Identification and phylogenetic analysis of sweet potatoes genotypes in subdistrict of Lembah Seulawah district of Aceh Besar

A Hafnizar, Rosmayati and N Rahmawati
Faculty of Agriculture, Universitas Sumatera Utara, Padang Bulan, Medan 20155, Indonesia

E-mail: nini@usu.ac.id

Abstract. The purpose of this study is to identify and create a data base on the diversity of sweet potato accession located in subdistrict of Lembah Seulawah District of Aceh Besar, has a diversity of accession of sweet potato genotype in subdistrict of Lembah Seulawah District of Aceh Besar to classify population that get high production and good fruit quality. The experiment was conducted in the area of sweet potato production center in exploratory survey method in Four Villages in subdistrict of Lembah Seulawah District of Aceh Besar, is Aceh, Saree, Blang Lambaro and Suka Mulia villages. The study was conducted from October to November 2017. The observations were made based on the identification and characterization of the International Agency List Description for Plant Genetic Resource Standards and the purposive random sampling technique. The results showed that there were 10 genotypes of sweet potatoes in Subdistrict of Lembah Seulawah District of Aceh Besar, which consisted of Aceh (A1, A2 and A3), Saree (A4, A5, A6, A7 and A8), Blang Lambaro (A9) and Suka Mulia (A10) with the closest relationship is A5 and A7 with coefficient similarity 29.227 and the furthest relation is A4 and A6 with coefficient of similarity 118.500.

1. Introduction
Sweet potatoes are a strategic crop of carbohydrate sources ranked 7th in the world while in Indonesia is a source of carbohydrate ranked 4th after rice, corn and cassava [1]. Sweet potatoes have an important role as food reserves when the production of rice and corn is not sufficient anymore. Sweet potatoes contain β-carotene, vitamin C, vitamin B1 (thiamine), and vitamin B2 (riboflavin) and contain minerals such as iron (Fe), calcium (Ca), potassium (K), phosphorus (P) and sodium (Na) [2].

There are 24 varieties of sweet potatoes that have been developed in Indonesia since 1977-2016. The still unknown accession of sweet potato has become an obstacle in sweet potato breeding. The success of plant breeding programs to improve the character of a plant is largely determined by the availability of genetic resources [3].

The collection of plant genetic diversity information is carried out through enrichment activities such as exploration. This activity allows the emergence of the desired genetic potential to be available [4]. Therefore, it is necessary to identify a plant. Characterization of collections (accessions) performed, aimed at obtaining data on the nature or character of agronomic morphology (basic morphological description) so as to distinguish the phenotype of each accession quickly and easily, by estimating how much genetic diversity it possesses [5].
Sweet potatoes can grow in the lowlands and highlands. One of the main factors affecting the growth of sweet potato plants is temperature, humidity, rainfall, sun exposure, wind conditions, soil conditions, soil geography, soil topography and soil properties [6].

Aceh is one of the areas of sweet potato production in Indonesia. Productivity of sweet potatoes in Aceh Province in 2013 is 106.05 ku / ha in 2014 of 107.38 ku / ha and in 2015 of 112.67 ku / ha [7]. Aceh Besar in 2015 has 5,980 tons of sweet potato production of 315 ha of plantation area and 299 ha of harvested area [8]. This data shows that the district of Aceh Besar, especially Lembah Seulawah District has potential in the development of sweet potato cultivation as a center of sweet potato production in Aceh Province.

Based on the above description, it is necessary to explore and identify the morphology of sweet potato crops from various accessions of sweet potatoes found in Kecamatan Lembah Seulawah Kabupaten Aceh Besar

2. Materials and Methods

This research was conducted from October to December 2017 by survey method. The survey method applied is by questionnaire technique, interview and direct observation on the location of sweet potato cultivation to know the local name, the utilization and the way of cultivation of sweet potato with guidance questionnaire that has been made.

The material used in this study is a sweet potato crop owned by farmers in Kecamatan Lembah Seulawah Kabupaten Aceh Besar (Table 1). Identify the plant based on the sweet potato morphology character of the International Board for Plant Genetic Resources by observing individual objects of sweet potato plants.

Data analysis technique performed is statistical analysis to see the suitability of data if it is factored by using factor analysis and cluster analysis with the help of SPSS 16 software in accordance with method developed.

The parameters observed were: 1) winding, 2) morphology of stem: rod type, main stem color, secondary stem color, hair stem, 3) leaf morphology: leaf length, leaf general shape, leaf size, leaf width, leaf repeating color, the color of the leaf, the color of the petiole, the type of lobes, the shape of the lobes, the number of lobes, 4) the morphology of the tubers: the shape of the tubers, the length of the tubers, the defects of the tubers, the thickness of the cortex, the color of the predominant skin, the intensity of the skin tone, leather secondary color, predominant meat color, secondary color of meat, 5) tuber yield, 6) total bulb, 7) number of bulbs worth selling, 8) total weight, 9) harvest age, 10) plant bulb weight, 11) reaction oxidation.

Table 1. Location of Sweet Potato Research in Kecamatan Lembah Seulawah Kab. Aceh Besar

| Village / Gampong | Elevation Place (mdpl) | Color Bulbs | Plant Age (Month) | Local Name | Code |
|-------------------|------------------------|-------------|-------------------|------------|------|
| Aceh              | 364.78                 | Yellow      | 3                 | Ubi Madu   | A1   |
| Aceh              | 364.78                 | Purple      | 4                 | Ubi Hitam  | A2   |
| Aceh              | 364.78                 | White       | 3                 | Ubi Sarioto | A3   |
| Saree             | 468.95                 | White       | 3                 | Ubi Sarioto | A4   |
| Saree             | 468.95                 | Yellow      | 3                 | Ubi Madu   | A5   |
| Saree             | 468.95                 | Purple      | 4                 | Ubi Hitam  | A6   |
| Saree             | 468.95                 | Orange      | 3.5               | Ubi Madu   | A7   |
| Saree             | 468.95                 | Yellow      | 3.5               | Ubi Madu Kuning | A8   |
| Blang Lambaro     | 461.81                 | Yellow      | 3                 | Ubi Madu   | A9   |
| Suka Mulia        | 448.03                 | White Purple| 3                 | Ubi Lobak  | A10  |

3. Results and discussion

Surveys conducted in the subdistrict of Lembah Seulawah District of Aceh Besar have found 10 genotypes of white, yellow, orange, purple, and purple white plants consisting of 4 types of sweet
potatoes (sweet potatoes, black yam, sarioto yam and sweet potato radish). The morphological characteristics of sweet potato plants are observed visually. Each sweet potato genotype is present in several locations that have different heights of different types of sweet potatoes that have different morphological characteristics. Based on morphological characters, sweet potatoes in Kecamatan Lembah Seulawah Regency of Aceh Besar get the value of kinship relationship which can be seen in table 2.

Table 2. Kinship relationship of 10 sweet potatoes genotypes in the subdistrict of Lembah Seulawah Districts of Aceh besar Based on Dissimilarity Matrix.

| No. | Kindship relationship | Coefficient Value | No. | Kindship relationship | Coefficient Value | No. | Kindship relationship | Coefficient Value |
|-----|-----------------------|-------------------|-----|-----------------------|-------------------|-----|-----------------------|-------------------|
| 1   | A9                    | 29.227            | 16  | A9                    | 55.185            | 31  | A10                   | 77.516            |
| 2   | A3                    | 30.717            | 17  | A4                    | 58.552            | 32  | A9                    | 78.630            |
| 3   | A8                    | 33.666            | 18  | A10                   | 58.677            | 33  | A8                    | 82.018            |
| 4   | A8                    | 36.692            | 19  | A7                    | 59.242            | 34  | A8                    | 85.555            |
| 5   | A7                    | 38.021            | 20  | A10                   | 60.213            | 35  | A2                    | 90.979            |
| 6   | A10                   | 40.246            | 21  | A8                    | 62.274            | 36  | A9                    | 91.760            |
| 7   | A10                   | 40.393            | 22  | A9                    | 62.933            | 37  | A9                    | 93.342            |
| 8   | A6                    | 41.758            | 23  | A9                    | 63.227            | 38  | A3                    | 96.440            |
| 9   | A4                    | 45.122            | 24  | A7                    | 64.585            | 39  | A10                   | 98.806            |
| 10  | A10                   | 45.122            | 25  | A5                    | 66.767            | 40  | A10                   | 101.654           |
| 11  | A10                   | 48.983            | 26  | A5                    | 71.525            | 41  | A4                    | 104.301           |
| 12  | A7                    | 50.730            | 27  | A8                    | 71.938            | 42  | A6                    | 104.523           |
| 13  | A9                    | 52.724            | 28  | A7                    | 73.140            | 43  | A8                    | 107.384           |
| 14  | A5                    | 53.395            | 29  | A7                    | 73.984            | 44  | A6                    | 111.559           |
| 15  | A5                    | 54.957            | 30  | A6                    | 75.547            | 45  | A6                    | 118.500           |

Table 2 shows if the coefficient value is smaller between the variables one with other variables, then the relationship between two variables closer or greater the similarity and vice versa. Thus it can be seen that the highest degree of closeness or kinship in 33 qualitative and quantitative characters found in A9 and A5 is 29.227, while the lowest degree of equality or the furthest kinship relationship found in A6 and A4 is 118,500. Studies of genetic diversity are needed to understand the genetic relationship between populations and establish accessions for specific heterogeneous groups that help identify the elder line for the best combination with maximum genetic potential for further selection [9].

Based on the morphological character of sweet potato in subdistrict of Seulawah Valley districts, it is found that all the genotypes of sweet potato can be grouped into two groups, three groups and four groups of members from each group (Table 3).

Table 3. Grouping of Multiple Accessions of Sweet Potatoes in subdistrict of Lembah Seulawah

| Code | 4 Group | 3 Group | 2 Group |
|------|---------|---------|---------|
| A1   | 1       | 1       | 1       |
| A2   | 2       | 2       | 2       |
| A3   | 1       | 1       | 1       |
| A4   | 3       | 3       | 1       |
| A5   | 4       | 1       | 1       |
| A6   | 2       | 2       | 2       |
| A7   | 4       | 1       | 1       |
| A8   | 4       | 1       | 1       |
| A9   | 4       | 1       | 1       |
| A10  | 1       | 1       | 1       |
The identified variations are expected to form a pattern of genetic relationships that can be used in classifying accession. In the accession grouping, cluster analysis has the ability to identify crop access with the highest similarity level using dendrogram [10]. Result of survey of sweet potatoes in Kecamatan Lembah Seulawah on 33 characters obtained relationship dendogram kinship which can be seen in Figure 1.

Analysis of kinship relationships based on 33 characters on a 25-degree scale formed into two groups. Where the first group (I) consists of A1, A3, A4, A5, A7, A8, A9 and A10 while the second group (II) consists of accessions A2 and A6. In the first group (I) it is divided into two sub- IA and IB, the first group (IA) consists of A1, A3, A5, A7, A8, A9 and A10 while the second group (IB) consists only of A4.

The further the kinship relationship will be the higher the level of diversity and the lower the level of uniformity, and vice versa [11]. The influence of environmental factors such as climate, temperature, soil type, altitude and humidity will cause the variation of plant morphology. This is not the case when the environmental factor conditions are the same [12].

Based on the above description it is suspected that the growing environment affects the morphological character of the plant to obtain different characters even though the same sweet potato type. The growing environments observed in this study are rainfall and soil conditions. The average annual rainfall in Kecamatan Lembah Seulawah is 157.5 mm / year while the rainfall requirement is 750 mm / year. These data indicate that the sweet potato grown in Kecamatan Lembah Seulawah is not in accordance with the ideal rainfall conditions for sweet potatoes. So to overcome the stress conditions experienced by plants, the appearance of morphological characters produced different related genes and environment.

The result of soil analysis at location 3 or village of Blang Lambaro shows high K content that is 2.29 me / 100 g. This value is higher than K levels in the other three research sites, causing different tuber weight. Potassium (K) enhances the formation of flowers and chlorophyll, promotes the formation of sugar substances, promotes carbohydrate formation, increases water absorption, increases
leaf strength, increases leaf enlargement, increases tuber bulbs, and increases resistance to disease [13].

4. Conclusions
The results showed that there were 10 genotypes of sweet potatoes in Subdistrict of Lembah Seulawah District of Aceh Besar, which consisted of Aceh (A1, A2 and A3), Saree (A4, A5, A6, A7 and A8), BlangLambaro (A9) and SukaMulia (A10) with the closest relationship is A5 and A7 with coefficient similarity 29.227 and the furthest relation is A4 and A6 with coefficient of similarity 118.500.

References
[1] Ambarsari I, Bachelor and Choliq A 2009 Recommendations In Stipulating Quality Standards of Sweet Potato Flour (Central Java: Agricultural Technology Assessment Center (BPTP))
[2] Pradhan D M P, Mukherjee A, George J, Chakrabarti S K, Vimala B, Naskar S K, Sahoo B K and Samal S 2015 *Ind J Trop Agric* **33** 397
[3] Renwain J, Hartana A, Hambali G G and Rumawas F 1994 *Zuriat* **5** 8
[4] Puslitbanbun 2007 *Guidelines for the Management of Plant Germplasm Plasma* (Bogor: Center for Plantation Research and Development)
[5] Bermawie N 2005 *Characterization of Germplasm Plasma. Manual of Plantation Germplasm Management Manual* (Bogor: Center for Plantation Research and Development) 38
[6] Dobermann A and Fairhurst T 2002 *Rice Nutrient Disorder and Nutrient management. Potash and Phosphate Instute (PPI) Photash & Phosphate Institute of Canada (PPIC) and IRRI* p 32
[7] Central Bureau of Statistics 2017 *Indonesia Sweet Potato Production Year 2015* (Jakarta)
[8] Central Bureau of Statistics 2016 *Aceh Besar In Figures 2015* (Aceh Besar)
[9] Mohammed W, Ali S, Shimelis B and Burga S 2015 *Science, Technology and Arts Research Journal* **4** 19
[10] Aliyu B and Fawole N G N Q 2000 *Nigeria Journal of Genetics* **15** 9
[11] Suratman, Dwi P and Ahmad D S 2000 *Biodiversitas* **1** 72
[12] Sitompul S M and Guritno B 1995 *Analisis Pertumbuhan Tanaman* (Gadjah Mada University Press)
[13] Juanda D and Bambang C 2000 *Budidaya dan analisis usaha tani manggis* (Yogyakarta: Kanisius)