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Emergence Rate and Initial Growth of Longan (*Dimocarpus longan* Lour) in Relation to Seeds Sizes

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Abstract

The fruit plant 'Longan' is considered as being native to Asia and is at present commercially explored in some regions. The objective of this work was to study the influence of seed size on seed emergence and initial seedling growth. The experiment was carried out using a randomized block design (DBC), with three treatments, namely, the seed sizes at seedling emergence according to their longitudinal diameter: small, medium and large. Each plot was composed of six seeds and five replications per treatment. The following characteristics were evaluated: emergence speed index, average time, percentage and relative frequency of emergence, leaf number, stem diameter, plant height, shoot dry mass and root dry mass. Seeds of medium and large size are those that presented satisfactory results for the characteristics related to seed emergence. The same ones stood out in relation to the small seeds for the variables percentage, average time, average speed and emergence speed index. Small seeds are not recommended for the production of 'Longan' seedlings, given the long period of time to emerge and the low probability of the seedlings establishing satisfactorily in the field. The medium and large seeds were the most promising for the variables number of leaves, stem diameter, plant height, dry shoot mass and dry root mass.Therefore, according to the conditions in which the present work was conducted, the use of medium and large seeds for the production of 'Longan' seedlings is suggested.

Keywords: seedlings, emergence, development

1. Introduction

The great fruit biodiversity that Brazil presents and their benefits cause to be necessary greater valuing of the fruits still little explored by research. 'Longan', 'Longana' or 'Dragon's Eye' (*Dimocarpus longan* Lour) is considered a fruit tree of the family Sapindaceae, native to Southern China to Thailand (Lorenzi et al., 2015) since it is promising, it can be an alternative of diversification for the small farmers Although little known, 'Longan' is distributed in great part of the subtropical regions. Its fruits, although it had similar characteristics to those of the Litchi (Colombo, Assis, Favetta, Yamamoto, & Roberto, 2018), differ, when ripe, by the brownish color and by the less pronounced flavor. It is run commercially in Thailand, China, Taiwan and in Vietnam. Other regions that have shown a growing commercial crop are Australia and the American States of Florida and Hawaii (Jesus, 2007).

The 'Longan' plants have been propagated by seeds, cuttings and air layering, the last propagation method being used most frequently. However, this method of plant multiplication brings results that in many cases are not feasible due to several factors such as wear of the mother plant and furthermore, it is part of a very time-consuming system, with low yield, resulting in seedlings with high prices.

On the other hand, in the sexual propagation, a lack of uniformity in both germination and vigor of the seedlings may occur, which may be related to seed size. In general, the seeds of larger size are well nourished during their development, so the seedlings formed are more vigorous as a result of the larger amount of reserves present in the larger embryos (Carvalho & Nakagawa, 2000). This fact occurs, therefore, the greater amount of reserve increases the probability of success in establishing the seedling, allowing survival for longer in unfavorable environmental conditions. That fact could be confirmed in a study by Vendramin et al. (2013). Although the authors observed that the rate of germination was similar for all treatments, seedling development was better in individuals from medium and large seedlings.

Seed size, in many species, may be indicative of their physiological quality (Souza et al., 2017). Thus, within the same lot, the smaller seeds can present decreased emergence of seedlings and vigor than the medium and large-sized seeds. Moreira et al. (2016), evaluating the germination and initial growth of cashew (*Anacardium microcarpum* ducke) as a function of seed size and imbibition time, observed that seed size influenced the germination and development of cashew seedlings, and the large seeds expressed the characteristics analyzed. Oliveira, Costa, Andrade, and Martins (2005) studying the influence of seed size on the emergence of 'Longan' seedlings observed that the seeds did not influence the characteristics such as germination rate (IVG) and emergence rate. According to these authors, regardless of seed size, they can be used for commercial propagation and breeding purposes. However, it is believed that other characteristics such as frequency and average speed of emergence are necessary for obtaining more conclusive results to determine the seed size for the purpose of seedling production. Such characteristics reflect the continuous development of the seeds after germination (Nietsche et al., 2004).

These parameters are influenced by several climatic factors that can greatly affect the physiological qualities of different seed sizes and consequently their emergence and growth. In view of the exposed, the objective of this work was to study the influence of seed size on seed emergence and initial seedling growth.

2. Methods

2.1 The Place of Experimentation

The experiment was installed and developed in the Orchard belonging to the Fruit Sector of the Department of Agriculture of the Federal University of Lavras (UFLA). The municipality is located at 21º14′06″ latitude south and 45º00′00″ longitude west, with an average altitude of 919 meters.

2.2 Seed Extraction and Seedling Preparation

The 'Longan' mother plants, from which the fruits were collected, are 20 years old coming from seedlings produced by seeds. The fruits were collected when they matured, that is, fruits brownish in color, crack in their barks and natural fall (Pina-Rodrigues & Aguir, 1993). Two hundred 'longan' fruits were collected on the middle third of the plant and on its four quadrants (East, West, North and South) and a composite sample was done. Then, on each fruit a cut was done in the transversal direction with the aid of a stiletto. Seed extraction consisted of rubbing them with sand under running water and afterwards, they were dried in the shade for 24 hours. The seeds were measured longitudinally and the values commonly found were studied and the size classes were divided as described in the experimental design.

Subsequently, they were sown in plastic bags (25.0 × 9.0 cm) containing Tropstrato® commercial substrate, composed of Pinus Bark, Vermiculite, PG MIX (14. 16. 18), Potassium Nitrate, Simple Superphosphate and Peat. The sowing was conducted by following the methodology of Galan-Sauco (1990) and Choo (2000), in which, the authors report that the seeds should be buried horizontally at a depth of 1.5 to 2.5 cm.

The plastic bags containing the seeds were placed in a greenhouse (covered with 50% shade) under concrete benches at 80 cm height. Because the conditions inside the greenhouse were not fully controlled, it was decided to use the randomized block design in order to reduce the experimental error.

2.3 Experimental Design

The experimental design was a randomized complete block (DBC) with three treatments characterized by seed sizes determined by the longitudinal diameter of the seeds: T1: small seeds (with diameters between 6.00 and 10.00 mm), T2: medium seeds (diameters between 10.00 and 12.00 mm) and T3: large seeds (diameters above 12 mm). Each plot was composed of six seeds and five replications per treatment.

2.4 Evaluations and Statistical Analyzes

The evaluations emergence speed index, mean time of emergence, percentage and relative emergence frequency were conducted daily between the beginning of the emergence and the numerical stabilization of the counts. Calculations of percentage of emergence, time mean and relative emergence frequency were performed according to formulas cited by Labouriau and Valadares (1976) and the emergence speed index (Maguire, 1962).

The evaluations number of leaves, stem diameter, plant height, were conducted and at the end of the experiment it were evaluated shoot dry mass and root dry mass. The seedling emergence percentage data were transformed into $\sqrt{x+1}$ for statistical analysis. The means were compared by the Tukey test at 5% probability of the R Studio software (R Studio, 2015).

3. Results and Discussion

It is found that the speed index (IVE), percentage (PE) and average speed of emergence (VME) of 'Longan' seeds were all influenced by seed size (Table 1).

Table 1. Emergence speed index (IVE), emergence percentage (PE) and average speed of emergence (VME) of 'Longan' as a function of seed size

Treatments	IVE	PE	VME
Small seeds	0.79 b	16.66 b	0.039 b
Medium seeds	8,74 a	90.00 a	0.056 ab
Large seeds	12.78 a	76.66 a	0.060 a
CV(%)	20.99	16.49	0.67

Note. Means followed by the same letters in the column do not differ from one another by the Tukey test at 5% of probability.

For all the mentioned characteristics, it is found that the small seeds presented smaller values in relation to those belonging to the other treatments. This fact may have occurred due to the smaller amount of reserves that the small seeds had in comparison to the ones of greater sizes, results that corroborate with those found by Schulz, Oro, Volkweis, M. de M. Malavasi, and U. C. Malavasi (2014), in which the authors report that the germination speed index of 'Ingá' in the seeds of larger size was higher than the treatment with seed of smaller size. On the other hand, Silva, Mendonça, Medeiros, Castro Freitas, and De Gois (2010), studying the influence of seed size on the germination and vigor of 'Jaqueira' seedlings observed that seed size did not influence significantly germination; however, the adoption of seed size classes was considered a preponderant factor, since this factor directly influenced the post-emergence characteristics.

The average speed of emergence presented higher values in medium and large size seeds. Possibly in these treatments the water content in these seeds was greater stimulating the germination. Marli, Santana, and Ranal (2005) evaluating emergence of *Anacardium humile* A.St.-Hil. (Anacardiaceae) observed that scarified and water-imbibed seeds showed a higher average speed of emergence.

Vendramin and Carvalho (2013) found similar behavior in pitanga tree, in which, the development of the shoot of the seedlings from medium and large seed was superior to those from small seeds. Thus, it is suggested that it is necessary to consider the size of the seed in its emergence and growth of the formed plant, being important, therefore, the producer of seedlings aims to obtain plants as uniform as possible and that they develop satisfactorily under adverse conditions in the field.

The results observed in the present study disagree with those found by Oliveira et al. (2005), who also studied the influence of seed size on the emergence of 'Longan' seedlings, in which the authors found no differences for these characteristics. However, it is believed that the different behaviors regarding seed germination in the present work and the responses found by Oliveira et al. (2005) occurred due not only to the quantity of reserves, but also to other factors. It is known that the success in seed emergence is related not only to intrinsic factors, but also to the set of extrinsic and intrinsic factors acting concomitantly. This fact can be corroborated by the study done by Silva and Cesarino (2016), in which the authors studied the influence of different temperatures on the emergence of 'Jutaí' seeds (*Hymenae aparvifolia* Huber.), obtaining different percentages and speed of emergence. In addition, the environmental factors of the fruit collection sites can influence the mother plants and consequently the physiological quality of the seeds, occurring variations in the emergence parameters, even within the same species (Santos, Bonadiman, Oza, Junior, & Mangeiro. 2018).

The results of the frequency of emergence of 'Longan' seeds are presented in Figures 1, in which, it is observed that for all the seed size ranges the frequency distribution demonstrated a polymodal character. According to Nassif and Perez (2000), this distribution asymmetry occurs because some seeds may germinate in advance or late because of temperature variations over time. Sharanagat and Kumar (2016) have shown that as the temperature was increased the rate of water absorption was also higher. In this way it is inferred that variations in the ambient temperature can compromise the metabolism of the seed and consequently the characteristics related to the emergence.

It is verified that the onset of the emergence of small seeds occurred at 17 days after sowing and the end at 37 days after sowing. Of the total number of seeds, only 16.66% emerged and the average emergence time was of 16.56 days with emergence of the seeds distributed over time (Figure 1).

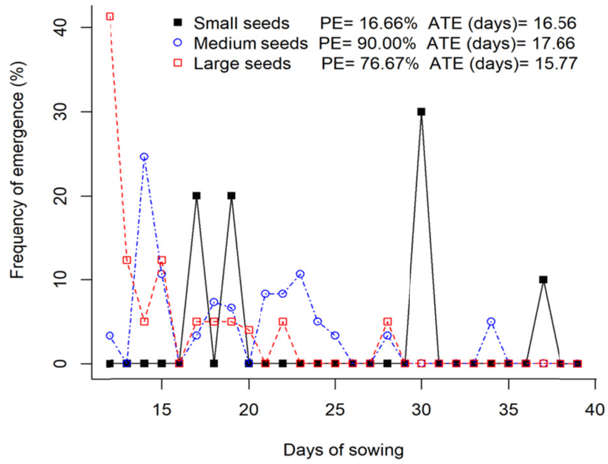

Figure 1. Distribution of the relative emergence frequency of small, medium and large 'Longan' seeds

Note. PE = Percentage of emergence, ATE = Average time of emergence.

Regarding the medium seeds, the onset of emergence occurred 12 days after sowing, with 25% of the seeds emerging on the 14th day after sowing and the end of emergence occurred 33 days after sowing. Of the total of seeds, 90% of the seeds emerged and the average time of emergence was 17.66 days (Figure 1).

Although the temperature conditions were the same for all the treatments, the climatic conditions associated with the reserves may have favored the germination of the large seeds. M. de M. Malavasi and U. C. Malavasi (2001) state that environmental factors together can be responsible for different responses to germination processes, so the species may present different responses to the characteristics studied owing to seed size and climatic variables where the seeds are being evaluated even due to the characteristics of the place of origin of the material collection. Regarding the latter case, Silva (2017) observed in his study that *Brachiaria Brizantha* seeds collected at different sites presented significant differences in the studied variables.

It was verified in the present work that the emergence of large seeds occurred at 12 days after sowing and the end of emergence occurred 29 days after sowing. Of the total of seeds, 76.67% emerged and the average time of emergence was of 15.77 days. The germination of most of the large seeds occurred, especially up to 23 days (Figure 1). It can be found then, in relation to the emergence, there was an early development in relation to the others (Table 1). Oliveira, Andrade and Martins (2003), in studies with 'Bacuripari' (*Rheedia gardneriana*), also found higher mean values of emergence time in larger seeds.

In this case, it is believed that the larger volume of the medium and large seeds can keep their viability for longer, favoring germination. This process is related to water absorption and generally in seeds of greater size, this process is more intense. According to Carvalho and Nakagawa (2012), water absorption causes rehydration from the seed tissues, influencing the increase of the metabolic rates, including respiration, culminating in the growth of the embryonic axis. In this process, the seed bark is ruptured by the increase in volume caused by the entrance of water. This finding can be corroborated by Smirdele, Lima, and Paulino (2013), who studying physic nut (*Jatropha curcas* L.) and the water increment in the seed was higher in the larger seeds, justifying the earliness in the emergence. In addition, Sharanagat and Kumar (2016) state that as the time of absorption and temperature increased, the grain diameter of 'Moong' beans also increased and, according to the same authors, in this case a correlation between seed diameter (after water absorption) and time can be established. Regarding this last finding, it is presumed that the seeds of medium and large size in the present work presented water content higher than the seeds of smaller size, that is, it is confirmed that the theory that the initial imbibition is influenced by several factors among them the initial water content in seeds (Hobbs & Obendorf, 1972; Vertucci & Leopold, 1983).

Considering the results of the characteristics studied, it is clear that medium and large seeds are the most viable, however, it can be inferred that the large ones are generally preferred for the production of 'longan'.

According to Table 2, there was a significant difference between the treatments, in which the medium and large seeds provided higher plant height, leaf number and plant stem diameter.

Table 2. Number of leaves, stem diameter and height of ‘Longan’ plant as a function of seed size

Treatments	Number of leaves	Stem diameter (cm)	Plant height
Small seeds	0.90 b	0.29 b	0.66 b
Medium seeds	4.13 a	1.22 a	4.35 a
Large seeds	5.26 a	1.29 a	4.75 a
CV(%)	30.16	24.37	31.25

Note. Means followed by the same letters in the column do not differ from one another by the Tukey test at 5% of probability.

The development of plant height of the small seeds was about 80% smaller than those belonging to the other treatments. Similar results were found in soybean by Vendramin and Carvalho (2013) in which taller plants were obtained from larger seeds. That result may have occurred due to the greater amount of the reserves present in the medium and large-sized seeds. The seeds with greater reserve germinate more uniformly and at a higher percentage and seedling vigor is directly related to seed size, which justifies the adoption of size classes for the production of seedlings (Biruel, Paula, & Aguiar, 2010). Such results are of great relevance, since the production of seedlings in a short period of time is desirable as far as agronomic issues and those related to cost reduction are concerned.

Therefore, the larger amount of reserves present in the seeds of larger size of ‘Longan’ during its development gave rise to seedlings possibly less susceptible to post-germinative stresses, qualifying them as easier to adapt and establish in the field (Table 2). The number of leaves associated to the stem diameter is an important characteristic observed in the choice of high quality seedlings; in addition, stem diameter is considered one of the factors most used for the grafting technique. Results similar to the present study were found by Silva et al. (2017), who studying seed sizes for the production of ‘Açaí’ seedlings, observed that seeds of medium and large size favored greater seedling development.

There was no statistically significant difference for the variables of shoot dry mass and root dry mass in the treatments coming from small and medium seeds, however, the large seeds presented high values (Table 3).

Table 3. Dry mass of the shoot (MSPA) and the roots (MSRA) of ‘Longan’ as a function of seed size

Treatments	MSPA (g)	MSRA (g)
Small seeds	0.13 b	0.08 b
Medium seeds	0.16 b	0.10 b
Large seeds	0.33 b	0.22 a
CV(%)	2.41	1.68

Note. Means followed by the same letters in the column do not differ from one another by the Tukey test at 5% of probability.

These results agree with those found by Vendramin and Carvalho (2013) in studies with ‘Pitanga tree seed, in which plants from larger seeds presented higher values for shoot dry mass and root dry mass. Similar results were also reported by Silva, Bruno and Melo (2015) in studies with the Quixabeira crop, in which the authors obtained better results for dry mass as the seed diameters were higher.

The dry mass of the roots has been recognized as one of the best and most important characteristics to determine the survival and initial growth of the seedlings, despite being obtained by destructive methods. It is considered an important characteristic to quantify it in relation to the quality and vigor, thus more developed seedlings and with greater dry mass of roots and of shoot in the transplanting period stand out in relation to the seedlings of less mass.

4. Conclusions

The Medium and large seeds are those that presented satisfactory results for the characteristics related to seed emergence. The same ones stood out in relation to the small seeds for the variables percentage, average time, average speed and emergence speed index.

Small seeds are not recommended for the production of 'Longan' seedlings, given the long period of time to emerge and the low probability of the seedlings establishing satisfactorily in the field.

The medium and large seeds were the most promising for the variables number of leaves, stem diameter, plant height, dry shoot mass and dry root mass.

Therefore, according to the conditions in which the present work was conducted, the use of medium and large seeds for the production of 'Longan' seedlings is suggested.

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