Characterization and Relationship Analysis of Various Genotypes of Collection *Jatropha curcas* L. Results of Crosses Based on Leaf Morphology

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Abstract. Jatropha (*Jatropha curcas* L.) is a shrub that is easy to grow. This plant has many benefits including as a raw material for biodiesel and has the potential to be developed into a future energy source. This study aims to determine the kinship hybrid numbers based on morphology. The experiment was conducted in Krajan hamlet, Kedung Pengaron village, Kejayen sub-district, Pasuruan district, East Java province. The material genetic used in this study is hybrid number 5 (SP-8 × SP-16), 6 (SP-8 × SP-38), 7 (SP-33 × HS-49), and 18 (SM-35 × SP-38). Observations were made on leaf morphology with scoring, percentage and Munsel Color Chart based on reference Sunil *et al*. The results showed that there was no difference between the four genotypes of the crosses tested on all leave morphology character except leaf angles on the main branch, percentage of leaf blade, leaf color, color of upper surface leaf bone, leaf green intensity, intensity of anthocyanin staining, corners of leaves, leaf scatter color, and young leaf color. Cluster analysis based on leaves morphological character showed that the *J. curcas* genotypes could be grouped into four clusters at cophenhetic distance of 0.6.

Keywords: Bioenergy plant, cluster analysis, physic nut, plant breeding, renewable energy.

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1 Introduction

Jatropha (*Jatropha curcas* L.) is a shrub that is easy to grow. This plant has many benefits including as a biodiesel feedstock and has the potential to be developed into a future energy source —renewable energy [1–3]. *J. curcas* is dubbed as green gold in the world of the biofuel industry to be more attractive to develop compared to other oil-producing plants because it is easy to adapt, grows fast, is easy to propagate, has high oil content, and the price of biodiesel produced is cheaper because it does not require high technology [4–6]. The distribution area of *J. curcas* in Indonesia is quite wide, ranging from very dry to very wet climates. *J. curcas*, as a bioenergy plant, not only produces renewable energy from oil obtained from seeds. But jatropha capsule husk has the potential to be clean energy, *i.e.*, biogas [7–9].

Besides jatropha, there are other members of the genus jatropha scattered throughout the world with a total of 170 species [10]. Among them is the bali jatropha (*Jatropha podagrica* Hook) which is used as an ornamental plant, it also has the potential as a donor of high oil character because the oil content in the seeds of this plant is more than 50 % [11]. In addition, there is also chinese jatropha (*Jatropha multifida* L.) which has large fruit size, then bellyache bush (*Jatropha gossypifolia* L.) which is tolerant of high salinity drought stress.

J. curcas is spread in various regions in Indonesia including Pasuruan and is estimated to have high genetic diversity. Information on genetic diversity possessed by jatropha accessions is needed to determine the relationship between these accessions. Information on genetic diversity is a basic asset for breeding and population geneticists in the development and improvement of plants, especially for distinguishing individuals within species as well as rapid identification of genotypes and identification of genes that have the potential to carry superior characters. Improvement of varieties can be implemented if there are adequate sources germplasm. In the management of germplasm, it is necessary to study the character of each accession through activities both in phenotypic and molecular characterization, therefore molecular characterization is needed in the breeding program [12].

In order to support the development of jatropha, one way is to provide superior varieties with high productivity by conducting hybridization between plants that have superior characters. The purpose of the jatropha plant breeding program with high yields can be achieved if the availability of a basic population that has high genetic diversity, especially in characters related to plant yields [13]. Genetic diversity in a jatropha plant population is very necessary because is a genetic wealth that can be used to develop and improve plants. Germplasm that has distant relatives is needed to determine the parents of the cross to assemble the variety. The size of the genetic diversity of germplasm can support the jatropha breeding program [14].

Characterization is an activity in the germplasm with the aim of knowing the morphological properties that can be used to see the differences in each accession, assessing the amount of genetic variation, identifying varieties, assessing the number of accessions, and so on [15]. Characterization of *J. curcas* has been carried out previously to see the diversity of characters of each accession of jatropha in Indonesia, as a way to find superior genotypes.

2 Methods

2.1 Time and place

The jatropha germplasm used in this study was in Krajan hamlet, Kedung Pengaron village, Kejayen sub-district, Pasuruan district, East Java. Map of Kedung Pengaron Village, the location of the garden is at coordinates 7°45'54.3"S 112°50'37.7"E

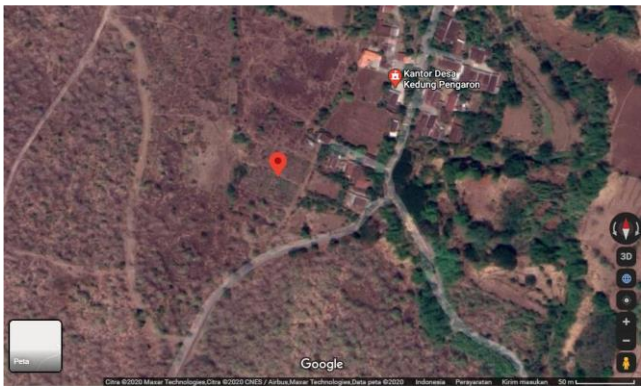

Fig. 1. Satellite map of the location of the jatropha garden collection in Pasuruan, Indonesia (Google Maps, 2020 - https://goo.gl/maps/og6iw2TkARo2CZHA7)

Material used in this study is the genotype group number of the jatropha crossing, namely numbers 5 (SP-8 × SP-16), 6 (SP-8 × SP-38), 7 (SP-33 × HS-49), and 18 (SM-35 × SP-38). Of the four hybrid numbers, 59 individuals were observed from crosses. Planting in the collection gardens was carried out using a Randomized Block Design (RAK) to anticipate differences in topography of the soil in the field. In this activity, watering is not provided and plant water needs only to use rainwater as a water source, because the plants used are plants that are tested for tolerance to drought stress. Fertilization is done twice at the beginning of the rainy season and at the end of the rainy season. Fertilizer is used using 2 × 20 g tree^{-1} yr^{-1} Urea, 2 × 20 g tree^{-1} yr^{-1} SP-36, and 2 × 20 g tree^{-1} yr^{-1} KCl. Weed control is done manually for cleaning weeds around the plant.

Observations were made on leaf morphology, which included: leaf shape, leaf tip, leaf base, leaf bone arrangement, leaf edge, leaf flesh, leaf surface, degree of leaf indentation, leaf hair, leaf tip direction, leaf arrangement on stem, leaf angle from main branch, number of lobes, leaf blade length, leaf width, number of leaf indentations, distance between leaf marks, young leaf color, old leaf color, leaf scatter color, upper surface stalk color, lower surface stalk color, leaf bone color upper surface, lower surface leaf bone color, leaf green intensity, leaf antocyanin staining intensity, leaf angle on main branches, leaf distribution color, young leaf color, old leaf color .

Observation data on the leaf morphology of jatropha are presented in groups based on percentages the character being tested. The use of scoring in this research activity is based on existing scoring methods, especially references per parameter from the Ditjenbun and Sunil *et al.*, [16–18]. Color characters on the leaves jatropha were observed using Munsell Plant Tissue Color Book.

Furthermore, cluster analysis is used to analyze the level of kinship between individuals and between genotype groups based on the morphological characteristics of the leaves that have been obtained. Cluster analysis performed with PBSTAT-CL (http://www.pbstat.com/). The results of the cluster analysis are presented in the form of dendrogram.

3 Result and discussion

The results of observations that have been made on leaf morphology, which include: leaf shape, leaf tip, leaf base, leaf bone arrangement, leaf edge, leaf flesh, leaf surface, degree of leaf indentation, leaf hair, direction of leaf tip, leaf arrangement on stem, old leaf color, leaf distribution color, lower leaf petiole color, upper leaf bone color, and lower leaf bone color, showed no difference between the four genotypes of the crosses tested.

Table 1. Percentage of leaf shape and leaf tip characters of various numbers from jatropha crossings.

Genotype	Leaf shape	Percentage (%)	Leaf tips	Percentage (%)
5	Shield	100	Tapered	100
6	Shield	100	Tapered	100
7	Shield	100	Tapered	100
18	Shield	100	Tapered	100

Description and scoring number: leaf shape character: round (1), shield (2), jorong (3), climb (4), lanceolate (5) [19]; leaf tip characters: pointed (1), tapered (2), blunt (3), rounded (4), rompang (5), split (6), spiny (7) [17].

The four genotypes from the cross showed the character of leaf shape in the form of a shield, tapered leaf tip (Table 1), curved leaf base, leaf bone arrangement (Table 2), and leaf margin with finger grooves (palmatilobus) with a percentage of 100 % (Table 3).

Table 2. Percentage of leaf base character and leaf bone arrangement of various numbers of jatropha.

Genotype	Leaf Build	Percentage (%)	Structure of bone leaves	Percentage (%)
5	Curl up	100	Finger shape	100
6	Curl up	100	Finger shape	100
7	Curl up	100	Finger shape	100
18	Curl up	100	Finger shape	100

Description and scoring number: leaf shape character: round (1), shield (2), jorong (3), climb (4), lanceolate (5) [19]; leaf tip characters: pointed (1), tapered (2), finger shape (3), rounded (4), rompang (5), split (6), spiny (7) [17].

Table 3. Percentage of leaf edge characters and leaf flesh of various numbers resulting from jatropha crossing.

Genotype	Leaf edge	Percentage (%)	Leaf flesh	Percentage (%)
5	Notched of finger shape (palmatilobus)	100	Like paper	100
6	Notched of finger shape (palmatilobus)	100	Like paper	100
7	Notched of finger shape (palmatilobus)	100	Like Paper	100
18	Notched of finger shape (palmatilobus)	100	Like paper	100

Description and number of scoring: the character of the leaf margins: notched pinnate (1), bercangan pinnate (2), sharing pinnate (3), notched of finger (4), with fingers (5), sharing fingers (6) [17]; characteristics of leaf flesh: thin like a membrane (1), like paper (2), thin soft (3), like parchment (4), like skin/bones (5), fleshy (6) [17].

Table 4. Percentage of leaf surface characters and degree of leaf indentation of various numbers of jatropha crossings.

Genotype	Leaf surface	Percentage (%)	Degree of leaf indentation	Percentage (%)
5	Smooth	100	Strong	100
6	Smooth	100	Strong	100
7	Smooth	100	Strong	100
18	Smooth	100	Strong	100

Description and scoring number: leaf surface character: smooth (1), bald (2), kasap (3), wrinkled (4), furry (6), fine & tight hair (7), coarse (8), scaly (9) [19]; character degree of leaf indentation: weak (1), moderate (3), strong (5) [18].

Table 4 shows that 100 % of the leaf surface of *J. curcas* was smooth in all tested genotypes, with a strong degree of leaf indentation, an upright leaf tip (Table 5), no leaf hairs, and alternating leaf arrangement on the stem (Table 6).

Table 5. Percentage of leaf hair characters and leaf tip directions of various numbers of jatropha crossbreeds.

Genotype	Leaf of hair	Percentage (%)	Leaf tip direction	Percentage (%)
5	Nothing	100	Erect	100
6	Nothing	100	Erect	100
7	Nothing	100	Erect	100
18	Nothing	100	Erect	100

Description and scoring number: character of leaf hair: none (1), available (2) [15]; character of leaf tip direction: right leaf direction (1), left leaf direction (2), straight leaf direction (3) [18].

Table 6. Percentage of leaf arrangement characters on stem and leaf angle at main branches of various numbers of jatropha crossings.

Genotype	Arrangement of leaves on the stem	Percentage (%)	Angle of leaves on main branches	Percentage (%)
5	Alternating	100	> 45º	100
6	Alternating	100	15º to 45º	100
7	Alternating	100	> 45º	100
18	Alternating	100	15º to 45º	100

Description and scoring number: character of leaf arrangement on stem: circular (1), alternate (2) [19]; angular characters of the leaves of the main branches: 0º to 15º (1), 15º to 45º (2), > 45º (3) [17].

Leaf angles on the main branch showed differences in the four genotypes tested, where genotype 5 showed the same results as genotype 7 (> 45º) and genotype 6 was the same as genotype 18 (15º to 45º) (Table 6). The number of lobes showed a difference in each tested genotype. The highest number of lobes is 6 (Genotypes 5 and 6) while the least number of lobes is 3 (Genotype 7) with 100 % achievement. Meanwhile, the length of the leaves of jatropha shows different percentages for each specified criterion (Table 7).

Table 7. Percentage of characters number of lobes and length of leaf blades of various numbers of jatropha crossings

Genotype	Number of lobus	Percentage (%)	Leaf blade length (cm)	Percentage (%)
			< 6	16
5	6	100	6 to 12	72
			> 12	12
			< 6	24
6	6	100	6 to 12	62
			> 12	14

Continue on the next page.

Table 7. Continue.

Genotype	Number of lobus	Percentage (%)	Leaf blade length (cm)	Percentage (%)
			< 6	4
7	3	100	6 to 12	82
			> 12	4
			< 6	16
18	5	100	6 to 12	68
			> 12	16

Description and scoring number: character number of lobes: 1 (1), 2 (2), 3 (3), 4 (4), 5 (5), 6 (6) [17]; characteristics of leaf blade length: short (< 6 cm) (1), medium (6 cm to 12 cm) (2), long (> 12 cm) (3) [16].

Table 8. Percentage of leaf width characters and number of leaf curves of various numbers of jatropha crossings.

Genotype	Width of leaf blades (cm)	Percentage (%)	Leaf curves	Percentage (%)
	< 6	12		
5	6 to 12	72	3 to 5	100
	> 12	12		
	< 6	21		
6	6 to 12	71	3 to 5	100
	> 12	8		
	< 6	10		
7	6 to 12	86	0 to 2	100
	> 12	9		
	< 6	21		
18	6 to 12	58	3 to 5	100
	> 12	21		

Description and scoring number: character leaf blade width: narrow (< 6 cm) (1), medium (6 cm to 12 cm) (2), wide (> 12 cm) (3) [16]; character number of leaf grooves: 0 to 2 (1), 3 to 5 (2), > 5 (3) [16].

The percentage of leaf blade width characters and the number of leaf indentations showed differences in the various numbers of jatropha crosses tested (Table 8). Likewise for the character of the distance between the leaf tufts and the color of the young leaves (Table 9)

The leaves of the jatropha plant are single leaves with grooves and 3 or 5 angles. The leaves are spread along the stem. The upper and lower surfaces are paler than the upper surfaces. The leaves are broad and heart-shaped or broadly oval with a length of 5 cm to 15 cm. The leaves are incised, grooved, and tapered at the ends. Leaf veins with 5 to 7 main leaf bones. The leaves are connected by petioles. The length of the petiole is between 4 cm to 15 cm [13].

Table 9. Percentages of distance between leaf sheaves and young leaf colors of various numbers of jatropha crossings.

Genotype	Distance between leaf sheaves (cm)	Percentage (%)	Leaves colour	Percentage (%)
5	< 8	100	2.5 R 4/2	100
6	< 8	100	2.5 R 4/2	100
7	8 to 15	100	2.5 R 4/2	100
18	< 8	100	5 R 3/2	100

Description and scoring number: character distance between files: short (≤ 8 cm) (1), medium (8 cm to 15 cm) (2), long (≥ 15 cm) (3) [19]; characteristics of young leaf color: 10 R 3/2 (1), 2.5 R 4/2 (2), 5 R 3/2 (3).

Table 10. Percentage of old leaf color characters and the color of the distribution of green leaves with various numbers of jatropha crossings.

Genotype	Color of old leaf	Percentage (%)	Distribution of color leaf green	Percentage (%)
5	7.5 GY 4/6	100	Bright green	100
6	7.5 GY 4/6	100	Bright green	100
7	7.5 GY 4/6	100	Bright green	100
18	7.5 GY 4/4	100	Dark green	100

Description and scoring number: dark leaf color character: 5 GY 4/4 (1), 7.5 GY 4/6 (2), 7.5 GY 4/4 (3), 7.5 GY 3/4 (4) ; leaf distribution color characters: bright green (1), dark green (2) [20].

The percentage of old leaf color showed a leaf color of 7.5 GY 4/6 of 100 % at 5, 6, 7 genotype. Meanwhile, genotype 18 showed a difference, namely 7.5 GY 4/6 (Table 10). The percentages of the color of the upper surface of the petiole and the color of the lower surface of the leaf stalks of various numbers from crosses of jatropha plants did not show any difference between the tested genotypes (Table 11).

Table 11. Percentage of upper surface petiole color characters and lower surface petiole colors of various numbers of jatropha crossings.

Genotype	Color of upper surface petiole	Percentage (%)	Color of lower surface petiole	Percentage (%)
5	5 R 4/4	100	2.5 GY 5/8	100
6	5 R 4/4	100	2.5 GY 5/8	100
7	5 R 4/4	100	2.5 GY 5/8	100
18	5 R 4/4	100	2.5 GY 5/8	100

Description and scoring number: character of upper surface petiole color: 5 R 4/4 (1) [20]; lower surface petiole characters: 2.5 GY 6/6 (1), 2.5 GY 5/8 (2) [20].

The test results for the upper surface leaf bone color showed that genotype 5, 6, 7 gave the same results (2.5 GY 8/6) and only genotype number 18 showed different results (2.5 GY 5/6). While the color of the lower surface of the leaf bone did not show any difference in the various genotypes tested (Table 12). The green intensity character and the anthocyanin staining intensity also showed differences in the various genotypes tested (Table 13).

Table 12. Percentage of upper surface leaf bone color characters and lower surface leaf bone color of various numbers of crosses jatropha.

Genotype	Color of upper surface leaf bone	Percentage (%)	Color of lower surface leafbone	Percentage (%)
5	2.5 GY 8/6	100	5 GY 5/6	100
6	2.5 GY 8/6	100	5 GY 5/6	100
7	2.5 GY 8/6	100	5 GY 5/6	100
18	2.5 GY 5/6	100	5 GY 5/6	100

Explanation and scoring number: upper surface leaf bone color character: 2.5 GY 8/8 (1), 2.5 Y 8/10 (2), 2.5 Y 7/8 (3), 2.5 GY 5/6 (4), 2,5 GY 8/6 (5); lower surface leaf bone color characters: 5 R 4/4 (1), 5 R 4/4 + 5 GY 5/6 (2), 5 GY 5/6 (3).

Table 13. The percentage of leaf green intensity characters and the intensity of anthocyanin staining of various numbers of jatropha crosses.

Genotype	Leaf green intensity	Percentage (%)	Intensity of anthocyanin staining	Percentage (%)
5	Medium green	100	None	88
			Weak	12
6	Medium green	100	None	75
			Weak	25
7	Light green	100	None	92
			Moderate	8
18	Dark green	100	None	80
			Weak	20

Information and scoring number: leaf green intensity characters: light green/bright (1), medium green (2), dark green/dark (3) [11]; characteristics of the intensity of anthocyanin staining: none (1), weak (2), moderate (3), strong (4) 11.

The leaf angle characters on the main branch were > 450 (genotypes 5 and 7) and 15º to 45º (genotypes 6 and 18). Meanwhile, the color of leaf distribution was bright green (genotype 5, 6, 7) and dark green (genotype 18) (Table 14). In the character of young leaf color and old leaf color, the difference is shown in genotype 18 (Table 15).

Table 14. Percentages of leaf angle characters on the main branches and leaf distribution colors of various numbers of jatropha crosses.

Genotype	Corners of leaves on main branches	Percentage (%)	Leaf scatter color	Percentage (%)
5	> 45º	100	Light green	100
6	15º to 45º	100	Light green	100
7	> 45º	100	Light green	100
18	15º to 45º	100	Dark green	100

Description and scoring number: character of leaf angle on main branches: 0º to 15º (1), 15º to 45º (2), > 45º (3) [16]; leaf distribution color characters: bright green (1), dark green (2) [20]; leaf green intensity characters: light/bright green (1), medium green (2), dark green/dark (3) [16]; character of the main branch branch angle: < 25º (1), 26º to 35º (2), 36º to 50º (3), 51º to 65º (4), > 65º (5).

Table 15. The percentage of characters of young leaf color and old leaf color of various numbers of jatropha crosses.

Genotype	Young leaf color	Percentage (%)	Old leaf color	Percentage (%)
5	2.5R 4/2	100	7.5 GY 4/6	100
6	2.5R 4/2	100	7.5 GY 4/6	100
7	2.5R 4/2	100	7.5 GY 4/6	100
18	5 R 3/2	100	7.5 GY 4/4	100

Information and scoring number: young leaf color characters: 10 R 3/2 (1), 2.5 R 4/2 (2), 5 R 3/2 (3); old leaf color characters: 5 GY 4/4 (1), 7.5 GY 4/6 (2), 7.5 GY 4/4 (3), 7.5 GY 3/4 (4) [21]; upper surface leaf bone color characters: 2.5 GY 8/8 (1), 2.5 Y 8/10 (2), 2.5 Y 7/8 (3), 2.5 GY 5/6 (4), 2.5 GY 8/6 (5) [21]; bar color characters: 7.5 YR 4/2 (1), 12.5 GY 5/2 (2), 5 Y 6/2 (3), 5 Y 5/2 (4), 7.5 GY 6/2 (5), 7.5 GY 4/4 (6).

Dendogram Numbers of 59 of jatropha crosses based on leaf morphology are shown in Figure 2. Based on the results of the analysis on the dendogram, from all the individual numbers of crosses tested, generally divided into four main groups, namely Genotype 18 (15 individual numbers), genotype 7 (12 individual numbers), Genotype 6 (17 individual numbers) and genotype 5 (15 individual numbers). In each individual plant jatropha (consisting of four genotypes including genotypes 5, 6, 7, and 18), showed that each plant in one number grouped in high genetic similarity. In general, four kinship groups were

obtained (18, 7, 6, 5) based on differences in the morphological characteristics of *J. curcas* leaves.

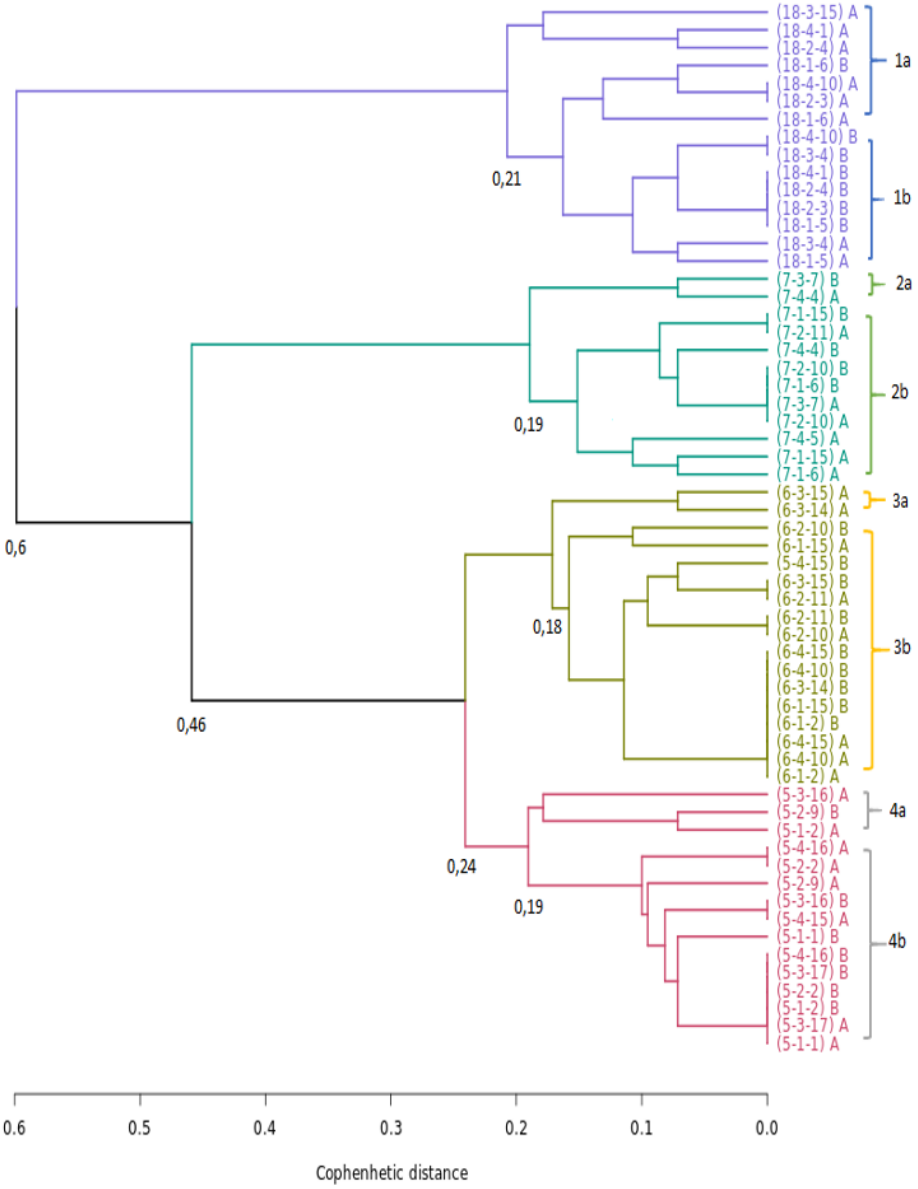

Fig. 2. Dendrogram of various numbers of jatropha crosses.

The first group (genotype 18) with a cophenetic distance of 0.21 had two sub-groups, namely 1a which consisted of three individual plants and 1b with twelve individual plants. Sub-group 1a consists of three individual plant numbers, namely (18-3-15) A, (18-4-1) A, (18-2-4) A, while sub-group 1b with a cophenetic distance of 0.17 consists of twelve individual plants, namely (18-1-6) B, (18-4-10) A, (18-2-3) A, (18-1-6) A, (18-4-10) B, (18-3-4) B, (18-4-1) B, (18-2-4) B, (18-2-3) B, (18-1-5) B, (18-3-4) A, (18-1-5) A. The second group (Genotype 7) and third group (genotype 6) each had two sub-groups. The second group has two sub-groups, namely 2a which consists of two individual plants,

namely (7-3-7) B, (7-4-4) A and 2b has ten individual plants, namely (7-1-15) B, (7-2-11) A, (7-4-4) B, (7-2-10) B, (7-1-6) B, (7-3-7) A, (7-2 -10) A, (7-4-5) A, (7-1-15) A, (7-1-6) A. The third group has two sub-groups namely 3a which consists of two individual plants namely (6-3-15) A, (6-3-14) A and 3b consisting of fifteen individual plants, namely (6-2-10) B, (6-1-15) A, (5-4-15) B, (6-3-15) B, (6-2-11) A, (6-2-10) A, (6-4-15) B, (6-4-10) B, (6-3-14) B, (6-1-15) B, (6-1-2) B, (6-4-15) B, (6-4-10) A, (6-1-2) A. The fourth group has sub-groups, namely 4a consisting of three individual plants, namely (5-3-16) A, (5-2-9) B, (5-1-2) A and 4b with twelve individual numbers *i.e.* (5-4-16) A, (5-2-2) A, (5-2-9) A, (5-3-16) B, (5-4-15) A, (5-1 -1) B, (5-4-16) B, (5-3-17) B, (5-2-2) B, (5-1-2) B, (5-3-17) A, (5-1-1) A. The second group (genotypes 7) and third group (genotype 6) had a cophenetic distance of 0.46, while the four genotypes tested (5, 6, 7, 18) showed a cophenetic distance of 0.6. This indicates that there is a diversity of leaf morphology possessed by individuals of each genotype resulting from jatropha crosses and between tested genotypes. Genotype group number 18 has the highest level of diversity difference from the other three genotype group numbers.

Machua *et al.* [21], stated in a homogeneous growing environment, the phenotypic diversity produced by a plant population is a reflection of the genotype diversity of the plant population. Plant diversity can be caused by environmental factors, genetics, or a combination of these two factors. Information on phenotypic diversity and genetic diversity can be used as a basis for selection, so that new varieties can be obtained as expected.

Cuttings is a treatment of separation/cutting of several plant parts (roots, stems or leaves) with the aim that these parts will form roots so that new individuals are obtained that have the same character as the parent [22]. The success of plant propagation using the cutting method can be supported by a growth regulator (rootone) in helping the growth of roots [23, 24].

The jatropha plants observed had identical vegetative organ characters with their parents, this was because the observed plants were taken from cuttings on the previous parent plants, namely with genotype groups numbers 5 (SP-8 × SP-16), 6 (SP-8 × SP-38), 7 (SP-33 × HS-49), and 18 (SM-35 × SP-38). Hartmann *et al.* [25], stated that vegetative propagation by stem cuttings will result in plant propagation having identical characters with the parent plant. Parental plants taken for the propagation of new cuttings are superior plants from various genotype group elders.

4 Conclusion

The results showed that there was no difference between the four genotypes of the crosses tested on all leave morphology character except leaf angles on the main branch, percentage of leaf blade, leaf color, color of upper surface leaf bone, leaf green intensity, intensity of anthocyanin staining, corners of leaves, leaf scatter color, and young leaf color. Cluster analysis based on leaves morphological character showed that the *J. curcas* genotypes could be grouped into four group of clusters at a cophenhetic distance of 0.6. Cluster one is namely genotype 18 consists of 15 individual numbers, cluster two is genotype 7 consists of 12 individual numbers, cluster three is genotype 6 consists of 17 individual numbers and cluster four is genotype 5 consists of 15 individual numbers. There is a diversity of leaf morphology possessed by individuals of each genotype resulting from jatropha crosses and between tested genotypes based on cophenhetic distance in each cluster. Genotype group number 18 has the highest level of diversity difference from the other three genotype group numbers.

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