Growth and production of several sweet potato genotypes 
(*Ipomoea batatas* L.) on various watering levels in rainfed 
paddy fields

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Abstract. Watering using 3 levels of watering is able to increase production and plant growth, 
specifically on suboptimal lands. This research aim was to determine the growth and 
production of several sweet potato genotypes (Beta 1 varieties with orange tuber, Perbaungan 
Accession with orange tuber and Cengkeh Turi Accession with yellow tuber) on various levels 
of watering with 3 levels: very limited watering (watering up to 1 month, intervals 10 days), 
limited watering (watering up to 2 months, intervals 10 days) and optimum watering (watering 
up to 4 months, intervals 10 days) in rainfed paddy field. This research was conducted in the 
paddy fields of Tandem Hilir I Village, Deli Serdang on April-July 2019. The results of this 
research represent that local sweet potato genotypes have good production and growth 
responses in paddy field cultivation. Perbaungan accessions with orange tuber and Cengkeh 
Turi Accession with yellow tuber obtained the highest tuber length, tuber diameter, average 
tuber weight and harvest index compared to other genotypes. Application of watering with 3 
levels in paddy fields proved not real on all observation parameters. Watering with 3 levels is 
best at limited watering (watering up to 2 months).

1. Introduction

Sweet potato is a local food group that has the potential to be developed that supports the non-rice 
food diversification program towards food security [1]. Sweet potatoes are generally planted in paddy 
fields after harvest season with limited irrigation at the beginning of the dry season or in the field at 
the beginning to the middle of the rainy season [2].

Drought stress causes inhibition of plant vegetative growth among others shoot weight, leaf area, 
tendrils length and the number of branches also decreases but stomata density tends to increase in 
plants that get drought stress under water stress conditions [3]. Watering aims to provide additional 
water in sufficient quantities at the time needed by plants [4].

Efforts that can be done to increase sweet potato production include using high-yielding seedlings 
or local seedlings that are able to overcome problems on dry land [5,6]. By using superior and local 
seeds, it is expected to identify the sweet potato clones that are resistant to drought [7].

The aim of this research was to determine the growth and production of several sweet potato 
(*Ipomoea batatas* L.) genotypes (Beta 1 varieties with orange tuber, Perbaungan Accession with
orange tuber and Cengkeh Turi Accession with yellow tuber) on various levels of watering in rainfed paddy field.

2. Materials and methods
The research was carried out in April-July 2019 in the paddy field of Tandem Hilir I Village, Deli Serdang. This research used a randomized block design with two factors, the first factor was the sweet potato local genotype (Beta 1 variety with orange tuber, Perbaungan Accession with orange tuber and Cengkeh Turi Accession with yellow tuber) and the second factor was Watering Level (P) with 3 levels: P1 = Very Limited Watering (watering up to 1 month, intervals 10 days), P2 = Limited Watering (watering up to 2 months, intervals 10 days), P3 = Optimum Watering (watering up to 4 months, intervals 10 days), watering is done by using a Hygrometer watered until the tool shows WET on the Hygrometer screen. This research started from seedling preparation, land preparation, planting, basic fertilization, watering according to treatment, soil moisture is determined using a hygrometer. Morphological parameter analysis which includes stem length, tuber length per sample, tuber diameter, average tuber weight and harvest index.

Data collection on morphological characters is stem length, that was carried out when the plants were 2 weeks old after planting (WAP) to 10 WAP. Observations of tuber length per sample, tuber diameter, average tuber weight and harvest index were done when the plant was 16 WAP.

Data were analysed statistically by the F test and continued by the Duncan’s Multiple Range Test (DMRT) at α 5%.

3. Results and discussion
Data presented in Table 1 and Figure 1 indicated that the three local sweet potato genotypes were not significantly different in the stem length parameters. Beta 1 varieties with orange tuber had the highest stem length compared to other genotypes. It was suspected that Beta 1 variety which is a national superior variety, has better stem growth compared to other genotypes. This is because Beta 1 variety has the advantage of being suitable for planting in paddy fields after rice planting which results in the Beta-1 variety having a higher stem length compared to other sweet potato genotypes. Saleh [8] reported that the superior varieties of Beta 1 had the advantage of being suitable for planting on upland fields from paddy fields after the rice was harvested hence they were more resistant to various conditions in the paddy fields environment.

| Table 1. Stem lengths of several sweet potato genotypes on several watering levels |
|-------------------------------------|-----|
| Treatment                          | Stem Length (cm) |
| Genotype                           |                |
| Beta 1 Variety with orange tuber   | 83.31          |
| Perbaungan Accession with orange tuber | 79.14          |
| Cengkeh Turi Accession with yellow tuber | 79.58          |
| Watering                           |                |
| Very Limited Watering up to 1 month | 78.42          |
| Limited Watering up to 2 months    | 75.43          |
| Optimum Watering up to 4 months    | 88.18          |

Data in Table 1 and Figure 2 indicated the sweet potato stems length which was watered with 3 different levels were not significantly different. Sweet potato which was watered until 4 months had the highest stem length. Rahayuningsih [3] reported that drought stress caused vegetative growth
inhibition of plants such as shoot weight, leaf area, tendrils length and the number of branches also decreased but stomata density tended to increase in plants that received drought stress.

![Figure 1. Stem lengths of several sweet potato genotypes](image1)

Data in Table 2 indicated that the tuber length in the three genotypes was not significantly different. Cengkeh Turi accession with yellow tubers had higher tuber length than other genotypes, because Cengkeh Turi accession with yellow tubers had a longer tuber shape compared to other sweet potato genotypes Andika et al. [9] reported that sweet potato genotypes had different characteristics among genotypes including leaves, stems, tuber shape, tuber skin colour, and tuber flesh colour. The difference in characteristics is influenced by genetic and environmental factors.

Watering with different levels also did not have significant effects on the tuber length. Sweet potato plants watered to 4 months with 10 days intervals produced tubers with the highest length compared to other watering levels. Drought at each stage of tuber formation and filling greatly affects the characteristics of the tuber. Plants watered for 4 months at 10-day intervals produce tubers length 14.01% longer than the lowest tuber lengths produced by plants watered for 1 month at 10-day intervals. This was presumably because the level of optimum watering to 4 months with 10 days intervals was able to meet the water needs of plants. One of them is to increase plant growth and increase the production of dry matter weight hence the process of photosynthesis can run optimally, finally, photosynthates that are transplanted from the leaves to the tubers run effectively resulted in
better tuber production. Wahyuni et al. [10] reported that in 'not optimal' irrigation of sweet potatoes cultivation, only able to produce small tubers.

Data in Table 3 indicated that the tuber diameters of the three genotypes had a significant effect. Perbaungan accession with orange tuber obtained the highest tuber diameter compared to other genotypes while Beta 1 varieties had the lowest tuber diameter compared to other genotypes at the level of watering. This was because local genotypes have a higher adaptation than superior varieties. Saleh., [8] stated that the superior varieties of Beta 1 had weaknesses which were less than optimal environmental adaptability, lower tuber weights and were not resistant to high soil water content. Zulkadifta et al., [11] stated that local genotypes have high levels of productivity, adaptability and excellent growth hence produce good tubers.

Watering with different levels also did not significantly affect the tuber length. Sweet potato plants watered to 2 months at intervals of 10 days produce tubers with the highest diameter compared to other watering levels. While sweet potato plants watered to 4 months at intervals of 10 days produce the lowest tuber diameter. Soil moisture needed by sweet potatoes at the beginning of growth ranged from 60-70%, in the middle of growth 70-80%, and at the end of growth requires 60% humidity. Although sweet potato is a drought-tolerant plant, long drought will disturb tuber formation.

Table 2. Tuber lengths of several sweet potato genotypes at several watering levels

| Treatment                        | Tuber lengths (cm) |
|----------------------------------|--------------------|
| Genotype                         |                    |
| Beta 1 Variety with orange tuber | 10.51              |
| Perbaungan Accession with orange tuber | 11.96          |
| Cengkeh Turi Accession with yellow tuber | 13.57        |
| Watering                         |                    |
| Very Limited Watering up to 1 month | 11.42          |
| Limited Watering up to 2 months  | 11.60              |
| Optimum Watering up to 4 months  | 13.02              |

Table 3. Tuber diameters of several sweet potato genotypes at several watering levels

| Treatment                        | Tuber diameters (mm) |
|----------------------------------|----------------------|
| Genotype                         |                      |
| Beta 1 Variety with orange tuber | 27.75 c              |
| Perbaungan Accession with orange tuber | 48.33 a          |
| Cengkeh Turi Accession with yellow tuber | 45.15 b        |
| Watering                         |                      |
| Very Limited Watering up to 1 month | 44.99         |
| Limited Watering up to 2 months  | 39.91               |
| Optimum Watering up to 4 months  | 36.32               |

Note: Numbers followed by the same letters indicated no significant difference in Duncan's Multiple Range Test at α = 5%.

Data in Table 4 indicated that the genotypes treatment significantly affected the average tuber weight parameters per sample. Cengkeh Turi Accession with yellow tuber obtained the highest average tuber weight per sample compared to other genotypes. Cengkeh Turi accessions with yellow
The tuber had high adaptability even though planted in different environmental conditions from which this genotype originated. Jusuf et al. [12] reported that widely adapted varieties/clones/genotypes have the advantage of being able to produce high yields in diverse agroecosystems.

Watering with different levels also did not significantly affect the average tuber. Sweet potato plants watered to 2 months at 10-day intervals produced the highest results on the average tuber weight parameters and plants watered to 1 month at 10-day intervals produced the lowest average tuber weight. This is because sweet potatoes have a tuber formation phase at 3-8 weeks where plants need adequate water intake. Widodo et al. [13] reported that dry weather is very suitable for tuber formation and development, but if drought conditions occur in the tuber formation phase (3-8 weeks old) it will result in a significant decrease in tuber production.

### Table 4. The average tuber weights of several sweet potato genotypes at several watering levels

| Genotype                          | Treatment                          | Average Tuber Weights (g) |
|-----------------------------------|------------------------------------|---------------------------|
| Beta 1 Variety with orange tuber  |                                    | 33.36 c                   |
| Perbaungan Accession with orange tuber |                                | 75.76 b                   |
| Cengkeh Turi Accession with yellow tuber |                              | 94.95 a                   |
| Watering                          |                                    |                           |
| Very Limited Watering up to 1 month |                                  | 56.63                     |
| Limited Watering up to 2 months   |                                    | 81.82                     |
| Optimum Watering up to 4 months   |                                    | 65.62                     |

Note: Numbers followed by the same letters indicated no significant difference in Duncan's Multiple Range Test at α = 5%

### Table 5. Harvest indexes of several sweet potato genotypes at various levels of watering

| Genotype                          | Treatment                          | Harvest Index |
|-----------------------------------|------------------------------------|---------------|
| Beta 1 Variety with orange tuber  |                                    | 0.04 c        |
| Perbaungan Accession with orange tuber |                                | 0.16 a        |
| Cengkeh Turi Accession with yellow tuber |                              | 0.15 b        |
| Watering                          |                                    |               |
| Very Limited Watering up to 1 month |                                  | 0.11          |
| Limited Watering up to 2 months   |                                    | 0.13          |
| Optimum Watering up to 4 months   |                                    | 0.11          |

Note: Numbers followed by the same letters indicated no significant difference in Duncan's Multiple Range Test at α = 5%

Data in Table 5 indicated that the harvest indexes of all three genotypes had a significant effect. Perbaungan Accessions with orange tuber and Cengkeh Turi Accession with yellow tuber yields the highest harvest index when compared to Beta 1 Varieties with orange tuber. Perbaungan accession with orange tuber produced the highest tuber diameter and harvest index compared to other genotypes. This was because local genotypes have a high level of productivity and plant adaptation also a very good growth hence yield good tubers. Watering with different levels also did not significantly affect the harvest index. In the watering level to 1 month, plants experience suboptimal growth due to stress
received by the plants are heavy enough that it inhibits the vegetative growth of the plant. Hapsari et al. [6] stated that the intensity of stress received by plants up to one month of age can be said to be the intensity of severe stress with a value (SI) of 0.79 while irrigation up to the age of 2 months includes moderate stress with a value (SI) of 0.54. Drought stress received by plants makes vegetative growth stunted.

4. Conclusion
The production and growth of local sweet potato genotypes are better in rainfed paddy fields. Sweet potato of Perbaungan accessions with orange tuber and Cengkeh Turi accession with yellow tuber produced tubers with highest tuber length, tuber diameter, average tuber weight and harvest index compared to Beta 1 varieties.

At the level of watering the rainfed paddy field has no significant effect on all observation parameters. Watering with the 3 best levels on limited watering (watering up to 2 months).

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