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Seed germination and seedling growth of *Chiococca javanica* (Rubiaceae) in relation to fruit maturation and media growth

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Abstract. *Purwantoro RS. 2017. Seed germination and seedling growth of Chiococca* javanica *(Rubiaceae) in relation to fruit maturation and media growth. Nusantara Bioscience 9: 111-119. Chiococca javanica* is a plant having ornamental potential. The seeds extracted from the fruits were classified according to maturity stage: Unripe - yellow; ripe - reddish; and over ripe - dark-red and seed germination were done in two germination media: sand and rice husk. The statistical approach was a randomized complete block design with three replications. Analysis of variance indicated that the seeds of *C. javanica* from the ripe and over ripe fruit had higher significances ($P<0.05$) on germination capacity, speed of germination, mean germination time, mean daily germination, peak value and germination value than the seeds from yellow fruits. The effect of growing media on germination process showed higher significance in sand than that in rice husk. Similarly, mean daily germination in sand was higher than that in rice husk. All seedling growth parameters of the seeds from ripe and over ripe fruit showed significant different on number of leaves, shoot length, diameter of seedlings, number of lateral roots, roots length, fresh weight and dry weight of plants than the seeds from unripe fruit.

Keywords: *Chiococca javanica*, fruit maturation, seed germinations, seedling growth

INTRODUCTION

In recent years, there had been an increased interest on the degradation of forest in Java. In the process of land use changes, there are also activities such as forest clearing for agriculture, wood extraction, settlement and infrastructure expansion that are attributed to deforestation process. (Prasetyo et al. 2009) This practice threats species diversity and promotes exhaustion of natural resources (Inácio et al. 2013). Such environmental changes are further aggravated by the rapidly increasing population number throughout the world placing high pressure on the forests, which calls for urgent action (Zewdie and Welka 2015). Conservation of utility plants is an important task that promotes species sustainability and maintains healthy ecosystems (Inácio et al. 2013).

Genus *Chiococca* belongs to family Rubiaceae which 22 species are found in North America to Brazil (Lopes et al. 2004), Sri Lanka (Macmmillan 1952) and Java (Sari et al. 2010). *Chiococca javanica* (Blume) Blume (syn: *Coffea javanica* Blume is a shrub or small tree with distinctive, conical crown shape, a lot of auxiliary yellow fruits on many branches, showy, opposite leaves, and white flowers. Flowers bloom from January through April in tropical environments. The trees can reach 9 m height. This plant prefers rich, moist soils, which is found in several plant associations occurring in West Java (Sari et al. 2010). One species is recognized as a medicinal plant and other species have a bioactive compound. Local people used a decoction of *C. alba* root as a drug for the treatment of dysentery and snake bites (Dzib-Reyes et al. 2012). A phytochemical research of *C. javanica* about the contents of alkaloid, flavonoid, terpenoid, glycoside, anthraquinone has been conducted (Elya et al. 2012).

In general, seed is a part of a plant used for natural propagation, especially in the act to conserve plants germ-plasm diversity or others purposes such as reforestation, plant population recovery, although, according to Janick (2005), there is a long juvenile period in plant grown from seed. Germination of a seed is the initial, and, under some circumstances, critical step in afforestation by natural or artificial means. Similarly, a species may be found in a wide variety of climatic regions, but the germination behavior may differ according to provenance (Masoodi et al. 2014). Benech-Arnold and Sanchez (eds.) (2004) reported that among the stages of the plant life cycle, seed germination and seedling establishment are the most vulnerable. The seed consists of three distinct parts: the embryo, the endosperm, and the peel. Four conditions essential to a successful germination are: a certain amount of moisture, a favorable degree of heat, fresh air and protection from strong light (Macmmillan 1952; Hartmann et al. 2004). In the absence of any of these conditions, a successful germination cannot be taken place (Macmmillan 1952). Seeds are self-contained units, environmental requirements for germination are fewer and simple, so germination is relatively independent from the environment for a considerable period of seedling development but other environmental factors are still needed, such as water, temperature, and oxygen (Benech-Arnold and Sanchez 2004).

Seeds of different species and of the same species from different provenances behave differently in their germination response and the equal knowledge about this thing is very essential for understanding plantation programs (Masoodi et al. 2014). Seed improvement quality is needed to get optimal germination. It is important to know the effect of the stage of seed maturation on its germination (Daff-Alla and Mustafa 2015). Battistus et al. (2014) reported that in order to obtain good quality seeds, there must be considerations about the fruit maturity and the maximum quality of the seed in association with the dryness. The process of physiological maturity in the fruits and seeds usually occur simultaneously (McAtee et al. 2013). Physiological maturity stage in the fruit consists of physiological and biochemical processes, and the decrease in seed moisture content. On the physiological and biochemical processes, the formation of reserves of food, especially carbohydrates, protein, and fat and hormone growth regulator, increases. Viability is expressed by the germination percentage, which indicates the number of seeds with high-quality characteristic and additional characteristics is prompt germination, vigorous seedling growth, and normal appearance (Hartmann et al. 2004).

Chiococca javanica as an associated forest vegetation for all in West Java has a good prospect as ornamental plants and its contents of chemical component can be used for a drug for human health, but any information including seed germination of the species is still poorly studied. The objective of this study is to identify the best fruit maturity stage of *C. javanica* in two different growing media, namely, sand and rice husk.

MATERIALS AND METHODS

Study area

The experiment was conducted at the Green House Nursery of Bogor Botanic Gardens, West Java, Indonesia during the period of September to December 2015. Seeds of *C. javanica* were used. The media for seeds sowing on the experimental treatment are sand and rice husk. The Bogor Botanic Gardens is located at 40 km from Jakarta and at an altitude of 250 m. The climate is rainfall in most months of the year according to Koppen classification. The average annual temperature in Bogor is 26.6°C. Precipitation is at an average of 3218 mm/year.

Procedures

Chiococca javanica Blume fruits were harvested from vigorous mother shrub at different fruit maturity level, namely, yellow fruit, reddish fruit and dark-red fruit on mother shrub from Bogor Botanic Gardens collection in Vak XI.XVII.246 in 8th September, 2015 and then, they were air-dried. Damaged seeds were hand-picked out. Each fruit maturity level is showed in Figure 1, and the seed germination was done in two germination media, i.e. sand and rice husk. The treatments were, first, the fruits were soaked in distilled water for 24 hours and then they were soaked in Dithane-M45 for 5 minutes in 41 x 32.5 x 14.5 cm plastic tray. The seeds sowing were done in September about 0.3 cm deep in different growth media i.e. sand and rice husk for all seeds from three fruit maturity stages, three replications per treatments, a replication consisted of 20 seeds. The plastic trays were watered immediately after seed sowing and the watering was repeated every day till the final emergence.

Germination study of *C. javanica* seeds from various fruit maturity stages in different germination media was conducted in sand and rice husk. Daily observations were made during radicle emergence (Gairola 2011).

Germination

Seed germination percentage was calculated using the following formula (Gairola 2011)

Germination % = Number of germinated seeds / Total number of seeds × 100

Germination associate parameters were calculated by using following formulas:

Speed of germination

Speed of germination was calculated with the following formula (Gairola 2011; Zewdie and Welka 2015)

Speed of germination= n1/d1+n2/d2+n3/d3+----------

*Note: n = number of germinated seeds, d = number of days.

Mean germination time (MGT)

Mean germination time was calculated with the formula given by Gairola (2011) and Zewdie and Welka (2015)

MGT = n1 x d1 + n2 x d2 + n3 x d3 + --------/ Total number of days

*Note: n = number of germinated seed, d = number of days

Mean daily germination (MDG)

Mean daily germination can be calculated with the following formula given by Gairola (2011)

MDG = Total number of germinated seeds / Total number of days

Peak Value (PV)

Peak value was calculated with the following formula given by Gairola (2011)

PV = Highest seed germinated / Number of days

Germination Value (GV)

Germination value was calculated with the following formula given by Gairola (2011)

GV = PV X MDG

Seedling growth associate parameters

Ten randomly selected seedlings were taken from each growing media treatment to measure the length of root and shoot, the length and the width of leaf, the number of leaves, the number of lateral roots, the fresh and dry weight of seedling. They were measured with a measuring scale and expressed in centimeters while the fresh and dry weight of seedlings were measured by three digit balance and expressed in gram. Measurement and number of the seedlings were measured after 80 days of seed setting (Islam et al. 2012)

Data analysis

Three replicates of 20 seeds from each fruit maturity stages were used in the treatment in sand media and rice husk media. The treatments were arranged in a complete randomized block design. The results were statistically analyzed by using MINITAB program version 16. Analysis of variance (ANOVA) was performed and difference between means was separated by F test at $P > 0.05$.

RESULTS AND DISCUSSION

During imbibition, the seed rapidly swells and changes in size and shape after seeds are watered for 24 h. Seeds absorb water from the soil by process of imbibition which leads to the swelling and breaking of the seed coat. Following imbibition process, hydrolytic enzymes (hydrolase) are activated which break down the stored food substance into metabolically useful chemicals (Petrollini 2011). Sand and rice husk have high porosity and it is an advantage since the porosity supports seed germination of *C. javanica* after the seeds are sown in the growing media based on various fruit maturity stages. Sand and rice husk charcoal have good aeration and drainage, but bad in water holding capacity, and therefore, seeds could not absorb water optimally in the imbibition process (Rivai et al. 2015). A specialized water-restriction zone within the water impermeable layer is responsible for regulating water entry into the seed (Puteh et al. 2011). High porosity in the growing media allows oxygen go into the seeds easily after the imbibition. Imbibition process occurs after the water goes into the seed followed by the entry of oxygen to start respiration processed. The amount of oxygen in the growing media is affected by its low solubility in water and its slow ability to diffuse into the media (Hartmann et al. 2002). Oxygen supply to support the metabolic activity becomes decisive at a very early stage in germination, and oxygen required by metabolic activity is detected at an early stage of germination, and is indicated by a sharp rise in the respiration rate of seeds; Another rise in respiration marks is at the beginning of the growth stage and at radicle emergence stage (Benech-Arnold and Sanchez (eds.) 2004).

Germination stages in correlation to different fruit maturation stage

Seed germination study on *C. javanica* germinated has been done and the seedling type of this plant showed hypocotyl development which was a characteristic of epigeal. The germination type is characterized by the pulling out of the rest of the seed as the enclosed plumulae are raised above the growing media then it starts the hypocotyl development growth to vertical elongate. The seed coat is cast off and the rest of the seed open up like two green leaves color (Figure 1). The green color of hypocotyl resulted in photosynthetic production to support the growth of the sprout including the development of root and then the maximal production has given by green plumulae to support all part of sprout development.

Analysis of variance for minimum days taken for the radicle, hypocotyl, plumulae, and leaf stages of *C. javanica* seed germination in sand growing media has been undergone and was shown in Table 1. The minimum days taken for each stage of germination for the plant showed significant variations in relation to fruit maturation stages at $P=0.05$ level. The minimum days taken for the radicle stage of over ripe fruit (18.3 days) and of ripe fruit (18 days) were lesser than the radicle stage of unripe fruit (30.3 days) (Figure 3). Similarly, the minimum days taken for the hypocotyl stage of over ripe fruit (19.3 days) and of ripe fruit (18 days) were lesser than the hypocotyl stage of unripe fruit (36.3 days) (Figure 4), the minimum days taken for the plumale stage of over ripe fruit (38.3 days) and of ripe fruit (38.7 days) were lesser than the plumale stage of unripe fruit (72 days) (Figure 5), the minimum days taken for the leaf stage of over ripe fruit (47 days) and ripe fruit (47.7 days) were lesser than the days for the leaf stage of unripe fruit (76.7 days) (Figure 6). Analysis of variance for minimum days taken for the radicle, hypocotyl, plumulae, and leaf stages of *C. javanica* seed germination in rice husk growing media could not be done because the data of all stages of seed germination of unripe fruit were incomplete. On this growing media, the growth stage of radicle did not emerge, and also, the stage of hypocotyl, plumulae and true leaves did not occur during the 80-days deadline for observation.

The seeds quality of *C. javanica* was influenced by fruits ripening. The fruit development which has reached the reddish to dark-red color indicates the maximum ripening of seeds where sprouts will grow and expand successfully through the stages of radicle, hypocotyl, plumulae and true leaf. The seeds germination of yellow fruit in both sand and rice husk growing media needed longer time to reach every germination stages than that of the seeds germination of reddish to dark red fruits.

Germination study in correlation to different fruit maturation stage

The effects of the three stages of fruit maturation on seed germination were observed in this study (Table 3). The seed germination percentage at different fruit maturation was significantly varied at $P<0.05$ level of significance for all parameters. Germination capacity was recorded as high on the seeds of over ripe fruit and ripe fruit (51.7 and 43.3%) and as low on the seeds of unripe fruit (10.0%). Similarly, the other parameters were recorded as significantly different on the speed of germination (0.35 and 0.3) and as low on the seeds of unripe fruit (0.04), as high on mean germination time (5.14 and 5.18) and as low on the seeds of unripe fruit (1.33), as low on mean daily germination (0.13 and 0.11) and as low on the seeds of unripe fruit (0.02), peak value (0.15 and 0.12) and lower the seed of unripe fruit stage (0.03), germination value (0.019 and 0.014) and lower the seed of unripe fruit stage (0.001).

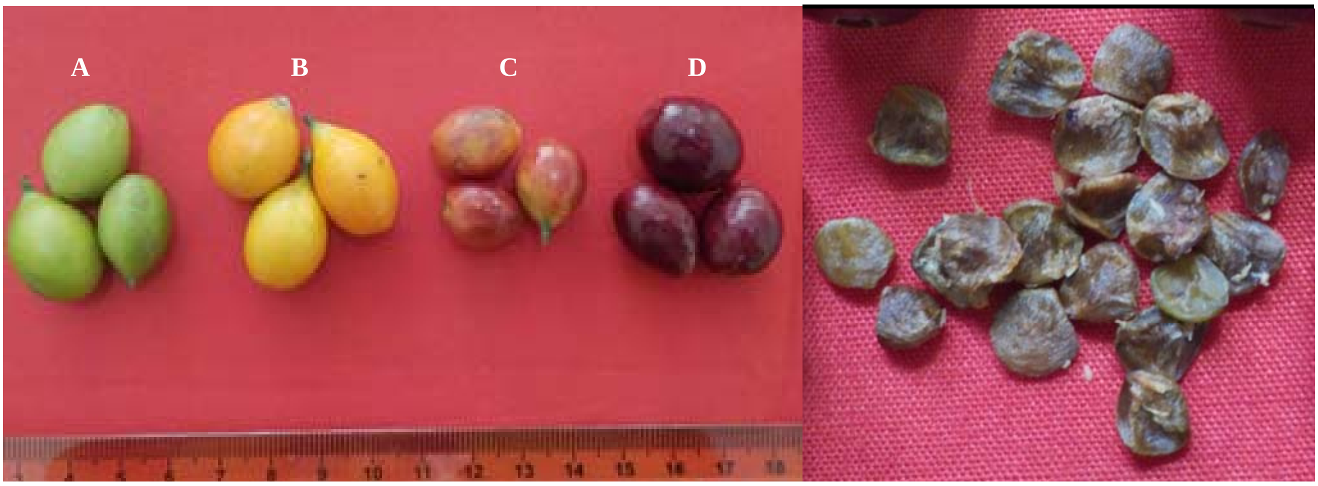

Figure 1. Fruits maturation levels of *C. javanica* and seeds. A. Young fruit, B. Unripe, C. Ripe, D. Over ripe

Figure 2. Germination stages of *C. javanica* consists of: A. Seed, B. Radicle, C-D. Hypocotyl, E. Plumulae, F. Epicotyl and leave (*left*), green hypocotyl (*right*)

This study shows the influence of fruit maturation stages on germination capacity, speed of germination, mean germination time, mean daily germination, peak value and germination value of *C. javanica*. Dark-red fruit color indicates the condition of seeds maturation that can reach a maximum germination. Although the fruit flesh has become soft, but it does not mean that the seeds have reached an optimal ripening stage. All parameters in this study showed that the seeds from both reddish and dark-red fruit are better than seeds from yellow fruit.

The seed germination in sand sowing medium was different significantly from that in rice husk sowing medium on germination capacity (Figure 7) and mean daily germination (Figure 8). The ripe phenotype is the summation of biochemical and physiological changes that occur at the terminal stage of fruit development and render the edible and desirable organs to seed-dispersing animals (Geovannoni 2001). Fruit ripening is accompanied by some biochemical events, including changes in color, sugar, acidity, texture, and volatiles aroma that are crucial for the sensory quality (Bouzayen et al. 2010). However, a seed maturity of *C. javanica* is characterized by the peel color change from reddish to dark red fruit, the softening of all part of fruit and the easiness of seeds extraction. Hartmann et al. (2004) reported that low germination can be due to genetic properties, incomplete seed development on the plant, injuries during harvest, improper processing, storage, disease, and aging. The low germination parameters occurred on seeds from yellow fruits of *C. javanica*. Yellow fruit was the fruit that was still undergoing a process of growth, as well as the seeds were still growing and developing. The mature seeds occurred on the red and dark-red fruit so seed germination can be done optimally.

Table 1. Analysis variance for the minimum days taken for the stage of radical, hypocotyls, plumulae, and the leaf of *C. javanica* seedlings in seeds from various fruit maturity stages in sand growing media

Response	Source	df	SS	MS	F	P
Radicle	Fruit maturity stages	2	296.22	148.11	30.3	0.001 *
	Error	6	29.33	4.89		
	Total	8	325.56			
Hypocotyl	Fruit maturity stages	2	626.89	313.44	108.5	0.000 *
	Error	6	17.33	2.89		
	Total	8	644.22			
Plumulae	Fruit maturity stages	2	2244.7	1122.3	16.78	0.003 *
	Error	6	401.3	66.9		
	Total	8	2646			
Leaf	Fruit maturity stages	2	1721.6	860.8	55.34	0.000 *
	Error	6	93.3	15.6		
	Total	8	1814.9			

Note: * and, ns: significant at P=0.05 and no significant, respectively; df: degree of freedom, SS: the sum of square, MS: mean the sum of square, F: F-satistic, P: P-value

Table 2. The minimum days taken for the radicle and the hypocotyl and the plumulae and the leaf of *C. javanica* seedlings in seeds from various fruit maturity stages in rice husk growing media

Factors	Radicle (days)	Hypocotyl (days)	Plumulae (days)	Leaf (days)
Over ripe fruit	20-21	24	36-40	50-52
Ripen fruit	20-22	24-26	33-39	50-52
Unripe fruit	-	40-more than 80	48-more than 80	More than 80

Note: -: data from replication of each stage of unripe fruit were incomplete

Table 3. Seed germination of *C. javanica* based various fruit maturation stages and different growing media

Factors	Germination capacity (%)	Speed of germination	Mean germination time	Mean daily germination	Peak value	Germination value
Over ripe fruit	51.7 a	0.35 a	5.14 a	0.13 a	0.15 a	0.019 a
Ripe fruit	43.3 a	0.30 a	5.18 a	0.11 a	0.12 a	0.014 a
Unripe fruit	10.0 b	0.04 b	1.33 b	0.02 b	0.03 b	0.001 b
Sand	41.1 a	0,26 a	4.35 a	0.10 a	0.11 a	0.013 a
Rice husk	28.9 b	0.2 a	3.41 a	0.07 b	0.09 a	0.010 a

Note: Means followed by the same letter in each column are not significantly different at 0.05 probability level.

Table 4. Seedling growth of *C. javanica* based various maturation fruit stages and different media

Factors	Number of leaves	Shoot length (cm)	Ø shoot (cm)	Number of lateral roots	Root length (cm)	Fresh weight of plants (g)	Dry weight of plants (g)
Over ripe fruit	2.7 a	7.6 a	6.0 a	11 a	7.0 a	0.3084 a	0.0844 a
Ripe fruit	2.7 a	7.4 a	6.0 a	14 a	5.5 ab	0.2753 a	0.0863 a
Unripe fruit	0.9 b	2.8 b	2.2 b	4 b	2.0 b	0.0662 b	0.0358 b
Sand	2.4 a	7.6 a	6.1 a	13.6 a	6.0 a	0.2505 a	0.0791 a
Rice husk	1.7 b	4.2 b	3.3 b	6.2 b	3.6 b	0.1827 b	0.0518 b

Note: Means followed by the same letter in each column are not significantly different at 0.05 probability level

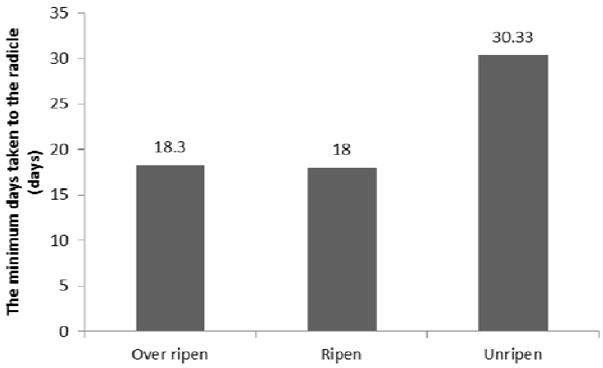

Figure 3. Minimum days taken for the radicle stage in sand

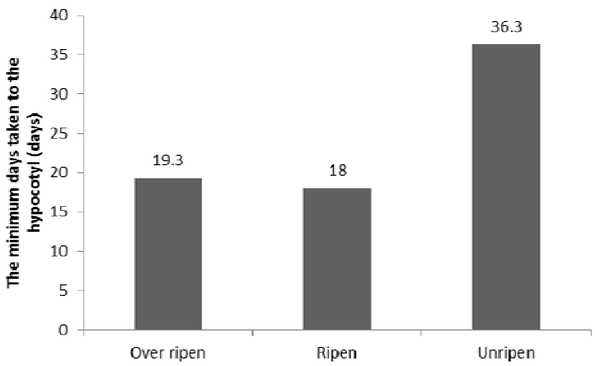

Figure 4. Minimum days taken for the hypocotyl stage in sand

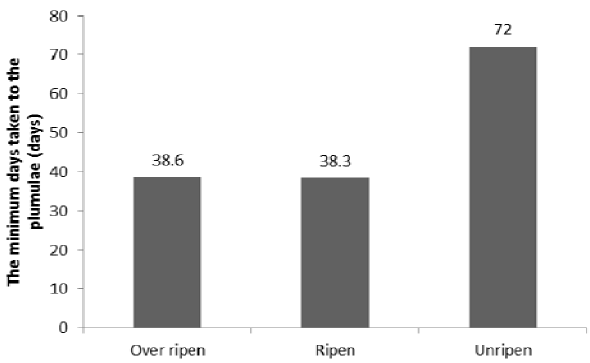

Figure 5. Minimum days taken for the plumulae in sand

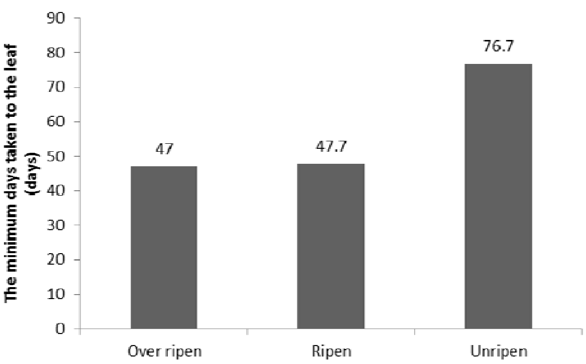

Figure 6. Minimum days taken for the leaf in sand

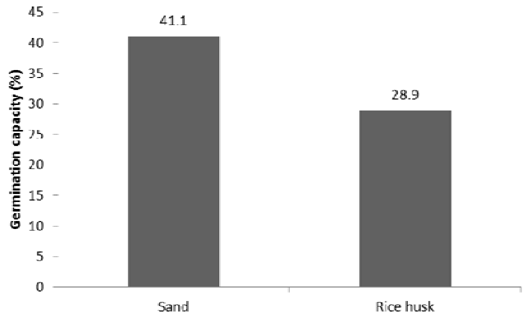

Figure 7. Germination capacity in two growing media

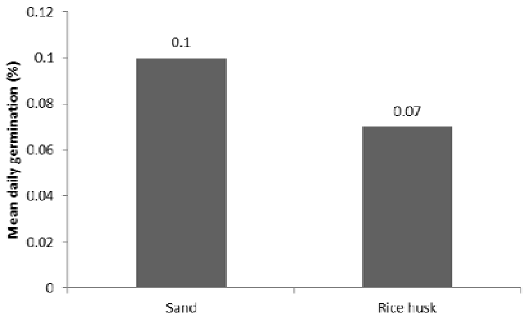

Figure 8. Mean daily germination in two growing media

Speed of germination of *C. javanica* seed in sand growing medium is higher (0.26) than in rice husk growing medium (0.2), mean germination time in sand growing medium is higher (4.35) than in rice husk growing medium (3.41), peak value of germination in sand growing medium is higher (0.11) than in rice husk growing medium (0.09), germination value in sand growing medium is higher (0.013) than in rice husk growing medium (0.01) and the differences among the growing media are statistically not significant at 0.05% level (Table 3). Differences in both mean germination time and speed of germination in different growing media are statistically not significant at $P<0.05$ significance level. All parameters of seed germination indicate that germination capacity, speed of germination, mean germination time, mean daily germination, peak value and germination view are recorded in its maximum capacity in sand medium sowing. The study shows that the preferable germination media for *C. javanica* is sand growing medium. The process of germinating seeds starts when the humidity of growing media meets the requirement. Media porosity allows for rapid germination by triggering the occurrence of imbibition on the seeds. In the day time, high temperature is suspected to cause the seed coat to be permeable against water spray resulting in seed germination. The mature seed, good aeration and gaseous exchange attained in well-structured, aggregated soil beds greatly assist the germinating seeds, since the CO_2 and ethylene can easily diffuse out of the soil so that seed dormancy and germination retardation in CO_2-sensitive species are relieved (Benech-Arnold and Sanchez 2004).

Seedling growth in different growing media

Seedling growth in different fruit maturation stages of *C. javanica* was also studied. Number of leaves was recorded to be maximum on both overripe fruit and ripe fruit (2.7) and it was different significantly with unripe fruit (0.9) at P<0.05 significant level. Similarly, shoot length which was recorded longer in seed of both over ripe and ripe fruit (7.6 and 7.4 cm) was significantly different from seed of unripe fruit (2.8). The shoot diameter was recorded to be longer in seed of both over ripe and ripe fruit (6 cm) than that of the seed of unripe fruit (2.2 cm). The number of root was recorded to be maximal in seed of both over ripe and ripe fruit (11 and 14) and it was different significantly from the seed of unripe fruit (4). The root length was recorded to be longer in seed of over ripe and ripe fruit (7 and 5.5 cm) than that of the seed of unripe fruit (2 cm).The fresh weight of plant was recorded to be maximal in seed of both over ripe and ripe fruit (0.3084 and 0.2753 g) and it was different significantly from the seed of unripe fruit (0.0662). The dry weight of plant was recorded to be maximal in seed of both over ripe and ripe fruit (0.0844 and 0.0863 g) and was different significantly from the seed of unripe fruit (0.0358 g) (Table 4).

Number of leaves in different growing media was recorded (2.4 and 1.7) and it showed significant different in different growing media at P<0.05 significant level (Figure 9). Similar to number of leaves, at P<0.05 significant level and at different growing media, significant variations were also recorded in length of shoot, which was 7.6 and 4.2 cm (Figure 10), shoot width which was 6.1 and 3.3 cm (Figure 11), number of lateral roots which were 13 and 6 (Figure 12), root length which was 6 and 3.6 cm (Figure 13), fresh weight of plant which was 0.2505 and 0.1827 g (Figure 14), dry weight of plant which was 0.0791 and 0.0518 g (Figure 15). However, the seedling growth of *C. javanica* prefers the sand growing media to rice husk growing media. The media growth may, under optimal conditions, complete its usefulness within few days after sowing, once seedlings are established, but under the impact of adverse weather the soil structure may fail or collapse because of fast wetting and drop impact. As a result, the failed structure may impose mechanical constraints on seed germination and stand establishment (Benech-Arnold and Sanchez 2004).

The seeds of *C. javanica* obtained from yellow fruits are lower in germination, slow in the speed of germination, shorter in mean germination time, shorter in mean daily germination, lower in peak value, lower in germination value than those seeds from more mature fruits (Table 3). The seeds from yellow fruits also have a smaller number of leaves, shorter length and narrower shoot, less number of lateral root, shorter root length, and lighter seedling compared to seeds from reddish or dark-red fruits (Table 4). Therefore, germination of seed collected from reddish or dark-red fruits resulted in the best quality seeds. Several observations on different fruit maturation levels showed variations of effect on seed germination: the highest physiological quality of *Jatropha curcas* was attained when fruits became yellow (da Silva et al. 2012), *Solanum melongena* seed's best quality occurred in mature fruit

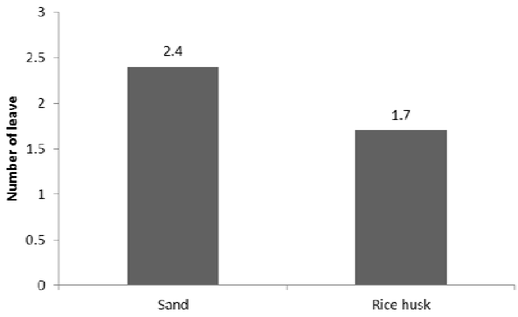

Figure 9. Number of leaves in two growing media

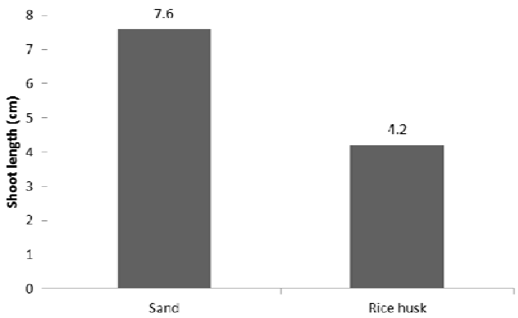

Figure 10. Shoot length in two growing media

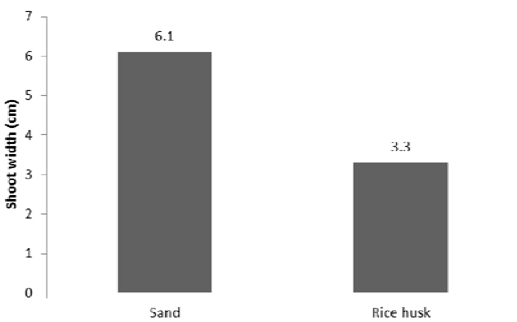

Figure 11. Shoot width in two growing media

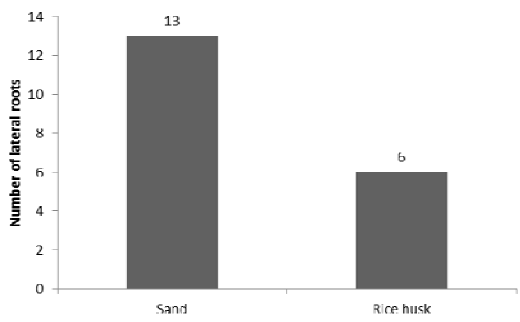

Figure 12. Number of lateral roots in two growing media.

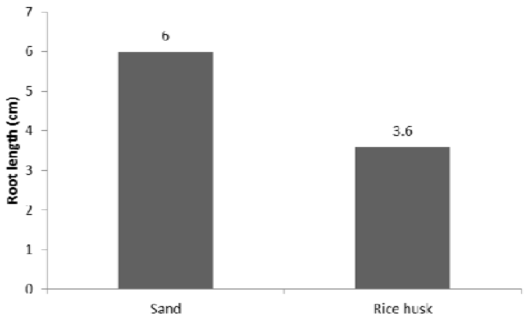

Figure 13. Root length in two growing media

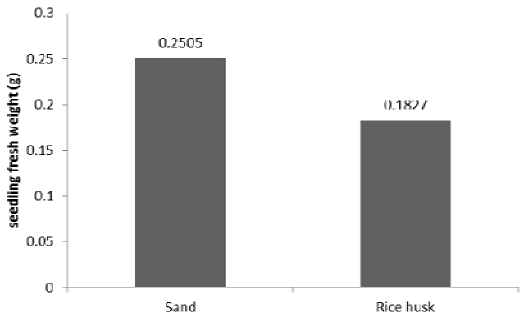

Figure 14. Seedling fresh weight in two growing media

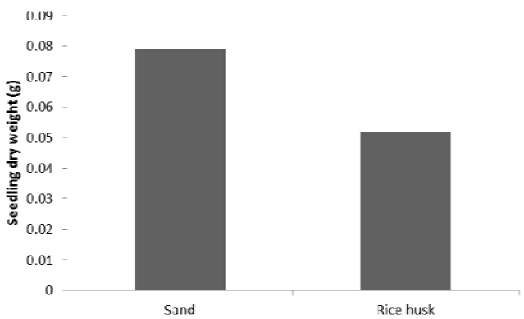

Figure 15. Seedling dry weight of *C. javanica* in two growing media

(Takač et al. 2015), *Gmelina arborea* seeds from yellow brown fruits gave the best germinative performance (Adebisi et al. 2012), *I. wombolu* seeds were best sown immediately after the fruits were harvested (Dolor 2011), sweet pepper (*Capsicum annuum*) seeds with high germination should be harvested when the outside of fruits are completely red (Vidigal et al. 2011), *Gmelina arborea* seeds from yellow brown fruits gave the best germinative performance (Adebisi et al. 2011), the physiological maturity of *Cucurbita moschata* seeds occurred on fruits maturity between 50 and 60 days after anthesis. The addition of soil to the rice husk could be a right step in the use of available RHC with agronomic benefits for vegetable production (Carter et al. 2013). Badar and Qureshi (2014) reported that the composted rice husk was found to be effective in increasing the shoot and root length of sunflower (*Helianthus annuus*), and in increasing the shoot and root length of *Lycopersicon esculentum* (Lu et al. 2015). When the rice husk substrate having inherently low organic matter contents and low water and nutrient retention capacities was added to soil, this mixture would improve not only good seedling emergence, but also increase plant growth at later stages. The germination of *Stevia rebaudiana* seeds in media with the combination of soil and rice husk (57.4%) gave higher result than those in sand growing media (48.4%) (Kumar 2013).

It was very interesting to investigate that over the period of time, the seeds of *C. javanica* from reddish and dark-red fruit were totally better to germinate with parameters as follows: germination capacity (43.3-51.7%), speed of germination (0.30-0.35), mean germination time (5.14-5.18), mean daily germination (0.11-0.13), peak value (0.12-0.15) and germination value (0.014-0.019). number of leaves (2.7), shoot length (7.4-7.6 cm), diameter shoot (6 cm), number of lateral root (11-14), root length (5.5-7 cm), fresh weight of plants (0.2753-0.3084 g), dry weight of plants (0.0844-0.0863 g). Seedling parameters still supported seeds quality from reddish to dark-red fruit color were better than seeds from yellow color fruit: number of leaves (2.7), shoot length (7.4-7.6 cm), shoot width (6 cm), number of lateral roots (11-14), root length (5.5-7 cm), fresh weight of plants (0.2753-0.3084 g), dry weight of plants (0.0844-0.0863 g). Moreover, the sand growing media treatment procedures applied in the study appeared to be applicable to improve the germination potential in *C. javanica*.

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