

Diversity of black pepper plant (*Piper nigrum*) in Bangka Island (Indonesia) based on agro-morphological characters

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Abstract. Prayoga GP, Aini SN, Mustikarini, ED, Rosalin Y. 2020. Diversity of black pepper plant (*Piper nigrum* L.) in Bangka Island (Indonesia) based on agro-morphological characters. *Biodiversitas* 21: 652-660. Black pepper (*Piper nigrum* L.) production in Bangka Belitung Islands Province continued to decrease in 2014-2017. Efforts to increase black pepper production was carried out by providing superior varieties that began with an increase in the genetic diversity of black pepper plants. Increasing the genetic diversity of black pepper can be done through black pepper germplasm exploration activities followed by characterization. The research aimed to obtain the agro-morphological characteristics of black pepper plants in Bangka island. Exploration was carried out by survey method in four regencies in Bangka Island. The research method used a survey method with convenience sampling technique. Observation of agro-morphological characters was carried out in accordance with the descriptor for black pepper from IPGRI (1995). The results of exploration of black pepper plants in Bangka Island have found 9 accessions of black pepper plants, consisting of 5 cultivars were Lampung Daun Lebar (LDL), Lampung Daun Kecil (LDK), Chunuk, and Jambi and 4 landraces namely Bogor, Peremis, Keriwil, and Merapin Daun Kecil (MDK). There were morphological differences in 9 accessions of black pepper plants, namely leaf lamina shape, leaf vein, leaf margin, lateral branch habit, leaf base shape, ripe fruit color, hanging vines, ground vines, and stem shape. Agro-morphological relationship of 9 accessions of black pepper plants can be divided into 5 clusters at a 50% similarity level. Based on this study, black pepper breeding program on Bangka Island could be done accessions of Peremis, Bogor, Nyelungkup, and Jambi as genetic sources. Furthermore, selection would be better to use length of petiole, length of stem segment, fruit size, percentage of perfect fruit, weight of 1000 fruits, and the weight of 1000 dried seeds as the selection criteria.

Keywords: Bangka, black pepper, relationship, variability

INTRODUCTION

Black pepper (*Piper nigrum* L.) is an important spice plant that cannot be replaced by other spices, contributors to the country's foreign exchange, employment providers, and domestic industrial raw materials. Black pepper is also famous as the king of spices due to its pungent quality (Srinivasan 2007). One of the black pepper producing regions in Indonesia is the Kepulauan Bangka Belitung Province (Yudiyanto et al. 2014), and its product was well known in the world market as Muntok White Pepper (Ravindran 2000) with Geographical indications: Muntok White Pepper (Direktorat Jenderal Kekayaan Intelektual 2019). Black Pepper productivity in Bangka Belitung has declined from 2014-2018, respectively 1.53, 1.26, 1.24, 1.20, and 1.17 tons/ha/year (BPS-Statistics of Kepulauan Bangka Belitung Province 2019). The decline of black pepper productivity in Bangka Belitung was influenced by various factors, including decreasing land production by the exploitation of smallholder plantations with limited scale of business and limited capital (Listyati et al. 2012), as well as disruption of plant organisms, especially stem rot disease (Wahyuno et al. 2010). Therefore, based on these conditions, efforts are needed to increase pepper production and productivity.

The first step in efforts to increase black pepper production is by providing superior varieties. At present, there are only ten varieties of black pepper in Indonesia, namely Natar 1, Natar 2, Petaling 1, Petaling 2, Lampung Daun Kecil, Bengkayang, Chunuk, Ciinten, Malonan-1, and Nyelungkup which were released in 1988-2018 (Pusat Perlindungan Varietas Tanaman dan Perizinan Pertanian 2019). Some of the varieties only have tolerant of stem rot disease (Lampung Daun Kecil, Bengkayang and Chunuk) and tolerant against yellowing disease (Bengkayang), but there are no varieties that are resistant to both of main diseases of the black pepper. Disease epidemics can narrow genetic diversity which may decimate population (Singh et al. 2014). Plant production tends to depend on genetic diversity. Substantial losses in production have resulted from a narrow genetic base (Cooper et al. 2001). Increasing the genetic diversity of black pepper is needed as a source of genes in the development of superior varieties of black pepper.

Increasing the genetic diversity of black pepper can be done through plant breeding programs. Breeding activities begin with germplasm collection as a source of diversity and several other stages of activity up to the release of plant varieties (Carsono 2008). Aside from the cultivation of black pepper germplasm, the source of genetic diversity for the improvement of black pepper varieties can also be

obtained from local, native and wild black pepper. In addition, increasing crop productivity in an area can be done by exploring genetic diversity of germplasm (Tshilenge-Lukanda 2012). Therefore, the position and role of germplasm are needed in an effort to increase the production of black pepper plants through the use of superior genes contained in germplasm accession.

The next activity after exploration is characterization. The stages of plant breeding begin with collecting germplasm, identification, and characterization, increasing diversity, selection, testing and evaluation, and ending with the release of varieties (Carsono 2008). Characterization is important because each germplasm will show different characteristics according to the environment. The availability of genotypes that have specific characteristics will have a major impact on the effectiveness and acceleration of plant breeding programs in producing superior varieties that have economic value. Bangka Island is dominated by acidic land and ultisols soil (Santi et al. 2018) allows the discovery of local black pepper germplasm that has the potential to be developed into national and regional-specific superior varieties. The research aims to obtain the black pepper plant on Bangka island and its agro-morphological characteristics. The information obtained can later be used as a basis for assembling national superior varieties of black pepper and region-specific varieties in order to increase national black pepper production.

MATERIALS AND METHODS

Plant materials

The research was conducted in December 2018 - May 2019 on Bangka Island. Exploration was carried out in four regencies (Bangka, Bangka Tengah, Bangka Barat, and Bangka Selatan), Kepulauan Bangka Belitung Province, Indonesia (Table 1 and Figure 1), especially black pepper planting centers, traditional production areas, and remote areas. During the exploration, plant passport data recording was also carried out, namely: accession number, accession name, and village. Black pepper plants that were observed were plants that had been planted in the same location for more than five years, with the age of the plants observed at least three years, to ensure that plants are local plants that have been cultivated for generations.

Table 1. Location of black pepper studied in Bangka Island, Bangka Belitung Province, Indonesia

District	Sub-district	Village
Bangka	Mendo Barat	Paya Benua
	Mendo Barat	Zed
Bangka Tengah	Pangkalan Baru	Air Mesu
Bangka Selatan	Air Gegas	Nyelanding
Bangka Barat	Simpang Teritip	Kundi
	Simpang Teritip	Air Menduyung

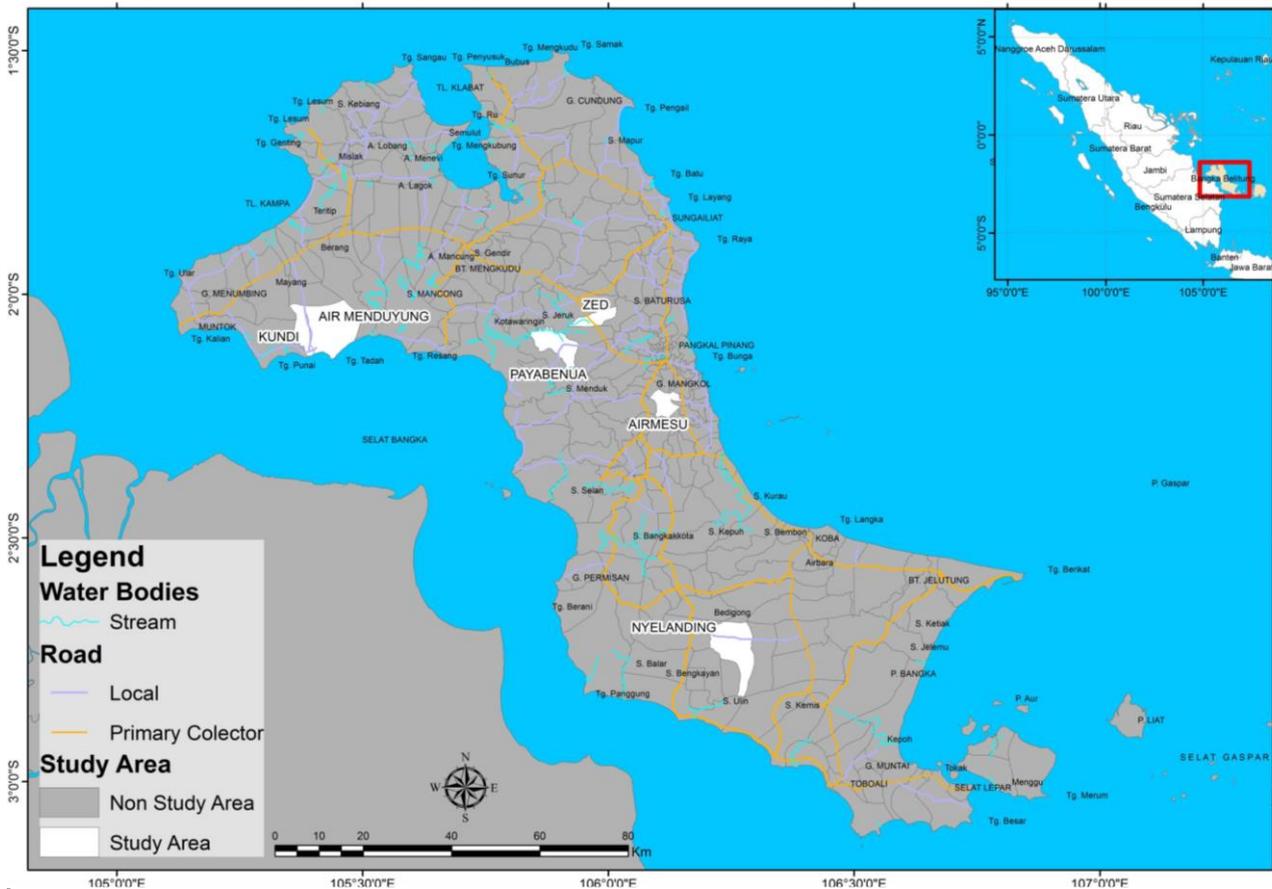


Figure 1. Location of black pepper studied in Bangka Island, Bangka Belitung Province, Indonesia

Procedure

The research method used the survey method. Sampling was done by using convenience sampling technique. Convenience sampling is one of the sampling methods based on the probabilities put forward in several practical criteria such as easy accessibility, geographical proximity, or time schedule in accordance with the research objectives (Etikan et al. 2016), on the account that the condition of the plantation was considered suitable as a data source. A minimum of 5 plant samples was taken from each location to meet the criteria of 10% of the population sample. Each plant sample was marked and the agro-morphological characters were observed. Observation of agro-morphological characters was carried out in accordance with the Descriptor for Black Pepper (*Piper nigrum* L.) (IPGRI 1995). The characters observed were leaf lamina shape, leaf surface, leaf vein, leaf margin, lateral branch habit, leaf base shape, leaf tip, leaf color, flowering nature, fruit shape, young fruit color, ripe fruit color, young stem color, ripe stem color, hanging vine, ground vine, stem shape, plant growth habit, length of petiole, length of stem segment, age of flowering, fruit size, fruit weight per spike, percentage of perfect fruit, weight of 1000 fruit, and weight of 1000 seeds.

Data analysis

The data obtained was divided into qualitative and quantitative data types. Analysis of qualitative data was done by descriptive method. Quantitative data were used to determine the phenotypic variability value of various characters of black pepper germplasm. Phenotypic coefficient of variation (PCV) was calculated by using the formula according to Kearsy and Pooni (1996) thus:

$$\%PCV = ((\sigma_p^2)^{1/2} (\bar{x})^{-1})100\% \text{ where } \sigma_p^2 = N^{-1} (\sum[xi - \bar{x}]^2)$$

Where, \bar{x} = grand mean of the character, xi = value of character-i, μ = mean of population, N = total of plant observed, σ_p^2 = phenotypic variance.

Morphological relationship analysis among black pepper germplasm was also carried out based on the UPGMA (Unweighted Pair Group Method with Arithmetic Mean) using Numerical Taxonomy and Multivariate Analysis System (NTSYS-PC) version 2.20 software.

RESULTS AND DISCUSSION

Exploration of black pepper in Bangka Island

Exploration of black pepper plants in Bangka Island has found 9 accessions, consisting of 5 cultivars and 4 landraces. The cultivars that were planted in Bangka Island were Lampung Daun Lebar (LDL), Lampung Daun Kecil (LDK), Chunuk, and Jambi varieties. Exploration results also found 4 landraces of black pepper, namely Bogor, Peremis, Keriwil, and Merapin Daun Kecil (MDK). Accessions of LDL, LDK, Chunuk, Jambi, Bogor, and MDK were reported as cultivated plants in Bangka island (Panggabean, 2016; Pusat Penelitian dan Pengembangan Perkebunan 2015), but Bogor, Peremis and Keriwil accessions have never been studied before. Black pepper's location and passport data from exploration results are shown in Table 2.

Agro-morphological characters of black pepper in Bangka Island

Agro-Morphological characters for 9 accessions of black pepper can be seen in Table 3. Morphological characters of 9 black pepper plants observed had some similarities, namely the leaf vein (campylodromous), leaf tips (pointed), leaf color (dark green), young stem color (dark green), ripe stem color (green-brown), young fruit color (dark green), flowering nature (seasonal), fruit shape (round), and climbing growth habit type. Morphological differences in 9 black pepper plants can be seen from several parameters, namely the character of leaf lamina shape, leaf surface, leaf margin, lateral branch habit, leaf base shape, fruit shape, ripe fruit color, hanging vines, ground vines and stem shape.

The nine accessions of black pepper have the same type of leaf vein, which is campylodromous (Figure 1). Campylodromous venation is which several primary veins run in prominent, recurved arches at the base, curving upward to converge at the leaf apex (Simpson 2011). The same type of leaf vein is also found in Ciinten variety (Bermawie 2019). Variations in the shape of black pepper leaves found were ovate-elliptic, ovate-lanceolate and elliptic-lanceolate (Figure 3). Black pepper plants had 2 variations of leaf base shape, namely Round and acute (Figure 4).

Table 2. Passport data of 5 black pepper cultivars and 4 local black pepper accessions explored in Bangka Island, Indonesia

Accessions	Code	Cultivar/Landrace	Village
Lampung Daun Lebar	LDL	Cultivar	Payabenua and Zed.
Lampung Daun Kecil	LDK	Cultivar	Air Mesu and Zed.
Chunuk	Cnk	Cultivar	Payabenua and Air Mesu.
Jambi	Jmb	Cultivar	Nyelanding and Payabenua.
Nyelungkup	Nye	Cultivar	Zed, Air Mesu, and Nyelanding.
Bogor	Bg	Landrace	Air Mesu and Payabenua.
Keriwil	Krl	Landrace	Zed
Peremis	Pr	Landrace	Payabenua
Merapin Daun Kecil	MDK	Landrace	Zed, Payabenua, Air Menduyung, and Kundi

Table 3. Agro-morphological characters of 9 accessions black peppers in Bangka Island, Indonesia

Characters	Landraces					Cultivars			
	Bogor	Keriwil	Peremis	Merapin Daun Kecil	Lampung daun Lebar	Lampung Daun kecil	Chunuk	Jambi	Nyelungkup
Leaf lamina shape	<i>Eliptic-lanceolate</i>	<i>Ovate-Lanceolate</i>	<i>Ovate-Lanceolate</i>	<i>Eliptic-lanceolate</i>	<i>Ovate-elliptic</i>	<i>Ovate-elliptic</i>	<i>Ovate-Lanceolate</i>	<i>Ovate-elliptic</i>	<i>Eliptic-lanceolate</i>
Leaf Surface	Smooth-glossy	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth-Glossy
Leaf Vein	<i>Campylodromous</i>	<i>Campylodromous</i>	<i>Campylodromous</i>	<i>Campylodromous</i>	<i>Campylodromous</i>	<i>Campylodromous</i>	<i>Campylodromous</i>	<i>Campylodromous</i>	<i>Campylodromous</i>
Leaf margin	<i>Wavy (repand)</i>	<i>Even (entire)</i>	<i>Even (entire)</i>	<i>Wavy (repand)</i>	<i>Even (entire)</i>	<i>Even (entire)</i>	<i>Even (entire)</i>	<i>Even (entire)</i>	<i>Even (entire)</i>
Lateral branch habit	<i>Hanging</i>	<i>Erect</i>	<i>Erect</i>	<i>Hanging</i>	<i>Horizontal</i>	<i>Horizontal</i>	<i>Hanging</i>	<i>Horizontal</i>	<i>Erect</i>
Leaf Base Shape	<i>Round</i>	<i>Acute</i>	<i>Acute</i>	<i>Round</i>	<i>Round</i>	<i>Round</i>	<i>Round</i>	<i>Round</i>	<i>Round</i>
Leaf tip	Acute	Acute	Acute	Acute	Acute	Acute	Acute	Acute	Acute
Leaf color	Dark green	Dark green	Dark green	Dark green	Dark green	Dark green	Dark green	Dark green	Dark green
Flowering nature	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal
Fruit Shape	Round	Round	Round	Round	Round	Ovate	Round	Round	Round
Young Fruit Color	Green	Green	Green	Green	Green	Green	Green	Green	Green
Ripe Fruit Color	Orange	Orange to red	Orange to red	Orange	Orange to red	Orange to red	Orange	Orange	Orange to red
Young Stem Color	Dark green	Dark green	Dark green	Dark green	Dark green	Dark green	Dark green	Dark green	Dark green
Ripe Stem Color	Greenish brown	Greenish brown	Greenish brown	Greenish brown	Greenish brown	Greenish brown	Greenish brown	Greenish brown	Greenish brown
Hanging Vine	None	None	Moderate	None	Few	Moderate	Few	Few	Few
Ground Vine	None	None	Few	None	Few	Few	Few	Moderate	None
Stem Shape	Flat	Flat	Intermediate	Flat	Round	Round	Round	Flat	Flat
Plant Growth habit	Climbing	Climbing	Climbing	Climbing	Climbing	Climbing	Climbing	Climbing	Climbing
Length of Petiole (cm)	1.2	1.8	1.6	1.3	1.7	1.9	1.6	1.8	1.6
Length of Stem Segment (cm)	6.0	4.0	5.0	3.5	3.9	4.4	6.0	5.4	4.5
Age of Flowering (month)	8	7	9	8	9	7	8	9	8
Fruit Size (mm)	6.2	5.7	6.4	6.5	6.1	6.4	6.2	4.0	4.9
Fruit Weight Per Spike (g)	7.5	8.3	8.0	5.3	11.5	9.2	4.5	11.2	7.0
Percentage of Perfect Fruit (%)	83.1	62.3	70.8	68.5	87.9	90.7	81.4	64.5	60.7
Weight of 1000 fruit (g)	125.8	89.98	150.08	125.8	129.43	131.2	144.93	174.56	140.55
Weight of 1000 dried seeds (g)	39.00	27.67	40.91	35.8	40.42	38.35	46.00	52.52	52.61



Figure 2. Leaf venation campylodromous

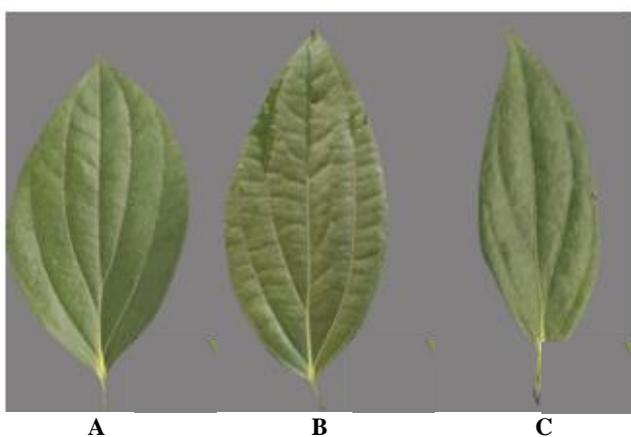


Figure 3. Variation in the leaf lamina shape; A. Ovate-elliptic, B. Ovate-lanceolate, and C. Elliptic-lanceolate

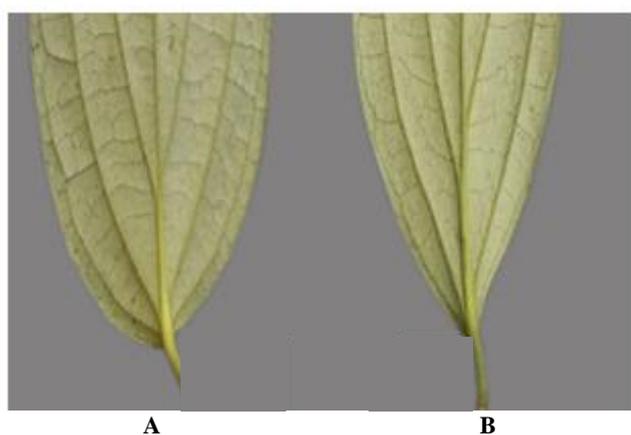


Figure 4. Variation in the shape of the black pepper leaf base shape; A. Round, and B. Acute

The shape of leaf margin explored had 2 variations, namely even and wavy (Figure 5). Based on Pusat Perlindungan Varietas Tanaman dan Perizinan Pertanian (2019), black pepper varieties in Indonesia have mostly ovate leaf lamina shape, round leaf base shape, and even type of leaf margin (Table 4). Bermawie (2019) also reported that Ciinten variety had an ovate-lanceolate leaf lamina shape, acute leaf tip, and cordate type of leaf base shape.



A **B**

Figure 5. Variation in the shape of the black pepper leaf margin; A. Even, and B. Wavy.



A **B**

Figure 8. Variation of Ripe Fruit Color; A. Orange, B. Red to Orange

The types of lateral branch habit observed had three types namely erect, horizontal and hanging (Figure 6). Most lateral branch habit of black pepper varieties in Indonesia are erect (Pusat Perlindungan Varietas Tanaman dan Perizinan Pertanian 2019). Stem shape on 9 black pepper plants obtained 3 types, namely round, flat, and slightly flat (Figure 7). There were 2 kinds of ripe fruit color, namely orange and orange to red (Figure 8). Almost all the accessions of black pepper have a round fruit shape, except for the Lampung Daun Kecil variety which has the ovate fruit shape. Orange ripe fruit and round ripe fruit is also found in Ciinten (Bermawie 2019), and Malonan 1 varieties (Pusat Perlindungan Varietas Tanaman dan Perizinan Pertanian 2019).

Relationship analysis of black pepper plants in Bangka Island based on agro-morphological characters is displayed as dendrogram (Figure 9). The dendrogram shows 5 clusters at a coefficient level of 0.50 or 50% similarity in characteristics. Lampung Daun Lebar (LDL) and Lampung Daun Kecil (LDK) varieties are in one cluster. Chunuk and Nyelungkup are in the same cluster as Bogor and Merapin Daun Kecil (MDK). Black pepper accessions of Jambi, Peremis, and Keriwil are each located in a different cluster. Black pepper plants that had the highest level of characteristic similarity, which was 77%, were accessions of Bogor and Merapin Daun Kecil.



Figure 6. Lateral branch habit: A. Erect, B. Horizontal, CHanging



Figure 7. Stem shape: A. Round, B. Slightly flat, C. Flat

Relationship analysis is used to classify objects based on the similarity of certain characteristics. For evolving high yielding varieties of any crop, knowledge on the relationship between characters is essential (Preethy et al. 2018). The dendrogram drawing of a 0.50 or 50% threshold line is divided into five clusters. The dendrogram results also showed a close relationship between accession Bogor and Merapin Daun Kecil (MDK), which was 0.77 or 77%. Goncalves et al. (2013) state the similarity distance with a coefficient of 75% or more can be said that the accession has a high similarity or low diversity. These similarities can be due to changes in phenotypic traits. Populations in the same ecological conditions, in the long-term evolutionary process, form the same adaptation matrix to produce phenotypic similarities (Sun et al. 2019). Close relationship between the accession of Bogor and Merapin Daun Kecil allegedly because these two varieties originated from the same parent. The morphological difference between Bogor pepper and merapin is only the size of the leaves, which is the size of Bogor pepper leaves is bigger than merapin

(Pusat Penelitian dan Pengembangan Perkebunan 2015). Some genetics originate from the same parent but are scattered to different places so that they are given different names and are cultivated from generation to generation without knowing their history and genealogy.

The criteria for variability of agro-morphological characters in 9 black pepper plants are listed in Table 5. The variability criteria were divided into 4 criteria: narrow, quite narrow, quite wide, and wide. The determination of the criteria for each character was based on the value of the phenotypic coefficient of variation (PCV). Based on Effendy (2018), the highest PCV value was determined as a 100% variation. The highest PCV value was owned by the character of length of petiole, namely 79%, so the PCV value range for variability criteria was 0-20% = narrow, 20-40% = quite narrow, 40-60% = quite wide, and 60-80% = wide. The character of length of petiole had wide phenotypic variability criteria. The characters that had phenotypic variability criteria which were quite wide, namely the length of stem segment and fruit size. The

character with phenotypic variability criteria of quite narrow was the age of flowering and the average fruit weight. Percentage of fruits per spike, weight of 1000 fruit, and weight of 1000 dried seeds had narrow phenotypic variability criteria.

The agro-morphological character of black pepper in Bangka Island has phenotypic variability or phenotypic diversity in the form of wide, quite wide, quite narrow, and narrow. The phenotypic variances were very far from each other shows the high influence of environment on black pepper traits (Preethy et al. 2018). The value of variability is the important component to measure before determining the method and time to perform further selection (Mustikarini et al. 2019). Characters that have a wide and quite wide phenotypic diversity can be utilized for developing superior varieties of black pepper. Goncalves et al. (2013) state that although the phenotype diversity value may not be inherited, if it has wide character, it will be the right start in an effective selection process. Conversely,

narrow variability indicated that the individuals were in a relatively homogenous population so that the selection which is based on the character will be less effective (Waqar-UI-Haq et al. 2008). Selection will be effective if done on characters whose variability is quite wide and wide. Based on variability results, the black pepper breeding program on Bangka Island can be done using length of petiole, length of stem segment, and fruit size. According to Preethy et al. (2018) selection program based on agronomic characters, such as dry weight of berries, would be better than selection based on size of berries and number of berries/spike in black pepper. Therefore, the selection criteria for black pepper breeding programs would be better if the percentage of perfect fruit, weight of 1000 fruits, and the weight of 1000 dried seeds were also used for selection. Furthermore, developing black pepper superior varieties could be done using accessions of Peremis, Bogor, Nyelungkup, and Jambi as genetic sources for breeding program.

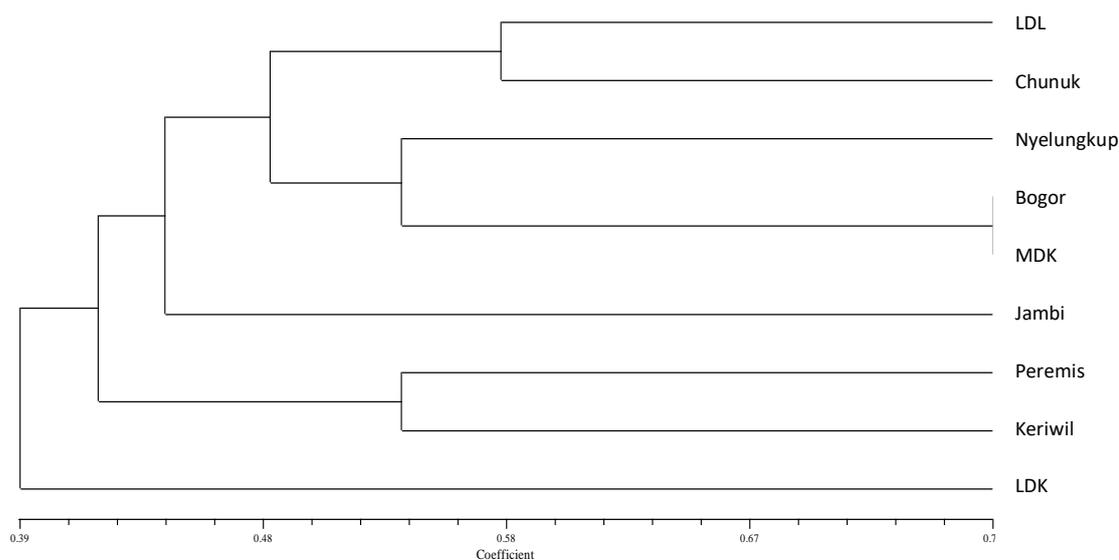


Figure 9. Dendrogram on the relationship of black pepper plants based on agro-morphological characters

Table 5. Variability of Agro-Morphological characters of black pepper plants in Bangka Island, Indonesia

Quantitative character	\bar{x}	σ_p^2	PCV (%)	Criteria
Length of petiole (cm)	1.6	1.611	79.328	Wide
Length of stem segment (cm)	4.7	4.744	46.342	Quite Wide
Age of flowering (month)	8	8.111	35.600	Quite Narrow
Fruit size (mm)	5.8	5.822	41.601	Quite Wide
Fruit weight per spike (g)	8.0	8.044	35.452	Quite Narrow
Percentage of perfect fruit (%)	74.4	74.426	11.595	Narrow
Weight of 1000 fruit (g)	134.7	134.703	8.616	Narrow
Weight of 1000 dried seeds (g)	41.5	41.476	15.519	Narrow

Note: \bar{x} = average, σ_p^2 = phenotype variance, PCV = phenotypic coefficient of variation

Table 4. Characteristics comparison between Bangka Island, Indonesia black pepper and black pepper released varieties

Characters	Bangka black pepper from exploration	Released varieties					
		Petaling 1	Petaling 2	Natar 1	Natar 2	Ciinten	Malonan 1
Leaf Lamina Shape	Ovate-lanceolate, elliptic-lanceolate, ovate-elliptic	Ovate	Ovate	Ovate	Ovate	Ovate	Elliptic
Leaf Surface	Smooth and smooth-glossy	Smooth-glossy	Smooth-glossy	Smooth-glossy	-	-	smooth
Leaf Vein	Campylodromous	Pinnate	Pinnate	Pinnate	Pinnate	Campylodromous	pinnate
Leaf margin	Even and wavy	-	-	-	Wavy	Even	Even
lateral branch habit	Erect, hanging, horizontal	Erect	-	Erect	Erect	-	-
Leaf Base Shape	Round and Acute	Round to Oblique	Acute to oblique	Round	Round to oblique	-	Round
Leaf tip	Acute	Acute	Acute	Acute	Acute	Acute	Acute
Leaf color	Dark green	Dark green	Dark green	Dark green	Dark green	Dark green	Green
Flowering nature	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	-	all year round
Fruit Shape	Round and ovate	Round	Round	Round	Round	Round	-
Young Fruit Color	Green	Green	Green	Green	Light green	Green	Green
Ripe Fruit Color	Orange and Orange to red	Orange to red	Orange to red	Orange to red	Orange to red	orange	Orange
Young Stem Color	Dark green	-	greenish purple	greenish purple	greenish purple	Green	Green
Ripe Stem Color	Greenish brown	-	-	-	-	Brown	Green
Hanging Vine	Few and moderate	Many	Few	Many	Few	Few	Few
Ground Vine	Few and moderate	Many	Few	Many	Few	Few	Few
Stem Shape	Flat, intermediate, round	Flat	Flat	Flat	Flat	-	Round
Plant Growth habit	Climbing	Climbing	Climbing	-	-	-	-
Length of Petiole (cm)	1.2-1.9	2.1	2.1	2	2.5	-	-
Length of Stem Segment (cm)	3.5-6.0	6.8	7.6	8.5	6.8	7.63	5.8
Age of Flowering (month)	7-9	-	-	10	10	-	-
Fruit Size (mm)	4.0-6.5	-	-	-	-	6.1	6.1
Fruit Weight per Spike (g)	4.5-11.5	-	-	-	-	-	-
Percentage of Perfect Fruit (%)	60.7-90.7	64.8	66.1	66.7	60.4	82	61.3
Weight of 1000 fruit (g)	89.98-174.56	57	56	53	57	155.2	118.2
Weight of 1000 dried seeds (g)	27.67-52.61	40.1	43.1	38	41.8	51.94	45.97

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