Versi online: http://ojs3.unpatti.ac.id//index.php/bdp
DOI: 10.30598/jbdp.2023.19.2.99

Jurnal Budidaya Pertanian
Vol. 19(2), 99-105 Th. 2023 ISSN: 1858-4322 (Print) ISSN: 2620-892X (On line)
Terakreditasi RISTEKBRIN Peringkat SINTA 3, SK. 85/M/KPT/2020

Identification and Morphological Characterization of Sugar Palm Plants (*Arenga pinnata* Merr.) Growing on Different Altitudes

Halimatus S. Hasibuan*, Muhammad P. Wisnubroto, Edwin, Dewi Rezki, Yulistriani

Agroecotechnology Study Program, Faculty of Agriculture, Andalas University
Jl. Lintas Sumatera Km. 4, Sungai Kambut, Pulau Punjung, Dharmasraya, West Sumatera
*E-mail Penulis Korespondensi: halimatussyahdia@agr.unand.ac.id

ABSTRACT

Trees of sugar palm (Arenga pinnata Merr.) can grow at an altitude of 0-1400 m above sea level. The best growth of the trees is at an altitude of 500-700 m above sea level. Sugar palm trees also have a wide adaptability to various environmental conditions. The purpose of this research was to determine the morphological characteristicss of sugar palm plants grown at an altitude of 500, 650, and 900 m above sea level so that the kinship relationship can be known. This research was conducted at three altitudes in Lareh Sago Halaban District, Lima Puluh Kota Regency, West Sumatra, namely Nagari Labuah Gunung (altitude 900 m above sea level), Nagari Bukik Sikumpa (altitude 650 m above sea level), and Nagari Tanjung Gadang (altitude 500 m above sea level) from July to August 2023. The method used was a survey with a purposive sampling technique. Identification was carried out on 36 morphological characters, including stems, leaves, fibers, fruits, and seeds. The data obtained were analyzed for their diversity and similarity. The results of the identification and characterization of qualitative and quantitative morphological characters at three different altitudes showed a relatively narrow diversity value. The overall morphological characters of the sugar palm plants were divided into 2 large groups with a coefficient value of 0.72 or 72% similarity distance.

***Keywords**: altitude, characterization, phenotype, sugar palm*

ABSTRAK

Tanaman aren dapat tumbuh pada ketinggian 0-1400 m dpl. Pertumbuhan tanaman aren terbaik adalah pada ketinggian 500-700 m di atas permukaan laut (dpl). Tanaman aren juga memiliki daya adaptasi yang luas pada berbagai kondisi lingkungan. Tujuan penelitian ini adalah untuk mengetahui karakter morfologi tanaman aren yang tumbuh pada ketinggian 500, 650, dan 900 m dpl sehingga dapat diketahui hubungan kekerabatan dengan tingkat persamaan atau perbedaan. Penelitian ini dilaksanakan pada tiga ketinggian tempat di Kecamatan Lareh Sago Halaban, Kabupaten Lima Puluh Kota, Sumatera Barat, yaitu di Nagari Labuah Gunung (ketinggian 900 m dpl), Nagari Bukik Sikumpa (ketinggian 600 m dpl), dan Nagari Tanjung Gadang (ketinggian 500 m dpl), pada bulan Juli sampai Agustus 2023. Metode yang digunakan adalah surveI dengan teknik *purposive sampling*. Identifikasi dilakukan terhadap 36 karakter morfologi yang meliputi batang, daun, ijuk, buah, dan biji tanaman aren. Data yang diperoleh dianalisis terhadap keragaman dan kemiripan. Hasil identifikasi dan karakterisasi karakter kualitatif dan kuantitatif morfologi tanaman aren pada tiga ketinggian tempat berbeda memiliki nilai keragaman yang tergolong sempit. Keseluruhan karakter morfologi tanaman aren dibagi menjadi 2 kelompok besar dengan nilai koefisien 0,72 atau jarak kemiripan 72%.

Kata kunci: altitude, aren, fenotipe, karakterisasi

INTRODUCTION

Sugar palm (*Arenga pinnata* Merr.), or '*aren'* in Indenesian language, is one of the local commodities in West Sumatra that provides income to the community. The area of sugar palm trees in Lima Puluh Kota Regency is the second compared to Tanah Datar Regency, with an area of 285 ha and a production of 499.14 tons (BPS West Sumatera, 2022). Lareh Sago Halaban District is one of the areas with a high population of sugar palm trees. The local community takes *'nira'*, or sweet fluid/sap tapped from stalks of sugar palm fuit bunches, to be used as a drink and processed into liquid sugar, brown sugar and ant sugar. The *'nira'* also has the potential to be used to produce bioethanol as an alternative energy source. The sugar palm plant can be utilized as a soil erosion preventer because it has shallow and spreading roots. The palm plants grow naturally and spread out so that they have an irregular planting distance. Farmers plant sugar palm trees together with other agricultural crops in an intercropping manner.

Sugar palm plants have two types, namely deep sugar palm and early maturing sugar palm. The early maturing type of sugar palm is shorter trees and smaller fruits and seeds compared to the deep type of sugar palm (Tenda *et al*., 2018). The productivity of sugar palm trees at the farm level is still relatively low. This is influenced by the factor that the seeds used come from the bottom of the sugar palm plant. Incentivized maintenance is also a limiting factor for palm production. Plant growth and development are influenced by the altitude of the place. Sugar palm plants can grow

at an altitude of 0 to 1400 m above sea level. The best growth of palm trees is at an altitude of 500 to 700 m above sea level (Kementerian Pertanian, 2013). Sugar palm trees also have wide adaptability to various environmental conditions. In general, different environmental conditions can affect the morphological diversity of plants (Mangoendidjojo, 2003). Sugar palm trees in Lareh Sago Halaban District are able to grow up to an altitude of > 1000 m above sea level. The altitude of the location will affect the temperature and humidity of the air. Soil moisture and rainfall can affect the formation of the leaf crown of sugar palm plants.

Plant characterization is a process of observing the morphological characteristics of plants so that differences between individuals in one type of plant are known. The purpose of plant characterization is to obtain a description of the plant so that parent plants can be obtained as genetic material in plant breeding. The characters of each cultivar can have similarities or differences. The relationship between cultivars can be determined by knowing the similarities and differences of cultivars. A cultivar has a close relationship if it has many character similarities. Cultivars that have many differences in characters show a distant kinship (Miswarti *et al*., 2014).

Phenotypic kinship between plants can be measured by observing the similarity in the number of characters that serve as the basis for assembling superior varieties. The opportunity to produce new plants with wide genetic variability will be greater in cultivars that have distant kinship relationships. Conversely, narrow genetic viability is caused by crosses with close kinship (Purwantoro *et al*., 2005).

The diversity and distribution of sugar palm plants vary greatly so it is necessary to identify and characterize their morphology so that it can be used as a source of germplasm for the breeding purpose. The purpose of this study was to determine the morphological characters of sugar palm plants grown at an altitude of 500, 650, and 900 m above sea level so that kinship relationships with the level of similarities or differences can be known.

MATERIALS AND METHODS

This research was conducted at three altitudes in Lareh Sago Halaban District, Lima Puluh Kota Regency, West Sumatra, namely Nagari Labuah Gunung (LG) at 900 m above sea level, Nagari Bukik Sikumpa (BS) at 650 m above sea level, and Nagari Tanjung Gadang (TG) at 500 m above sea level from July to August 2023.

The research material was 3 sugar palm plants for each height so that 9 samples of sugar palm plants were obtained. The tools used were GPS, clinometer, ladder, knife, meter, crossbar, plastic, vernier, and scales.

The method used was a survey with purposive sampling technique, namely sampling with predetermined criteria, namely palm trees that could be tapped and were > 5 years old. Identification was carried out on 36 morphological characters, including 20 qualitative characters and 16 quantitative characters. The characterization was carried out on the stems, leaves, fibers, fruits, and seeds of sugar palm plants. The value of the amount of tapped sweet sap or *'nira'* produced per day was obtained by interviewing the owner of the sugar palm trees.

The genetic diversity analysis was conducted based on morphological characters from qualitative and quantitative data. The data obtained were converted into binary data by scoring the data based on the criteria set for each variable (Saputri, 2011). The analysis of variance was done using the formula (Steel and Torrie, 1995):

$$S^2 = \frac{\sum(xi - x)^2}{n - 1}$$

S^2 = diversity, *xi* = the value of the-i observation, *x* = the average value of observation, n = number of observations.

The criteria for assessing the extent or narrowness of phenotypic variability referred to Pinaria *et al*. (1995), namely if v > 2 SD means the phenotypic variance is large and if v < 2 SD means the phenotypic variance is small. The formula of SD (standard deviation):

$$SD = \sqrt{s^2}$$

SD = standard deviation standar, S^2 = diversity.

The similarity analysis aimed to determine the closeness of relatives between one sugar palm plant and another one obtained in the field. Morphological parameter similarity analysis was processed by making dendrograms using the Numerical Taxonomy and Multivariate System (Ntsys) Ver.2.02 program.

RESULTS AND DISCUSSION

Qualitative Characters

The results of the identification of 20 qualitative characters of sugar palm plants at three different altitudes in Lareh Sago Halaban District can be seen in Table 1. The qualitative characters of the identified palm plants showed no variation in the three altitudes except for the color of the bark and the color of the young seeds. The color character of the stem bark obtained two color variations, namely light brown at an altitude of 900 m above sea level and grayish brown at an altitude of 500-650 m above sea level. The seed color characters identified were dominated by yellowish white color, but in plant sample 3 at an altitude of 650 m above sea level (TG3), clear white seeds were found. According to Soeseno (1991), half-ripe sugar palm fruit has a thin, soft and yellow seed coat. The seed kernel

(endosperm) has a slightly clear and soft white color. The appearance of qualitative characters of sugar palm plants at three different altitudes in Lareh Sago Halaban District can be seen in Figure 1.

Table 1. Qualitative character identification results of sugar palm plants at three different altitudes in Lareh Sago Halaban District.

No	The Qualitative Character	Range
1	Stem surface	There are frond marks
2	Bark Color	Light brown, grayish brown
3	Frond shape	Square
4	Frond arrangement	Scattered
5	Frond color	Green
6	Petiole shape	Square
7	Petiole color	Green
8	Build leaflets	Elongated
9	Leaflet tip	Rounded
10	Base of leaflets	Blunt
11	Leaflets	Straight reinforced
12	Leaflets edge	Scratched/scratched
13	Leaflets surface	Wax-coated
14	Leaflets layout	Face-to-face
15	Leaflets color	Dark Green
16	Fiber surface	Rough
17	Palm fiber color	Black
18	Fruit shape	Round
19	Seed shape	Oval Round
20	Young seed color	Clear white, yellowish white

Quantitative Characters

The identification results of 19 quantitative characters of sugar palm plants at three different altitudes in Lareh Sago Subdistrict can be seen in Table 2. The identified sugar palm plants have a plant height of 6.16 - 14 m, trunk circumference of 1.34-1.83 m, and trunk diameter of 42.68-58.28 m. The diameter of the trunk is 60-65 cm. The sugar palm plant is an annual plant that can grow up to 12-20 m with a trunk diameter of 60-65 cm (Soesono, 1992; Ramadani et al., 2008). The trunk circumference obtained was categorized as large and very large except for sample TG3 at 650 m above sea level which was categorized as medium. The height of the identified sugar palm plants was categorized as very low and low at an altitude of 900 and 500 m above sea level, while at an altitude of 650 m above sea level, the plant height was categorized as very low in all plant samples.

The leaf characters of the identified sugar palm plants have variations at three different altitudes. The length of the fronds identified was 6.5 - 9.8 m with the category of very short and short at 900 m above sea level, classified as very short and medium at 650 m above sea level, and classified as short at 500 m above sea level. The length of the leaf rachis identified was 4.96 - 8.34 m with very short, short, and medium categories at 900 m asl, classified as very short, short, and long at 650 m asl, and short and medium categories at 500 m asl. Based on the correlation test, it was found that midrib length had a highly significant correlation at the 1% real level with rachis length, which is 0.979**. The positive value indicates that midrib length has a unidirectional correlation with rachis length. This means that the longer the midrib, the longer the rachis length. This correlation relationship is very strong as indicated by a number close to the value of 1.

The length of the petiole identified was 1-1.63 m with medium and long categories at an altitude of 500 and 900 m above sea level (MASL), while at an altitude of 650 m asl the category was short and medium. The number of leaflets in one midrib identified was 210-320 strands with many and very many categories at an altitude of 900 m asl, few and many categories at an altitude of 650 m asl, and medium, many and very many categories at an altitude of 500 m asl. The length of the leaflets identified was 1-1.63 m with long and very long categories at 900 and 500 m asl, short and long categories at 650 m asl. The width of the leaflets identified was 7-11 cm with a wide category at an altitude of 900 m asl, medium and very wide categories at an altitude of 650 and 500 m asl. Based on the correlation test, it was found that petiole length had a significant correlation value at the 5% real level with leaflet length, which is 1**. The positive value indicates that petiole length has a unidirectional correlation with leaflet length. This means that the longer the petiole, the longer the leaflets. This correlation relationship is very strong as indicated by the value of 1.2

The number of fruit bunches per plant identified was 1 - 7 bunches with medium category at 900 m above sea level, few and medium categories at 650 m above sea level, and very few and medium categories at 650 m above sea

level. The number of fruit strands per cluster identified was 30-35 with few and medium categories at three different altitudes. The fruit diameter identified was 33.2-46 mm with very small and large categories at 900 m asl, small, large and very large categories at 650 m above sea level, medium, heavy and very large categories at 500 m above sea level. The weight per fruit identified was 23.27-55.74 g with a very heavy category at the three different altitudes. Based on the correlation test, it was found that fruit diameter had a significant correlation at the 1% real level with fruit weight, namely 0.911** and a significant correlation at the 5% real level with seed diameter and weight per seed, that is 0.732* and 0.744*. Positive values indicate that fruit diameter has a unidirectional correlation with fruit weight, seed diameter and weight per seed. The larger the fruit diameter, the larger the seed diameter and weight per seed. This correlation is very strong as indicated by the number close to 1.

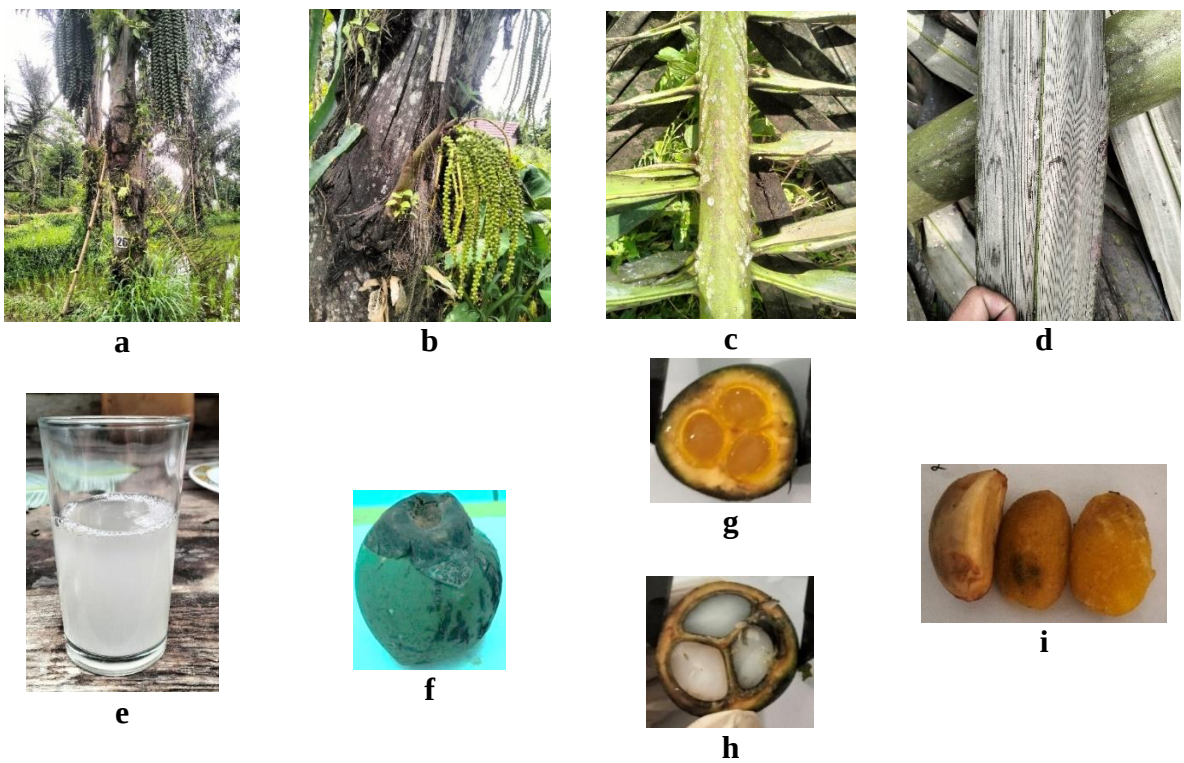

Figure 1. The qualitative character appearance of sugar palm plants: a, b). stem c) midrib; d) leaflets; e) *nira*; f) fruit shape; g, h) seed color; i) seed shape

The diameter of the seeds identified was 10-15.3 mm with very small and small categories at 900 m above sea level, small and medium categories at 650 m above sea level, medium and large categories at 500 m above sea level. The number of seeds per fruit identified was 3 with the category of many. The weight per seed identified is 1.48 - 9.90 g with a very large category. Based on the correlation test, it was found that the thickness of the seed coat had a significant correlation at the 1% real level with the thickness of the fruit, namely 0.995**. The positive value indicates that the thickness of the seed coat has a direct correlation with the thickness of the fruit with a very strong correlation relationship. The thicker the seed coat, the thicker the fruit. Seed diameter and weight per seed had a significant correlation at the 5% real level with weight per fruit, namely 0.784* and 0.844*. The larger the seed diameter and seed weight, the heavier the weight per fruit with a very strong correlation relationship.

The amount of *nira* tapped per day per bunch identified was 12-25 liters with a very large category. Based on the correlation test, it was found that the number of liters per day per bunch had a significant correlation value at the 5% real level with fruit diameter, that is -0.752. The negative value indicates that the amount of *nira* per day per bunch has an opposite correlation with fruit diameter. This means that the more the amount of *nira*, the smaller the fruit diameter. This correlation is very strong as indicated by a number close to 1.

Diversity analysis

The variability value of quantitative characters of sugar palm plants in Lareh Sago Halaban District can be seen in Table 3. The results of diversity analysis show that the S value is smaller than 2 times the SD, which means that all qualitative and quantitative characters are classified as narrow. This contradicts the results of research by Ferita *et al.* (2015) which states that in general, quantitative characters have a relatively wide phenotypic diversity value while qualitative characters tend to have a relatively narrow diversity value. Environmental factors do not really affect

qualitative characters because the grouping is relatively easy (Crowder, 1993). The quantitative characters are influenced by genes and environmental factors (Makmur 1992). This proves that the characterization of phenotypic appearance of all characters is more influenced by genetics so that it has a close relationship. Sugar palm plants at three different altitudes cannot be used as a basis for plant breeding selection. Ferita et al. (2015) stated that the requirement for genotype selection as a source of germplasm must have a wide phenotypic variation.

Table 2. The results of identification of quantitative morphological characters of sugar palm plants at three different altitudes in Lareh Sago District

Character	Labuah Gunung village (>900 MASL)			Tanjung Gadang village (650 MASL)			Bukik Sikumpa village (500 MASL)		
	LG 1	LG 2	LG 3	TG 1	TG 2	TG 3	BS 1	BS2	BS3
Trunk									
Trunk circumference (m)	1,83	1,67	1,58	1,34	1,45	1,73	1,47	1,58	1,63
Stem diameter (cm)	58,28	53,18	50,31	42,68	46,18	55,09	46,81	50,31	51,91
Plant Height (m)	7,87	11	14	8,4	8,42	7,28	6,16	7,85	12,89
Leaves									
Frond length (m)	6,87	6,5	8,95	6,83	6,69	9,8	8	9,05	7,1
Leaf rachis length (m)	5,77	5,36	7,12	5,5	4,96	8,34	6,8	7,5	5,64
Petiole length (m)	1,55	1,36	1,62	1	1,02	1,37	1,37	1,63	1,5
Number of leaflets in one leaf (blade)	320	264	318	284	210	268	284	306	236
Leaflet length (m)	1,55	1,36	1,62	1	1,02	1,37	1,37	1,63	1,5
Leaflet Width (cm)	9	9	8,4	10	8	11	7	10	9,6
Fruit									
Number of fruit bunches per plant (bunches)	7	5	5	5	7	2	1	5	6
Number of fruit strands per bunch	33	30	35	33	32	30	30	33	35
Fruit diameter (mm)	43,5	43	33,2	42,2	38	45,1	44,2	39,3	46
Weight per fruit (g)	53.678	35.902	23.271	45.496	34.164	55.743	50.050	39.930	55.500
Thickness of fruit (cm)	0,6	0,7	0,5	4	0,4	0,4	0,7	0,5	0,5
Seeds									
Seed coat thickness (cm)	0,2	0,2	0,2	0,3	0,2	0,2	0,2	0,2	0,2
Seed diameter (mm)	12,6	11,3	10	13,8	12,4	13,2	15,3	13,1	15
Number of seeds per fruit	3	3	3	3	3	3	3	3	3
Weight per seed (g)	7,27	4,06	1,48	6,66	4,08	9,90	4,38	4,22	6,08
Nira									
Amount of *nira* per day/bunch (l)	15	12	25	15	15	15	15	15	15

Table 3. Phenotypic variability based on quantitative characters of sugar palm plants at three different altitudes

No	Character	Average	S^2	SD	2 SD	Criteria
1	Trunk circumference (m)	1,59	0,44	0,67	1,33	Narrow
2	Plant height (m)	10,96	0,22	0,47	0,94	Narrow
3	Frond length (m)	7,75	0,44	0,67	1,33	Narrow
4	Leaf rachis length (m)	6,33	0,89	0,94	1,89	Narrow
5	Petiole length (m)	1,38	0,62	0,79	1,57	Narrow
6	Number of leaflets in one leaf (blade)	276,67	0,89	0,94	1,89	Narrow
7	Leaflet length (m)	1,38	1,21	1,10	2,20	Narrow
8	Leaflet width (cm)	9,14	0,62	0,79	1,57	Narrow
9	Number of fruit bunches per plant (bunches)	4,78	0,44	0,67	1,33	Narrow
10	Number of fruit strands per bunch	32,33	0,22	0,47	0,94	Narrow
11	Fruit diameter (mm)	42,33	1,58	1,26	2,51	Narrow
12	Weight per fruit (g)	43,75	0	0	0	Narrow
13	Diameter biji (mm)	12,50	0,89	0,94	1,89	Narrow
14	Number of seeds per fruit	3	0	0	0	Narrow
15	Weight per seed (g)	5,35	0	0	0	Narrow
16	Amount of *nira* per day/bunch (l)	15,78	0	0	0	Narrow

The similarity analysis

The dendrogram results of 36 qualitative and quantitative characters of sugar palm plants in three different altitudes can be seen in Figure 2. The similarity analysis of 36 characters of sugar palm plants resulted in a coefficient value of 0.72-0.86 or a similarity distance of 72-86%. The overall morphological characters of sugar palm plants are divided into 2 large groups, namely group I and group II with a coefficient value of 0.72 or 72% similarity distance.

Group I consists of 7 plants namely BS3, BS2, LG3, TG2, TG1, LG2, and LG1. Group IA consists of TG2, TG1, LG2, LG1. Group IB consisted of BS3, BS2, LG3. Group II consists of 2 plants, TG3 and BS1.

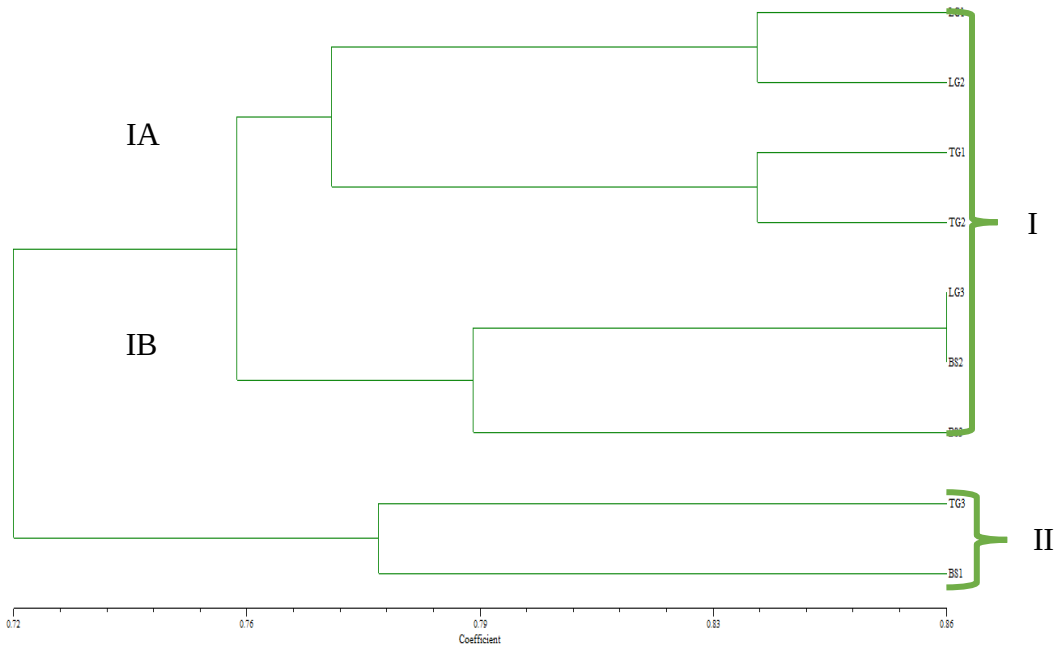

Figure 2.The dendrogram of 36 qualitative and quantitative characters of sugar palm plants at three different altitudes

The sugar palm plants that have the greatest similarity or the closest phenotypic similarity are LG3 and BS2 with a coefficient value of 0.86 or a similarity distance of 86%. This shows that the sugar palm plants in that location are in the same line or group. The greater value of the similarity coefficient indicates a greater level of plant similarity (Syukur *et al*., 2012).

More similarity in characters indicates a closer relationship or vice versa. The close kinship will affect the low value of heterosis so that it cannot be used as germplasm in plant breeding programs. The morphological similarity of sugar palm plants in this location is because the seeds obtained are still in a close geographical location. The same opinion was also expressed by (Miswarti *et al*., 2014). The low genetic diversity is caused by genotypes located in the same line (Zubair and Yoshida, 2004).

CONCLUSIONS

The results of identification and characterization of qualitative and quantitative morphological characters of sugar palm plants at three different altitudes in Lareh Sago Halaban District showed a relatively narrow diversity value. The overall morphological characters of sugar palm plants could be divided into 2 large groups with a coefficient value of 0.72 or 72% similarity distance.

ACKNOWLEDGMENTS

The gratitude is expressed to the Faculty of Agriculture, Andalas University, which has provided funds in the implementation of this research (Number: 6/PL/SPK/PNP/FAPERTA- Unand/2023), and also to the students of the Agroecotechnology Study Program who have assisted in the implementation of this research.

REFERENCES

Badan Pusat Statistik Sumatera Barat. (2022). Provinsi Sumatera Barat Dalam Angka. ISBN: 0303-5328

Crowder, L.V. (1993). Genetika Tumbuhan. Penerjemah: Soetarso L.K., Terjemahan dari: Plant Genetics. Gadjah Mada University Press. Yogyakarta. ISBN: 978-623-359-009-9

Ferita, I., Tawarati, & Syarif, Z. (2015). Identifikasi dan karakterisasi tanaman enau (*Arennga pinnata*) di Kabupaten Gayo Lues. *Pros Sem Nas Masy Biodiv Indonesia***,** 1(1), 31-37. https://doi.org/10.13057/psnmbi/m010105

Makmur, A. (1992). Pemulian Tanaman. Rineka Cipta. Jakarta. ISBN: 979-518-275-7

Mangoendidjojo, W. (2003). Dasar Pemuliaan Tanaman. Kanisius. Yogyakarta. ISBN: 978-979-21-0507-0

Miswarti, Nurmala, T., dan Anas. (2014). Karakterisasi dan kekerabatan 42 aksesi tanaman jawawut (*Setaria italica L. Beauv*). *Pangan*, 23(2), 166-177. https://doi.org/10.33964/jp.v23i2.61

Kementerian Pertanian. (2013). Pedoman Budidaya Aren (*Arenga pinnata* Merr) Yang Baik. No.133/Permentan/OT.140/12/20134 Tahun 2013. Kementerian Pertanian, Jakarta.

Pinaria, A., Baihaki, A., Setiamihardja, R., & Daradjat, A.A. (1995). Variabilitas genetik dan heritabilitas karakter-karakter biomassa 53 genotipe kedelai. *Zuriat*, 6(2), 88-92. ISSN-print: 0853-0858; ISSN-online: 2615-6261

Purwantoro, A., Ambarwati, E., & Setyaningsih, F. (2005). Kekerabatan antar angrek species berdasarkan sifat morfologi tanaman dan bunga. *Ilmu Pertanian*,12(1), 1-11. https://doi.org/10.22146/ipas.59934

Ramadani P., Khaeruddin, I., Tjoa, A., & Burhanuddin, I.F. (2008). Pengenalan Jenis-Jenis Pohon Yang Umum di Sulawesi. UNTAD Press. Palu. ISBN: 978-970-3701-64-6

Saputri, F. (2011). Eksplorasi dan Identifikasi Tanaman Enau (*Arenga pinnata* Merr.) di Kabupaten Agam Berdasarkan Karakter Fenotifik. Skripsi. Fakultas Pertanian. Universitas Andalas. Padang

Soeseno, S. (1992). Bertanam Aren. Penebar Swadaya. Jakarta. ISBN: 979-489-103 7

Steel, R. G. D. & Torrie, J. H. (1995). Prinsip dan Prosedur Statistik. Penerjemah Bambang Sumantri. Gramedia. Jakarta. ISBN: 979-403-2808

Syukur M., Sujiprihati, S., & Yunianti, R. (2012). Teknik Pemuliaan Tanaman. Penebar Swadaya. Jakarta. ISBN: (13) 978-979-002-549-3

Tenda, E.T., Maskromo, I., & Miftahorachman, I. (2018). Karakteristik empat aksesi baru aren (*Arenga pinnata* Merr.) dari Kalimantan Selatan. Pusat Penelitian dan Pengembangan Perkebunan, Badan Penelitian dan Pengembangan Pertanian, Kementerian Pertanian, Bogor.

Zubair, A. & Yoshida, T. (2004). Genetic Diversity among Japanese cultivated sorghum assessed with simple sequence repeats markers. *Plant Prod. Sci*. 7(2), 217-223. https://doi.org/10.1626/pps.7.217