condition of coconut plants (Continue).

| Sub-District | Village      | Genotype Code | Altitude (m) | Coordinate Point        |
|--------------|--------------|---------------|--------------|-------------------------|
| Tenggulun    | Adil Makmur II | AS 4          | 18           | N 41°13.7352"          |
|              |              |               |              | E 98°0’19.9332"        |
|              |              | AS 5          | 21           | N 41°19.5672"          |
|              |              |               |              | E 98°0’18.6516"        |
|              |              | AS 6          | 27           | N 41°21.882"           |
|              |              |               |              | E 98°0’12.2472"        |
| Proyek       |              | AS 7          | 24           | N 43°4’.2516"          |
|              |              |               |              | E 97°59’49.0056"       |
|              |              | AS 8          | 23           | N 43°15.7716"          |
|              |              |               |              | E 97°59’45.8376        |
|              |              | AS 9          | 23           | N 43°23.3316"          |
|              |              |               |              | E 97°59’46.698"        |
| Seruway      | Gelung       | AS 10         | 9            | N 42°30.5412"          |
|              |              |               |              | E 98°12’30.456"        |
| Paya Udang   |              | AS 12         | 5            | N 42°2.0472"           |
|              |              |               |              | E 98°12’28.4148"       |
|              |              | AS 13         | 7            | N 42°29.8976"          |
|              |              |               |              | E 98°12’5.9328"        |
|              |              | AS 14         | 7            | N 42°10.3188"          |
|              |              |               |              | E 98°12’11.232"        |
|              |              | AS 15         | 7            | N 42°10.6392"          |
|              |              |               |              | E 98°12’11.232"        |
| Sei Kuruk    |              | AS 16         | 7            | N 42°30.6864"          |
|              |              |               |              | E 98°11’21.0156"       |
|              |              | AS 17         | 17           | N 42°26.8452"          |
|              |              |               |              | E 98°11’13.2648"       |
|              |              | AS 18         | 10           | N 42°13.976"           |
|              |              |               |              | E 98°11’12.0768"       |
| Rantau       | Suka Jadi    | AS 19         | 34           | N 41°69.4224"          |
|              |              |               |              | E 98°6’34.8372"        |
|              |              | AS 20         | 34           | N 41°6.5764"           |
|              |              |               |              | E 98°6’37.0692"        |
|              |              | AS 21         | 34           | N 41°6.6556"           |
|              |              |               |              | E 98°6’38.6856"        |
| Suka Mulia   |              | AS 22         | 27           | N 41°60.5988"          |
|              |              |               |              | E 98°6’54.9936"        |
|              |              | AS 23         | 21           | N 41°57.2148"          |
|              |              |               |              | E 98°6’57.6756         |
|              |              | AS 24         | 22           | N 41°60.2316"          |
|              |              |               |              | E 98°7’4.8756"         |
| Suka Rahmat  |              | AS 25         | 25           | N 41°54.378"           |
|              |              |               |              | E 98°7’14.1924"        |
|              |              | AS 26         | 26           | N 41°51.3828"          |
|              |              |               |              | E 98°7’18.4692"        |
|              |              | AS 27         | 31           | N 41°47.7756"          |
|              |              |               |              | E 98°7’33.8736"        |
Based on observations of tree morphological characters, there were 4 types of canopy shapes found, namely round, half round, X-shaped 'silhouette' and V-shaped (Fig. 1). In general, the coconut crown shapes were found in V-shaped on AS4, AS8, AS10, AS13, AS14, AS15, AS16, AS18, AS22, AS23. In addition, the growth pattern of coconut stems is generally upright. This is in accordance with the opinion of [8] which states that coconut plants require high sunlight intensity. Plants that are in the shade in a protected place do not grow well.

Based on the identification of morphological characters of fruit, there were four kinds of fruit shape, oval found on the AS8, AS19, and AS22; oval contained in AS1, AS2, AS3, AS4, AS5, AS14, AS15, AS16, AS18, AS22, AS23. In addition, the growth pattern of coconut stems is generally upright. This is in accordance with the opinion of [8] which states that coconut plants require high sunlight intensity. Plants that are in the shade in a protected place do not grow well.

Figure 1. Differences in morphological characters of tree, flowers and coconut fruit in Tenggulun, Seruway, and Rantau Sub-Districts.
AS20, AS22, AS23, and AS25; angled contained in AS11, AS12, AS13, AS14, AS17, AS18, and AS24; round found in AS6, AS21, and AS26. In general, the shape of the fruit is round egg, green, polar egg shape, equatorial angular fruit shape. In the character of the shell shape, there were 4 types, namely Oblate found in AS2, AS3, AS5, AS10, AS21, and AS25; in almost round shell shapes AS9, AS14, AS15, AS16, AS18, AS19, and AS20; ovoid shell shapes were found on AS1, AS4, AS6, AS7, AS11, AS26, and AS27 and the round shapes AS12, AS13, AS17 and AS24. In general, the shell shape is almost round. According to [9] coconut plants have very diverse phenotypes. Diversity of fruit morphology, especially in fruit colour, shape and size of fruit.

| No. | Kinship Relations | Euclidean value |
|-----|-------------------|-----------------|
| 1   | AS24              | AS17            | 3.000 |
| 2   | AS4               | AS23            | 3.000 |
| 3   | AS23              | AS22            | 3.162 |
| 4   | AS25              | AS8             | 3.742 |
| 5   | AS16              | AS4             | 3.873 |
| 6   | AS22              | AS16            | 4.000 |
| 7   | AS8               | AS25            | 4.000 |
| 8   | AS23              | AS5             | 4.123 |
| 9   | AS17              | AS6             | 4.123 |
| 10  | AS5               | AS15            | 4.243 |
| 11  | AS5               | AS22            | 4.359 |
| 12  | AS13              | AS25            | 4.796 |
| 13  | AS12              | AS4             | 4.899 |
| 14  | AS13              | AS7             | 4.899 |
| 15  | AS1               | AS12            | 5.000 |
| 16  | AS8               | AS16            | 5.000 |
| 17  | AS11              | AS1             | 5.099 |
| 18  | AS25              | AS1             | 5.196 |
| 19  | AS24              | AS2             | 5.196 |
| 20  | AS19              | AS2             | 6.000 |
| 21  | AS25              | AS9             | 6.000 |
| 22  | AS9               | AS1             | 6.245 |
| 23  | AS6               | AS2             | 6.245 |
| 24  | AS18              | AS23            | 7.000 |
| 25  | AS24              | AS7             | 7.071 |
| 26  | AS12              | AS9             | 7.071 |
| 27  | AS22              | AS27            | 7.937 |
| 28  | AS22              | AS24            | 8.000 |
| 29  | AS18              | AS1             | 8.062 |
| 30  | AS2               | AS12            | 8.944 |
| 31  | AS9               | AS14            | 8.944 |
| 32  | AS26              | AS27            | 9.000 |
| 33  | AS6               | AS1             | 9.055 |
| 34  | AS12              | AS6             | 9.110 |
| 35  | AS26              | AS21            | 10.050 |
| 36  | AS9               | AS9             | 10.050 |
| 37  | AS19              | AS26            | 10.536 |
Based on the results of the identification that has been carried out, it is known that there are various variations in coconut morphology in Aceh Tamiang Regency due to farmers doing generative propagation of coconuts or using fruit, causing segregation and variations between genotypes. According to [9], the large diversity of coconuts is caused by the flowers of the monoicous type and there are differences in the initial time and length of the anthesis period of male and female flowers receptive.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{dendrogram.png}
\caption{The dendrogram of kinship.}
\end{figure}

Based on the Euclidean value and dendrogram (table 2 and figure 2), there are two main parts, namely parts A and B, the kinship relationship on the dissimilarity scale 25. Part A is the Inner coconut group and part B is the Quick coconut. Group A was divided into two groups, namely A₁ and A₂. Group A₁ consisted of 9 genotypes, namely AS₁₇, AS₂₄, AS₂₆, AS₆, AS₁₉, AS₁₄, AS₁₈, AS₂ and AS₂₇ which were combined with the same 3 characters, namely the colour of the female flower, the colour of the male flowers and the colour of the flower stalks. Group A₂ consisted of 1 genotype, namely AS₂₁. The special character possessed by AS₂₁ is the highest coir weight.

Group B is divided into two groups, namely B₁ and B₂. Group B₁ consisted of 16 genotypes, namely AS₁₂, AS₁₃, AS₇, AS₁₁, AS₅, AS₂₅, AS₈, AS₁₅, AS₁₆, AS₄, AS₂₃, AS₂₂, AS₁, AS₂₆, AS₉ and AS₃.
which were put together with the same character, namely the normal flowering type. Group B \(_2\) consisted of 1 genotype, namely AS\(_{10}\).

The closest of kinship relationship or the lowest dissimilarity value was obtained on AS\(_{17}\) from Sei Kuruk village, Seruway Sub-district and AS\(_{24}\) from Suka Mulia village, which was 3,000 with 13 character differences from 37 identified characters, namely the type of flower, the shape of the polar fruit, the shape equatorial fruit, trunk circumference, tree height, stem length, stem width, rachis length, number of spikelets with female flowers, number of spikelets without female flowers, number of female flowers in one bouquet, fruit weight and weight of fruit flesh.

The farthest of kinship relationship or the highest value of dissimilarities was obtained on AS\(_{19}\) from the village of Suka Jadi and AS\(_{26}\) from village Suka Rahmat amounting to 10.536 in the presence of 21 different characters from 37 characters identified as crown shape, height, colour stalk, petiole length, rachis length, flowering type, flower stem colour, female flower colour, male flower colour, flower stalk thickness, number of spikelets with female flowers, number of female flowers in one bouquet, fruit colour in fruit shape, polar fruit shape, shell shape, weight of fruit, weight of coir, weight of shell, weight of pulp, thickness of fruit flesh, volume of coconut water.

4. **Conclusions**

In dendrography, there are two main groups, namely group A (Deep Coconut) and group B (Coconut Early). The kinship relationship on a kinship distance scale of 25 with the closest kinship is AS\(_{24}\) and AS\(_{17}\) with a Euclidean value of 3.00 while the farthest kinship is found in AS\(_{19}\) and AS\(_{26}\) with a Euclidean value of 10.536.

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