2011 International Conference on Environment and BioScience
IPCBEE vol.21 (2011) © (2011) IACSIT Press, Singapore

Seed Germination and Seedling Performance of *Jatropha Curcas* l. Fruit Based on Color at Two Different Seasons in Northern Philippines

Charlie B. Batin

Mariano Marcos State University

Abstract. The study characterized the fruit maturity of *Jatropha curcas L.,* determined the fruit color that yields the highest oil content, and evaluated the seed germination and growth performance of Jatropha seedlings collected from Jatropha plantation in Lubbot, Batac City, Ilocos Norte. Changes in fruit color starting from the development of fruit until the color changes to black were documented for a period of 34 days. The experiment was laid out in Complete Randomized Design with four (4) treatments and three (3) replications. Treatments are as follows: T1-green (141D), T2- yellow (11B), T3- dark yellow and T4- black (202A). The longest observable color transformation was observed in green (141D) to yellow (11B) color, while the shortest was exhibited by dark yellow (12B) to black (202A) color using the Royal Horticultural Color Chart (RHCC). Seeds produced during the dry season had higher oil content than seeds during the wet season. Seeds taken from yellow fruits had the highest oil yield in both seasons. Germination and growth performance of Jatropha seedlings was significant for both seasons. Seeds taken from black colored fruits during the dry season and dark yellow for the rainy season were recommended for better germination and growth. These colors were found to produce higher seed quality and more vigorous seedlings compared to other fruit colors considered in the study.

Keywords: Jatropha curcas L., biodiesel crop, Germination value, Relative Growth Rate, Crude Fat Content

1. INTRODUCTION

The escalating prices of imported crude oil which the Philippines is almost fully dependent on prompted the government to prepare measures that will help the country to reduce from utilizing fossil fuels towards greater use of indigenous energy resources. One of the species identified as potential source of biofuel for biodiesel is *Jatropha curcas* L. known as Jatropha or tuba-tuba.

Philippine government has launched a novel approach in reducing the nation's dependence on imported fossil fuels like crude oil, by tapping vast tracts of unproductive idle public and private lands (mostly denuded mountains and forests) for large-scale bio-fuel crop cultivation. The initiative mandates the propagation and the commercial cultivation of the bio-fuel crop Jatropha, a drought resistant small tree that yields seeds containing high amount of oil that can substitute petrol-based diesel.

The amount of oil extracted from Jatropha seed depends on the volume and quality of harvested Jatropha seeds. Hence, huge production of Jatropha seeds depends on the success of plantation activities. In the same manner, successful plantation activities for Jatropha provides viable seeds for the production of quality seedlings which will later on provide good harvest along with proper care and maintenance. To date, the potential of Jatropha is still constrained by the lack of technical information particularly in selecting the best fruit maturity color that could give the most excellent seed germination and seedling growth performance. Proper selection of fruit maturity of Jatropha based on color must be ascertained in order to produce quality planting stocks for outplanting in the field to meet the increasing demand for Jatropha as rehabilitation species and source of oil. Hence, fruit color documentation of *Jatropha curcas* L. is necessary address issues on poor germination and growth.

Most of the problems encountered in the nursery are often associated with poor germination of the seeds during the nursery operation. Low seed viability leads to poor germination which is sometimes attributed to the poor quality of seedstock. The use of immature seeds could also be a factor that attributes to poor germination.

This particular study aims to: (1) document the changes of fruit color from the time the flower emerged until the fruit becomes black; (2) determine the fruit color of *Jatropha curcas* that yields the highest oil content; and (3) assess the performance of *Jatropha curcas* seeds taken from the colored fruits in terms of germination and seedling growth.

2. MATERIALS AND METHODS

2.1. Locale of the study

Seeds of Jatropha were collected in the Jatropha plantation located in Lubbot, Batac City, Ilocos Norte, which was established in December 2006 out of seeds originating from India. The plantation is on a rugged, sloppy, and mountainous area and surrounded with agricultural crops.

Ilocos Norte province is generally warm with two distinct seasons, wet season from the later part of May to October and the dry season from November to April. The climatic condition is considered as Type 1 under the Corona's classification system.

2.2. Phases of the Study

The study involved two phases. First, the documentation on the development of fruit until the color changes to black using the Royal Horticultural Color Chart (RHCC) as an index. Second, seed germination and seedling growth evaluation for each maturity color.

Jatropha fruits were collected based on the fruit color gathered in the documentation stage. The mid-point of the duration of days of each color transformation was used as time of gathering fruits. From each color, a total of 50 fruits were collected as samples. A total of 150 fruits were used for germination test. A kilo of Jatropha fruits of each color were tested for oil content.

2.3. Data Gathering

Samples were tested for growth and germination test 12 days after sowing. Germinated seeds were monitored everyday. Growth performance of the seedlings were measured 12 days after sowing (DAS) and 12 days after potting (DAP). Fifty (50) grams of seeds from each color was tested for percent crude fat. Samples were taken for two seasons; wet and dry. Gathering of data was done at the MMSU Central nursery.

2.4. Experimental Design

This study was laid out using a Randomized Complete Block Design (RCBD), with four treatments and three replications. A total of 600 Jatropha seeds were used for germination while 50g of seeds were used in the test for the percentage crude fat. Analysis of the crude fat content of the seeds was analyzed at the analytical laboratory of the National Institute of Molecular Biology and Biotechnology (BIOTECH), University of the Philippines Los Banos, College, Laguna, Philippines.

The changes of fruit color of Jatropha were used as treatments following the color coded Royal Horticultural color chart as follows (Figure 1): 1) T1: green (141D), 2) T2: yellow (11B), 3) T3: dark yellow (12B) and 4) T4: black (202A).

2.5. Data Analysis

All the data gathered from the study were subjected to analysis of variance using SPSS program. Significant findings were further analyzed using the Least Significant Difference (LSD). Correlation between fruit colors as to germination and growth performance and germination value as to germination and growth performance were performed for both seasons using the Pearson correlation.

T1(141D) T2(11B) T3(12B) T4(202A)

Fig. 1. The *Jatropha curcas* plantation located in Batac City, Ilocos Norte, Philippines

3. RESULTS AND DISCUSSION

3.1. Fruit Color Documentation

Based on the documentation, it took 16-day, 12-day, 4-day, and 2-day period to develop to green (141D), yellow (11B), dark yellow (12B), and black (202A). A period of thirty four (34) days was used in the documentation process.

3.2. Germination Characteristics

Pre-germination period and percentage germination of *Jatropha curcas* seeds differ significantly among treatments both in the wet and dry season (Fig. 2 & 3). Seeds taken from black and dark yellow fruit had the shortest pre-germination period during the dry and wet season, respectively.

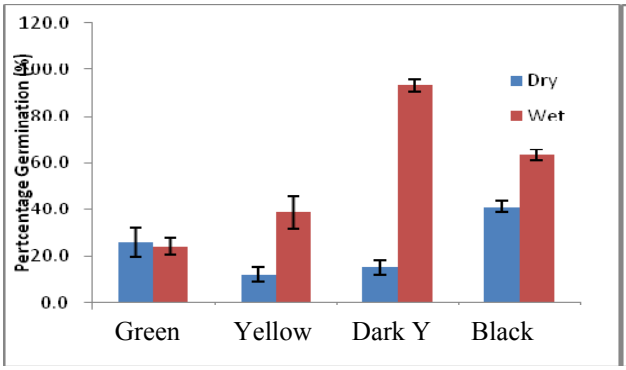

Fig 2. Pre-germination period of *Jatropha curcas* L. seeds as affected by fruit maturity.

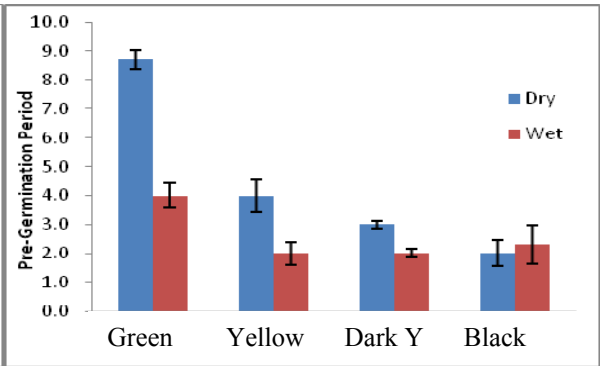

Fig. 3. Percentage germination (%) of *Jatropha curcas* L. seeds as affected by fruit maturity.

Seeds taken from young fruits (green) produced immature seeds hence, resulting low and delayed germination performance. The pre-germination result supports the percentage germination gathered. Seeds taken from green colored fruits had the lowest percentage germination with 26.0% and 24.0% for the dry and wet season, respectively. The results implied that seeds taken from immature fruits (green) results to low germination. This proved the claim of Basra (2006) that seed viability is higher at the mature stage and decreases with early or late harvest. Harvesting seeds too early may result in more immature seeds with low germination percentage.

Mean differences of germinative energy period (GEP) and germinative energy (GE) for both seasons differ significantly among treatments (Fig. 4 & 5). Seeds collected from dark yellow and black fruits during the dry season had the shortest germinative energy period with 4.0 days while yellow fruit had a GEP of 3.0 days during the wet season. On the other hand, GE during the dry season was highest in seeds taken from black fruit (17.3%) while seeds taken from dark yellow (31.3%) during the wet season had the highest GE. The result signify that seeds taken from dark yellow and black fruits are the earliest to germinate and considered as the most vigorous seeds and will produced the most vigorous seedlings over green and yellow. According to Aldhous (1972), germinative energy is a measure of the speed of germination and hence, is assumed to be a measure also of the vigor of the seed and of the seedling which it produces. The low vigor level of green colored fruits suggests that seeds are not yet fully mature. As such, harvesting at this stage is

not advisable because seedlings might not be able to continue growing and develop into normal plants (Aquino, 2009).

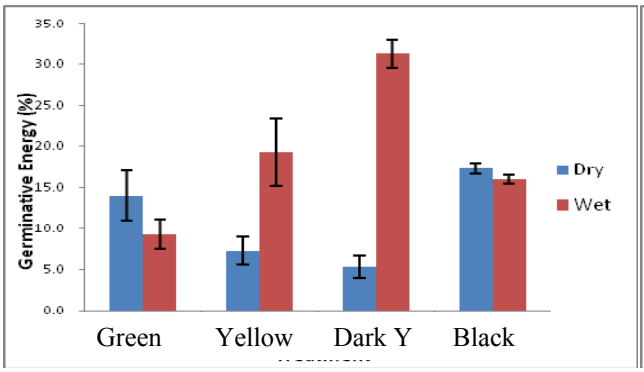

Fig 4. Germinative Energy Period (GEP) of *Jatropha curcas* L. seeds as affected by fruit maturity.

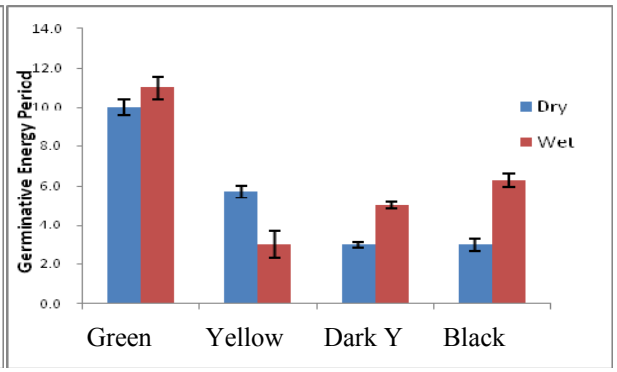

Fig 5. Germinative Energy (%) of *Jatropha curcas* L. seeds as affected by fruit maturity.

Percentage germination and germination value were presented in Fig. 6 and 7. Germination was highest in the seeds taken from black color during the dry season with 41.3% while 93.3% germination percentage was obtained from dark yellow fruit (wet). The results implied that seeds taken from immature fruits (green) results to low germination. This proved the claim of Basra (2006) that seed viability is higher at the mature stage and decreases with early or late harvest. Harvesting seeds too early may result in more immature seeds with low germination percentage. Moreover, germination value was highest in dark yellow (20.64) and black fruits (5.32) for the rainy and dry seasons, respectively. The result implied that seeds taken from matured fruits (dark yellow and black colored fruits) had better seed quality than immature fruits (green fruit). This supports the result obtained by Aquino (2009) that seeds of black colored fruits were the most vigorous among the four stages of maturity (green-yellow-green, yellow-black and black), and therefore, the best stage to harvest high quality seeds.

Germination value in relation to growth rate of the seedlings had indirect relationship. Germinants derived from green fruit had higher growth rate compared to germinants from dark yellow fruit but in terms of survival rate, germinants from green color had the highest mortality rate.

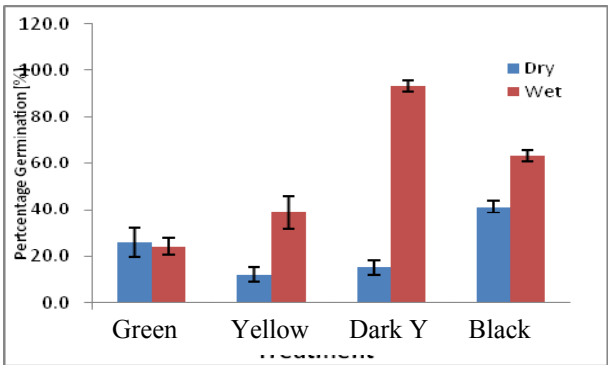

Fig 6. Percentage germination of *Jatropha curcas* L. seeds as affected by fruit maturity.

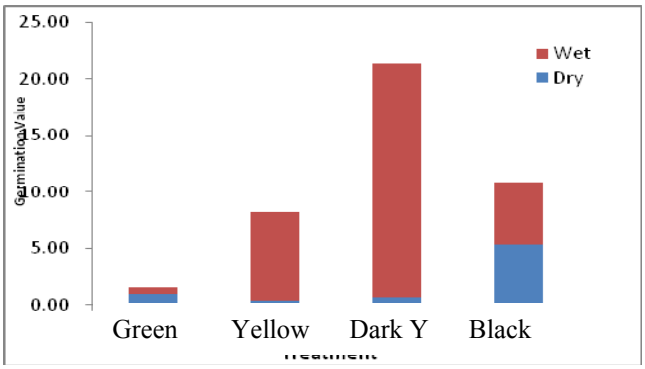

Fig 7. Germination value of *Jatropha curcas* L. seeds as affected by fruit maturity.

3.3. Growth Characteristics

Height and diameter of the seedlings at 12 days after sowing (DAP) and 12 days after potting (DAP) were (Figure 8, 9, 10 and 11) statistically significant among treatments for both seasons. Seeds taken from black colored fruit (14.5 cm and 16.8 cm) had the highest measurements at two measuring periods during the dry season while dark yellow (19.12 cm and 20.15 cm) during the wet season. The result implied that germinants produced from seeds taken from mature color (dark yellow and black fruits) are more robust and grow faster than immature fruit (green). This also confirmed the result of Jacinto (2008) that germinants from seeds taken from yellow and black fruits were taller than those seeds of green fruits.

On the other hand, diameter of the seedlings was highest in the seeds taken from dark yellow fruit at 12 DAS and 12 DAP for both seasons. The result denotes that mature fruits (dark yellow) exhibited bigger diameter than those taken from immature fruits (green). It supports the claim of Jacinto (2008) that germinants produced from seeds taken from dark yellow fruit had bigger diameter increment than green fruit.

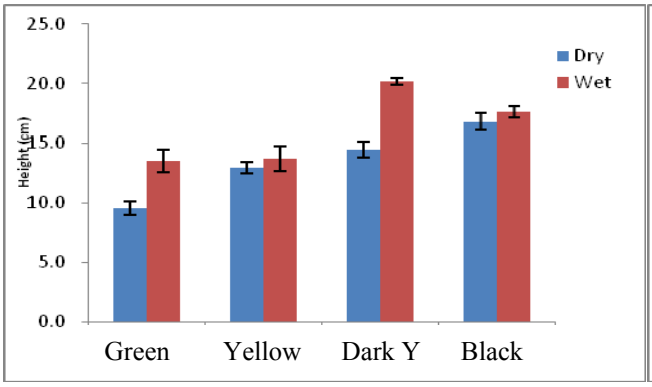

Fig 8. Height (cm) of *Jatropha curcas* L. seedlings at 12 days after sowing (das) as affected by fruit maturity.

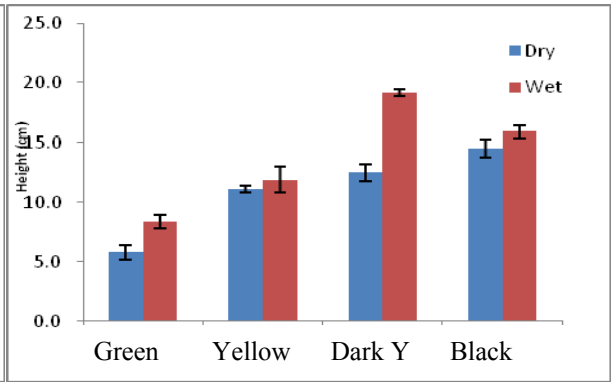

Fig 9. Height (cm) of *Jatropha curcas* L. seedlings at 12 days after potting (dap) as affected by fruit maturity.

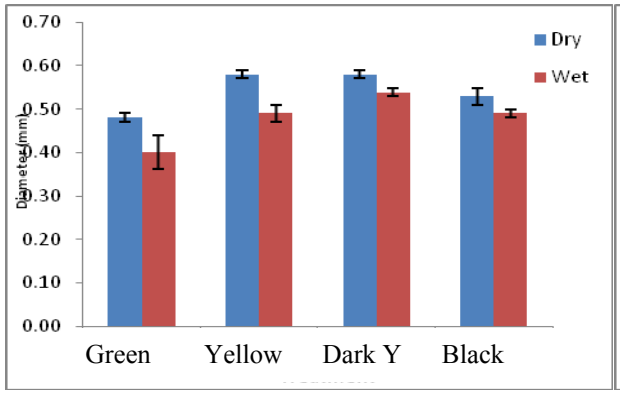

Fig 10. Diameter (mm) of *Jatropha curcas* L. seedlings at 12 days after sowing (das) as affected by fruit maturity.

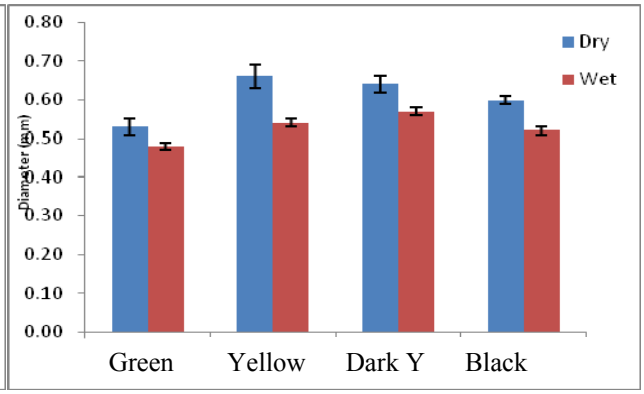

Fig 11. Diameter (mm) of *Jatropha curcas* L. seedlings at 12 days after potting (dap) as affected by fruit maturity.

A remarkably significant analysis among treatments of the relative growth rate for height of *J. curcas* was presented in Fig. 12 while insignificant analysis for diameter (Fig. 13). Green color obtained the highest growth rate for height (0.31 cm and 0.43 cm) for dry and wet season. The result further proved the claim of Causton and Venus (1991) that relative growth rates are near maximal when seedlings are young and then decrease over time. This means that when the plants attained its maximal growth, diameter increment is already negligible.

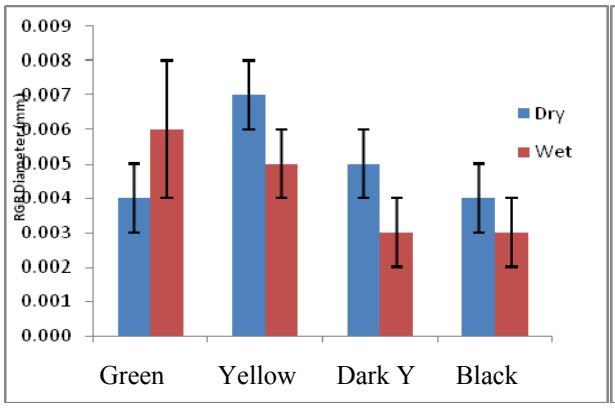

Fig 12. Relative Growth Rate (RGR) for height (cm) of *Jatropha curcas* L. seedlings as affected by fruit maturity.

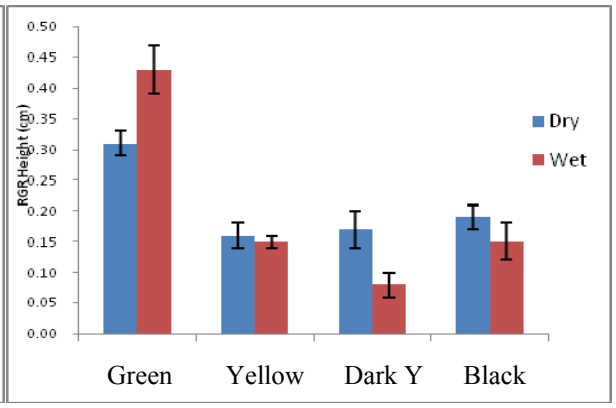

Fig 13. Relative Growth Rate (RGR) for diameter (mm) of *Jatropha curcas* L. seedlings as affected by fruit maturity.

Percentage survival of the seedlings was statistically insignificant among treatments (Fig. 14). However, germinants produced from dark yellow and black colored fruits had 100% survival rate. The result denotes that mature fruits (dark yellow and black color) had better percent survival rates than immature fruits. Moreover, percentage crude fat of the seeds was highest in seeds taken from yellow fruit (65.8% and 49.22%) for both seasons (Fig. 15). In a study conducted by Anandalakshmi (2009), he recommended to harvest yellow fruits for maximum oil yield.

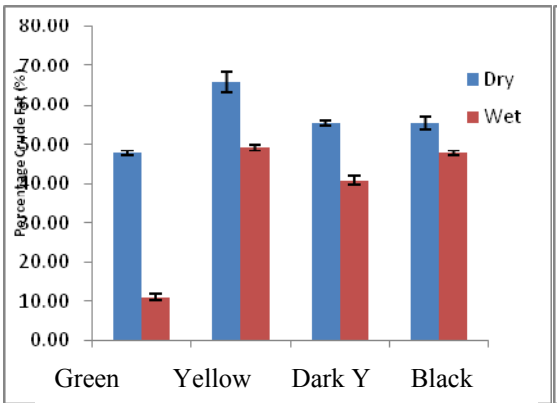

Fig 14. Percentage survival (%) of *Jatropha curcas* L. seedlings as affected by fruit maturity.

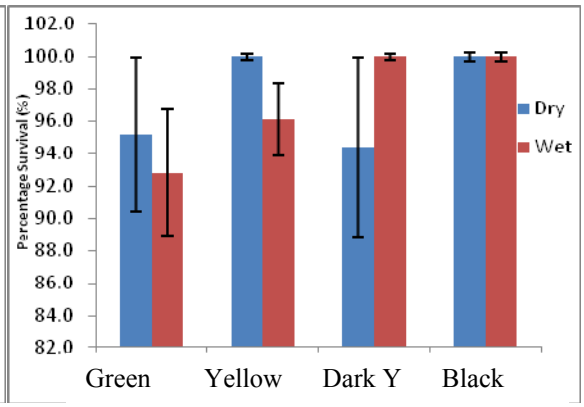

Fig 1**5.** Percentage crude fat (%) of *Jatropha curcas* L. seedlings as affected by fruit maturity.

3.4. Correlation Studies

Correlation between fruit colors as to germination and growth performance was presented in Table 1. Fruit color significantly affects germination performance in terms of pre-germination period and germinative energy period during the dry season while all other parameters were significant during the wet season. The result implied that wet season is the best time to harvest fruit for better germination and growth. Germination value on the other hand was insignificant (Table 2) except in germinative energy and percentage seed germination during the dry season. However, during the wet season, significant effect was observed in germination performance of the seedlings. This means that seeds taken from different maturity colors of Jatropha during the wet season are more viable compared to dry season.

Table 1. Correlation between fruit colors as to germination characteristics and growth performance of *Jatropha curcas* L. seeds and seedlings.

VARIABLE	DRY		WET	
Germination Performance	***r***	***P***	***r***	***P***
Color x Pre-germination Period	-0.981**	0.000	0.782**	0.003
Color x Germinative Energy	-0.133 ns	0.681	0.609*	0.036
Color x Germinative Energy Period	-0.990**	0.000	-0.768**	0.004
Color x Percentage Seed Germination	0.125 ns	0.698	0.763**	0.004
Growth Performance				
Color x Height @ 12 Days after Sowing	0.957**	0.000	0.853**	0.000
Color x Height @ 12 Days after Potting	0.920**	0.000	0.686*	0.014
Color x Diameter @ 12 Days after Sowing	0.679*	0.015	0.740**	0.006
Color x Diameter @ 12 Days after Potting	0.655*	0.021	0.691*	0.013
Color x Percentage Survival	0.184 ns	0.567	0.663*	0.019

***- significant at 1% level*
**- significant at 5% level*
ns- not significant

Table 2. Correlation between gemination value as to the germination characteristics and growth performance of *Jatropha curcas* L. seeds and seedlings.

VARIABLE	DRY		WET	
Germination Performance	***r***	***P***	***r***	***P***
GV x Pre-germination Period	-0.466 ns	0.126	0.611*	.035

GV x Germinative Energy	0.698*	0.012	0.917**	.000
GV x Germinative Energy Period	- 0.380 ns	0.223	-0.616*	.033
GV x Percentage Seed Germination	0.835**	0.001	0.872**	.000
Growth Performance				
GV x Height @ 12 Days after Sowing	0.550 ns	0.064	0.077ns	.811
GV x Height @ 12 Days after Potting	0.640*	0.025	-0.040ns	.902
GV x Diameter @ 12 Days after Sowing	-0.193 ns	0.548	0.652*	.022
GV x Diameter @ 12 Days after Potting	-0.147 ns	0.648	0.797**	.002
GV x Percentage Survival	0.225 ns	0.482	-0.094ns	.772

***-significant at 1% level*
**- significant at 5% level*
ns- not significant

4. CONCLUSION

The documentation phase of the study showed that 34 days were utilized in documenting the changes in the fruit color of Jatropha from the development of the fruit until the color changed to black. Fruit maturity had an influence on the germination and growth, performance of Jatropha curcas seeds and seedlings including percentage crude fat content. The best maturity color of Jatropha for oil yield production was dark yellow because it produced the highest oil content for both seasons of seed collection.. During the dry season period of collection, black color was the most promising in terms of germination and growth performance. Similarly, dark yellow was the most promising for the rainy season.

5. ACKNOWLEDGMENT

This study was supported by the Southeast Asia Regional Center for Graduate Studies in Agriculture (SEARCA) and partly by the Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development (PCARRD) of the Department of Science and Technology (DOST) and Department of Agriculture-Bureau of Agricultural Research (DA-BAR).

6. REFERENCES

[1] ALDHOUS, J.R. 1972: Nursery practice. Forestry Comm. Bull. No. 43, London.

[2] AQUINO, AL. 2009. "Seed Quality of Physic Nut (*Jatropha curcas* L) at Different Stages of Fruit Maturity". Philippine Journal of Crop Science (PJCS). Crop Science Society of the Philippines. University of the Philippines Los Banos, Laguna, Philippines.

[3] ANANDALAKSHMI**.** 2009. Development of forest harvest techniques for seed production in *Jatropha curcas***.** <http://www.icfre.org/UserFiles/FileProjects/IFGTB-2008-2009/IFGTB-COMPLETED-EXTEuary RNALLY-2008-09.pdf. Date retrieved 02 February 2010.

[4] BASRA, AS. 2006. Handbook of Seed Science and Technology. The Haworth Press, Inc. 10 Alice Street, Binghamton, NY. 548 p.

[5] CAUSTON D.R. and VENUS J.C. 1991. The biometry of plant growth. Edward Arnold, London, United Kingdom.

[6] JACINTO, J.B. 2008**.** Effect of fruit maturity and drying methods on the germination of *Jatropha curcas* L. seeds. Unpublished Undergraduate Thesis. Mariano Marcos State University, Batac, Ilocos Norte.