International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Response of Tuber Seed Size to Fertilizer on Yam Plant (*Dioscorea alata* L.)

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Abstract: ***The Dioscorea family is a carbohydrate-producing plant suitable for growing in Indonesia and the potential to be developed to support the diversification of food and energy. The Yam (Dioscorea alata* L.*) are accessible to growth and have broad adaptability in terms of altitude and latitude boundaries. In Indonesia, where the main food ingredients are rice, corn, and cassava, making the yam will not competitive with rice and cassava. The research aims to obtain optimal cultivation techniques through efficient use of seeds and fertilizing, to provide sufficient carbohydrates for bioethanol raw materials from yam. The study was carried out in the Station Research of the Faculty of Agriculture, University of Merdeka Madiun, done in the rainy season of November 2018 until July 2019. Three tuber seed sizes and four levels of fertilizer combination tested by RCBD and analysis by F-test and DMRT. No interaction between fertilizer and size of tuber seed. A combination of organic compost and NPK inorganic fertilizers showed a significant response to the increase in tuber weight and dry matter. While the size of seed tubers, the difference in size does not significantly affect the tuber yield, although there is a tendency to increase with increasing tuber weight.***

Keywords: fertilizer, optimal cultivation, tuber seed size, yam ("uwi")

1. Introduction

The demand for rice in Indonesia is increasing every year, thus creating a more considerable gap between production and consumption. The excess demand is covered by rice imports, which causes domestic rice prices to respond to global rice price movements, which are detrimental to producers and consumers [1]. Rice production is always synonymous with paddy/irrigation based agriculture, and dependence on rice causes exploitation of irrigated land so that it quickly undergoes deterioration [2]. Likewise with fossil energy sources that are increasingly depleting so that it will create an energy crisis. While the real increase of population is very contradictory to the energy needs for the next human survival, and this condition will cause food and energy fluctuations to will even experience scarcity. Therefore, it is necessary to have alternative food and energy sources through food and energy diversification.

Yam or "uwi" plants (*Dioscorea alata* L.) is one of the tuber plants that have high carbohydrates. So that the tubers can be possible as a potential food substitute for rice and as bioethanol. Dioscorea plants are quite common and grown in the tropics. Three species of Dioscorea are the staple food for more than 60 million people in five West African countries, where more than 90% of world Dioscorea production is produced in this region [3]. Whereas in Indonesia today, "uwi" or yam plants are almost forgotten and rarely found, because people do not yet know the potential of "uwi" plants. Though "uwi" has the potential as a substitute for wheat flour and also some varieties can be beneficial for health [4]. Dioscorea tubers have a variety of compounds that are beneficial to health. Uwi plants contain silver nanoparticles that function as antimicrobials [5]. In the upper tubers ("katak") of "uwi" is very good for consumption because it can be anti-inflammatory [6]. Whereas the ground tubers can function as mitogenic, antioxidant, hepatoprotective, anti-ulcer and antidiabetic activities [7].

"Uwi" plants (yam) have several advantages. The production potents of the plant can reach 40 tons ha-1, growing on broad altitude until more than 1500 asl, ranging from moist soil (swamps) to dry land and relatively tolerant of shade. Beside it, this plant generally resistant to soil born disease; tubers are relatively immune to the storage and have antioxidant and medicinal properties [8]. This plant is highly sought after in terms of nutrition and therefore requires sufficient soil fertility. Plant growth and yield are affected by many factors, including virus threat, photoperiod, and culture period [9].

Furthermore, the chemical content of 6 varieties of *D. alata* tubers shows an array of values, namely carbohydrates 20.87-31.64 percent, glucose 0.006-0.458 percent, protein 1.44-2.36 percent, fat 0.43-1.27 percent, water content 64.96-75.82 percent, ash content 0.53-1.53 percent and crude fiber 1.47-5.43 percent [10]. In addition to the analysis of tubers, Uwi tuber flour also has diverse materials, including carbohydrates 77.95-82.88 percent, water 7.77-10.66 percent, ash 2.1-3.7 percent, fat 0.12- 0.52 percent and protein 2.59-10.49 percent [11].

Uwi propagation can be done by using various sizes of seeds ranging from small, medium, and large. Compact bulbs of large bulbs have better growth compared to the others, and this is natural because thick seedlings have more carbohydrate content. However, small implants can still be used for seedlings even though they grow more slowly. This condition can be overcome by useful cultivation techniques with sufficient fertilization so that the plant can grow optimally [2]. About 30% of the tubers harvested are used in subsequent planting as seedlings, thereby reducing yields. Larger seedling bulbs indicate faster growth with higher biomass due to more rapid growth rates during the initial growth period. The tuber yield of 200 g seedlings is higher than 50 g, but the yield advantage is not enough to offset the more enormous tuber size costs. So planting 50 g seed bulbs is probably the most cost-effective. Even 50 g seed tubers produce more than 1 kg of tubers per plant. Thus, planting

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with a smaller sett can be a promising method for increasing cassava production efficiently [22].

Based on this reason, a study about "Response of Tuber Seed Size to Fertilization of Yam (*Dioscorea alata L.)"* was conducted. This research aims to determine the effect of different types of tuber seed size and applying various types of fertilizers on the growth and yield of “uwi” (yam) plants.

2. Materials and Methods

2.1 Place and Time

The study conducted in the station research of the Faculty of Agriculture, Merdeka Madiun University, at an altitude of 63 m above sea level. The experiment held in November 2018 until July 2019.

2.2 Materials and tools

Materials needed include Uwi tuber of *Dioscorea alata*, soil media, cow manure, NPK “Mutiara” fertilizer. The equipment used includes polybags, bamboo propagators, earth moving equipment, ovens, as well as measuring devices of length and weight.

2.3 Research Methods

The study used a factorial randomized block design (RCBD) consisting of 2 (two) factors.
The first factor in fertilizer composition consists of four levels:
P1: Control treatment (no fertilizer)
P2: Cow manure fertilizer of ½ kg/plant
P3: NPK fertilizer of 5 g/plant
P4: ½ kg cow manure and 5 g NPK fertilizer/plant

Second factor: The weight size of the seed tuber consists of 3 levels:
U1: 50 g
U2: 100 g
U3: 200 g

2.4 Research practices

2.4.1 Nursery seedlings
Before being cut, tubers selected which have taken a uniform size/diameter. Seedlings that have cut according to treatment are planted in the nursery media, using husk media placed in the nursery container and placed in the greenhouse. To keep the moisture watering every day so the shoots can grow.

2.4.2 Planting
Planting is done when the seeds have rinsed for three weeks, and buds have appeared. Tuber seed planted in the polybags with 40 cm x 45 cm x 40 cm size with immersed in the soil about 5 to 10 cm from the surface. Then, it covered with soil and watered until all the media is moist.

2.4.3 Treatment applications
Giving cow manure is done simultaneously in the manufacture of planting media in accordance with the treatment by mixing manure with soil. Whereas in the NPK “Mutiara” fertilizer application is given four times of application, starting at the age of two weeks at intervals once a month.

2.4.4 Plant mMaintenance
"Uwi" plants that have grown are watered by looking at the condition of the plants and cleaning weeds that grow around the plants by pulling out the growing weeds. Control of pests and diseases is not done, considering there are no significant pests and diseases.

2.4.5 Harvesting
"Uwi" plants can be harvested at the age of 7 months or when the leaves have yellowed, fallen, and the tree begins to dry. Planting using polybags makes it easy to harvest because tubers gather inside the polybags.

3. Result and Discussion

The analysis showed that there was no interaction between fertilizer type factor and seedling weight of all observed parameters. These indicate that the size of the seeds from the tubers gives the same response to all fertilizer tratments. The results of the analysis on the main effect of each observation shows, as mention, follows. Based on figure 1 shows that the fertilizer treatment (P) has the highest average value in the treatment of cow manure and NPK fertilizer (P4) but not significantly different in the parameter of the branches number, the number of leaves, leaf area, fresh stover weight and weight of the tuber. Those show that the combination of cow manure and NPK fertilizer can produce maximum growth and yield of yam plants compared to other fertilizer treatments. As mention in other studies, the application of organic and inorganic fertilizers can significantly increase the average of yam's tuber growth at the age of four months after planting compared to controls [12].

3.1. Growth of plant length

From figure 1, it can be seen that the growth of plant length increased significantly after the plant was 59 days after planting, showing that the "uwi"/yam plant showed vegetative growth quickly after two months of age, where plant roots were optimal for absorbing plant nutrients. It means that fertilizing action will be more effective applied at that age to support the rapid growth of the plant. In this condition, the water need can be supply enough from rainwater in the middle of the rainy season.

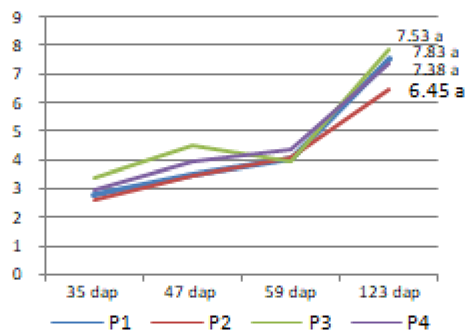

Figure 1: Development of the plant length (m) effect of fertilization. dap= days after planting

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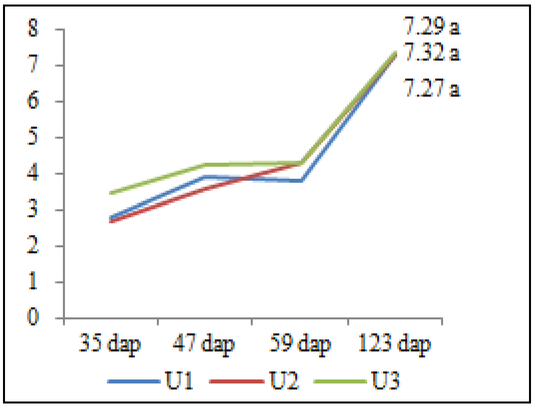

Figure 1: Development of the plant length (m) effect of seed tubers size. dap= days after planting

4.1 Branch number, leave's number, and leave's area

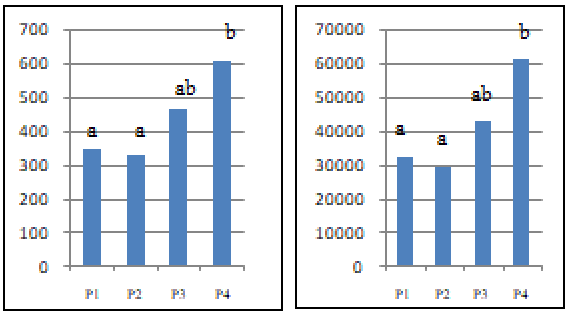

Figure 3: Effect of fertilizer to number of leaves (left) and leaves area (right, cm^2)

4.2 Fresh weight and dry weight

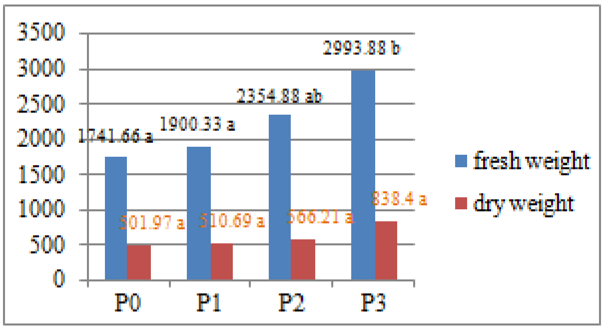

Figure 4: Effect of fertilizer on fresh and dry weight of plant (g)

4.3 Yield of tubers

Figure 4 shows that without fertilizing plants are still able to provide the same growth and yields with organic fertilization. This shows that uwi plants are relatively resistant to critical land conditions. Growth and yield increase in line with the addition of NPK fertilizers indicate that the uwi plant also responds only to the addition of nutrient elements.

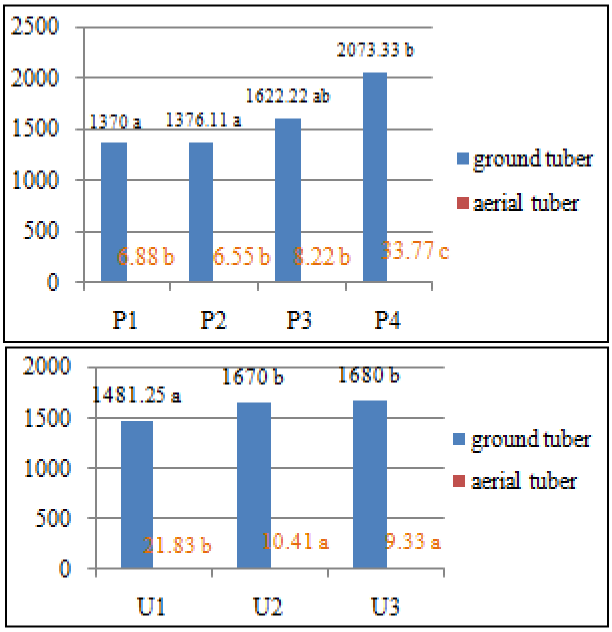

Figure 5: Effect of fertilizer (top) and size of tuber seed (bottom) on ground tuber and aerial tuber weight (g)

The content of N elements is very influential in influencing the vegetative growth of "uwi" plants [13]. The N element functions as a constituent of enzyme molecules, protein synthesis, and carbohydrate metabolism, while phosphorus plays a role in plant metabolism [14]. Increased chlorophyll will encourage the formation of photosynthates, which are more active in transferring energy in plant cells. Furthermore, this condition will be even more significant in supporting cell division and differentiation, which have a direct impact on the growth and development of plant organs [15]. Element K can also function to form and stimulate plant growth. It was also seen that plant growth increased rapidly after two months of age. In this period, nutrients availability was sufficient, supported by the development of roots and the availability of enough water so that there was an increase in nutrient absorption for growth.

Furthermore, this growth has an impact on optimally increasing the tuber weight, as is the case with other tuber plants [16]. Organic fertilizer plays a role in improving soil physical properties so that the availability and nutrient uptake becomes more optimal. Also, organic fertilizer can help increase root activity and accelerate the speed of photosynthesis to produce better growth [17].

The size of the tuber does not affect plant growth, indicating that the tuber food reserves are only to support budding and early growth. After growing roots and leaves, growth entirely determined by the rate of photosynthesis. For the small tuber size, there is a tendency increase to form the aerial tubers so that the weight of the ground tubers decreases. Tubers are sinks of photosynthesis product, and these are a characteristic of all tuber plants. If the development of the dominant tuber is dominant, then the development of the tuber will undoubtedly decrease. The absence of a tuber size effect on plant growth, making this plant can be propagated quite easily using tubers. However, the lower tuber weight in small seed sizes, there is a tendency to limit specific tuber sizes so that plants can grow optimally. The other studies showed that the mini set of

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sweet potato (50-59 g) gives the same growth performance. The significant effect shown in shoot height and thickness, the number of segments and leaf width macro set yam (150-200 g). Thus the mini set of "uwi" bulbs shows great potential for seed production, which can be used for further yam production or direct consumption [21]. The results of other studies indicate that planting 50 g tubers is more cost-effective and can produce more than 1 kg of tubers per plant. Thus, planting with a smaller sett can be a promising method for increasing cassava production efficiently, in line with other studies for the same commodity [22].

Figure 6: Sample of plant and it's tubers

4. Conclusion

The difference in fertilization does not give a different response to the kind of tuber seed size on growth and yield of yam ("uwi") plants. Effect of the main factor, the combination of cow manure and NPK "Mutiara" significantly produce and increase the growth and yield of Yam, whereas the variety of tuber seed size does not have a significant effect on the growth and yield of Yam.

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