The Appropriate of Plant Propagation Technology of Yam (Dioscorea alata L) to Reduce Multiplication Ratio

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Abstract. Plant propagation of yam (Dioscorea alata L) variety ubi putih is the one of cultivation technology to conserve the plant. Propagation of D.alata can use seed, stem sett, whole tuber, tissue culture, and small sett tuber. The choose of appropriate plant propagation can reduce propagation ratio is the important thing. Although the plant has significant potential aspect, the multiplication ratio is high. Farmers usually use the whole tuber to yield favorable tuber. Using small sett tuber is the appropriate plant propagation. Reducing the multiplication ratio of D.alata is the goal of this study. The research method used two treatment factors namely the weight of tuber cuttings and tuber cuttings part. The weight of tuber cuttings used was 10-15 g; 20-25 g; 30-35 g; 40-45 g; 50-55 g. Tuber cuttings consist of the base, middle, and tail. These treatments are arranged in a two-factor factorial design. The tuber cuttings were planted with a spacing of 80 cm X 80 cm on beds with an area of 2.40 m × 2.40 m, and were repeated three times. Each bed is planted with 16 tuber cuttings. The result shows that the small sett tuber can reduce the multiplication ratio of D.alata. Sett tuber 50-55 g get the highest yield tuber (2158g) and multiplication ratio 0.023.

1. Introduction
Yam (Dioscorea alata L) is one type of tuber crops that have not received special attention from the government and researchers in Indonesia. This is indicated by production data from these plants which are not covered specifically such as cassava, sweet potato, and potato. Data on the production of D.alata L. tubers has not been found in Indonesian Year Book. However, D.alata plants grow and are cultivated in almost all islands in Indonesia. The tropical climate in Indonesian region, which is favorable for the growth of D.alata L. and enables an even distribution of the plant over the archipelago from the far west (Sumatera Island) until far east (Papua), additionally convinces the potential aspect of D.alata on the primary food source in the nation (Sastraprja, et al., 1981 in [1-4]. The Luwuk Banggai Islands in Sulawesi consume D.alata tubers as a staple food. Some of the islands of Maluku and Papua also consume D.alata L. tubers as the staple food. If climatic conditions and cultivation techniques are right, tuber production can reach 61 tons ha⁻¹ [5].

Despite the significant potential aspects of D.alata, the multiplication ratio of the plant has not been optimal compared to the rice. For instance, the multiplication ratio of D.alata L. is only 0.2 which is far larger than that of potato 0.1 [6-7]. The higher multiplication ratio of D.alata is probably caused by the conventional method of multiplication commonly used by Indonesian farmers in which they usually utilize the whole tuber of the plant (~200-500 gram weight) to be seed or use the head.
section of the tuber where shoots appear which is also heavy. However, this ratio can be reduced by alternatively considering the usage of a small portion of the tuber from the middle and tail sections of the tuber. The main issue in cultivating *D. alata* is the higher Multiplication Ratio (MR) of the plant as compared to other plants. The higher MR of *D. alata* is caused by the conventional method. However, it is thought to be possible that the higher MR of *D. alata* can be reduced by considering the usage of mini seed which can be obtained from all sides of the tuber (i.e. the head, middle and tail sections). This proposed approach was based on the fact that each surface of tuber skin can be stimulated to produce shoot to develop to be a new plant [8]. This approach was proposed to reduce the higher MR of the plant and also to help farmers to sustain their production.

The results of the analysis of nutrient composition carried out by the United States Ministry of Agriculture on tubers *D. alata* L. in one hundred grams of edible material are: 74% water 2.1 g protein 101 kcal energy 0.2 g fat, 1 mg ash, 20 mg calcium 20 mg, 69 mg phosphorus, 0.6 mg iron, 600 mg potassium, 0.1 mg thiamine, 0.04 mg riboflavin, niacin 0.5 mg, and ascorbic acid 9 mg [9]. Utilization of *D. alata* L. tubers in addition to being food, it is also used as feed ingredients, even in the Philippines, it has been processed as an ice cream coloring agent. *D. alata* L. Tubers can be processed into intermediate materials for industrial raw materials and alcohol production [10].

2. Experimental

2.1 Experiment detail
The experiments were conducted in Ambon May 2018 – January 2019. Yams were divided of the head, middle, and tail portion. Yams were divided of the head, middle, and tail portion. The portion was cut to a small section. The section consist of 10-15 g; 20-25 g; 30-35 g; 40-45 g; 50-55 g.

2.2 Plantation and Observation
The Sett was planted on field experiment mostly at the surface depth. Watering with a watering can once each day to maintain the humidity of the soil and to accelerate the growth. To protect the plant from pathogens, Furadan 3g was used on the plantation days around the sett and sprayed insecticide Desis according to dosage recommendation.

2.3 Observed Parameters.
Variable of observation was weight of fresh tubers. Measured this variable using a digital scale. The weight of fresh tuber is the most important to count the multiplication ratio.

2.4 Data analysis
Observation result to count the multiplication ratio using simple mathematics.

3. Results and Discussion
The use of stem cuttings as propagation material has a low success rate when applied to farmers. The use of tubers as propagation material is the right choice that can be applied at the farm level. Whole tubers are used as propagation material, will produce a high propagation ratio, for example, tuber production of 12 tons ha-1 will be set aside about 2 tons for propagation material. The ratio of multiplication from the use of whole tubers is 2/12 = 0.16. This value is very high as the value of the ratio of propagation. High propagation ratio makes it difficult for farmers to provide planting material. Results from this study are presented in Table 1.
Table 1. Sett section and weight sett to get multiplication ratio

| Sett tuber section | Sett tuber weigh (g) | Fresh tuber plant (g) (yield) | Multiplication Ratio (MR) = sett tuber weight x fresh tuber |
|--------------------|----------------------|-------------------------------|------------------------------------------------------------|
| head               | 10-15                | 1205                          | 0.012                                                      |
|                    | 20-25                | 1670                          | 0.015                                                      |
|                    | 30-35                | 1797                          | 0.018                                                      |
|                    | 40-45                | 2158                          | 0.022                                                      |
|                    | 50-55                | 2415                          | 0.023                                                      |
| middle             | 10-15                | 1185                          | 0.013                                                      |
|                    | 20-25                | 1650                          | 0.015                                                      |
|                    | 30-35                | 1619                          | 0.018                                                      |
|                    | 40-45                | 1707                          | 0.023                                                      |
|                    | 50-55                | 1890                          | 0.026                                                      |
| tail               | 10-15                | 1055                          | 0.014                                                      |
|                    | 20-25                | 1590                          | 0.016                                                      |
|                    | 25-30                | 1608                          | 0.018                                                      |
|                    | 35-40                | 1112                          | 0.035                                                      |
|                    | 50-55                | 1510                          | 0.033                                                      |

Table 1. Shows that the use of tuber cuttings from the base to the tip can be used as plant propagation material. Weights from 10-15 g up to 50-55 g can be used as planting material. Results in Table 1. Shows that the results obtained for each section of tuber cuttings and tuber cuttings weight differ. Fresh tuber weights were obtained at the end treatment with a value of 2415 g plant⁻¹, compared to other treatments. But the value of the multiplication ratio can be the same as other treatments, but the results are still higher. The highest yield of fresh tubers with a low propagation ratio is the most appropriate.

This difficulty will reduce the interest of farmers to cultivate these crops. Therefore the value of the multiplication ratio needs to be reduced to produce a small multiplication ratio but produces an optimal tuber production (fair sale value), so that it is economically profitable. The results of the research reported by [8] that the value of the ratio of multiplication 0.2. This was also confirmed by [7]. Thus the weight of tuber cuttings can be reduced by assuming that the crop hormone content[12] can play a role in stimulating latent shoots to grow into shoots and develop into whole plants. The results of studies that have been reported that the use of tubers 25-50 g can significantly reduce the multiplication ratio [11-12]. Therefore, the multiplication ratio calculation can be done for each section with different weights.

The difference in hormone content in each part of the tuber setts shows that the movement of each hormone in the plant body is different or uneven so that the accumulation of the tubers is also different. The movement of hormones that occur in the plant follows the acropetal pattern, which is the hormone that is synthesized at the tips of the roots (meristem roots) will move towards the top of the plant, while the hormones that are synthesized at the tips of the shoots will move towards the bottom of the plant including the roots (basipetal) [13]. This difference in content causes the potential for each part of the tuber to have the speed to shoot out also different.

So far, the cultivation of D.alata L. uses whole tubers as material or seeds to be planted again. Generally, tubers that have sprouted are used as replanting material. Buds that appear on the tuber
usually begin at the base. When the tubers begin to germinate during storage, they indicate that the tubers can be planted. In addition to using whole tubers, usually the tubers at the base of the buds are taken to be planted. The weight of the tuber pieces (tuber cuttings) taken from whole tubers is usually 200-500 grams. The length of the tuber buds and tuber cuttings at the base when planted is not less than 10 cm.

The phenomenon of the emergence of shoots at the base of the tubers will cause apical dominance, so that the buds (latent shoots) that spread on each surface of the tuber skin are not able to appear as new shoots [7]. These latent shoots that do not appear will shoot out if apical dominance is removed. Removal of apical dominance is done by cutting the tubers into cuttings so that other parts of the tuber besides the base can also shoot out. The speed of release of shoots from each part of the cuttings of these tubers is different because of the different composition of hormone content. The hormone content in the tubers is related to the size of the propagation material that can be used to reduce the multiplication ratio. D.alata L. tuber production is very high and varied (10-60 tons ha\(^{-1}\)) depending on the planting area and cultivation techniques.

In general, D.alata L. can be propagated generatively using seeds and vegetatively using plant parts other than seeds. The use of seeds as propagation material is usually done for the benefit of plant breeding. The use of seeds usually requires a longer time from preaching to harvest than using tubers. Vegetative propagation usually uses bulbs. The use of tubers as propagation material that is whole tubers, micro tubers engineered by plant tissue culture laboratory, and pieces of tubers or tuber cuttings. Whole tubers and tuber cuttings are generally applied at the farm level. Thus, in the tuber budding process, the base that shoots out more quickly will compress other parts so that it cannot produce buds, even though the anatomy of the D.alata bulbs shows that on each surface of the tuber skin there are growing points (latent buds) that are able to produce new shoots if physiological conditions allow. The technique for reducing apical dominance contained in the tubers is to use tuber pieces called tuber cuttings. Tuber cuttings allow latent shoots that do not germinate to produce new shoots. Each growth point (future shoot) contained in the tuber cuttings will germinate due to the content of several growth hormones that can spur the germination (Figure 1.). The hormone content of the D.alata L. tubers (Figure 1) allows small tuber cuttings (10-50 g) to be stimulated to grow to produce new shoots and develop into perfect plants.

The presence of auxin in all sections of the D.alata’s tuber indicates the potential aspects of the sections to produce new individuals e.g. the growth of shoots. Auxin has been reported by previous studies to play a significant role to directly influence the growth of shoots [14-15]. As a result, the usage of all sections in multiplying D.alata should need to be taken into account and is likely to reduce the larger value of the multiplication ratio of D.alata due to the usage of the whole tuber. Apart from the results of the analysis that has been known that gibberellin is contained in the tuber, also found bad other parts of the plant. Plant parts that contain gibberellins, namely internod, petiol, leaves that are still developing, apical stems, fruit, and seeds that are developing, as well as in germination of seeds and tubers [16]. Gibberellins are also thought to be a hormone that is important in embryo germination [16-17]. Furthermore, states that gibberellin’s biosynthesis occurs in plant tissues that experience growth and differentiation. In addition to auxin contained in D.alata L. tuber cuttings, gibberellins are also found at the base of tuber cuttings [18]. Gibberellins are solutions that regulate various processes in plants, such as seed germination, leaf growth, and flower and fruit development [16-19]. In this role, gibberellins spur RNA transcription and spur cell development [20]. Therefore the role of gibberellin is very important in the formation of shoots and plant development.

4. Conclusion
The different size of sett tuber can yield the difference multiplication ratio. Sett tuber 45-50g get the highest yield tuber (2158g) and multiplication ratio 0.023.
Acknowledgement
We acknowledge the support from The Faculty of Agriculture of Pattimura University in facilitating the use of field experiments. We also thanks to The Departement of Agriculture for their support to conduct this research.

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