Analysis of yields quantity and quality of several sweet potatoes genotypes at different harvest ages

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Abstract. Efforts to increase production and yield quality can be done by planting local superior genotypes and setting the right harvest ages. This research was conducted to analyse the effect of harvesting age and genotype on the quantity and quality of sweet potato production. The location of planting in the research area on Jalan Pasar 1 Medan Selayang, from May to September 2019. This research used a randomized block design with 2 factors, namely local genotype (Perbaungan, Cengkeh Turi with orange tuber, Cengkeh Turi with yellow tuber), Beta-1 and harvest age (14, 16, and 18 weeks). The highest production quantity indicated by the tuber weight, the best harvest quality indicated by the fresh tuber grade A grading and the highest yield index were the local genotypes of Cengkeh Turi with yellow tubers. The highest grade B fresh tuber grading was produced by Perbaungan local genotypes. Beta-1 variety produced the highest plant fresh weight. Sweet potato harvested at the age of 18 weeks produced the highest tuber weight, the best grade A fresh tuber grading, and the highest yield index. Production weight and yield quality were not influenced by the interaction between the treatment of harvest age and sweet potato genotype.

1. Introduction
Sweet potato is positioned as the main source of carbohydrates, after rice, corn, cassava and flour, and has an important role in providing food, industrial raw materials and animal feed. Sweet potatoes contain quite good calories, fiber, vitamins and minerals. The vitamin content in sweet potatoes in the form of beta-carotene, thiamin, riboflavin, niacin, and ascorbic acid is equivalent to the vitamin content found in carrots and tomatoes [1].

Cultivated varieties and cultivation methods are varied. In general, the productivity of sweet potato at the farmer level is still low, hence the farmer's income is also low. The low productivity of sweet potato at the farmer level can occur, among others, due to inadequate cultivation techniques, the low production potential of cultivated varieties, or less attention paid to pests and diseases [2].

New superior varieties are a very strategic component of production technology to increase sweet potato production because they are associated with high yield potential. New superior varieties that have characters according to user needs and preferences are also relatively easy for farmers to accept, and are compatible with other components of cultivation technology [3].

In general, sweet potatoes can be harvested at the age of 95 days to 5 months after planting depending on the variety [4]. Determination of the right time to harvest sweet potatoes is very important because the harvest age affects the chemical composition of fresh tubers and sweet potato flour produced. The age of 120 days is the optimum harvest age for fresh sweet potatoes based on the
highest starch content and minimum fiber. Likewise, for sweet potato flour, the highest starch content was obtained at 120 days of tuber harvest. After all, at the age of 150 days, there had been a decrease in starch content because some of it was converted into reducing sugar [5]. This research was conducted to analyze the effect of harvesting age and genotype on the quantity and quality of sweet potato production.

2. Materials and Methods
The location of planting in the research area on Jalan Pasar 1 Medan Selayang, from May to September 2019. The research design used a factorial randomized block design with 2 factors. The first factor was the sweet potato local genotype (Perbaungan, Cengkeh Turi with orange tuber, Cengkeh Turi with yellow tuber), and Beta-1 varieties. The second factor was harvest age (14, 16 and 18 weeks after planting).

The materials used in this research were sweet potato stem cuttings, Urea fertilizer, SP-36 fertilizer and KCl fertilizer as basic fertilizer. The research stages were land preparation, planting, fertilizing, watering, and controlling pests and diseases. Observation of parameters was carried out at the time of harvest following the predetermined harvest time.

The observed parameters were the plant fresh weight, tuber weight per plot, tuber grading based on SNI 01-4493-1998 with the following criteria; Class A (tuber weight is > 200 g/tuber), Class B (tuber weight is > 100 - 200 g/tuber), Class C (tuber weight is 75-100 g/tuber), and harvest index. To test the effect of treatment, the F test was used and to test the mean value between treatments, it was followed by Duncan Multiple Range Test at the 5% level.

3. Results and discussion
Shoot fresh weight is the accumulated weight of plant shoot consisting of stems and leaf organs. Net photosynthesis rate and nutrient availability will affect shoot fresh weight. Fresh weight is the result of net assimilation of plants that still contain water. The data in Table 1 showed that Beta-1 sweet potato variety had the highest fresh weight, significantly different from the local genotype of Perbaungan and Cengkeh Turi with yellow tuber. Beta-1 is national superior varieties that can adapt to various environmental conditions. Pattiserlihun et al [6] explained that genetic factors would determine the growth of different sweet potato clones. The genetic potential of sweet potato to grow and produce maximally must be supported by the appropriate environmental factors.

| Sweet Potato Genotype | Harvest Age | Mean   |
|-----------------------|-------------|--------|
|                       | 14 Weeks    | 16 Weeks | 18 Weeks |
| Perbaungan (Local)    | 364.92      | 330.58  | 395.92   | 363.81 c |
| Orange Cengkeh Turi (Local) | 575.83     | 603.25  | 547.92   | 575.67 ab |
| Yellow Cengkeh Turi (Local) | 537.25     | 686.92  | 336.67   | 520.28 b  |
| Beta-1                | 705.33      | 685.92  | 725.25   | 705.50 a  |
| Mean                  | 545.83      | 576.67  | 501.44   |

Note: Mean values by the same letter do not significantly differ base on DMRT (F = 5%)
their environment. Jusuf et al [7] explained that the ability of plant genotypes to adapt to different agroecosystems is an advantage that can be seen from high production.

Table 2. Tuber weight per plot of different local genotypes of sweet potato at different harvest ages.

| Sweet Potato Genotype          | Harvest Age | Mean     |
|--------------------------------|-------------|----------|
|                               | 14 Weeks    | 16 Weeks | 18 Weeks |
| Perbaungan (Local)             | 161.32      | 183.61   | 198.15   |
| Orange Cengkeh Turi (Local)    | 95.04       | 180.60   | 159.60   |
| Yellow Cengkeh Turi (Local)    | 236.87      | 270.25   | 438.42   |
| Beta-1                         | 72.86       | 81.66    | 148.59   |
| Mean                           | 141.52 c    | 179.03 b | 236.19 a |

Note: Mean values by the same letter do not significantly differ base on DMRT (F = 5%)

Table 3. Grade A of fresh tuber grading on several local genotypes of sweet potato at different harvest ages.

| Sweet Potato Genotype          | Harvest Age | Mean     |
|--------------------------------|-------------|----------|
|                               | 14 Weeks    | 16 Weeks | 18 Weeks |
| Perbaungan (Local)             | 5.67        | 6.33     | 4.33     |
| Orange Cengkeh Turi (Local)    | 1.67        | 6.33     | 6.67     |
| Yellow Cengkeh Turi (Local)    | 5.00        | 5.00     | 6.33     |
| Beta-1                         | 0.00        | 0.33     | 2.33     |
| Mean                           | 3.08b       | 4.50a    | 4.92 a   |

Note: Mean values by the same letter do not significantly differ base on DMRT (F = 5%)

Sweet potato quality standards are needed to maintain the quality of sweet potatoes that reach consumers. The quality standard for sweet potatoes is found in the Indonesian National Standard (SNI) number 01-4493-1998. In SNI 01-4493-1998, it is stated that the quality standard of sweet potato is needed hence both consumers and producers have certainty of the desired quality. That way, consumers will get the quality of sweet potatoes according to their purchasing power and producers will get prices according to their products. Another advantage of having sweet potato quality standards is that it can be used for guidance to improve the quality of sweet potatoes. The uniformity of tuber weight is according to 3 kinds of weight classification, namely: a. group A weights ≥ 200 grams per tuber, b. group B weighs 100-200 grams per tuber, c. group C weights ≤ 100 grams per tuber.

The results showed that the local sweet potato genotypes had higher grade A fresh tuber grading than Beta-1 varieties (table 3). Local sweet potato genotypes have a better ability to adapt to the environment. Jusuf et al [8] stated that sweet potato varieties which have wide adaptability (stable in many environments) are needed to develop in the future in different agro-ecosystems with different user preferences.

The results showed that the number of tubers included in class A increased with the increase in harvest age (table 3). Rahayuningsih et al [9] stated that the process of tuber size enlargement continues until the plant is 4.5 months old.

The data in table 4 showed that the number of class B sweet potatoes was significantly different in the four genotypes studied. The local genotype of Cengkeh Turi with orange tuber produced the
highest class B sweet potato compared to the other four genotypes. Jusuf et al [8] stated that the variation in environmental factors influences the response of plants at various growth stages which in turn affects yield. In general, local varieties have specific location characteristics and when planted in other areas the yield is not optimal. Meanwhile, the harvesting age did not significantly affect the number of fresh tubers in class B. The highest number of class B fresh tubers was found in sweet potatoes harvested at the age of 16 weeks.

Table 4. Grade B of fresh tubers grading on several local genotypes of sweet potato at different harvest ages.

| Sweet Potato Genotype  | Harvest Age |          |          |          |          |
|------------------------|-------------|----------|----------|----------|----------|
|                        | 14 Weeks    | 16 Weeks | 18 Weeks |          |          |
| Perbaungan (Local)     | 4.67        | 6.33     | 5.00     | 5.33b    |          |
| Orange Cengkeh Turi (Local) | 4.67        | 8.67     | 5.33     | 6.22a    |          |
| Yellow Cengkeh Turi (Local) | 3.33        | 3.33     | 2.33     | 3.00c    |          |
| Beta-1                 | 1.00        | 1.00     | 2.33     | 1.44d    |          |
| Mean                   | 3.42        | 4.83     | 3.75     |          |          |

Note: Mean values by the same letter do not significantly differ base on DMRT (F = 5%)

Table 5. Grade C of fresh tubers grading on several local genotypes of sweet potato at different harvest ages.

| Sweet Potato Genotype  | Harvest Age |          |          |          |          |
|------------------------|-------------|----------|----------|----------|----------|
|                        | 14 Weeks    | 16 Weeks | 18 Weeks |          |          |
| Perbaungan (Local)     | 2.00        | 2.33     | 3.33     | 2.56     |          |
| Orange Cengkeh Turi (Local) | 1.67        | 2.00     | 4.67     | 2.78     |          |
| Yellow Cengkeh Turi (Local) | 1.00        | 3.00     | 0.33     | 1.44     |          |
| Beta-1                 | 1.00        | 1.33     | 2.33     | 1.56     |          |
| Mean                   | 1.42        | 2.17     | 2.67     |          |          |

The research data in table 5 showed that sweet potato genotype and harvest age were not significantly different in the number of tubers included in the grade C of fresh tuber grading. The genotype of Cengkeh Turi with orange tuber sweet potato produced the highest number of grade C tubers compared to other genotypes. The genotype of Cengkeh Turi with orange tubers produced the highest number of grade C tubers. Nai'em [10] stated that genetic differences, growth environment and the interaction of genetic and environmental are the factors that cause variations in plants. Nedunchezhiyan et al. [11] also explained that environmental factors greatly influence the differences in weight and amount of sweet potato produced.

The number of grade C fresh tubers increased along with the increased harvest age. Rahayuningsih et al [9] stated that the number and weight of very large and large tubers will increase until the harvest age is 4.5 months. On the other hand, medium, small, to unfit for sale size decreased at the age of 4.5 months after planting. Based on the pattern of tuber size development, the best harvest time fell at the age of 4.5 months after planting.

The harvest index showed the distribution of dry matter in plants which indicated the balance of dry matter which has economic value with the total weight at harvest time. The results showed that local genotypes of Cengkeh Turi with yellow tuber had the highest yield index which was significantly different from other genotypes, while Beta-1 varieties produced the lowest yield index (table 6).
According to Mekonnen et al. [12], fresh sweet potato production is a selection criterion which is an indicator of the adaptation degree of a clone to certain environmental conditions. Each clone/variety will show a different response from vegetative and generative growth [13]. These characters can be used as a basis for selection in determining clones that are able to adapt to certain conditions.

Table 6. Harvest index on several local genotypes of sweet potato at different harvest ages.

| Sweet Potato Genotype       | Harvest Age | Mean  |
|-----------------------------|-------------|-------|
|                             | 14 Weeks    | 16 Weeks | 18 Weeks |       |
| Perbaungan (Local)          | 0.27        | 0.44    | 0.36      | 0.36b  |
| Orange Cengkeh Turi (Local) | 0.14        | 0.24    | 0.26      | 0.21c  |
| Yellow Cengkeh Turi (Local) | 0.30        | 0.43    | 0.56      | 0.43a  |
| Beta-1                      | 0.06        | 0.16    | 0.19      | 0.14c  |
| Mean                        | 0.12c       | 0.32b   | 0.34a     |        |

Note: Mean values by the same letter do not significantly differ based on DMRT (F = 5%)

Apart from genotypic factors, harvest time also had a significant effect on the sweet potato harvest index (table 6). The research data showed that the sweet potato harvest index increased along with the increasing days in the harvest time. Sweet potato harvested at the age of 18 months has the highest harvest index, which has 1.83% differences when compared to sweet potato harvested at the age of 14 weeks. This is presumably because, at the age of 14 to 18 weeks, the tubers are still developing well, thus increasing the productivity of the sweet potato plant. Increasing the age of harvest also increases tuber weight produced by sweet potato plants This is following the statement of Antarlina et al. [14] and Rahayuningsih et al. [9], which stated that tuber yield increases with the increasing of plant age. Rahayuningsih et al. [9] also stated that the harvest index showed an increase with the increase of age and has a positive correlation with tuber yield. The number and weight of large to very large tubers increase until 4.5 months after planting.

4. Conclusions
The highest production quantity indicated by the tuber weight parameter per plot, the best harvest quality indicated by the fresh tuber grade A grading parameter and the highest yield index were the local genotypes of Cengkeh Turi with yellow tubers. The highest grade B fresh tuber grading was produced by Perbaungan local genotypes. Beta-1 variety produced the highest plant fresh weight. Sweet potato harvested at the age of 18 weeks produced the highest tuber weight, the best grade A fresh tuber grading, and the highest yield index. Production weight and yield quality were not influenced by the interaction between the treatment of harvest age and sweet potato genotype.

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