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THE GROWTH OF SETT OF *DISCOREA ALATA* ORIGINATED FROM SECTION OF TUBER WITH DIFFERENT SETT SIZE

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ABSTRACT

Plant prograpagation of *Discorea alata* generally uses whole tuber of *D. alata* with weight of 100-500 g. this can produce multiplication ratio of this plant of 0.2 -1. The usage of small portion of the tuber will reduce this higher ratio. The current study aims to reduce this higher ratio using small portion of the tuber from the head, middle and tail sections with the weight of 25-50 g. the results show that the usage of these small portions reduce the multiplication ratio to be 0.025-0.03.

INTRODUCTION

Dioscorea spp. is tuber plant which has many cultivars. The plant is the source of carbohydrate in tropical and sub-tropical areas (Okibo & Nmeka, 2005). The nutrient analysis conducted by Agricultural Department of the US on this plant show that it contains 74% water, 2.1 g protein, 101 kkal energy, 0.2 g fat, 1 mg ash, 20 mg Ca, 69 mg P, 0.6 mg iron, 600 mg K, 0.1 mg thiamin, 0.04 mg riboflavin, 0.5 mg niasin, and 9 mg ascorbat acid (Horton, 1988). Additionally, Baah *et al*. (2009) reported that 1 mg/kg *D. alata* flour contains 71.8 water, 28.2 dry material, 5.9 protein, 3.5 ash 5.8 glucose, 68.4 carbohydrate, 1535.7 P, 328.8 Ca, 474.1 Mg, 15334.4 K, 106.9 Na, 11.7 Mn, 14.1 copper dan 12.2 Zn.

Behera *et al.* (2009) showed that the potential of *D. alata L* can reach up

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to 61 ton/ha. Although this plant has significant potential aspect, the multiplication ratio (MR) of this plant is high. The MR of *D. alata* is 0.2 (Asea *et al.*, 2010; Onwueme, 1978) which is higher than potato (0.1) (Hillary, 2014). This higher MR is thought to be possible due to conventional method used in the plant propagation of this plant.

The plant propagation of *D. alata* L. uses parts of tuber usually for human consumption while cassava and sweet potatoe use their stem which are not for the consumption. Generally, farmers conduct the plant propagation using larger portion of the whole tuber (200-500 g) while they only save 20% of their harvest for the next plant propagation (Onwueme, 1978). Besides using the larger portion of tuber, head section is also used for the sett (Balogun *et al*., 2014). However, the MR of the plant seems to be reduced using small portion of the tuber (50 g) such as middle section and tail section. This is because all parts of the tuber are potential to produce new individuals (Onwueme, 1978) as they also contain growth hormones (Walsen *et al*., 2016).

The goal of this study is to obtain the optimal mini tuber of *D. alata* L. to produce high quality growth of new individuals and to reduce the MR.

METHODS

a. *Experiment design*

The experiments conducted using completely randomized design. The first factor assessed was sett tuber (**S**) consisting of head section (**S_1**), middle section (**S_2**) and tail section (**S_3**). The second was weight sett (**B**) including 25-30 g (**B_1**), 35-40 g (**B_2**) and 45-50 g (**B_3**). All combinations were iterated three times: **S_1B_1; S_1B_2; S_1B_3; S_2B_1; S_2B_2; S_2B_3;S_3B_1; S_3B_2; S_3B_3.**

b. *Experiment details*

The experiments were conducted in green house of Agricultural Faculty of Gadjah Mada University on January and April 2016. Plastic boxes for plantation media had a dimension of 64 cm X 44 cm X 38 cm. The plastic media were filled with regosol soil and were placed with a distance of 30 cm per box. The setts of *D. alata* L. were prepared by mixing with **ash** mixed with Dithane M-45 to protect the setts from fungi.

c. *Plantation and observation*

Setts were planted in the plastic boxes mostly at the surface depth. Watering with soft spray was done once each day to maintain the humidity of the soil and to accelerate the growth. To protect setts from pathogen, Furadan 3G was used on the plantation days around the setts. Weeds were remove regularly.

d. *Harvest*

Harvest was done for sett plant with age around 2 months due to the 100% appearance of shoots

e. *Observed parameters*

Variable of observation were (1) indeks rate sprouting (IRS) were multiplication between days that sprouting of sett and sett sproutingn on same days then general sum. As mathematical formula is Index of Rate Growth : IRG = 1/a.X1+1/bX2+1/cX3 where a, b, c were days of observation, X1, X2, X3 were sum of sett sprouting (Byrd, 1978), (2) fotosintesis rate, use licor 6000. (3) length of sprout (4) root area, use area meter, (5) weight of fresh tubers used digital scale, (6) tuber diameter, measured on middle of tuber by vernikel cliper, (7) length tuber, measured by gauge.

f. *Analysis data*

Observation results were assessed using variance assessment (Steel dan Torrie, 1981) and Duncans's new multiple range test at 5 % level. The analysis software for this assessment was SAS versi 9.3.

RESULT AND DISCUSSION

Results from this study are presented in Tables 1 – 4. In Table 1, Index of Growth Rate, photosynthesis rate and plant height are presented.

Table 1. Index of Growth Rate, photosynthesis rate and plant height for weight Of sett tuber treatment.

Tuber section for sett	Index of Growth Rate	Photosynthesis rate (µmol $CO_2 m^{-2} s^{-1}$)	Plant height (cm)
Head	4.70 a	151.44 a	136.66 a
Middle	4.05 b	148.00 b	118.35 b
Tail	4.10 b	145.44 c	110.83 c
Weight of sett tuber (g)			
25-30	4.00 q	145.67 q	115.37 r
35-40	4.25 q	147.22 q	121,04 q
45-50	4.61 p	152.00 p	129.44 p
Interaction	(-)	(-)	(-)

Note : Mean followed by same letters in the same column were not significantly different by Duncans's new multiple range test at 5 % level

Index of Growth Rate in Table 1 shows that there is no interaction between treatments of using sett tuber and weight of the sett tuber. The index shows that head section of the sett tuber stimulate the index (4.7) higher than that found at the middle and tail sections. This indicates the influence of significant growth hormone contents, protein and carbohydrate at the head section (Walsen, *et al.*, 2016).

The treatment of sett tuber with weights of 45-50 g and 35-40 g do not have a significant Index of Rate Sprouting difference but do have to that of 25-30 g. This difference is due to the bigger size containing more reserved nutrition. This happens as decomposition of carbohydrate by alfa amilase enzyme to be starch occur prior to the emergence of shoot.

The rate of photosynthesis occurs on the sett originally form head section is higher than the rest sections (Table 1). In addition, the larger size of sett also produces the highest rate of photosynthesis (Table 1). Therefore, the head section with larger size produce a rapid growth of shoot. This phenomena is supported by the study of Walsen *et al.*, (2016) in terms of the concentration of hormone in the head section with larger size. In addition, Table 1 shows the variation in the plant' height. Higher plant (136.66 cm) was produced by sett from head section
of the tuber.

Figure 1. Shoot from S_1B_1 (head section 25-30 g); S_1B_2 (head section 35-40 g); S_1B_3 (head section 45-50 g); S_2B_1 (middle section 25-30 g); S_2B_2 (middle section 35- 40 g); S_2B_3 (middle section 45-50 g); S_3B_1(tail section 25-30 g); S_3B_2 (tail section 35-40 g); S_3B_3 (tail section 45-50 g)

Figure 1 shows that S_1B_3 produce the best shoot. This is supported by the fact that in this treatment, the carbohydrate and protein contents in this treatment is the most abundant.

Table 2. Area of root (mm^2) due to the treatment of using sett sections and sett weight of *D. alata* L.

Sett weight (g)	Sett section						Mean
	head		middle		tail		
25-30	41,97	d	33,45	e	26,10	f	33,84
35-40	56,31	b	39,73	d	40,62	d	45,55
45-50	64,9	a	47,41	c	43,79	cd	52,03
Mean	54,39		40,20		36,84		(+)

Note : Mean followed by same letters in the same column were not significantly different by Duncans's new multiple range test at 5 % level

Table 2 shows that there is an interaction between sett tuber and sett tuber towards root area. This phenomena indicates that two treatments determines root area. The use of sett from head section of the tuber with larger size produces the largest root area. This pattern is also supported by the use of sett from middle and tail sections. The more size of root area, the more effective the nutrient can be absorbed to the plant.

Table 3. Wet weight of sett due to the treatment of using sett sections and sett weight of *D. alata* L.

Sett weight (g)	Sett section						Mean
	head		middle		tail		
25-30	7,58	ef	4,81	g	6,87	fg	6,42
35-40	15,51	b	10,76	cd	12,1	c	12,79
45-50	20,05	a	11,69	cd	9,51	d	13,75
Mean	14.38		9.09		9,49		(+)

Note : Mean followed by same letters in the same column were not significantly different by Duncans's new multiple range test at 5 % level

Table 3 shows that that there is an interaction between sett tuber and sett tuber towards the wet weight of the tuber. The use of sett from head section of the tuber produces the heaviest tuber.

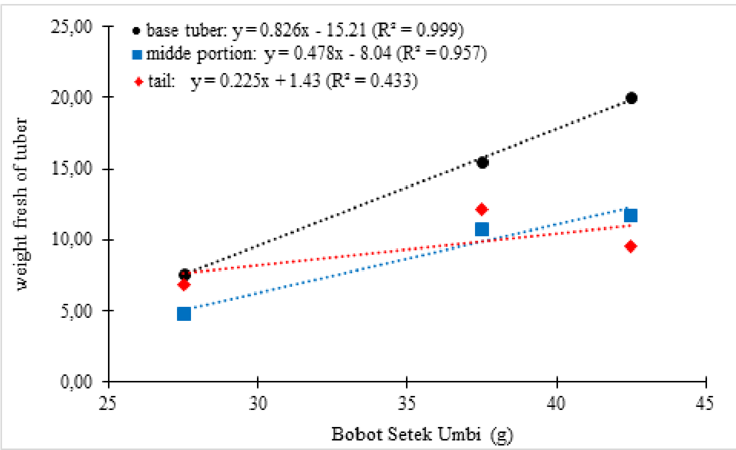

Figure 2. The relationship between weight of sett tuber and the weight of fresh tuber.

Figure 2 shows a linear relationship between weight of fresh tuber and weight of sett tuber. The diameter and length of tuber produced by treatments in this work are shown by Table 4.

Table 4. Diameter and length tuber produced by treatments in this work.

Tuber section	Diameter of tuber (cm)	Tuber length (cm)
Head	3.20 a	4.35 a
Middle	2.52 b	3.29 b
Tail	2.20 c	3.01 b
Weight of sett tuber (g)		
25-30	2.82 q	2.82 r
35-40	3.81 p	3.81 q
45-50	4.02 p	4.02 p
Interaction	(-)	(-)

Note : Mean followed by same letters in the same column were not significantly different by Duncans's new multiple range test at 5 % level

Table 4 shows that the treatment of sett from head section of tuber produces largest diameter. In addition, the larger size of sett tuber produces also the largest diameter (Table 4). In terms of the tuber size as plants grow, the largest sett tuber (45-50 g) produce the largest tuber. This indicates that the growth of *D. alata L.* is supported by the available food within the sett tuber. This food functions to stimulate adequate growth.

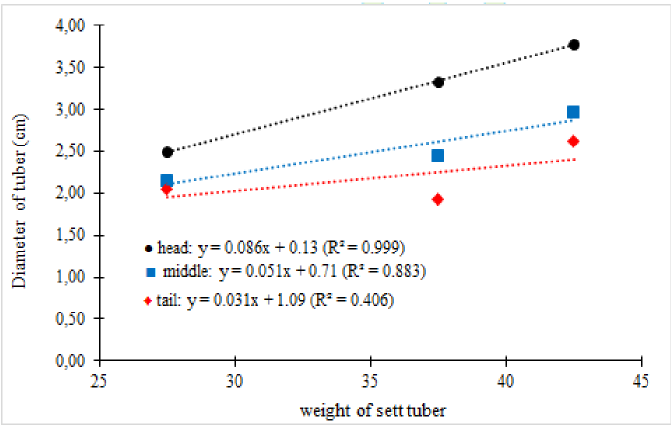

Figure 3. The weight of sett tuber vs the diameter of produced tuber

Figure 3 shows a linear relationship between the weight of sett tuber and the produced tuber. The larger size of sett tuber is used, the larger diameter of tuber will be produced.

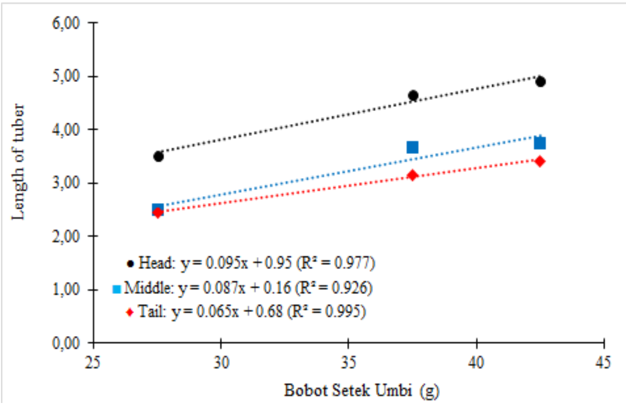

Figure 4. Weight of sett tuber vs length of tuber.

Figure 4 illustrates a linear relationship between the weight of sett tuber and the length of produced tuber. It is shown that the sett obtained from the head section of the tuber produce the longest tuber.

General Discussion

This research reports that sett tuber of *D. alata* obtained from head section produces the optimal results of tuber. This is due to the content of growth hormone within this part (Walsen, *et al*., 2016). The difference in the hormone found in all sections of the tuber show the accumulation of the hormone distributed variously within the sections. This leads to the variation in the rate of growth including the production of shoot.

The shoot emerging from head section of the whole tuber occurs due to apical domination which thus, produce latent shoot (Onwueme, 1978). These latent shoots can appear as the apical domination is removed. The removal of the apica domination can be done by cutting the whole tuber to be small size (hence, sett tuber) so that all sections of the tuber can produce shoots. The rate of shoot growth from each section of the tuber being cutted differs due to the variation in the hormone contents within these sections.

Analysis hormone of growth can be an important reference for the application on other plants. Once the proximate and hormone analysis are known, this analysis can be the reference.

Hormones contained in the tuber have two movements: basipetal (from leaf to root) and acropetal (the inverse). This movement is related to the characteristics of the hormones themselves. This movement leads to the accumulation of hormones from these two movements occurring at the head section of the tuber which thus, causes the high possibility of shoot for emmerging from this section.

The presence of apicalist domination on the head section causes some shoot points are constrained since there will be rapid cell division which thus produces growth hormone that support the shoots. The treated shoot on tuber is shown by Figure 1.

Besides the higher growth hormones found at the head section of tuber, the protein and carbohydrate are also found significant at this location. This, hence, stimulates the growth of shoot very rapid compared to other sections of the tuber and this has been proven through Index of Rate Sprouting. In Table 1, this rate was found higher for the head section of tuber despite the insignificant statistical difference. This higher rate of growth on the head section of tuber causes rapid synthesis of food within this location which is essential for shoot and for root which is to absorb water and nutrient from soil.

Auxin is well-known growth hormone and is in the form of indole acetic acid. In plants, this hormone is produced from tryptophan. The synthesis of auxin occurs in young leaves and sett (Bandurski *et al*., 1995; Normanly *et al*., 1995; Naqvi, 1999). In general, auxin plays a significant role in the length of cell as it stimulates cation H^+ from cell to the wall of cell. Cation stimulates the enzyme activities which break molecule bonds of celulose which leads to the inflow of water into vacuolamaka cell and this will extend the length of cell (Taiz dan Zieger, 2006). Besides this, auxis also contributes to the growth of plants. In the growth of setts, auxin contributes to the form of meristem apical of the stem and root (Miller dan Walsh, 1990; Grierson, 1995). Besides this hormone, giberaline is also found in the head section of the tuber.

Giberaline is found in the tuber and other parts of plants including internod, petiol, growing leaves, apical stem, fruits and growing setts (Sponcel 1995 *cit*. Olszewski, 2002). Besides containing auxin and giberalin, tuber of *D. alata* also contains cytokinin in the form of zeatin and kinetin. Biosynthesis of cytokinin is controlled by enzyme isipentenyl transferase. The genetical expression of this enzyme is strongly evident within the root. This is in line with the analysis conducted on *D. alata* in association with the form of tuber within soil as nutrient is supplied from root to tuber. Cytokinin is also well-known for controlling cell division process and its differentiation (Takei *et al*., 2001; Sun *et al*., 2003). Cytokinin also contributes to prevent the aging process and to stimulate the growth of lateral shoot.

CONCLUSION

Conclusion of this research is that we have shown the combination between sett obtained from head section of tuber with largest weight (45-50 g) produces an optimal shoot

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