Flower Characteristics and the Yield of Jatropha (*Jatropha curcas* L.) Accessions

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The flower characteristics of a plant is one of the important traits correlated to its productivity. Study on flower characteristics is useful to understand how to increase the crop productivity. The research was conducted at Agro Techno Park Center, Indonesian State Ministry of Research and Technology, Bakung Village, Ogan Ilir Distric South Sumatra from April 2007 to August 2008. The objective of this research was to evaluate the flower characteristics and the yield of jatropha (*Jatropha curcas* L.) accessions. The research was arranged in a randomized block design, consisted of fifteen accessions of jatropha, with three replicates. The Jatropha accessions were collected from different agro ecosystems located in Sumatra, Java, and Borneo. The results indicated that the evaluated accessions have significant differences in the flower characteristic and the yields. The ratio male–female flower is the most important character for *J. curcas* L. because it has a significant correlation to the yield.

Key words: flower, yield, *Jatropha curcas*

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INTRODUCTION

The Jatropha development in Indonesia is still in controversial issues. The contra opinion argues that the Jatropha is not potential to be developed as a biofuel crop in Indonesia because of its low productivity. The maximum Jatropha productivity is only 5 tons of seeds per ha per year (Mahmud *et al*. 2008) compared to palm oil which can produce 25 tons fresh fruit bunches per ha per year. Hence, we need to do some intensive researches for Jatropha development, for example how to increase its productivity. The Indonesian State Ministry of Research and Technology (2006) reported that one of problems for Jatropha development is the lack of superior varieties with high productivity and oil content.

In some crops, the superior varieties can be created by breeding program such as selection, introduction and crossing. The first step for creating a new variety is development of germplasm collection. Some researchers have reported the genetic variability of Jatropha (Heller *et al*. 1996; Yunus 2007; Sunil *et al*. 2009). Heller *et al*. (1996) have identified 13 accessions which have high potency of productivity. Those accessions were selected from some countries such as Senegal, Cape Verde, Ghana, Benin, Burma, India, Costa Rica, and Mexico. On the other hand, Indonesian Plantation Research Center reported that they have some varieties which were selected from different areas in Indonesia (Hasnam & Mahmud 2006). The richness of Jatropha germplasm is a high potency as breeding materials for creating a Jatropha superior hybrid.

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The local germplasm are often used as important breeding materials. Granado *et al*. (2001) argued that the local germplasm as parental material in breeding program for many crops is optimal step for overcoming the marginal environment. The local germplasms have a high adaptation to marginal environment but they do not produce high yield even whey they are grown under optimal environment. There are some Jatropha local germplasms which are grown in Indonesia. Heller *et al*. (1996) informed that in 15 centuries the Portuguese distributed the Jatropha to African and Asian continents. However, the local germplasm has generally a low productivity. Therefore, it is needed to introduce new varieties as gene donor for increasing the productivity trait.

The flowering characteristic is the important trait which has a significant correlation to productivity. Miftahorrachman *et al*. (2000) argued that spiklet (female flower) of coconut has a high correlation to productivity. Liu *et al*. (2008) reported that the sex ratio of *Sagittaria potamogefilia* (female to male flower) decreased with the inflorescane numbers and the plant size, eventhough the nutrient had impact on the flower number and production. On the other hand, Mendez and Traveset (2003) reported that the plant can modify its gender through number of male and female flowers, stamens and carpels per flower or pollen grains and ovules per floral organ. Based on the above information, it is evidence that flower characters have a correlation to the yield. Because of that it is needed to evaluate the number of male and female flower and its correlation to the yield of Jatropha accessions collected from different areas in Indonesia. This information is very important to identify the Jatropha accessions and to understand how to increase the yield of Jatropha by modification of flower characters.

MATERIALS AND METHODS

Germplasm Collection. The Jatropha accessions were from some different agro ecosystems. Criteria for mother trees: (i) the trees had to be old enough, indicated by the high of plant diameter; (ii) the trees were propagated from plant grow in those area; and (iii) the trees must be free from pest and diseases. The evaluated accessions in this research are described in Table 1.

Time and Location. The research was carried out from April 2007 to August 2008 at Agro Techno Park, Indonesian State Ministry Research and Technology. The research location was in Bakung village which is about 45 km from Palembang South Sumatra. It is classified as a wet tropical climate area with the average of more than 2,500 mm rain falls per year. Its temperature was range between 25-32 °C, the soil texture is sandy loam with low to middle soil property status.

Experimental Design. This research used Randomized Block Design with three replicates. Each treatment unit was 7.5 x 6 m = 45 m^2. There was 4,000 m^2 land for 15 accessions and each accession has 20 plant samples. The plants were 6 months old.

Parameters. The accession identification used the morphology and growth parameters. The parameters were: (i) Number of male flowers per inflorescence, (ii) Number of female flowers per inflorescence, (iii) Total flowers per inflorescence, (iv) Ratio male - female flowers per inflorescence, (v) Number of fruits per inflorescence, (vi) Seed weight per plant, (vii) Jatropha oil yield per plant.

Data Analysis. The quantitative data was analyzed by analysis of variance (ANOVA). The means values of the genotype were compared using Fischer's Least Significant Difference test (LSD test). The coefficient correlation between flower characteristics and yield was calculated using formula:

$$r = \frac{\sum (X - \overline{X})(Y - \overline{Y})}{\sqrt{\sum (X - \overline{X})^2 (Y - \overline{Y})^2}}$$

Table 1. The evaluated accessions are collected

Name of accession	Code accession	Note
Komering	KMR	Low land in Komering River Catch Area
Palembang	PLG	Low land Palembang
Jogyakarta	JGY	Costal area in Jogyakarta
Indralaya	INR	Swamp area in South Sumatra
ATP 1	ATP1	The best clone is selected from 90 clones which produced by mutation from BATAN
ATP 2	ATP2	The second of the best clone is selected from 90 clones which produced by mutation from BATAN
Pontianak	PNT	Low land in Borneo
Lahat	LHT	Middle land in South Sumatra
Pagaralam	PGR	High land in South Sumatra
Curup	CRP	High land in Bengkulu
Lampung	LMP	Plantation Research Center in Bogor
Medan	MDN	Low land in Medan
Aceh Besar	ABS	Midle Land in Aceh
Pidie	PDI	Low land in Aceh
Gorontalo	GRT	PT. Rajawali Nusantara 2.

RESULTS

Analysis of Variance showed that there were highly significant in the most of observed parameters except ratio male flower to female flower (Table 1). It proved that the Jatropha accessesions have different performance in flower characteristics (Table 2).

We recorded that the accessions from ATP2, ATP1, and Pidie had the highest number of female flower. On the other hand, accessions from Indralaya, Aceh Besar and Gorontalo had a lower number of female flower (from 3.5 to 4.2) comparing to the other accessions. The average of female flowers of evaluated Jatropha accessions was 5.2 flowers per inflorescence. The number of female flowers of some different Jatropha accessions is shown in Figure 1.

We recorded that most of the accession had a relative similar number of male flowers. However, the LSD analysis showed that the ATP1 and ATP2 had the highest male flower number (Figure 2). They were 119.64 and 111.06 male flowers

Table 2. F-value and mean value of each character

Character	F-value	Mean value
Number of female flower	2.5291**	5.20 ± 1.09
Number of male flower	3.2743**	68.20 ± 19.55
Total flower	3,3200**	74.20 ± 20.38
Ratio male – female flower	1.4540[ns]	13.34 ± 2.30
Fruit number	2.1788*	5.40 ± 0.19
Seed weight per plant (g/plant)	351.61**	149.20 ± 103.47
Oil yield per plant (g/plant)	3.9509**	102.37 ± 30.57

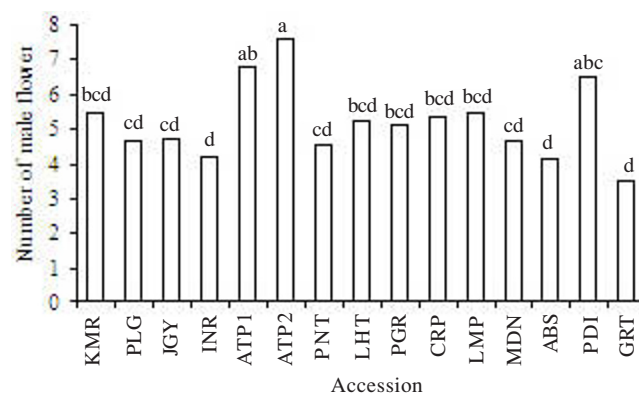NS = Non Significant (P > 0.05), *significant (0.01 < P ≤ 0.05), ** highly significant difference (p ≤ 0.01).

Figure 1. Number of female flower of some different Jatropha accessions.
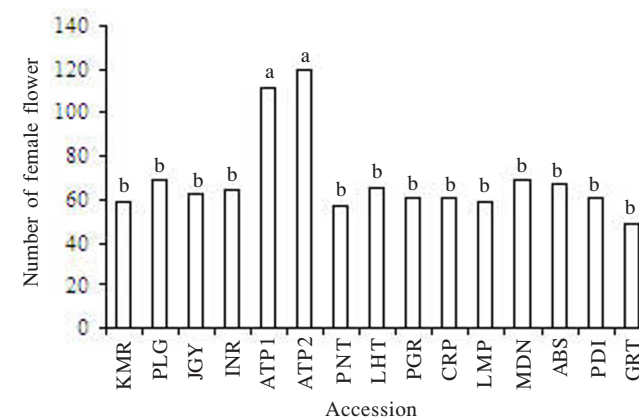
Figure 2. Number of male flower of some different Jatropha accessions.