The effect of bokashi rice straw on the increase in production of three purple sweet potato varieties (*Ipomoea batatas* L.)

Jonatan Ginting
Department of Agrotechnology, Faculty of Agriculture, Universitas Sumatera Utara, Jl. Prof. A. Sofyan No. 3 Kampus USU Medan 20155, Indonesia
Email: gintingjonatan@ymail.com

Abstract. This research was conducted in the agricultural area of Pasar Kawat Village, Beringin District, Deli Serdang Regency, North Sumatra Province, Indonesia. Conducted from June to November 2015. The study aimed to find purple sweet potato varieties that produced high and optimal bokashi rice doses. The experimental design used was a randomized block design with two treatment factors and three replications. The first treatment factor is the variety consisting of: Antin-1, Antin-2 and Antin-3. The second treatment factor is the bokashi dose of rice straw consisting of four treatments: 0 tons/ha, 5 ton/ha, 10 tons/ha, and 15 tons/ha. The results showed that the highest variety of purple sweet potato which gave the highest production was found in the treatment of Antin 2 varieties and bokashi doses of rice straw 5 tons/ha with tuber production that could be achieved 908.07 g/plot (4.54 tons/ha).

1. Introduction
Sweet potato plants are one of the most important sources of food crops in Indonesia as a source of carbohydrates including purple sweet potato plants with various varieties. Sweet potato plants in almost every province in Indonesia are cultivated by farmers. Therefore, sweet potato plants are plants that are commonly known by the community. However, the production obtained is still relatively low, which requires efforts to increase production. One effort that can be done to increase production is to use a type of superior variety that has high tuber production potential and applies the use of organic fertilizers such as bokashi organic fertilizer from rice straw. Purple sweet potato varieties that have high production potential such as the Antin-1 variety have tuber production potential of up to 33.2 tons/ha, contain amylose around 25%, anthocyanin around 34 mg/100 g, harvest age 4-5 months, drought tolerant and tuber taste delicious. Antin-2 varieties have a production potential of 37 tons/ha, harvest age is around 4 months, starch content is 22%, beta-carotene 130 µg/100 g, tuber taste is good and rather sweet and the level of anthocyanin is high. Antin-3 varieties have tuber production potential of 35 tons/ha, age of around 4 months, high anthocyanin levels of 34 mg/100 g, starch content of 23% and good taste [6,7].

Bokashi rice straw is one of the organic fertilizers that has been well decomposed. Contains macro nutrients such as N 2.11%, P (P$_2$O$_5$) 0.64%, K (K$_2$O) 7.7%, Ca 4.2%, Mg 0.5% and micro nutrients such as Cu, Mn and Zn. Bokashi rice straw also contains organic compounds, amino acids, sugar and alcohol [9, 1]. All the ingredients contained in this rice straw bokashi organic fertilizer improve the condition of soil fertility. Organic materials as fertilizer materials affect the physical, chemical and biological properties of soil and plant growth. Organic fertilizers play a role as a granulator, which is
to improve soil structure, source of macro nutrients and micro elements to plants, increase the ability of soil to hold water and resist soil nutrients, soil cation exchange capacity (CEC) becomes high, and as an energy source for soil microorganisms so that soil biological activities increase. All plants can grow better when given organic fertilizer. In acid soils organic fertilizer can increase soil pH (neutralize Al by forming Al-organic complex), and can increase the availability of micro elements in the soil through chelating micro elements with organic matter [2,12].

According to Rosmarkam and Yuwono [8] the good properties of organic fertilizers on soil fertility are mentioned: Organic materials in the mineralization process will release complete plant nutrients (N, P, K, Ca, Mg, S and micro nutrients), improve soil structure, cause the soil to be light to be processed and easily penetrated by the roots, facilitate the processing of heavy soils, increase the power to hold water so that the ability of the soil to provide water becomes more, soil moisture is more maintained, makes soil permeability better, increases cation exchange capacity so that the ability to bind cations becomes higher, improve the biological life of the soil for the better because the availability of food is more secure and contains sufficient amounts of microbes which play a role in the process of decomposition of organic matter.

Sutanto [12] also explained that organic matter added to the soil would be an energy and food source for various microorganisms in the soil. Various soil microorganisms become active through the food chain, then undergo a decomposition process to produce various organic and inorganic compounds. Based on the description above, it is necessary to conduct a study on how the effect of giving rice straw bokashi organic fertilizer to the increase in tuber production of purple sweet potato varieties. The purpose of this study was to obtain purple sweet potato varieties that produced high and appropriate bokashi rice straw doses.

2. Materials and Methods

2.1. Place and time
The study was conducted in the agricultural area of Pasar Kawat Village, Beringin District, Deli Serdang Regency, North Sumattra Province, Indonesia. The study took place from June to November 2015.

2.2. Materials and tools
The main ingredients used in the study include varieties of sweet potato Antin - 1, Antin - 2 Antin - 3, organic liquid fertilizer, bokashi rice straw, the equipment used consists of hoes, meter measuring instruments, analytical scales, sample scraps, loose , stationery and others.

2.3. Research methods
The study used a randomized block design with two treatment factors, namely: The treatment factor of sweet potato varieties consists of 3 types of varieties: \( V_1 = \text{Antin} - 1 \), \( V_2 = \text{Antin} - 2 \), \( V_3 = \text{Antin} - 3 \). The factor for treating bokashi rice straw doses consists of 4 levels: \( J_0 = 0 \text{ tons/ha} \), \( J_1 = 5 \text{ tons/ha} \), \( J_2 = 10 \text{ tons/ha} \), \( J_3 = 15 \text{ tons/ha} \). The study consisted of 3 replications/blocks with a total number of treatment plots of 36 plots with the size of each plot of 200 cm x 100 cm. The number of plants in each plot has 6 plants with a sample size of 4 plants per plot. The spacing of sweet potatoes in each experimental plot was 30 cm x 30 cm. Experimental data was processed using the Variance Analysis method (Fisher test) and the mean Duncan Multiple Ranga Test (DMRT) difference test at the 5% real test level [11].

2.4. Implementation of research
The research land is cleaned from growing weeds, then the soil is processed and mixed with 20 cm deep hoe. Experimental plots were made, 200 cm x 100 cm x wide 30 cm with a total of 36 experimental plots divided into three experimental blocks. The distance between the experimental plots is 30 cm and the distance between blocks is 50 cm. Around the trial area a drainage ditch was made. As a research material, bokashi rice straw was made, one month before planting. Bokashi rice
straw is a mixture of finely chopped rice straw with livestock manure, fine bran, husk charcoal, biostater and enough water after 14 days of brewing. The application of bokashi rice straw to soil in experimental plots was carried out by applying evenly distributed soil according to the prescribed dose treatment. Planting sweet potato seeds according to the varieties studied in this study are varieties: Antin - 1, Antin - 2 and Antin - 3, planted 1/3 of the cuttings into the soil and 2/3 of the soil. The seeds planted are shoot cuttings, 25 cm long with a spacing of 30 cm x 30 cm. Every planting hole is planted. Maintenance carried out during the research is watering plants carried out in the morning and evening if there is no rain, fertilizing using organic liquid fertilizer is applied once a week, removal of the stem is done at the age of 50 days after planting, weeding is done manually, plant growth is done at 4 - 8 weeks after planting, controlling pests and plant diseases is done by spraying insecticides and fungicides. Harvesting of tubers is carried out when the sweet potato is aged 16 weeks after planting.

3. Results and Discussion

3.1. Number of tubers per plant

Based on the results of data analysis in Table 1, it can be seen that the treatment of varieties has a significant effect on the parameters of the number of tubers per plant. Whereas the rice straw bokashi fertilizer dose and its interaction with the varieties have not shown a significant effect on the number of tubers per plant.

| Variety   | Bokashi straw rice dosage | Average |
|-----------|---------------------------|---------|
|           | J₀ (0 ton/ha) | J₁ (5 ton/ha) | J₂ (10 ton/ha) | J₃ (15 ton/ha) |
| V₁ = Antin 1 | 1.17          | 1.08        | 1.25          | 1.17          | 1.17b          |
| V₂ = Antin 2 | 1.17          | 1.67        | 1.58          | 1.33          | 1.44a          |
| V₁ = Antin 3 | 1.42          | 1.08        | 1.00          | 1.00          | 1.13c          |
| Average   | 1.25          | 1.28        | 1.28          | 1.17          | 1.24           |

Description: The numbers followed by the same letters on the same line are not significantly different according to DMRT at the level of α = 5%.

The highest number of tubers was found in Antin-2 varieties compared to Antin-1 and Antin-3. In the influence of rice straw bokashi doses there was a tendency for the best dosage of the number of tubers per plant ranging from 5 - 10 tons/ha. And the best interaction effect between varieties with rice straw bokashi fertilizer is found in 5 tons/ha bokashi dose. The number of tubers per plant is one of the important production components in sweet potato plants. The difference in the number of tubers in each variety is related to differences in genetic make up of each variety. More adaptive varieties will provide better growth and production. [3]. The existence of bokashi organic fertilizer will improve the condition of soil fertility both from soil physical fertility such as soil moisture, soil chemistry and soil biology which will increase the number of tubers per plant compared to without the provision of rice straw bokashi organic fertilizer. This is in line with the function of organic matter in improving soil fertility [2].

3.2. Tuber weight per plant

Parameters of tuber weight per plant both due to the influence of varieties treatment, bokashi doses of rice straw as well as the interaction of varieties with bokashi doses of rice straw can be seen from the data in Table 2 not yet giving a significantly different effect.
Table 2. Tuber weight per plant (g) in the treatment of varieties and bokashi doses of rice straw

| Variety   | Bokashi straw rice dosage | Average |
|-----------|---------------------------|---------|
|           | J₀ (0 ton/ha) | J₁ (5 ton/ha) | J₂ (10 ton/ha) | J₃ (15 ton/ha) |
| V₁ = Antin 1 | 59.80         | 56.43        | 77.34          | 50.44          | 61.00 |
| V₂ = Antin 2 | 76.84         | 164.65       | 112.78         | 120.20         | 118.62 |
| V₃ = Antin 3 | 19.48         | 29.02        | 103.80         | 112.87         | 66.29 |
| Average   | 52.04         | 83.37        | 97.50          | 94.50          | 81.97 |

Description: The numbers followed by the same letters on the same line are not significantly different according to DMRT at the level of 𝛼 = 5%.

However, seen from the absolute number of tuber weights per plant in the variety factor, the best is found in the Antin variety - 2. This shows an indication that the Antin - 2 variety is more adaptive than the Antin - 1 and - 3. In the bokashi dose treatment factor, there is a tendency for application dosage the best for tuber weight per plant ranged from 10-15 tons of bokashi fertilizer/ha. On the interaction effect, the best tuber weight was found in the treatment of a combination of varieties of Antin - 2 with a 5-ton/ha bokashi rice straw. Tuber weight per plant shows differences in each variety tested according to its adaptability to the growing environment. Each plant variety has its own adaptive ability which is determined by its genetic makeup factor [3,10]. Bokashi organic matter improves soil structure, causes the soil to be light to be processed and easily penetrated by roots, increases the water holding capacity so that the ability of the soil to provide more water, increases cation capacity so that the ability to bind cations becomes higher [2,5,8]. This component will all improve the increase in tuber weight per plant.

3.3. Harvest Index

Parameters of the harvest index are significantly influenced by the variety treatment factors, while the fertilizer factor for rice straw bokashi fertilizer and the interaction of the variety treatment factors and bokashi fertilizer dosages have not given a significant effect on the harvest index parameters.

Table 3. Harvest index on the treatment of varieties and bokashi doses of rice straw

| Variety   | Bokashi straw rice dosage | Average |
|-----------|---------------------------|---------|
|           | J₀ (0 tons/ha) | J₁ (5 tons/ha) | J₂ (10 tons/ha) | J₃ (10 tons/ha) |
| V₁ = Antin 1 | 0.08           | 0.06        | 0.07          | 0.04          | 0.06c |
| V₂ = Antin 2 | 0.11           | 0.16        | 0.15          | 0.14          | 0.14a |
| V₃ = Antin 3 | 0.02           | 0.03        | 0.13          | 0.13          | 0.08b |
| Average   | 0.07           | 0.09        | 0.11          | 0.10          | 0.09 |

Description: The numbers followed by the same letters on the same line are not significantly different according to DMRT at the level of 𝛼 = 5%.

The highest harvest index for varieties based on the data in Table 3 is found in the Antin 2 and the lowest varieties found in the Antin variety 1. This shows that the production capacity is better shown by the variety Antin 2 compared to other varieties studied in this study. This difference is due to differences in genotypic factors of each variety [3,10]. For bokashi doses of rice straw, the best effect on the harvest index was found at doses of bokashi fertilizer 10 - 15 tons/ha. Whereas the best interaction was shown in the Antin 2 variety with a dose of rice straw bokashi fertilizer between 5 - 10 tons/ha. The harvest index is also related to the improvement of planting media with the provision of rice straw bokashi organic fertilizer. The tuber harvest index is better with the presence of bokashi.
compared to without the provision of bokashi. As previously explained, organic materials improve soil fertility both from the fertility of physical, chemical and biological properties of the soil such as soil moisture, the power to resist ground water, cation exchange capacity, increase macro and micro nutrients, increase soil biological activity [2, 4, 5].

3.4. Tuber production per plot

Tuber production per plot was significantly influenced by variety treatment, bokashi doses of rice straw and interaction of varieties and bokashi rice straw fertilizer doses as seen from the results of data analysis in Table 4 below.

| Variety | Bokashi straw rice dosage | Average |
|---------|--------------------------|---------|
| J₀ (0 ton/ha) | J₁ (5 ton/ha) | J₂ (10 ton/ha) | J₃ (10 ton/ha) |
| V₁ = Antin 1 | 304.23e | 310.30e | 440.01d | 285.17e | 334.93b |
| V₂ = Antin 2 | 248.89e | 908.07a | 696.83b | 304.42e | 539.55a |
| V₃ = Antin 3 | 125.57f | 112.23f | 538.80c | 554.13c | 332.68b |
| Average | 226.23c | 443.53b | 558.55a | 381.24b | 402.39 |

Description : The numbers followed by the same letters on the same line are not significantly different according to DMRT at the level of α = 5%.

In the variety treatment, the highest production per plot was shown by the Antin-2 variety while the Antin-1 and -3 varieties showed relatively the same production capability. In the treatment of rice straw bokashi fertilizer dosage, the best dosage of bokashi fertilizer for tuber production per plot ranged from 5 - 10 tons/ha. Whereas on the effect of interaction, the best tuber production per plot was found in the Antin 2 variety with a bokashi rice straw fertilization dose of 5 tons/ha where the level of tuber production reached 908.07 g/plot (4.54 tons/ha). The difference in production between varieties is highly influenced by genetic factors of each variety. In its growth the role of bokashi organic fertilizer improves soil fertility conditions. The giving of bokashi organic fertilizer in each variety can increase tuber production compared to without boocation fertilizer. Organic materials improve soil fertility both from physical, chemical and biological fertility of the soil such as cation exchange capacity, soil structure, adding nutrients, increasing soil biological activity [4, 5].

4. Conclusions

Based on the results of the study showed that the treatment of purple sweet potato varieties that provided the best tuber production was found in the Antin 2 variety with a dose of 5 tons of rice straw bokashi fertilizer/ha.

5. Recommendation

For purple sweet potato cultivation, one of the recommended varieties can use Antin 2 sweet potato variety by giving bokashi organic rice fertilizer at a dose of 5 tons/ha.

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