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Growth and Production of *Amorphophallus paeoniifolius* Dennst. Nicolson from Different Corm Weights

Edi Santosa[1*] and Nobuo Sugiyama[2]

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ABSTRACT

The effect of different seed corm weight on the growth and production of elephant foot yams (*Amorphophallus paeonifolius* Dennst. Nicolson) were studied. Two forms of corm with same weight were prepared, i.e., whole corm and vertically sectioned by 1/2. The fresh mass of each whole corm and corm section was the same. Six different corm weights were compared, i.e., 50, 100, 200, 500, 1000 and 2000 g. Growth and development of elephant foot yam were determined by corm weigth, large seed corm produced larger leaf and fresh mass of daughter corms. On the contrary, number of leaf decreased with increasing seed corm weight. Plants from whole seed corms emerged earlier and they were larger than those from the sectioned corms, irrespective of weight. Plants from small sized whole corm emerged earlier than the larger ones. Dissecting the main bud caused the development of lateral buds, resulted in a delay of leaf emergence. The lower yield obtained by the use of sections might be related to the late emergence leading to shorter vegetative period in the field. In the cultivation, it is recommended to use whole seed corms of 100 or 200 g.

Key words : Elephant foot yams, tuber crop, Araceae, corm weight, tuberization rate

INTRODUCTION

Elephant foot yams (*Amorphophallus paeoniifolius* Dennstedt-Nicolson, synonym of *A. campanulatus* Decaisne) is locally used as staple food in many Asian countries (Jansen *et al*., 1996). In Indonesia, elephant foot yam is commonly grown in homegardens, upland and edge of lowland paddy fields (Santosa *et al*., 2002). Rural people in Sumatra, Java, Madura, Bali, Lombok and Sulawesi consume the corms and young leaves as vegetable occasionally. In urban areas, the plants usually grow wild and can be found in damped areas, cemeteries or on abandoned lands at elevation of 0-900 m above sea level.

Elephant foot yams is a potential new cash crop because the tuber contain high starch (O'hair and Asokan, 1986). Regarding food security program in Indonesia, the elephant foot yam is prospective as an alternative food source particularly in drought prone areas with frequent lack of cereal production. Furthermore, Ermiani and Laksmanaharja (1996) stated that elephant foot yam is potential as raw material for industries. Sen *et al*. (1996) and Santosa *et al*. (2006) stated that the plant is adaptive to low light intensity therefore it is suitable to be grown under intercropping or multiple cropping system. Santosa *et al*. (2003) noted that increasing productivity is essential since the average productivity is still low compared with its potential.

In the cultivation, farmers prefer large corms as planting materials because such corms can produce large daughter corms (Sen *et al*., 1996; Das *et al*., 1997). Nutrient reserved in the seed corms determines growth and development in many tuberous plants such as *A. konjac* (Miura and Watanabe, 1985; Yokoi *et al*., 1991, Inaba, 1992), *Dioscorea* sp. (Onwueme, 1973) and *Colocasia* sp. (El-Habbasa *et al*., 1976; Wilson and Siemonsma, 1996). In *Amorphophallus*, using small corm or cormels, the daughter corms reach harvestable size (about 1 kg or heavier) at 3–4 years after planting (Jansen *et al*., 1996). Soemono *et al*. (1986) evaluated seed corms of 25 to 150 g, and she pointed out that vegetative growth of elephant foot yam was affected by seed corm weight; larger seed corms produced larger plants. However, Sen *et al*. (1996) found out that it was not easy to provide a large number of large sized seed corms as planting material. Therefore, pieces of large corm are often used as planting materials instead of whole corms. The aim of the present study was to evaluate the effect of different corm weight on the growth and production of *A. paeoniifolius*.

MATERIALS AND METHODS

The experiment was carried out in the field of the Cikabayan Experimental Farm, University Farm, Bogor Agricultural University, Indonesia (6°36'S; 106°48'E;

[1] Departement of Agronomy and Horticulture, Faculty of Agriculture, Bogor Agricultural University, Jl. Meranti Kampus IPB Darmaga, Bogor 16168 Indonesia. Telp/faks : +62(251)629353.
Email: editodai@yahoo.com (*Author for correspondence)
[2] Graduate School of Agricultural and Life Sciences, The University of Tokyo, Tokyo 113-8657, Japan

240 m above sea level), from October 2002 to July 2003. During the experiment, monthly rainfall ranged from 118 - 556 mm, with 363 mm on average. Maximum, minimum, and average daily temperatures were 33.4 °C, 22.0 °C and 25.9 °C, respectively. The relative humidity was 83.6% on average.

Corms without cormels were watered every day for one month in September 2002 to stimulate the sprouting of apical buds about 1 cm. Corm of different weight, i.e., 50, 100, 200, 500, 1000 and 2000 g of whole corm and half-section corms were prepared. To obtain half-section corms, whole corms were dissected vertically through apical bud. For example to obtain a 50 g half section a corm of 100 g was sectioned, and to obtain a 2000 g half section a corm of 4000 g was sectioned. In total, twelve planting materials were prepared in the present study.

The experiment was arranged in randomized block design with three replications, and twelve corms in each replication were used. Data on growth variables were collected from three plants per replication.

Seed corms were placed in a 30 cm × 30 cm × 30 cm planting hole. Each hole was added with 0.5 kg of rice husks, and buried with a mixture of soil and goat manure (4:1, v/v). Seed corms were planted at depths of 6 cm with the bud at the top. Plants were arranged in a triangle with a side distance 80 cm, and grown under 50% shading net in order to reduce the light intensity.

Time to emergence, i.e., bud visible on the soil surface, and the size and number of leaves were recorded weekly. Daughter corms were harvested and cleaned when plant dormant completely in July 2003. Cormels were detached and weighed. The diameter, height, and fresh and dry masses (DM) of daughter corms were measured after oven drying at 65 ^{o}C for 3 days.

RESULTS AND DISCUSSION

Emergence

Time to emergence was affected by corm weight and section. Whole corms of small sizes emerged earlier than those of larger sizes (Table 1). At two weeks after planting (WAP) 17-67% of corms weight up to 500 g had sprouted, but neither 1000 nor 2000 g germinated. Whole corms emerged earlier than those of half-section, irrespective of corm weight. At 2 WAP, 25% of whole seed corms sprouted while the same rate was attained at 5 WAP for half section seed corms. All buds from whole seed corms completely emerged at 7 WAP, while at the same time 64% emerged of the half-sectioned corms. It is likely that time to emergence of sectioned seed corms occurred randomly and seemed independent of corm weight, unlike of whole corms.

Table 1. Germination rate (%) of *A. paeoniifolius* obtained from different seed corm sizes

Seed corm size (g)		Week after planting (WAP)^{z}				
		2	4	6	8	10
50	Whole	66.7	100.0	100.0	100.0	100.0
	Half-section	0.0	0.0	50.0	83.3	100.0
100	Whole	33.3	100.0	100.0	100.0	100.0
	Half-section	0.0	16.7	50.0	83.3	100.0
200	Whole	16.7	100.0	100.0	100.0	100.0
	Half-section	0.0	0.0	66.7	100.0	100.0
500	Whole	33.3	83.3	100.0	100.0	100.0
	Half-section	0.0	0.0	33.3	100.0	100.0
1000	Whole	0.0	100.0	100.0	100.0	100.0
	Half-section	0.0	33.3	66.7	100.0	100.0
2000	Whole	0.0	100.0	100.0	100.0	100.0
	Half-section	0.0	0.0	0.0	100.0	100.0

^{Z} Percentage was calculated from total plants therefore statistical analysis was not applicable

Bud emerged from main bud of whole seed corm, while it emerged from lateral bud near the main bud in half-sectioned corm. All corms developed single bud, irrespective of weight and section. Santosa *et al*. (2006) found that when main bud was sectioned, the main bud damaged and a lateral bud near the main bud developed into a new plant. It is likely that delayed bud emergence of sectioned seed corms because there is time lag of lateral bud elongation.

Leaf Number

Seed corms of 50 g significantly produced larger number of leaf than other treatments, irrespective of seed corm condition. In the plants with large number of leaf, two or more leaves usually coexisted. Single leaf was produced by 500 g seed corms or larger, while up to 5 leaves by 50 g seed corms (average 4.7 leaves) and up to 3 for 100 and 200 g (average 2.5 leaves, data not shown). This is inline with result of Santosa *et al.* (2006) where seed corm of bud portion of originally large corm (e.g. 2000 g) produced single leaf. It needs further investigation why plants originated from large seed corms produced one leaf during vegetative. Hormones that responsible for apical dominant such as gibberellins might be higher in large corms than those of small ones.

Individually, leaf life span generally shorter in plants with many leaves than plants with single leaf, i.e., 1.5 months vs. 4 months, respectively. The single leaf usually existed until plant entered dormancy.

Leaf size

Petiole height and diameter were significantly affected by corm weigh and corm section at planting (Table 2). Larger size of seed corms produced larger petioles. Sectioned seed corms tended to produce smaller leaves than those of whole corms. However, tripartite angles of rachises were not affected by seed corm at planting, i.e., 136 ^{o}, irrespective of seed corms weight and section.

Table 2. Petiole diameter, height and rachis length of *A. paeoniifolius* from different corm sizes

Seed corm size (g)		Petiole height (cm) ^{z}		Petiole diameter (cm) ^{z}		Rachis length (cm) ^{z}	
50	Whole	74.1 ±6.6	a^{y}	1.9 ±0.2	a	37.3± 4.0	a
	Half-section	71.8 ±5.5	a	2.0 ±0.2	a	37.1± 3.7	a
100	Whole	92.2 ±2.5	b	2.5 ±0.1	b	47.6 ±1.4	ab
	Half-section	70.4 ±6.3	a	1.9 ±0.2	a	36.5 ±4.1	a
200	Whole	115.5 ±5.0	c	3.2 ±0.1	c	61.7 ±2.8	b
	Half-section	94.7 ±5.8	b	2.8 ±0.2	b	51.6 ±4.6	ab
500	Whole	124.3 ±9.3	cd	3.9 ±0.4	c	70.8 ±5.2	b
	Half-section	112.2 ±7.8	c	3.1 ±0.2	c	61.7 ±5.9	b
1000	Whole	183.6 ±2.0	e	5.4 ±0.1	d	110.8 ±1.6	e
	Half-section	168.8 ±4.7	d	5.4 ±0.1	d	90.7 ±5.2	c
2000	Whole	218.6 ±12.5	f	6.6 ±0.3	e	127.6 ±7.5	f
	Half-section	150.9 ±10.5	d	5.2 ±0.6	d	84.4 ±8.8	d

Mean ± S.E

^{z} was measured on the final leaf before dormant

^{y} Values in the same column followed by different alphabet are significantly different at LSD 5%

Rachis length increased with increasing seed corm weights, particularly when seed corms were larger than 500 g (Table 2). Rachis of sectioned seed corms was slightly shorter than those of the same weight of whole corm, irrespective of corm weight. Agronomically, canopy width was calculated from rachis length by multiply 2. It is worthy to note that canopy width was nearly double of petiole height. This implies that planting distance of elephant foot yam will be determined by seed corm weights, where larger planting distance is required when plant large seed corms to get optimum leaf area index (LAI).

Related to planting distance, Das *et al.* (1997) stated that LAI of *A. paeoniifolius* increases up to 120 day after planting (DAP) and decline thereafter, with maximum LAI reached at highest planting density (0.14 million plants/ha), i.e., 6.1; LAI 4.4 and 5.4 are attained from 0.1 and 0.12 million plants/ha, respectively. Moreover, planting 250 g seed corms at a population of 0.14 million-plants/ha produces daughter corm 85.8 tones/ha, 0.12 million/ha produces 69.6 and 0.1 million/ha produces 56.3 tones/ha.

Daughter Corm

Seed corm weight significantly affected daughter corm weight and size. Larger seed corms produced larger daughter corms, particularly when seed corms of

500 g or larger for both whole and half-section were planted (Table 3). There was no significant different in daughter corm weight of 100 g and 200 g seed corms, irrespective of whole and half-section corms. Seed corms of 2000 g produced smaller daughter corms than those of 1000 g, even though there were not significantly different. It is probably that late emergence of buds cause variability on daughter corm weight as indicated by large S.E. value (Table 3). Table 3 shows that dry mass content of daughter corms was not different among treatments, however, half-section seed corms tended to have higher DM content.

Table 3. The effect of seed corm weight on daughter corm weight, corm size, cormels and dry atter content of *A. paeoniifolius*

Seed corm size (g)		Daughter corm weight (g)		Daughter corm size (cm)				DM (%)	
				Width		Height			
50	Whole	797±150	ab[z]	11.4±0.7	b	7.1±0.5	a	15.7±1.1	a
	Half-section	536±131	a	9.4±0.8	a	5.8±0.4	a	23.8±1.1	a
100	Whole	1,576±141	c	14.1±0.2	c	8.8±0.4	b	19.4±0.8	a
	Half-section	537± 47	a	9.3±0.5	a	6.6±0.2	a	24.9±0.9	a
200	Whole	1,790±125	c	15.3±0.4	c	9.6±0.5	b	17.1±0.5	a
	Half-section	600± 91	a	9.9±0.7	a	7.1±0.5	a	19.9±0.4	a
500	Whole	2,132±286	cd	15.8±0.8	c	9.6±0.2	b	18.6±1.1	a
	Half-section	1,135±199	b	12.4±0.7	b	7.9±0.5	ab	21.9±1.1	a
1000	Whole	3,883±367	e	20.9±0.8	e	11.3±0.4	c	16.9±0.6	a
	Half-section	2,550±304	d	17.3±0.9	d	10.8±0.1	bc	17.4±0.2	a
2000	Whole	4,963±403	f	23.1±0.9	f	12.9±0.9	c	19.1±1.5	a
	Half-section	2,278±686	cd	15.7±2.2	c	10.0±1.0	b	20.1±1.3	a

Mean ± S.E

[z] Values in the same column followed by different alphabet are significantly different at LSD 5%

Daughter corm of whole and sectioned-corms were not different among 100 g, 200 g and 500 g, but they were significantly different to those of other treatments for whole seed corm (Table 3). For half-sectioned corms, increasing in seed corm weight has a tendency to increase daughter corm weight, linearly. A 1000 g of half-section seed corm produced the biggest daughter corm, while the 50 g corm produced the smallest one, i.e., 17.3 vs. 9.5 cm in width and 10.8 vs. 5.7 cm in height, respectively.

Furthermore, corm shape as reflected by ratio height/width was mostly globose and slightly depressed globose (ratio 0.54-0.72). Santosa *et al.* (2004b) pointed out that corm shape is affected by planting depth. Therefore, it is unlikely that the corm shape is affected by corm weight.

Whole corms produced larger daughter corms than half-sectioned corms (Table 3). Half-section seed corms produced lower fresh mass daughter corm as compare to whole seed corms. It may be caused by shorter life span of their leaves. Table 1 shows that the leaves of half-sectioned corms emerged later than those of whole corms. During the experiment, most leaves started wither in early dry season (March) and completely die in July 2003 when dry season started, irrespective of corm weight and section. From the green house experiment, Santosa *et al.* (2004a) found that limited water availability induced elephant foot yam to enter dormancy.

Tuberization rate (daughter corm weight/seed corm weight) was significantly higher in whole corms than that in half-sectioned corms, irrespective of weight. Figure. 1 shows that tuberization rate decreased by increasing the weight, irrespective whole and section ones. In whole corms, the rate nearly 12 times of 50 g seed corm, about 5 times of 500 g and about 2 times of 2000 g seed corm. In half-section, it was 7, 3 and 1.5 times of 50, 500 and 2000 g seed corm, respectively. It is likely that seed corm of 100 g and 200 g are the optimum seed weight to obtain marketable size (larger than 1 kg).

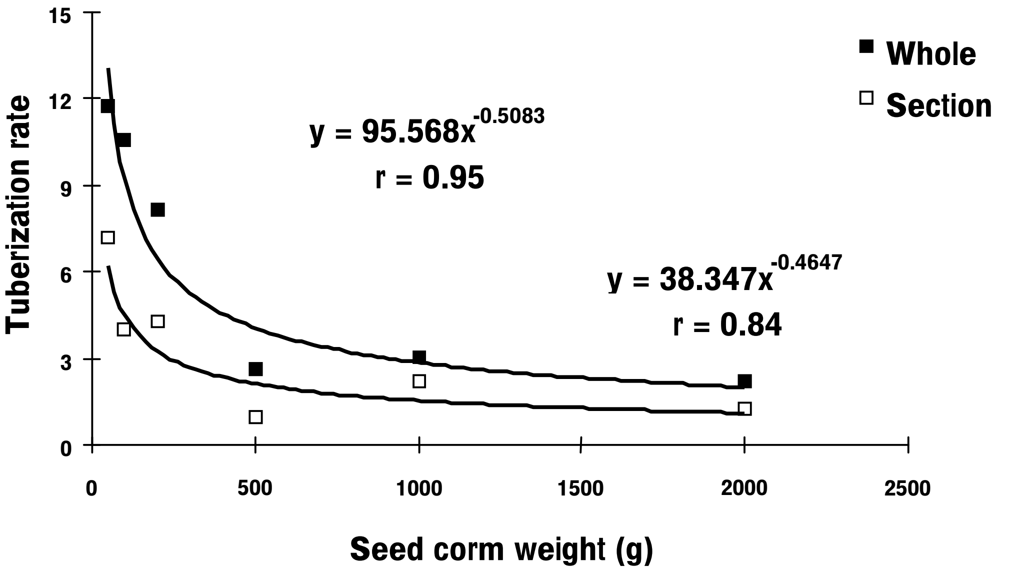

Figure 1. Tuberization rate (daughter corm weight/seed corm weight) of elephant foot yam as affected by seed corm weight and section

Furthermore, productivity of sectioned seed corms was lower than that of whole seed corms (Figure. 2). For example, 100 plants of whole seed corms of 200 g produced 179 kg, when it was sectioned into two pieces (become 200 plants) the total harvest was 107 kg. It means that sectioning seed corms does not increase the productivity.

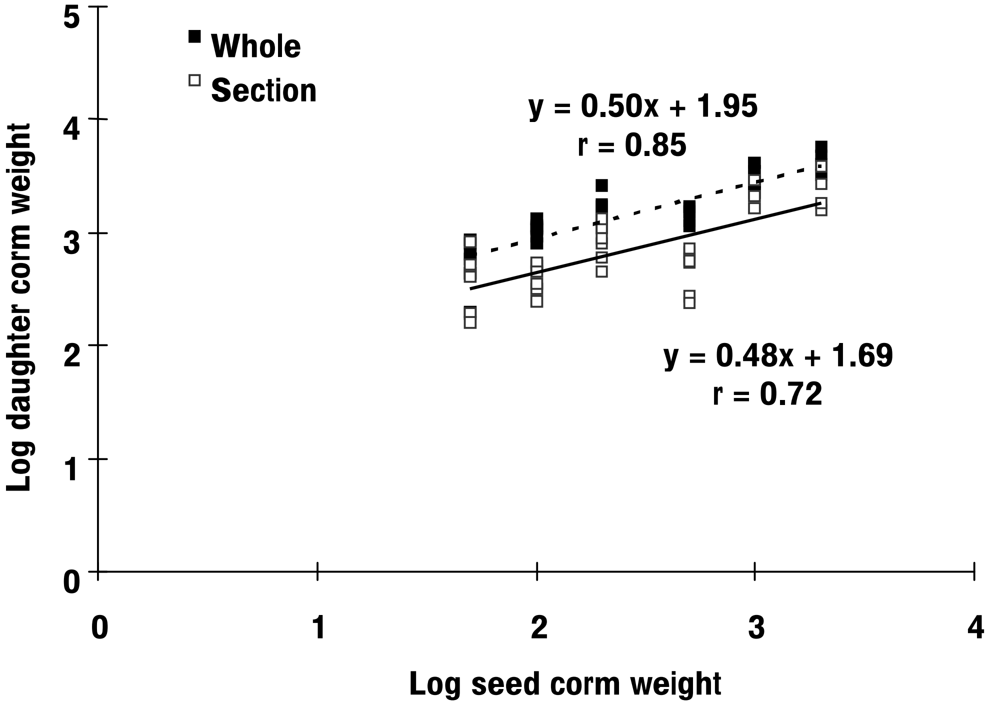

Figure 2. Effect of seed corm weight and section on daughter corm weight of elephant foot yam

Cormels

Total weight of cormels was affected by seed corm weight; large seed corms produced heavier cormels. In the half-sectioned seed corms, the seed larger than 100 g, except for 500 g, tended to produce heavier total cormels than those of 50 g (Table 4).

Table 4. The effect of seed corm weight and section on weight and size of cormels of *A. paeoniifolius*

Seed corm size (g)		Total cormels (g)		No. Cormels (%)[z]					
				Large		Medium		Small	
50	Whole	210±59	b[y]	38.4±13.7	cd	11.7±4.6	a	49.9±11.0	ab
	Half-section	110±29	a	10.2±4.1	a	25.9±3.2	ab	63.9±5.2	c
100	Whole	522±97	d	12.8±2.7	a	14.4±2.4	a	72.8±3.5	d
	Half-section	133±17	a	20.9±4.3	bc	20.9±6.9	ab	58.2±5.6	b
200	Whole	495±76	d	12.3±1.8	a	16.6±3.6	ab	71.1±3.8	d
	Half-section	275±72	c	25.2±6.8	bc	27.4±4.3	b	47.4±9.2	a
500	Whole	468±63	d	14.9±2.4	ab	29.0±3.8	b	56.1±5.6	b
	Half-section	113±21	a	16.0±7.4	ab	23.6±7.7	ab	60.5±12.3	bcd
1000	Whole	852±84	e	13.3±1.5	a	27.4±2.2	b	59.2±3.2	b
	Half-section	315±42	c	19.6±1.6	b	15.6±1.3	a	64.8±2.2	c
2000	Whole	509±157	d	8.8±2.9	a	24.4±9.9	ab	66.8±12.1	bcd
	Half-section	277±83	b	47.0±8.0	d	10.4±2.9	a	42.6±10.7	a

Mean ± S.E

[z] Small cormels ≤ 4 g; medium 4.1≤x ≤13 g; large ≥13.1 g.

[y] Values in the same column followed by different alphabet are significantly different at LSD 5%

Regarding number of cormels, about more than 60% composed of small sized cormels followed by medium and large size, irrespective of seed corm weight. It is unlikely that distribution of cormels size was affected by corm weight and section. However, half-sectioned corms have a tendency to produce high percentage of large size cormels than whole corms, except for 50 g.

CONCLUSION

Growth and development of elephant foot yam were determined by seed corm weigth. Large seed corm produced larger leaf and fresh mass of daughter corm. On the contrary, number of leaf decreased with increasing seed corm weight. Half-sectioned seed corms produced smaller growth parameters than those of whole corms, and sectioning did not increase productivity of elephant foot yam. However, sectioning seed corms still may useful in nursery. In the cultivation, it is recommended to use whole seed corms of 100 or 200 g.

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