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TUBER YIELD AND QUALITY OF NINE GENOTYPES YAM BEAN (*PACHYRHIZUS* SPP.) DUE TO SINK-REPRODUCTIVE PRUNING

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Abstract

Yam bean tuber starch extract has been widely used for traditional cosmetics material in Indonesia. This experiment was aimed to acquire yam bean tuber with high yield and starch content. Materials used were 9 yam bean genotypes collection of Agung Karuniawan (Plant Breeding Laboratory, Universitas Padjadjaran) consisted of three genotypes of P. erosus, one genotype of P. ahipa, two genotypes of P. erosus intraspecific crossing and three genotypes resulted from interspecific crossing between P. erosus and P. ahipa. The field trial was conducted at experimental field of Faculty of Agriculture, Universitas Padjadjaran Jatinangor from August 2009 until March 2010. The experiment was arranged in split plot design repeated twice. The main plot consisted of two treatments namely without sink-reproductive pruning and with sink-reproductive pruning. The main plot was divided into nine subplots based on genotypes. Pruning and genotype independently affected tuber fresh weight. The heaviest tuber produced by P. erosus B-1 / EC 033. Genotypes affected on tuber dry matter and tuber starch content. The highest dry matter was contained in interspesific crossing between P. erosus x. P. ahipa EC 550 x AC 208-72h. The highest tuber starch content was resulted by P. ahipa AC 216-139d. Sink-reproductive pruning and genotype interacted in tuber dry matter trait.

Key words: *Sink-reproductive Pruning, Starch, Yam bean, Yield.*

INTRODUCTION

Yam bean or *bengkuang* in Indonesian is actually benefited not only for food but also for medication or cosmetic functions. This crops is widely cultivated in Sumatra, Java, Southeast Nusa, Sulawesi, Bali and Kalimantan (Karuniawan, 2004). At current time, the tuber starch extract used both as traditional and modern cosmetics for brightening skin naturally. In fact, some of modern cosmetics with yam bean starch extract based have won several national and international awards (Ratu, 2012). Therefore the development of yam bean tuber starch production is actually needed.

From the analysis of 100 g of fresh yam bean, starch content is at 2.1 g - 10.7 g (Sorensen, 1996), even in Indonesia the starch content for *P. erosus* is averaged only around 1% (UTP, 2011) The highest dry matter content enclosed in *P. ahipa* that is equal to 26% - 24% then *P. erosus* by 6% - 22%. One disadvantage of starch yam bean tuber use is the high water content, so that although the tuber has great size but still has low starch level due to the low dry matter content. To broaden genetic diversity and increase the amount of dry matter, Plant Breeding Laboratory, Universitas Padjadjaran did intraspecific and interspecific hybridization between *P. erosus* and *P. ahipa*.

Besides plant breeding, the potential of yam can be improved by developing appropriate cultivation techniques. One of the frequent cultivation techniques is sink-reproductive pruning (Sorensen). This technique is done by cutting off reproductive parts of plants, which is begun at the first flower bud emergence. Sink-reproductive pruning aimed to reduce competition of photosynthates distribution between the reproductive and tuber sink parts. Flower bud pruning on the yam bean can increase 30%-70% of tuber fresh weight [6]. Therefore, sink-reproductive pruning will shift assimilate to tuber.

This study aimed to test the simultaneous effect of sink-reproductive pruning on yam bean yield and tuber quality traits namely starch content and dry matter content. Further, expectantly there will be genotypes with high starch content as potential yam bean genotypes especially for cosmetics raw material.

MATERIALS AND METHODS

Materials used in this experiment were nine yam bean genotypes collection of Agung Karuniawan (Plant Breeding Laboratory, Universitas Padjadjaran). It consisted of three *P. erosus*, one *P. ahipa*, two intraspecific crossing of *P. erosus* and three interspecific crossing of *P. erosus* and *P. ahipa*.

The field trial was conducted at experimental field of Faculty of Agriculture, Universitas Padjadjaran Jatinangor located at an altitude of 753 m above sea level with Inceptisols soil type and type C rainfall according to Schmidt-Fergusson. The experiment was conducted from August 2009 until March 2010.

The experiment was arranged in split plot design repeated twice. The main plot consisted of two treatments: without sink-reproductive pruning and with sink-reproductive pruning. The main plot was divided into nine subplots based on genotypes. Each subplot size was 2 m x 3 m with spacing 50 cm x 50 cm between plants and 100 cm between subplots. Fertilizer recommendation given referred to the sweet potato cultivation in dry land.

Sink-reproductive application treatment was carried out after 50% of plants per plot had entered the flowering phase (R5) (Zanklan, 2003), it was done once a week until the harvest time. Harvesting of tuber was approximately 180 days (six months) after planting.

Characters observed were tuber fresh weight (g), tuber dry matter content (%) and tuber starch content (% WB). Yam bean tuber starch content was analyzed using Luff Schoorl method conducted at Yield Physiology Laboratory, Vegetable Research Institute, Lembang West Bandung.

Data were analyzed using statistical analysis of variance (anova) using Statistix 8 program. Comparison of the mean value was done using the least significant difference test (LSD) on the real level 5%.

RESULTS AND DISCUSSIONS

Based on analysis of variance (Table 1), pruning and genotype treatments independently gave significant different on tuber fresh weight character. Genotypes as the subplot factor, gave significant different on all tuber traits observed. Sink-reproductive pruning and genotypes interacted on tuber dry matter trait in highly significant difference.

Table 1. Analysis of Variance for Tuber Fresh Weight, Tuber Dry Matter, Tuber Starch Content of Nine Genotypes Yam Bean

Variables	F		
	Pruning	Genotype	Interaction PxG
TFW (g)	2.51 *	11.7 **	1.9
TDM (%)	1.15	4.90 *	18.05 **
TSC (%)	0.01	20.30 **	2.02

TFW=Tuber Fresh Weight; TDM=Tuber Dry Matter; TSC= Tuber Starch Content; *=significant on α 0,05; **= significant on α 0,01

Table 2 shows least significant difference (LSD) test on tuber fresh weight affected by pruning and genotype In this study, sink-reproductive pruning generated higher tuber fresh weight trait. Non pruning treatment only resulted 122.35 g, whereas, sink-reproductive pruning 371.61 g. Sink-reproductive pruning of flower bud removal diverts assimilate distribution into tuber storage sinks. The increased flow of assimilate to the tuber, consequential on the change in dimensions. In addition, the increased of assimilate flow also affect tuber fresh weight.

The smallest yield result for genotype showed by *P. ahipa* AC 216-139 d that was 86,45 g per tuber, however the other genotypes were in same group ranged from 205,76 g- 342,95 g per tuber. It is mean that even the elder was *P. ahipa* but the crossing with *P. erosus* will increase the yield.

Table 2. Analysis of Variance for Tuber Fresh Weight, Tuber Dry Matter, Tuber Starch Content of Nine Genotypes Yam Bean

Treatments	Tuber fresh weight (g)
Sink-reproductive pruning	
Without	122,35 b
With	371,61 a
Genotypes	
B-10 / EC 550	254,32 a
B-1 / EC 033	342,95 a
B-56 / CJ	297,88 a
AC 216-139 d	86,45 b
B-10 / EC 550 x AC 216-139 d	205,76 a
B-1 / EC 033 x B-56 / CJ	184,99 a
AC 216-139 d x B-56 / CJ	308,46 a
B-10 / EC 550 x B-56 / CJ	308,27 a
B-10 / EC 550 x AC 208-72h	233,76 a

Numbers followed by the same letters are not significantly different on alpha 0.05 LSD test

Table 3 defines LSD test for genotypes effect on tuber dry matter and tuber starch content. EC 550 x AC 208-72h had the highest value on dry matter content. Otherwise, on tuber starch content character the best result was showed by AC 216-139 d, then followed by EC 550 x AC 208-72h. The average tuber starch content of yam bean produced in Indonesia is about 1%, therefore the new genotype resulted from interspesific crossing between *P. erosus* and *P. ahipa* (EC 550 x AC 208-72h) could be considered for further development for cosmetics raw material.

Table 3. Effect of genotypes on yam bean tuber dry matter and total starch content

Genotypes	Tuber Dry Matter	Tuber Starch Content
	%	%
B-10 / EC 550	6,11 de	1,07 c
B-1 / EC 033	5,36 e	1,20 c
B-56 / CJ	7,33 bcde	1,63 c
AC 216-139 d	9,39 abcd	6,71 a
B-10 / EC 550 x AC 216-139 d	7,50 abcde	1,34 c
B-1 / EC 033 x B-56 / CJ	8,82 ab	1,68 bc
AC 216-139 d x B-56 / CJ	6,60 cde	1,45 c
B-10 / EC 550 x B-56 / CJ	8,35 abc	1,76 bc
B-10 / EC 550 x AC 208-72h	10,27 a	2,66 b

Numbers followed by the same letters are not significantly different on alpha 0.05 LSD test

There was interaction between genotypes x sink-reproductive pruning on tuber dry matter content, it is shown on Table 4. On non-pruning treatment, only *P.* ahipa AC 216-139 d gave smallest mean value for tuber dry matter character. While, contrast result was shown on sink-reproductive pruning, AC 216-139 d genotype had the highest value than other genotypes, then followed by interspesific hybrid genotype EC 550 x AC 208-72h.

In this study, pruning did not affect the qualitative traits such dry matter and starch content of tuber. Yam bean production increased as the result of pruning, but this practice did not affect the percentage of soluble sugar content and dry matter percentage. However, there are variations of these traits on genotypes were evaluated caused by genetic factors (Zanklan, 2003). This variation can be seen in the character of dry matter and starch. Tuber dry matter content is a parameter that reflected the extent of how far photosynthesis product is distributed to the tuber. Efficiency of the photosynthetic process is shown in the rate of accumulation of dry matter content (Gardner et al., 2008).

Table 4. Interaction between Genotypes x Sink-Reproductive Pruning on Tuber Dry Matter

Genotypes	Tuber Dry Matter	
	Without Pruning	With Pruning
B-10 / EC 550	8,51 abc A	3,71 B B
B-1 / EC 033	6,04 bcd A	4,68 B A
B-56 / CJ	7,65 abcd A	7,01 B A
AC 216-139 d	1,38 d B	16,34 A A
B-10 / EC 550 x AC 216-139 d	8,78 abc A	6,22 B A
B-1 / EC 033 x B-56 / CJ	10,42 ab A	7,23 B A
AC 216-139 d x B-56 / CJ	9,70 abc A	3,50 B B
B-10 / EC 550 x B-56 / CJ	8,34 abc A	8,37 Ab A
B-10 / EC 550 x AC 208-72h	11,71 a A	8,84 Ab A

Numbers followed by the same letters are not significantly different on alpha 0.05 LSD test Small letter read vertically; Capital letter read horizontally

P. erosus is the most stable species in production, also it produces the prime number for yield (Kale, 2006). *P. ahipa* is known as species with smaller tuber, but higher in dry matter and starch content. Therefore, hybridization using those species is expected to gain the new genotype in high production amount with better quality especially starch content. This study noted that intraspesific and interpesific crosses produced a new genotype with higher production yield with better quality character for dry matter and starch than the elders.

CONCLUSIONS

Pruning and genotype independently affected tuber fresh weight. The heaviest tuber produced by *P. erosus* B-1 / EC 033.

Genotypes affected in tuber dry matter and tuber starch content. The highest dry matter was contained in interspesific crossing between

P. erosus x. *P. ahipa* EC 550 x AC 208-72h. The highest tuber starch content was resulted by *P. ahipa* AC 216-139d.

Sink-reproductive pruning and genotype interacted in tuber dry matter trait.

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