Morphological characterization of local durian of Banten Province, Indonesia

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Abstract. Durian (Duriozibethinus) is an exotic fruit with relatively advanced varietal improvement prospects. Indonesia is one of the countries with high durian diversity, one of which is located in Banten Province. This study aims to determine the diversity and relationships of several local durians in Pandeglang and Lebak Regencies of Banten Province based on the morphological characters of leaves, flowers, and fruit. The durian samples were obtained by purposive sampling and interview methods. The morphological characterization was carried out according to the guidelines of the "Bioversity International" including the description of stems, leaves, flowers, fruits, and seeds. After the characterization, scoring, standardization, and similarity index (IS) were calculated between samples. Cluster analysis was carried out using Cluster Observation with Ntys 2.0 software. The analysis was conducted on 50 characters in 20 local durian accessions. The results showed that the clustering analysis was divided into three clusters with a similarity coefficient of 0.64. Group I consisted of SangkanWangi 2. Group II consisted of Hauk, Ketan Jaya, Grinsing, Sikucing, Kadu Katung, Jangkung, Sibening, Siradio, Sirau, Sipeang, Sikempong, Sicayut, and Sijabrig. Meanwhile, Group III consisted of Siemas, Baranjang, Kaduhejo, Kadukuning, Sangkan Wangi 1, and Sibening.

1. Introduction
Durian fruit is counted in the leading crop commodities of Banten Province along with melinjo, sugar palm, and melon. Durian production in Banten Province increased by up to 250% in 2018 from 22,628 tons to 77,629 tons [1]. Lebak and Pandeglang Regencies are durian production centers in Banten Province, which contribute around 44.6% of total annual production [2]. As durian becomes a sensational plant for Banten’s people, there is a notable number for naming places using the word “Durian” in Sundanese, ie. “Kadu.” The naming is based on the experience and consideration of the community as well as existing geographic phenomena [3]. Banten Province has a high durian planting area, so it is considered to produce a high diversity of durian species as well. The number of cultivars that develop durian can cause difficulties in distinguishing between cultivars that exist because of the lack of information about the characteristics of durian cultivars [4]. The results of the identification of 19 accessions of durian from Banten, based on the leaf character differences, showed that there was a high diversity of durian (more than 50%) [5].

However, identification based on the leaf morphology must be strengthened based on plant, fruit, and flower morphology so that the analysis results can represent the actual plant phenotype. The characteristic that is often used as a distinguishing character between durian cultivars is the appearance of the fruit. The character of the fruit is often used as the basis for naming community groups. Apart
from fruit morphology, the distinguishing character can also be obtained from the morphology of other organs, such as leaves, stems, and flowers. The introduction of durian plants based on morphological characters can help plant breeding efforts to obtain high-quality durian [6]. Morphological observations are also important to determine the variety or diversity of a plant species [7].

The purpose of this study was to determine the diversity and kinship between durian plant varieties in Banten Province. Most of the accessions in this study have been registered at the Centre for Plant Variety and Agricultural Licensing Protection (PPVTPP) of the Ministry of Agriculture. It is expected that the results of this study can reduce double naming for varieties that have the same kinship value. Besides, it can initiate a germplasm database from a typical local durian Banten.

2. Method
There were twenty potential varieties of plant materials used for the analysis, which 12 of them have been registered at PPVTPP (Centre for Plant Variety Protection and Agriculture Licensing). Plant materials were collected from two regencies in Banten Province, eg. Pandeglang and Lebak. The landraces were analyzed as single trees, and morphological observations were conducted in-situ based on descriptors for durian [8].

The observation involved fifty characters, namely five characters of the tree, 17 characters of leaves, and 28 characters of fruit and seed. Morphological characters were classified into descriptive data, which was divided into several categories; score 1 for presence and 0 for absence.

Genetic similarity between accessions was estimated according to the formula of the Unweighted Pair Group Method Average similarity (UPGMA) [9]. UPGMA cluster analysis was used to assess patterns of diversity among the accessions. Dendrograms were constructed using the TREE program of Numerical Taxonomy and Multivariate System (NTSys) PC version 2.1 software (Exeter Software 2019 NTSYSpC) [10]. The coefficient used in the similarity matrix was DICE.

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Sim_{UPGMA}(U,V) = \frac{1}{|U||V|} \sum_{u \in U, v \in V} \cos(\theta_{u,v}) = \frac{c_U^T c_V}{|U||V|}\]  

Remarks: |U| is the amount of data in the U cluster, and c^U is the centroid for the U cluster

3. Results and discussion
Local durians were collected from Pandeglang District (16 accessions) and Lebak District (four accessions) (Table 1). A total of 12 durian accessions have been registered in PPVTPP. Some are in preparation for releasing local varieties.

The results of the morphological identification analysis of 20 durian accessions showed high diversity. The analysis was conducted on 52 qualitative and quantitative characters, including tree characters (five characters), leaves (17 characters), fruits (25 characters), and seeds (five characters). Some of the analyzed characters showed a proportion of diversity ranging from 5-95% (Table 2). The high diversity of durian may be caused by the reproductive system of cross-pollination by plants. On the other hand, farmers generally use seeds derived from natural crosses [11]. Many durian plants in Banten Province that grow naturally are not in the form of plantations, so it is suspected that the diversity of durian in Banten is very high.

Flesh taste and thickness of durian fruit are some of the key criteria to choose durian. Consumers of durian in Indonesia generally favor sweet to bittersweet taste with thick fruit flesh [11 - 12]. Overseas consumers have similar tastes when it comes to thick, yellow-colored fruit, but they prefer odorless durian, and slightly bitter sweetness [13]. Characterization of 20 types of Banten durian had showed that, in general, the thickness of fruit flesh are medium and the flesh are sweet in taste. This criterion is following the taste of Indonesian and foreign durian consumers.

There were six forms of local durian crown shape, namely pyramid (four accessions), oblong (five accessions), spherical (five accessions), semi-circular (two accessions), ellipses (two accessions), and irregular (two accessions). Yuniasuti et al. [14] had studied durian in Central Java, and they only
found three forms of the crown shape, namely pyramid, oblong, and irregular. These results indicated that Banten durian had a greater variety of canopy forms than other local durians.

Table 1. List of varieties analyzed in the study.

| No. | Accession | District     | Sub-District | Village | Status   | Registered Number |
|-----|-----------|--------------|--------------|---------|----------|-------------------|
| 1   | Si Bening | Pandeglang   | Karangtanjung | Juhut   | Registered | Dr. Lk/BT/117/2016 |
| 2   | Si Jabrig | Pandeglang   | Majasari     | Cilaja  | Unregistered | -                 |
| 3   | Si Pedang | Pandeglang   | Majasari     | Cilaja  | Registered  | 933/PVL/2018      |
| 4   | Si Ceer   | Pandeglang   | Majasari     | Cilaja  | Unregistered | -                 |
| 5   | Si Cayut  | Pandeglang   | Majasari     | Cilaja  | Unregistered | -                 |
| 6   | Si Kempong| Pandeglang   | Majasari     | Cilaja  | Registered  | 896/PVL/2018      |
| 7   | Si Radio  | Pandeglang   | Cadasari     | Tapos   | Registered  | Dr.Lk./BT/113/2016 |
| 8   | Jangkung  | Pandeglang   | Jiput        | Jayamekar | Unregistered | -                 |
| 9   | Grinsing  | Pandeglang   | Jiput        | Jayamekar | Registered  | 895/PVL/2018      |
| 10  | Kueh Kuning| Pandeglang   | Jiput        | Jayamekar | Unregistered | -                 |
| 11  | Kueh Hijau| Pandeglang   | Jiput        | Jayamekar | Unregistered | -                 |
| 12  | Hauk      | Pandeglang   | Jiput        | Jayamekar | Unregistered | -                 |
| 13  | Si Bintang| Pandeglang   | Cadasari     | Koranji | Registered  | 932/PVL/2018      |
| 14  | Baranjang | Pandeglang   | Cadasari     | Koranji | Registered  | 894/PVL/2018      |
| 15  | Ketan Jaya| Pandeglang   | Cadasari     | Koranji | Registered  | 893/PVL/2018      |
| 16  | Siemas    | Pandeglang   | Cadasari     | Koranji | Registered  | 931/PVL/2018      |
| 17  | Kadu Katung| Lebak       | Leuwidamar   | Cisimeut Raya | Unregistered | -                 |
| 18  | Sikucing  | Lebak        | Leuwidamar   | Sangkanwangi | Registered  | 934/PVL/2018      |
| 19  | Sangkan Wangi 1 | Lebak     | Leuwidamar   | Sangkanwangi | Registered  | 994/PVL/2018      |
| 20  | Sangkan Wangi 2 | Lebak     | Leuwidamar   | Sangkanwangi | Registered  | 995/PVL/2018      |

The diversity was also seen from the shape of the leaf and leaf blade margin. 95% of accessions in this study had a flat-leaf blade margin (entire); only one accession with undulated type was observed, namely durian Jangkung. Yuniastuti et al. [14] only found the entire leaf blade margin of durian in Central Java. Leaves with more serrations show more active photosynthesis, but they are not beneficial in dry environments because of higher transpiration [15]. An entire form is a form commonly found in the shape of the leaf blade margin. Jangkung Durian comes from Jiput District, Pandeglang Regency. Jiput District is one of the durian centers. It is known for its durian types with good taste, including one of the Bintang durian, which costs up to IDR 500,000 per-fruit.
| Main Characteristics          | Sub Characteristics | The proportion of Sub-Characteristics (%) | Main Characteristics          | Sub Characteristics | The proportion of Sub-Characteristics (%) |
|------------------------------|---------------------|------------------------------------------|------------------------------|---------------------|------------------------------------------|
| Crown Shape                  | Pyramid             | 20                                       | Fruit shape                  | Globose             | 25                                        |
|                              | Oblong              | 25                                       |                               | Oval                | 35                                        |
|                              | Spherical           | 25                                       |                               | Ellipse             | 15                                        |
|                              | Semi-circular       | 10                                       |                               | Obovoid             | 15                                        |
| Ellipse                      |                     |                                          |                               | Ovoid               | 10                                        |
| Irregular                    |                     | 10                                       | Fruit spine shape            | Hooked              | 15                                        |
| Tree growth habit            | Erect               | 5                                        |                               | Convex              | 10                                        |
|                              | Intermediate        | 55                                       |                               | Concave             | 35                                        |
|                              | Spreading           | 40                                       |                               | Pointed concave     | 20                                        |
| Leaf upper surface color      | Light green         | 10                                       |                               | Confocal            | 20                                        |
|                              | Green               | 50                                       | Fruit thickness              | Thin                | 25                                        |
|                              | Dark green          | 40                                       |                               | Medium              | 65                                        |
| Leaf lower surface color      | Silvery brown       | 80                                       |                               | Thick               | 10                                        |
|                              | Coppery brown       | 20                                       | Flesh taste                  | Slightly sweet      | 25                                        |
| Leaf density                 | Sparse              | 5                                        |                               | Sweet               | 60                                        |
|                              | Medium              | 75                                       |                               | Bittersweet         | 15                                        |
|                              | Dense               | 20                                       | Presence of fiber            | Low                 | 55                                        |
| Leaf-blade width             | Narrow              | 5                                        |                               | Medium              | 30                                        |
|                              | Intermediate        | 70                                       |                               | High                | 15                                        |
|                              | Wide                | 25                                       | Seed Shape                   | Spheroid            | 5                                         |
| Leaflet shape                | Oblong              | 5                                        |                               | Ellipsoid           | 75                                        |
|                              | Linear – Oblong     | 25                                       |                               | Oblong              | 10                                        |
|                              | Ellipse             | 65                                       |                               | Other               | 10                                        |
|                              | Ovate               | 5                                        | Seeds per-carpel             | Few                 | 15                                        |
| Curved of leaf               | Half curved         | 95                                       |                               | Intermediate        | 80                                        |
|                              | Curved              | 5                                        |                               | Many                | 5                                         |
| Leaf-blade margin            | Entire              | 95                                       |                               |                     |                                           |
|                              | Undulate            | 5                                        |                               |                     |                                           |
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Table 3. The diversity of some quantitative characters of 20 durian accessions in Pandeglang and Lebak Regencies.

| Varieties     | Petiole Length (mm) | Petiole Width (mm) | Fruit Length (cm) | Fruit Diameter (mm) | Fruit Weight (kg) | Seed Length (mm) | Seed Width (mm) | Seed Thickness (mm) |
|---------------|---------------------|--------------------|-------------------|---------------------|-------------------|------------------|-----------------|-------------------|
| Si Bening     | 19.42               | 24.62              | 17.41             | 26.22               | 2.09              | 25.92            | 15.78           | 11.51             |
| Si Jabrig     | 18.33               | 17.40              | 21.00             | 15.80               | 3.00              | 48.98            | 27.52           | 22.01             |
| Si Pedang     | 14.42               | 15.40              | 28.30             | 55.00               | 2.46              | 49.80            | 28.60           | 21.16             |
| Si Ceer       | 16.51               | 24.96              | 28.00             | 51.20               | 1.70              | 43.90            | 18.59           | 24.30             |
| Si Cayut      | 16.90               | 20.01              | 83.34             | 88.13               | 2.11              | 50.10            | 28.10           | 23.90             |
| Si Radio      | 22.60               | 33.60              | 18.50             | 14.30               | 3.00              | 44.98            | 26.09           | 16.46             |
| Kadu Katung   | 23.48               | 26.30              | 37.70             | 63.20               | 3.34              | 52.18            | 47.54           | 35.49             |
| Jangkung      | 27.90               | 12.00              | 27.00             | 31.75               | 3.34              | 35.30            | 29.40           | 2.42              |
| Grinsing      | 18.30               | 32.00              | 8.22              | 42.22               | 1.80              | 24.68            | 11.38           | 9.78              |
| Kueh Kuning   | 17.15               | 66.20              | 22.00             | 24.00               | 1.30              | 53.30            | 17.00           | 2.43              |
| Kueh Hijau    | 20.90               | 11.30              | 20.20             | 21.60               | 0.95              | 44.80            | 23.67           | 6.52              |
| Hauk          | 18.10               | 12.00              | 26.00             | 26.15               | 3.00              | 53.30            | 29.20           | 2.89              |
| Si Bintang    | 18.80               | 24.40              | 78.30             | 86.00               | 1.90              | 55.84            | 29.77           | 28.94             |
| Si Kempong    | 19.04               | 24.50              | 29.60             | 49.00               | 1.71              | 46.70            | 32.66           | 22.61             |
| Baranjang     | 20.20               | 27.00              | 19.50             | 50.60               | 1.58              | 42.36            | 25.84           | 22.92             |
| Ketan Jaya    | 21.70               | 27.30              | 15.50             | 46.20               | 1.02              | 42.40            | 25.00           | 19.36             |
| Si Kucing     | 19.10               | 22.20              | 23.50             | 55.00               | 2.26              | 46.90            | 26.60           | 21.50             |
| Sangkan Wangi 1 | 18.30             | 27.90              | 18.20             | 48.00               | 1.36              | 45.20            | 26.81           | 23.73             |
| Sangkan Wangi 2 | 21.40             | 23.40              | 19.80             | 58.00               | 2.48              | 65.16            | 44.88           | 27.38             |
| Si Emas       | 21.40               | 20.40              | 15.50             | 41.00               | 0.72              | 32.80            | 21.10           | 16.50             |
| Average       | 19.70               | 24.64              | 27.88             | 84.33               | 2.06              | 45.23            | 26.78           | 18.09             |
| Max           | 27.90               | 66.20              | 83.34             | 86                  | 3.34              | 65.16            | 47.54           | 35.49             |
| Min           | 14.42               | 11.30              | 8.22              | 14.30               | 0.72              | 24.68            | 11.38           | 2.42              |
| Std           | 2.94                | 11.63              | 19.20             | 188.44              | 0.80              | 9.78             | 8.55            | 9.36              |

The observation of 20 local durian accessions on quantitative characters (Table 3) showed the differences between characters in all accessions. Observation of the petiole length was in the range of 14.42 - 27.90 mm, with a standard deviation of 2.94. The petiole width ranged from 11.30 - 66.20 mm, and the average was 24.64 mm. Furthermore, the fruit length ranged between 8.22-83.34 cm, and the average was 27.88 cm. The fruit diameter indicated an average of 84.33 cm. The weight of fruit
characters ranged between 0.72-3.34 kg, with an average of 2.06 kg. The character of obtained seeds resulted in the length of seeds with an average of 45.23 mm and a standard deviation of 9.78. The width of the seed character had an average of 26.78 mm with a standard deviation of 8.55, and then the average of seed thickness was 18.09 mm, and the standard deviation was 9.36. The results of these observations indicated the diversity of all the characters observed, according to Table 3. Differences in quantitative characters indicated the diversity in the various durian varieties observed in two districts of Banten Province.

Figure 1. Dendrogram base on scored data of observed morphological characters of 20 durian accessions in two districts of Banten Province.

Figure 2. Fruit representatives of group I, Sangkan Wangi 2 (top); group II, Sibintang (middle); group III, Siemas (bottom).

The results showed that the similarity coefficient values between 50 vegetative and generative characters from 20 accessions ranged from 0.63 - 0.79 (Figure 1). The greatest similarity was found in
The accession of durian Kadu Katung and Si Kucing by 79%. The high similarity of characters between accessions indicated the greater value of the similarity coefficient, which is the closeness of the genetic relationship between accessions and the contrary [16]. The distance of this coefficient varied in each region. Lestari et al. [17] obtained a similarity coefficient of 0.42 - 0.66 for 36 durian accessions in Bengkalis. Analysis of 35 characters from 29 durian genotypes in Bengkulu Province produced a similarity coefficient of 0.65–0.85 [18]. The wider coefficient range, which is 0.18–0.97, was produced from an analysis of 58 characters from 81 durian genotypes in Tanah Datar West Sumatra [19].

Based on the similarity coefficient of 0.64 (Figure 2), accessions were divided into three clusters. Group I was Sangkan Wangi 2. Group II consisted of Hauk, Ketan Jaya, Grinsing, Sikucing, Kadu Katung, Jangkung, Sibintang, Siradio, Siceer, Sipedang, Sikempong, Sicayut, and Sijabrig. Then group III was Siemas, Baranjang, Kaduhejo, Kadu Kuning, Sangkan Wangi 1, and Sibening. Sangkan Wangi 2 had the most different characteristics from other accessions, so it was grouped in separate clusters. The distinctive characters of Sangkan Wangi 2 were the fruit spine. The form of fruit spine shape was convex; the surface of the spine was globrous, and the fruit spine density was sparse (Figure 3).

Out of the 50 characters with 140 sub-characters analyzed, there were several characters with high similarity between the accessions, and there were characters with high variation. Characters with high variations have the potential to become character traits. The characters with high diversity are leaf shape, fruit shape, bottom fruit shape, upper fruit shape, fruit skin color (ripe), thorn density, thorn length, thorn shape, fruit flesh tenderness, fruit flesh color, fruit flesh taste, the aroma of fruit flesh, the fiber in fruit flesh, the seed shape, and color of the seed coat.

4. Conclusion
Based on the analysis, the similarity coefficient between 50 vegetative and generative characters from 20 accessions ranged from 0.63 - 0.79 (63% - 79%). The greatest similarity was found in the accession of durian Kadu Katung and Si Kucing by 79%. Characters with high diversity are leaf shape, fruit shape, bottom fruit shape, upper fruit shape, fruit skin color (ripe), thorn density, thorn length, thorn shape, tenderness fruit, fruit flesh color, fruit flesh taste, the aroma of fruit flesh, the fiber in fruit flesh, seed shape, and color of the seed coat. Correspond to the similarity coefficient limit of 0.64%, accessions were clustered into three groups. Group I consisted of Sangkan Wangi 2, while group II consisted of Hauk, Ketan Jaya, Grinsing, Sikucing, Kadu Katung, Jangkung, Sibening, Siradio, Siceer, Sipedang, Sikempong, Sicayut, and Sijabrig. Then, group III was Siemas, Baranjang, Kaduhejo, Kadu Kuning, Sangkan Wangi 1, and Sibening.
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