Evaluation of Vegetative Growth and Total Chlorophyll of Four Sweet Potato Genotypes in the Highland and Lowland

Darma Bakti[1], Rosmayati[1,2] and Nini Rahmawati[1,2]
[1]Faculty of Agriculture, Universitas Sumatera Utara, Padang Bulan, Medan 20155, Indonesia
[2]Centre for Roots and Tuber Studies Universitas Sumatera Utara
{darma, rosmayati, nini }@usu.ac.id

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Abstract: Sweet potato crop productivity is influenced by several factors such as the growing season, soil type, irrigation system, plant propagation materials, use of genotypes, plant nutrition and others. The objective of this study was to evaluation of vegetative growth and total chlorophyll of four sweet potato genotypes in the highland and lowland. Field experiment was conducted on April – July 2018 was arranged in a randomized block design with two factors, the first factor is the genotypes of sweet potato (UbiSibolu accession from SaribuDolok Village Simalungun, UbiSibolu accession from Kasemak Village Simalungun and UbiSibolu accession from BatangBeruh Village and Beta – 1 variety). The second factor was altitude of planting area (highland 1440 MSAL and lowland 28 MSAL). The result showed three local sweet potato genotypes from upland areas in Simalungun Regency and DairiRegency Sumatera Utara have the ability to adapt and grow well in the lowland and in the highland which are not their origin compared to varieties Beta-2 which is a national superior variety. Vegetative growth of four sweet potato genotypes is better in the lowland than in the highland.

1 INTRODUCTION

Sweet potatoes are an important food crop in the world (Šlosár et al., 2016). Among the tuber groups, sweet potatoes are one of the potential local food ingredients to be developed in the future. It is based on the consideration that sweet potatoes are the fourth source of carbohydrates after rice, maize, and cassava; have high productivity potential; have diversified product diversity potential; has a diverse nutritional content, and has the potential market demand both local, regional, and exports are increasing (Šlosár et al., 2016; Laban et al., 2015; Ahmad et al., 2011).

Growth and development of plants is influenced by external and internal factors. External factors include soil, humidity, air, temperature, light and water. Internal factors may include genes, hormones, chlorophyll content as well as morphological and anatomical structures of plant organs (Widya, 2015). Environmental factors are an important consideration in the selection of plants or locations for more productive crop cultivation. Plant growth and development are significantly affected by elevation and altitude. In addition, environmental factors also affect the ability of plants to adapt (Krishania et al., 2013; Nayak and Altekar, 2015; Maria and Rodica, 2015

Sweet potato crop productivity is influenced by several factors such as the growing season, soil type, irrigation system, plant propagation materials, use of genotypes, plant nutrition and others. Identification of accession groups with excellent production potential is a population of the sweet potato genetic development program in the future (Vargas et al., 2017). Sumatera Utara is one of the centers of sweet potato production in Indonesia. Research on the exploration and identification of sweet potatoes in Sumatera Utara shows various types of sweet potatoes from various accessions with a variety of different characters. These local sweet potato genotypes have the potential to be developed for assembly of sweet potato varieties that have wide adaptability (Rosmayati and Bakti, 2018).

Sweet potatoes are plants that have wide adaptability. Determining the appropriate location is very important to consider to get maximum tuber yield. Sweet potatoes can be planted in areas with a height of 0 - 3000 MASL and maximum tuber formation at a temperature of 25°C at night, this

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indicates environmental factors such as light and temperature are very important to consider (Sulistiani et al., 2018)

The objective of this study was to evaluation of vegetative growth and total chlorophyll of four sweet potato genotypes in the highland and lowland as preliminary data to determine environmental suitability and adaptability of sweet potato genotypes.

2 MATERIALS AND METHODS

Field experiment was conducted on April – July 2018 at the experimental farm in Balai Penelitian Tanaman Sayuran Tongkoh – Berastagi (1440 MASL) and Cengkeh Turi Village Binjai (28 MASL), chlorophyll analysis is carried out in Tissue Culture Laboratory Faculty of Agriculture Universitas Sumatera Utara. Materials and tools used in this study include sweet potato stem cuttings, fertilizer, aquades, 80% acetone, erlenmeyer, filter paper, UV-VIS spectrophotometer and label.

A randomized block design with two factors with three replications was employed. The first factor was the genotypes of sweet potato (UbiSibolu accession from SaribuDolok Village Simalungun, UbiSibolu accession from Kasemak Village Simalungun and UbiSibolu accession from BatangBeruh Village and Beta – 1 variety). The second factor was altitude of planting area (highland 1440 MSAL and lowland 28 MSAL). The research stages include land preparation, making beds, planting, fertilizing using urea, TSP and KCl fertilizer, maintenance and parameter observation. The observation on vine length, number of branch, number of leaves, fresh vine weight were collected in the fifth and tenth weekss after planting, while chlorophyll total were observed in the tenth weeks after planting.

Data analysis using analysis of variance (ANOVA). Duncan Multiple Range Test (DMRT) was used to separate means at 5% level of probability. Please remember that all the papers must be in English and without orthographic errors.

3 RESULTS AND DISCUSSION

Plant morphology is influenced by environmental conditions and genetic factors. Both factors will interact during the life cycle of the plant and so that plant phenotypes appear that are similar to each other or completely different. If environmental influences are dominant compared to genetic, morphological variations may occur from the same species (Suranto, 2002). The results showed that the morphological appearance and vegetative growth of four sweet potato genotypes showed significant differences in vine length, number of leaves and fesh vine weight (Table 1 and Table 3).

Table 1.Vine length and branch number of four sweet potato genotypes on 5 and 10 weeks after planting

Genotype	Five weeks after planting		Ten weeks after planting	
	Vine lenght (cm)	Branch number (branch)	Vine lenght (cm)	Branch number (branch)
Ubi Sibolu Saribu Dolok	125,83 a	5,50	238, 33 a	8,83
Ubi Sibolu Kasemak	104,50 a	5,17	223,00 ab	8,67
Ubi Sibolu Batang Beruh	106,00 a	5,17	223,50 ab	8,33
Beta – 1 variety	79,83 b	4,83	207 b	8,50

Note : Mean values followed different letter in the same column is significantly difference based on DMRT at α = 5% .

The vegetative growth of genotipeSibolu with accession of SaribuDolok Village Simalungun is higher than the other two local genotypes, they were Sibolu with accession Kasemak Village Simalungun Village and Sibolu with accession BatangBeruh Village, Dairi which can be seen from all observed growth parameters. Whereas the vegetative growth of sweet potato of national superior variety Beta-2 is the lowest compared to the three local genotypes. This condition is suspected because the local genotype has the ability to adapt better to an environment similar to its original accession. Environmental similarities, namely climatic and soil conditions support the growth and development of local genotypes better than invasive genotypes (Boshier et al., 2015; Zen and Syarif, 2013). Each plant genotype requires an environment suitable for its growth and development (Chen et al., 2015).

Table 2. Vine length and branch number of sweet potatoes on highland and lowland on 5 and 10 weeks after planting

Altitude	Five weeks after planting		Ten weeks after planting	
	Vine lenght (cm)	Branch number	Vine lenght (cm)	Branch number
Lowland (28 MSAL)	137,33 a	5,33	277,67 a	8,67
Highland (1440 MSAL)	70,75 b	5,00	168,25 b	8,50

Note : Mean values followed different letter in the same column is significantly difference based on DMRT at α = 5%.

Sweet potato vegetative growth is strongly influenced by environmental factors. The results of the study showed that there were significant differences in the parameters of vine length, number of leaves and fresh vine weight of sweet potato grown in the lowlands and highlands (Table 2 and Table 4). Previous research also showed that sweet potatoes grown in the lowlands had longer vines than those in the highlands (Sulistiani et al., 2018). This condition is thought to be due to differences in temperature and rainfall in the lowlands and highlands. The average temperature in lowland during April – Juli 2018 in the day 27°C, 22°C in night and average rainfall was 159.5 mm, while in the highlands daytime temperatures were 24°C, 14°C in nite and rainfall during the study was 147.8 mm (Data.org, 2018).

Table 3. Number of leaves and fresh vine weight of four sweet potato genotypes on 5 and 10 weeks after planting

Genotype	Five weeks after planting		Ten weeks after planting	
	Number of leaves	Fresh vine weight (g)	Number of leaves	Fresh vine weight (g)
Ubi Sibolu Saribu Dolok	62,83 a	259,83 a	146,33 a	644,83 a
Ubi Sibolu Kasemak	59,17 ab	210,83 b	141,50 ab	587,67 ab
Ubi Sibolu Batang Beruh	54,33 ab	209,50 b	138,50 ab	591,00 ab
Beta – 1 variety	53,83 b	204,00 b	137, 17 b	534,67 b

Note : Mean values followed different letter in the same column is significantly difference based on DMRT at α = 5%

The study of Gajanayake et al. (2015) also shows an increase in temperature will increase the length of sweet potato stems. The growth of plants including sweet potatoes is strongly influenced by temperature, both air temperature and soil temperature (Gajanayake et al., 2015; Hatfield and Prueger, 2015; Ravi et al., 2009). An increase in air temperature plays an important role in stem extension, canopy development, and biomass accumulation (Patel and Franklin, 2009). Optimum temperature for growth and stem and need leaf area between 29-30˚C.

Table 4. Number of leaves and fresh vine weight of sweet potatoes on highland and lowland on 5 and 10 weeks after planting

Altitude	Five weeks after planting		Ten weeks after planting	
	Number of leaves	Fresh vine weight (g)	Number of leaves	Fresh vine weight (g)
Lowland (28 MSAL)	59,17	232,33 a	145,00 a	623,17 a
Highland (1440 MSAL)	55,92	209,75 b	136,75 b	555,92 b

Note : Mean values followed different letter in the same column is significantly difference based on DMRT at α = 5%

The results showed that the number of leaves and fresh vine weight were influenced by the genotype and environment of growing sweet potatoes (Table 3 and Table 4). Number of leaves and fresh vine weight of local genotypes were higher than those of superior varieties of Beta-1, and sweet potatoes grown in the lowlands also had a number of leaves and fresh vine weight which was higher than in the highlands. The plant canopy plays an important role as a source of photosynthate producing which will determine plant productivity. Leaves are important plant organs because they contain pigments or biochromes which play a role in light absorption. Pigments such as chlorophyll are needed by plants to absorb light for photosynthesis (Hue et al., 2011). Chlorophyll content is one of the determinants of plant growth (Rosmayati and Bakti, 2018)

Table 5. Total chlorophyll of four sweet potato genotypes on 5 and 10 weeks after planting

Genotype	Total chlorophyll (mg/g)
Ubi Sibolu Saribu Dolok	2,02
Ubi Sibolu Kasemak	2,01
Ubi Sibolu Batang Beruh	1,95
Beta – 1 variety	2,03

Based on statistical analysis, the total chlorophyll in the sweet potato genoltipe was not significantly different (Table 5). The highest chlorophyll total is in Beta - 1 varieties. Chlorophyll formation is influenced by several factors, namely plant genetic factors, light intensity, oxygen, carbohydrates, nutrients, water, and temperature (Setyanti et al., 2013).

Table 6. Total chlorophyll of sweet potato on five on highland and lowlandon 5 and 10 weeks after planting

Genotype	Total chlorophyll (mg/g)
Lowland (28 MSAL)	2,06 a
Highland (1440 MSAL)	1,95 b

Note : Mean values followed different letter is significantly difference based on DMRT at α = 5%.

The results of the study show that total chlorophyll is significantly influenced by environmental factors. The total chlorophyll in sweet potato leaves cultivated in the lowland is higher than that of sweet potatoes grown in the highlands (Table 6). Total chlorophyll content in the lowlands increased by 5.64% compared to the highlands. This condition is due to the higher light intensity and air temperature in the lowlands. Chlorophyll formation is affected by sunlight and air temperature. Dwidjoseputro (1981) stated that chlorophyll can be formed in the presence of sunlight which directly affects plants and 30-40°C temperature is a good condition for chlorophyll formation in most plants, but the best is at temperatures between 26-30°C.

4 CONCLUSIONS

Evaluation of vegetative growth and total chlorophyll parameters shows three local sweet potato genotypes from upland areas in Simalungun Regency and DairiRegency Sumatera Utara have the ability to adapt and grow well in the lowland and in the highland which are not their origin compared to varieties Beta-2 which is a national superior variety. Vegetative growth of four sweet potato genotypes is better in the lowlands than in the highlands.

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