Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 39-46

ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2104

PRODUCTION AND OIL CONTENT OF PHYSIC NUT (*Jatropha curcas L.)* FOR THE FIRST AND SECOND HARVEST YEARS IN EAST NUSA TENGGARA-INDONESIA

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Abstract

Jatropha curcas Linn. is one of many bioenergy plants which is potential to produce biodiesel in the tropical country. However, has not found highly potential varieties on dry land yet. The purpose of this research is to gain information of *J. curcas* L. seeds production and oil content on first and second harvest in East Nusa Tenggara breeding location. The research was conducted in East Nusa Tenggara province – Indonesia, with the materials used in this research are the four numbers of *J. curcas* hybrids, they are SP8×SP16, SP8×SP38, SP33×HS49, SM35×SP38, and two control accession from Indonesia Agricultural Ministry IP3A and IP3P. The SP8×SP16 hybrid produces the highest number of fruits /plant (97.23 fruits/plant) and seeds dry weight average (179.34 g/plant) in second harvest, with dry weight of 100 seeds 71.25 gram, oil content 31.252 %, and first harvest time 90-91 days. And than followed by SP33×HS49 hybrid, with average seed dry weight 123.07 g/plant, number of fruits 71.22, oil content 30.72%, but the first harvest time longer than another hybrids (101-102 day). In this research, all off hybrids produce higher seed dry weigh compare to control plant (IP3A and IP3P).

Keywords: East Nusa Tenggara, first and second harvest, hybrids, *Jatropha curcas* Linn.

INTRODUCTION

The increasing demand of fuel requires significant effort to develop new and renewable energy resources nationwide (Irianto, 2010). To support the utilization of bioenergy as a renewable resource, Indonesian government has declared a President Decree No. 5 of 2006 on National Energy Policy which, among other things, sets the target use of biofuels from 0.2% to more than 5% of national energy consumption by 2025 (Sardjono, 2007).

J.curcas plant is one of the pants producing energy which can be found in almost all provinces in Indonesia (Hasnam et al, 2007).

This plant has broad adaptability, grows in all types of soil, and able to withstand long periods of drought. *Jatropha* can survive in critical land where the availability of water and nutrients is limited or in marginal land (Ikbal et al, 2010). *J.curcas* is a versatile plant and all its body parts have high potential for usage. One of the advantages is that the seeds contain oil by 35-40% which can be used as biodiesel. *J.curcas* is also included as a plant fuel to support diversification program of alternative energy resources. *J.curcas* oil, in addition to its function as a source of renewable oils, is also included as non edible oil so it does not compete with human consumption needs such as palm oil and other vegetable oils. The usage of *J.curcas* oil as biodiesel material is seen as an ideal alternative to reduce the demand of fuel as well as to substitute diesel oil (Center for

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Research and Development of Estate Crops, 2008).

J.curcas is categorized into *Euphorbiaceae* family that has high potential as a producer of biofuels, lubricating oil, raw material in the manufacture of high quality soaps, raw materials in insecticides industry, fungicides and moluskasida and as anti-tumor drugs. *J.curcas* is very prospective to be manufactured as a source of biodiesel since it has the ability to grow in less fertile soil. It has strong root system which is able to withstand ground water and can serve as barriers to erosion (Divakara et.al., 2010). Jatropha can be grown in a variety of textures and types of soil, such as in rocky, sandy, argillaceous or clay ground. Jatropha's ability to grow on dry land has not been widely studied, but the results of several studies have explained the performance of Jatropha plants under conditions of minimal water availability (Achten et.al., 2010; Pompelli et.al., 2010).

In an effort to accelerate the supply and utilization of biofuels (BBN), the President Decree followed by President Instruction No. 1 of 2006 were regulated which, among other things, instruct the Minister of Agriculture to encourage the provision of *J.curcas* planting. Therefore, in order to achieve a high-productivity planting materials, the producers have done various selection processes. However, quality yielding variety of planting materials has not been discovered or released until now (Hariyadi, 2005). There is not any available planting material which has production potential of more than 10 tons/ha/year (Irianto, 2010); therefore, the presence of new varieties and superior planting material are of urgency.

Plant breeding is a human activity in maintaining and producing plants' offspring while improving its quality (Salim, 2010). Attempts to obtain superior planting materials through conventional breeding activities are generally conducted through crossbreeding. The success of breeding programs to obtain planting material is determined by the richness of the available genetic resources (Hasnam et al., 2007). The presence of new individuals in the population as a result of crossbreeding can encourage variety and diversity from recombination processes in the crossbred and has a close relationship with its varied parent. Genetic diversity information is highly significant as the data base for breeding programs, conservation, evaluation, and selection of plants.The availability of high genetic diversity will allow breeders to select genetic material. Initial characterization activities have to be done before making variety repair, in order to know the identity of each individual.

Several studies have explained the behaviors of some *J.curcas* accessions in different environmental conditions (Achten et.al., 2010). Although Jatropha is known to have capability to grow in dry climates and marginalized area, these plants still need water and sufficient nutrients to be able to produce optimally. In commercial scale of Jatropha plant development, the availability of quality seeds is to be one of the obstacles. This is because until now there has not been obtained any Jatropha variety that has special abilities in a specific environment (Hartati, 2012). To overcome this problem, efforts should be made in Jatropha planting material through the improvement of plant breeding activities (Maftuchah et.al., 2013).

Indonesia has quite extensive potential of non-productive dry land, especially in eastern part of Indonesia. Most of these regions have more arid climates that have not been used maximally for agricultural cultivation. These locations are very suitable for Jatropha's plantation. The research team has been conducting cross breeding to obtain

properties of plants tolerant to drought. This activity was followed by the selection of potential hybrid products (Maftuchah et.al, 2015). Currently, four numbers featured hybrids have been selected (SP8XSP16, SP8XSP38, SP33XHS49, SM35XSP38) and proceeded with multi-location test. This study aimed to obtain information of production level and seed oil level of some *J.curcas* hybrids in the first and the second year of harvests in East Nusa Tenggara province.

MATERIALS AND METHOD

The research was conducted in Maumere, East Nusa Tenggara, using four different varieties of *J.curcas* hybrids, i.e. SP8XSP16, SP8XSP38, SP33XHS49, SM35XSP38 and two comparative crops set by the Ministry of Agriculture; they were IP3A and IP3P. Both accession comparators were high potential yielding accessions as the results of mass selection in Asembagus and Pakuwon.

The study was conducted by applying a simple Randomized Block Design (RBD), with four groups. Each group utilized 20 plant samples. The planting material used was *J.curcas*stem cuttings with 30 cm long cuttings and 2-3 cm in diameter. Seeding stage was done in a polybag with a diameter of 15 cm and a length of 20 cm, which had been filled with soil planting medium, sand, and manure with a ratio of media 1: 1: 1. Maintenance activities included daily seedling watering, manual weeding, fertilizing, and pest and disease control done when necessary. Treatment for plants was conducted within 2 months, until the Jatropha plant was ready to be transferred to the field.

Planting hole was made in the field with the size of 40x40 cm and a hole depth of 40 cm with a spacing of 2x2 meters. At the bottom of the hole, manure was given as much as 50 kg/hole. After the age of 2 months, *J.curcas* seedlings were transplanted to the field. Transplanting was done during the rainy season. Observations on the plant height were conducted every month until the plant reaches two years old. Observations on the parameters of generative plants, such as the first harvest age, the number of bunches per plant, the number of fruits per plant, seeds' dry weight per plant, dry weight of 100 seeds and seed oil content were executed every time the crop enters the generative phase. This study was conducted over the past two harvest seasons. Seed oil level was then analyzed through a micro Kjeldahl method.

RESULTS AND DISCUSSION

The result presented that there was no significant difference to the life of the first crop on each *J.curcas* hybrid tested in East Nusa Tenggara. The test result also showed that the average age of first harvest of *J.curcas L* hybrid was in the range of 90 to 101 days after transplanting (Table 1).

The average age of first harvest, the number of bunches, fruit, dry seed weight, and dry weight of 100 seeds of hybrid numbers from the first crop were shown in Table 1, while the second harvest details were shown in Table 2. In the first harvest, there was no significant difference in the number of fruit, whereas in the second crop, there was significant difference in the number of fruits per plant.

Duncan test results to the amount of fruit bunches indicated a difference in the first and second crop harvests, while in the parameters of the number of pieces only indicated a difference in only the second harvest. The highest number of bunches in the second crop was achieved by hybrid SP8XSP16 (producing fruit bunches of 21,286), and not significantly different in the case of SP33XHS49

treatment (number of bunches: 15,911). Similarly, the highest number of fruits was obtained from hybrid SP8XSP16 (97.23 pieces) and was significantly different from all other treatments including the control group. The highest dry seed weight in the second harvest was also obtained from the SP8XSP16 treatment (179.34 g/plant) and it was higher than all other treatments (Table 1 and 2).

Jatropha is a perennial plant that is relatively tolerant to drought. However, the level of Jatropha production is influenced by genetic potential, environmental conditions and crop management level (Ratree, 2004). Observation of the level of production and quality of Jatropha can be done via the measurement of the parameter number of fruits per plant, dry seed weight per plant, dry weight of 100 seeds and seed oil content.

Jatropha can be generatively cultivated by seed and vegetatively grown by planting stem cuttings. Plants from cuttings tend to bloom their flower faster than that derived from seeds, it is because the plants derived from the seeds must go through a juvenile phase (Sudhakara, et.al., 2012). Results of other studies have also shown that Jatropha derived from vegetative propagation will enter the flowering phase faster than propagated from seed.

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Table 1. The average age of first harvest, the number of fruit bunches, fruit number, dry seed weight, dry weight of 100 seeds of J.curcashybrids on the first harvest in Maumere, East Nusa Tenggara.

Accessions	Age of First Harvest (HST)	∑ fruit bunches per plant	∑ fruit per plant	Dry Seed Weight(gram/plant)	Dry weight for 100 seeds (gram)
SP8XSP16	90.041 a	16.10 ab	26.989 a	44.87 a	66.167 ab
SP8XSP38	96.696 a	14.57 ab	23.526 a	36.60 ab	66.083 ab
SP33XHS49	101.330 a	13.65 ab	23.733 a	38.90 ab	68.417 a
SM35XSP38	94.821 a	18.44 a	27.695 a	47.63 a	70.125 a
IP3A	99.754 a	6.98 b	11.467 a	9.83 b	62.833 bc
1P3P	96.842 a	9.61 ab	14.980 a	17.60 ab	59.833 c

Notes: HST=days after transplanting to the field; BK = Dry Weight;the numbers followed by the same letter in the same column are not significantly different at 5% Duncan test.

Table 2. The average number of fruit bunches, fruit number, dry seed weight, dry weight of 100 seeds of J.curcas hybrids on the second harvest in Maumere, East Nusa Tenggara.

Accessions	∑ fruit bunches per plant	∑ fruit per plant	Dry Seed Weight (gram/plant)	Dry weight for 100 seeds (gram)
SP8XSP16	21.286 a	97.23 a	179.34 a	71.25 a
SP8XSP38	14.411 bc	62.53 bc	80.11 bc	56.67 a
SP33XHS49	15.911 ab	71.22 b	123.07 b	72.50 a
SM35XSP38	12.155 bc	51.73 bc	89.05 bc	55.63 a
IP3A	9.060 c	43.68 c	65.66 c	49.58 a
1P3P	9.291 c	41.21 c	73.64 bc	50.83 a

Notes : BK= Dry Weight; The numbers followed by the same letter in the same column are not significantly different at 5% Duncan test.

The number of productive branches on *J.curcas* will determine the productivity of the plant (Ratree, 2004). *J.curcas* seed production in the first year may reach 318 g/plant (Heller, 1996). In India,

J.curcas starts its production in the second year and is able to produce seeds from 0.4 to 12 tonnes/ha (Lele 2005). If planted as a hedge plant, Jatropha seed production ranged between 0.8-1.0 kg of seeds/plant, equivalent to 2.5-3.5 tonnes/ha/year (Henning, 2004). Based on the potential oil production of 1,590 kg oil/ha/year derived from the seeds of Jatropha, the production achieved in this study would be lower. However, in this research, Jatropha cultivation was done on land that is the dry land of East Nusa Tenggara which generally cannot be used for cultivation.

In the first harvest, the dry weight of 100 seeds reached by Jatropha hybrids ranged from 66,083 up to 70,125 grams. The four tested hybrids produced the dry weight of 100 seeds higher than the IP3P IP3A control plants. Whereas in the second harvest, the dry weight of 100 seeds did not indicate any difference among all tested treatments (Table 1 and Table2).

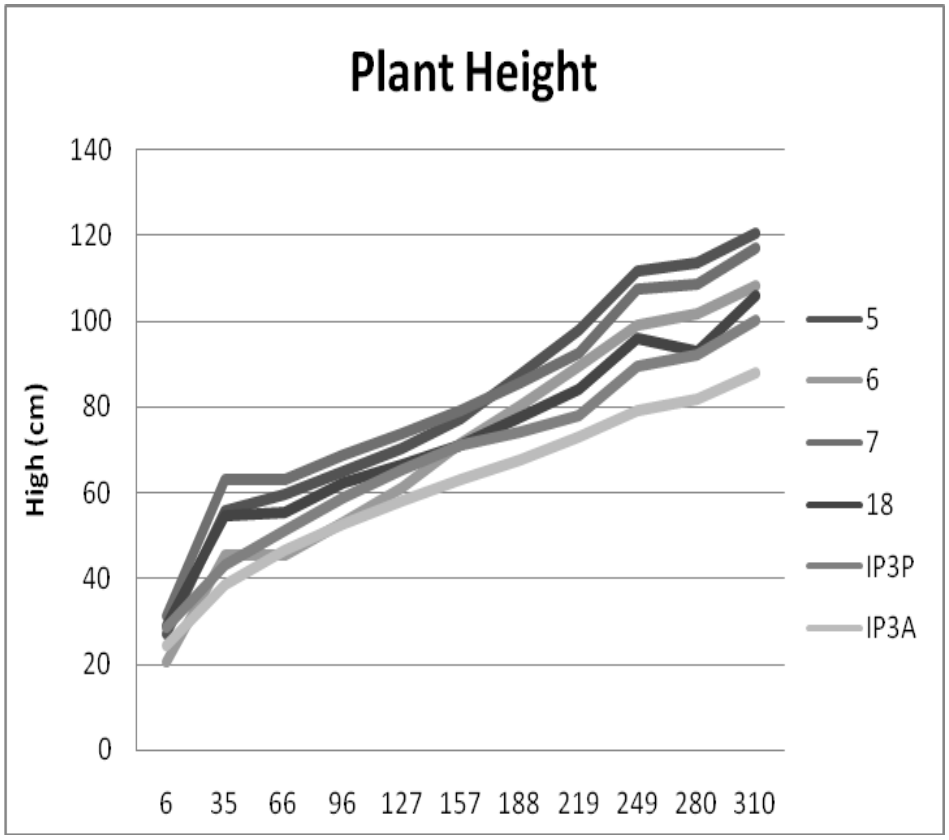

Figure 1.The Height of J.curcas L. hybrid varieties in Maumere-East Nusa Tenggara at the age of 6 up to 310 days after transplanting.

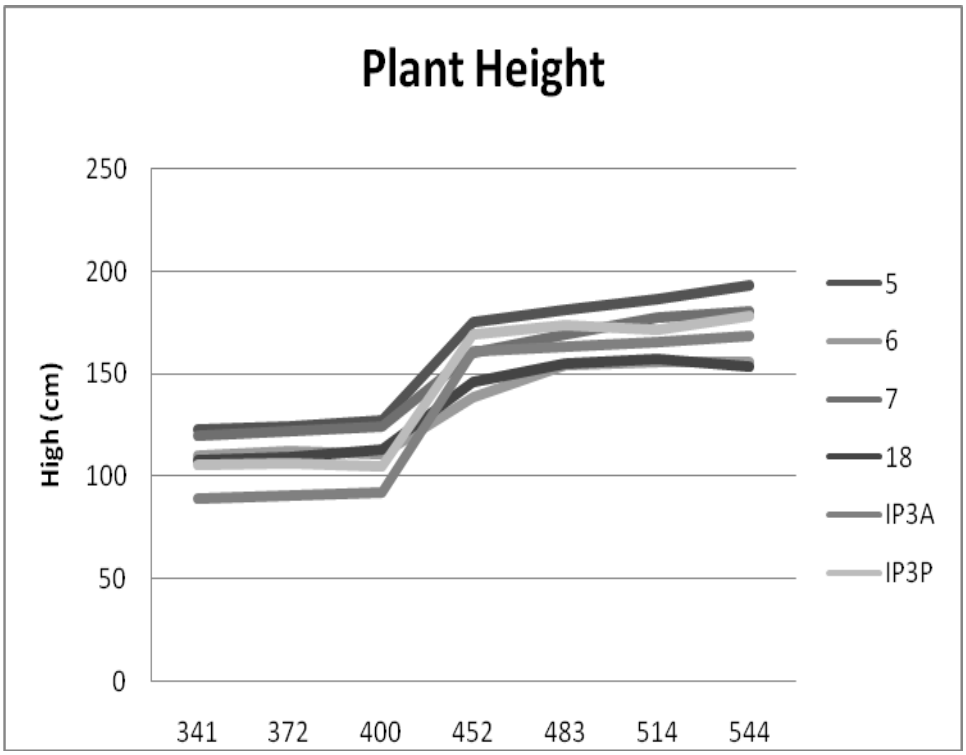

Figure 2.The Height of J.curcas L. hybrid varieties in Maumere-East Nusa Tenggara at the age of 341 up to 544 days after transplanting.

Data of plant height from varieties of *J.curcas L.* hybrid, which were tested in East Nusa Tenggara field at the age of 6 to 310 days and 341 up to 544 days after transplanting, were shown in Figures 1 and 2. In this study, the planting of Jatropha was implemented by using trunk cuttings which was about 30 cm long. Plant height growth charts showed that the average plant height achieved by *J.curcas* SP8XSP16 hybrid was higher than the other three hybrids and plant control. The figure also interpreted that upon entering the generative phase, Jatropha plants displayed a reduction in the growth rate of its height, compared to the beginning of the growing season (Figure 2)

Table 3. Average seed oil level of J.curcas L hybrids on the first and second harvests in Maumere, East Nusa Tenggara.

Accessions	Oil Level of First Harvest (% dry seed)		Oil Level of Second Harvest (% dry seed)	
SP8XSP16	36.336	a	31.252	a
SP8XSP38	36.511	a	30.190	a
SP33XHS49	36.455	a	30.717	a
SM35XSP38	37.210	a	29.232	a
IP3A	33.232	b	28.180	a
1P3P	33.537	b	29.304	a

Notes : BK= Dry Weight; The numbers followed by the same letter in the same column are not significantly different at 5% Duncan test

The average oil level of *J.curcas* hybrids' seed varieties on the first and second harvests in Maumere, East Nusa Tenggara, are presented in Table 3. The observation of seed oil level of *J.curcas* projected a difference in the first year observation. Duncan test results showed that the

four tested hybrids provided higher production of oil than the control plants. Oil level in the tested seeds of hybrid plants ranged from 36,336 to 37,210 percent of their dry weight; while in the second year of harvesting, seed oil level analysis did not show any significant differences (Table 3).

The higher number of fruit bunches and total fruits in each bunch tend to be followed by higher dry weight. This is consistent with results of previous studies, proving that the characters which have positive correlation with dried seed yielding potential and have more prominent heredity value are: leaf width, number of primary branches, number of secondary branches, total of bunches per plant and the number of fruit per plant. Therefore, these characters can be used as selection criteria in planting *J.curcas* (Zainudin et. al., 2014).

In one research on Jatropha's yielding potential in West Lombok, West Nusa Tenggara, it was reported that the production potential of the seeds in the first year could reached 189.86 g/cuttings from the origin plant, and 170.75 g/plant from seeds (Sudhakara et.al. 2012). Compared to the previous data, the potential results obtained in this study could be lower. However, in the course of this research, irrigation for plant was not given at all in order to test the sustainability of plant growth and to check potential yielding crop under severe drought.

CONCLUSION

This study results showed that SP8XSP16 hybrid plant produced the highest number of fruit/plant (97.23 fruit/plant) and the highest average dry weight of seed (179.34 g/plant) in the second harvest, with a dry weight of 100 seeds of 71.25 grams, with seed oil level of 31.252 percent and the age of first harvest on 90-91 days after transplanting. It was then followed by SP33XHS49 hybrid, with an average weight of 123.07 grams of dry seed/plant, with total fruit of 71.22, oil level of 30.72%, but the age of first harvest was longer than the other hybrids (101-102 days). In this study, the overall tested hybrids produced dry seed weight higher than the control plants (IP3A and IP3P).

ACKNOWLEDGEMENT

This study was funded by the Directorate General of Higher Education through Excellence Research Scheme of Higher Education for 2013 fiscal year. A sincere thank is delivered to the head and staffs of Research Institute for Agricultural Technology (BPTP) of East Nusa Tenggara province on aiding the maintenance and observations of planting and harvesting during the study.

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