RESEARCH NOTE

Physiological ripening of *Anadenanthera colubrina* (Vellozo) Brenan seeds [1]

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ABSTRACT – The seed physiological maturity knowledgment is critical determine its maximum production and physiological quality. The objective of this study was to determine the ideal time to harvest by evaluating seeds physiological maturity. Seventeen weekly harvests of fruits and seeds from matrices located in the Brazilian city of Botucatu, SP, were performed from May to September 2001. Fruits size and weight, seed water content and dry matter, and germination and emission of primary root were evaluated. Seeds showed maximum dimension in the thirteenth week of collection, while the highest fruit weight was obtained in the twelfth week of collection. Water content decreased over time. Seeds dry matter showed its highest value in the sixteenth week harvest, while germination percentage showed its highest value between the fourteenth and fifteenth week harvest. The percentage of primary root emission was observed with maximum value in the tenth week harvest. Based on the results, it is concluded that the best *Anadenanthera colubrina* harvest season occurs between the fourteenth and fifteenth weeks.

Index terms: harvest period, germination, forest seeds.

Maturação fisiológica de sementes de Angico (*Anadenanthera colubrina* (Vellozo) Brenan)

RESUMO – Conhecer o processo de maturação de sementes é fundamental para auxiliar na busca da máxima produção e qualidade fisiológica das mesmas. O objetivo deste trabalho foi determinar o momento ideal de colheita por meio da avaliação da maturidade fisiológica de suas sementes. Foram realizadas 17 coletas semanais de frutos e sementes de matrizes localizadas no município de Botucatu – SP, no período de Maio a Setembro de 2001. Avaliaram-se as dimensões dos frutos, peso dos frutos, teor de água e massa seca das sementes, além da germinação e emissão de raiz primária. As sementes apresentaram dimensão máxima a partir da décima até a décima terceira semana de coleta, enquanto que o maior peso dos frutos foi obtido na décima segunda semana de coleta. O teor de água decresceu com o passar do tempo. A massa seca de sementes apresentou valores máximos na décima sexta semana de coleta, enquanto que a porcentagem de germinação apresentou valores máximos entre a décima quarta e décima quinta semana de coleta. Já a porcentagem de emissão de raiz primária mostrou-se com valor máximo na décima semana de coleta. Conclui-se que a melhor época de colheita de *Anadenanthera colubrina* ocorre entre a décima quarta e décima quinta semana de coleta.

Termos para indexação: época de colheita, germinação, sementes florestais.

Introduction

The destruction of natural habitats has been increasingly responsible for the decline of native vegetation and makes necessary the creation of programs seeking the recovery of these areas, taking into account from ecological factors to social and economic ones (Santos et al., 2012).

Increased production of seedlings and seeds of native

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species is of great importance, as these are key to the restoration and recovery of ecosystems and degraded areas (Sarmento and Villela, 2010). This leads to the increase in demand for native species of seeds in order to use them in natural resources restoration and conservation programs (Prudente et al., 2012), besides the search for more information about their best germination and propagation conditions (Varela et al., 2005).

There are still restrictions on the knowledge about the quality of forest seeds, a characteristic that can be influenced by the ripening point in which they are (Lopes et al., 2008), as the harvesting time does not always coincide with its maximum vigor and the crop, before or after seed ripening, can influence the plant formation and seed loss (Borges and Borges, 1979).

The study of seed physiological ripening is related to morphological and physiological changes from egg fertilization to its ripening (Mata et al., 2013). Knowing the seed ripening process is critical to assist in the pursuit of its maximum production and physiological quality (Nogueira et al., 2013).

The physiological ripening study is based on the seeds physical and physiological characteristics, such as size, water content, dry matter content, germination and vigor (Carvalho and Nakagawa, 2012), and the higher the association between the different parameters evaluated, the more accurate the assessment and determination of the seeds physiological ripening point (Piña-Rodrigues and Aguiar, 1993).

Angico *(Anadenanthera colubrina*) is a native species of the Brazilian flora belonging to the Mimosaceae family and commonly known as angico (*Anadenanthera colubrina* (also known as vilca, huilco, huilca, wilco, willka, cebil). It is between 10 and 20 m tall, usually having a straight trunk and bark up to 20 mm thick. It has white to yellowish flowers, dry dehiscent fruits and dark, shiny and flat seeds. It is classified as a pioneer to early secondary, with rapid growth and frequent in the Semi-deciduous State Forest (Carvalho, 2003). Angico seeds do not have dormancy and germinate quickly. Also, the species shows vigorous reproduction and resistance to desiccation of its plants due to the presence of reserve organs (Maia, 2004).

Thus, this study has aimed to evaluate the physiological ripening of *Anadenanthera colubrina* seeds in the Brazilian city of Botucatu, SP, to determine the optimal time to harvest.

Material and Methods

Characterization of the study area

The experiment with *Anadenanthera colubrina* was carried out between May and September 2001, in the Brazilian municipality of Botucatu, São Paulo. The matrix trees selected are located on the campus of São Paulo State University (Universidade Estadual Paulista "Júlio de Mesquita Filho", UNESP). The site is located between latitudes 22°54'S and longitudes 48°26'W, with an altitude of 786 meters (Martins, 2003). According to Köppen classification, the climate is humid hot temperate (mesothermal), with annual rainfall and average temperature of 1428.4 mm and 20.5 °C, respectively (Cunha and Martins, 2009).

The analysis of physiological parameters was conducted at the Laboratório de Sementes do Departamento de Produção e Melhoramento Vegetal da Faculdade de Ciências Agronômicas (Seed Laboratory of the Plant Production and Breeding Department of the Faculty of Agronomic Sciences) (FCA/UNESP), Botucatu Campus, SP.

Collection of fruits and seeds

The fruit collection was started from the appearance of the seeds, when these had sufficient size to be handled without being damaged, and was finished at the beginning of the seeds dispersion, i.e., between May 16 and September 5, 2001. Six matrix trees of *Anadenanthera colubrina* were randomly selected, of which 15 fruits of each individual were weekly collected with a metal trimmer for a 17-week period, always taking care not to harvest dry, broken or damaged fruits. The pods harvested were stored in labeled plastic bags, which were transported to the laboratory to be submitted to evaluations by the following parameters:

Dimensions of fruits

After homogenizing the fruits in an aluminum tray, four samples with 10 fruits each were withdrawn, of which weight, width, length were measured. Measurements were taken after each weekly collection, totaling seventeen.

Pods weight was determined using an analytical balance, with the result in grams. For the fruits width a digital caliper (mm) was used while the length was obtained from a string placed next to the fruit, which was then measured with a ruler (mm).

After the weekly fruit evaluations, they were mixed and then 180 seeds were withdrawn, of which 80 were used for determining the water content and 100 for the germination test.

Water content of the seeds

Eighty seeds were used to determine the water content, which were separated into four replicates of twenty. The seeds were placed in previously identified aluminum cans and weighed. They were then placed in an oven at 105 ± 3 °C for 24 hours and weighed again according to the methodology proposed by Brasil (1992). The results were expressed in percentage.

Dry matter mass of the seeds

The seeds dry matter mass was obtained together with the determination of water content, and these data were generated by weighing the seeds after drying them in the oven. The result was expressed in mass of one hundred seeds (grams).

Germination

The germination test was conducted with 100 seeds per matrix separated into four replicates of twenty-five seeds each. Seeds were sown on paper towels, previously moistened with distilled water equivalent to 2.5 times the weight of the dry paper and identified. Then they were wrapped and packed in sealed plastic bags. They were taken to the germinator set at alternating temperatures of 20 – 30 °C (Souza and Lima, 1985) for a period of 14 days. After this time, the numbers of normal seedlings, abnormal seedlings and dead seeds were evaluated (Brasil, 1992). The result of the germination was expressed as a percentage of normal seedlings.

Emission of primary roots

It was obtained concomitantly with the germination, after 14 days in the germinator set at alternating temperatures of 20 – 30 °C. The sum of normal and abnormal seedlings was considered as seeds with primary root emission. The result was expressed in percentage.

Statistical design and analysis

The statistical design used was a completely randomized one and the data were submitted to analysis of variance and polynomial regression, considering 17 times of harvest, evaluating the linear, quadratic and cubic models, where the higher order model that would promote estimates of the events analyzed was selected.

Results and Discussion

The harvest periods showed significant effects at 1% for length (Figure 1) and width (Figure 2) of the fruits. For both parameters, the fruits showed a maximum growth from the tenth until the thirteenth weeks after the start of the collections, subsequently decreasing as a result of natural drying. The fruits reached the maximum size prior to germination peak (15th week of seeds collection) (Figure 6), which did not prove to be a good parameter indicator of physiological ripening in this work.

Similar results were obtained by Alves et al. (2005), in which the fruits of *Mimosa caesalpiniifolia* reached maximum size values before the ripening point and decreased thereafter. Therefore it was not considered a good parameter to help determine physiological ripening of its seeds. Lazarotto et al. (2011) have also found the same results for the size of *Erythrina crista-galli* L fruits, in which only the fruit length was considered as a parameter to assist in determining the physiological seed ripening of this species.

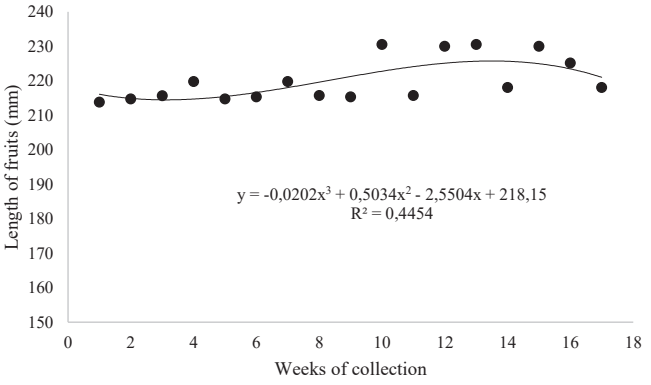

Figure 1. Length of *Anadenanthera colubrina* fruits in the different weeks of collection in Botucatu, SP.

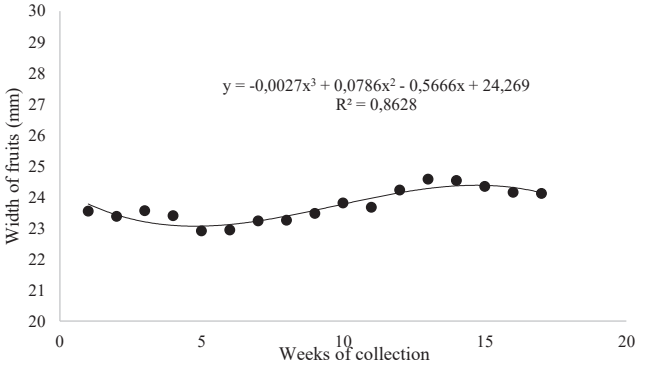

Figure 2. Diameter of *Anadenanthera colubrina* fruits in the different weeks of collection in Botucatu, SP.

The fruit fresh matter (Figure 3) has also presented significance at 1%, with the highest values being observed in the sixth and twelfth weeks of collection. However, the fruits peak filling was found in the twelfth week.

Seeds water content was adjusted to the cubic model as shown in Figure 4, with high levels being initially found and the lowest value found in the last week of collection (39%) due to the fruits natural drying over time. According to Carvalho and Nakagawa (2012), seeds have high water content after being formed, there is a small increase and then a slow reduction of this content, the duration of which varies according to the species, climate conditions and the plant, which decreases again until it begins to vary with relative air

humidity changes, which can demonstrate that the parent plant does not exert control over the seeds water content anymore. In this work, in the early seed dispersion, although they had the lowest water content, this was high (39%), indicating that they were in a quick water loss stage (Figure 4).

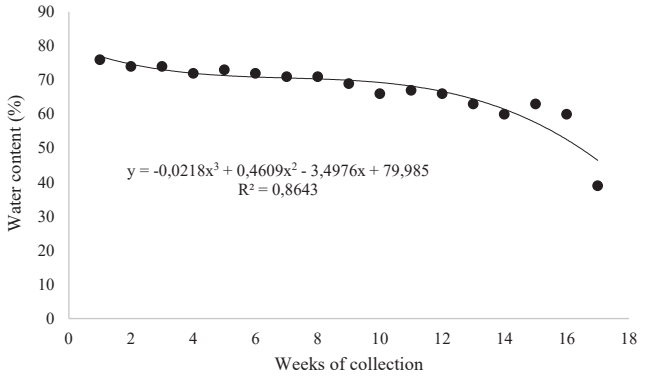

Figure 3. Fresh matter of *Anadenanthera colubrina* fruits in the different weeks of collection in Botucatu, SP.

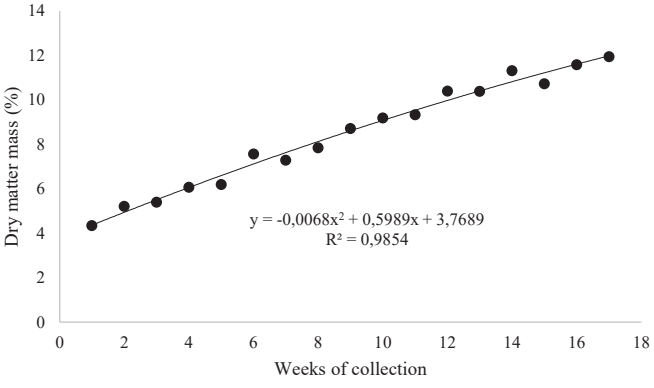

Figure 4. Water content of *Anadenanthera colubrina* seeds in the different weeks of collection in Botucatu, SP.

Fonseca et al. (2005) have found high water content (61.3%) during physiological ripening of *Tabebuia chrysotricha* (Mart. Ex A. Dc.) Standl seeds, which declined sharply thereafter. Lazarotto et al. (2011) also found similar results when working with *Erythrina crista-galli* seeds, which dropped from 31.8% in water content in the tenth week to 1.9% in the eighth week.

During seeds ripening, the evolution of the dry matter mass (Figure 5) was better explained by the quadratic model, which had its maximum values from the 16th week of collection, after the point of maximum germination (Figure 6). For some species, the use of only this parameter has been considered ineffective to determine the physiological ripening point as, for example, with *Myroxylon balsamun*, where the peak dry weight was reached two weeks prior to physiological ripening (Aguiar and Barciela, 1986).

Lazarotto et al. (2011) have found maximum values of dry matter (0.474 g/seed) of *Erythrina crista-galli* L. seeds in the same period of maximum seed germination and development, considering the seeds dry matter as a suitable parameter to indicate physiological ripening of the species. Alves et al. (2005) have also found in the seeds dry matter a good parameter to indicate physiological ripening because the *Mimosa caesalpiniifolia* Benth seeds showed peak values (1.484 g) along with the period of maximum germination percentage.

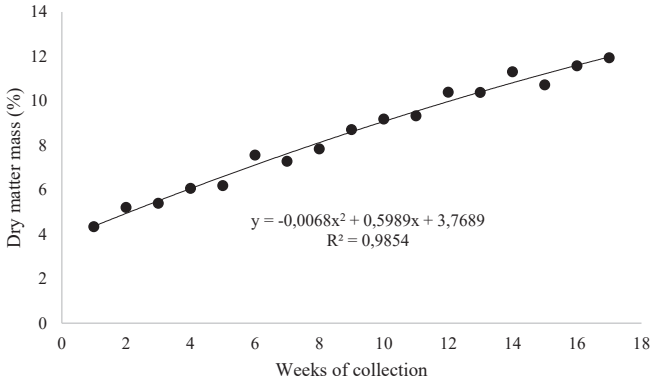

Figure 5. Dry matter mass of *Anadenanthera colubrina* seeds in the different weeks of collection in Botucatu, SP.

As for the maximum percentage of germination, it occurred between the fourteenth and fifteenth weeks of collection, according to the data and the regression curve (Figure 6). In this range, the seeds water content remained between 66% (12th week) and 60% (14th week) (Figure 4). Souza and Lima (1985), analyzing ripening of other species of the same genus, Anadenanthera (*Anadenanthera macrocarpa* (Benth) Brenan), have observed that seeds had a high water content in the physiological ripening point (60%).

From the twelfth week of collection there was a drop in the seeds water content (Figure 4) until they began to be scattered (17th week of collection), which corroborates with the statement by Barros (1986), where after physiological ripening the fruits are withdrawn from the parent plant and there are physiological changes that make seeds dry in order to prepare them for natural dispersal.

This demonstrates the importance of finding the proper seed harvesting time for some forest species, as in the case of *Anadenanthera colubrina*, because the dehiscent-type fruits still open in the trees and there is a natural dispersal of their seeds, making it difficult to harvest them directly on the ground, as in the case in which the seeds are too small or there

is a risk of their predation and dispersal before the harvest (Piña-Rodrigues and Aguiar, 1993).

The percentage of primary roots was better represented by the cubic model (Figure 7), showing maximum point in the 12th week, with 90% of primary roots emission. Similar results were obtained by Gemarque et al. (2002) when analyzing the seeds of *Tabebuia impetiginosa* (Mart.) Standl., in which they had higher primary root emission rates along with the highest values of dry matter and percentage of normal seedlings.

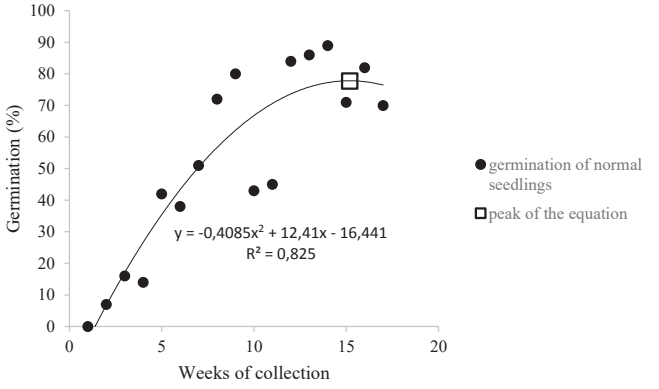

Figure 6. Germination of *Anadenanthera colubrina* seeds in the different weeks of collection in Botucatu, SP.

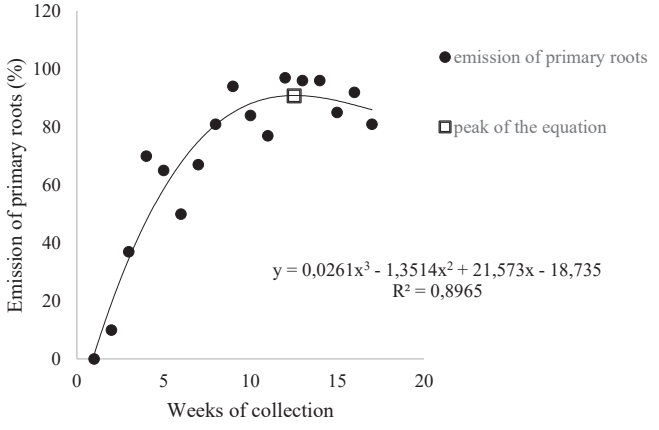

Figure 7. Percentage of emission of primary roots of *Anadenanthera colubrina* in the different weeks of collection in Botucatu, SP.

Observing the results, it is possible to see that there was a decline both in rootlets emission values (Figure 7) as in the normal seedling germination values (Figure 6) in the period of the tenth and eleventh collections. As the drop in these values between the two variables is uneven, possibly there are differences in development levels among seeds of the samples of these two collections.

With this, for the results found for *Anandenathera colubrina* seed size was not a good parameter indicative of physiological ripening, which lies between the fourteenth and fifteenth weeks of collection, during which there are maximum germination, high content of dry matter and water content.

Conclusions

Anadenanthera colubrina seeds harvest, in the conditions of Botucatu, SP, must be performed between the 14th and 15th weeks of collection, before the beginning of the seeds dispersal.

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ERRATUM

In the Research Note entitled Physiological ripening of *Anadenanthera colubrina* (Vellozo) Brenan seeds, published in Journal of Seed Science, v.38, n.2, p.155-160, 2016 (https://dx.doi.org/10.1590/2317-1545v38n2153112), the correct Figures 3 and 4 are:

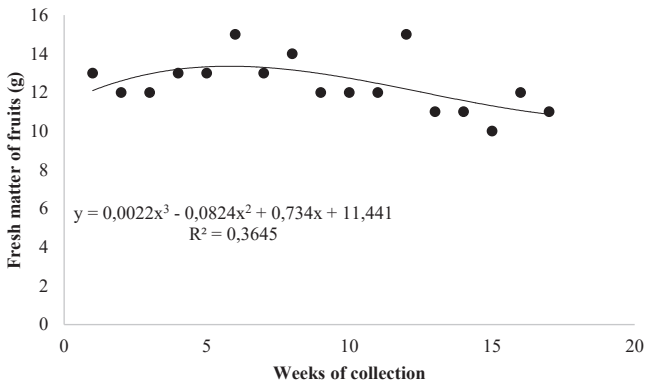


Figure 3. Fresh matter of Anadenanthera colubrina fruits in the different weeks of collection in Botucatu, SP.

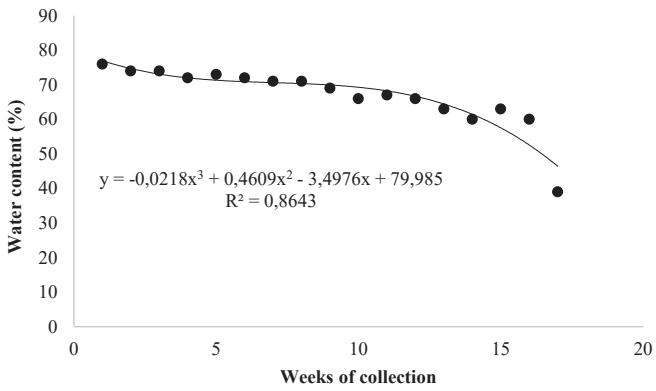
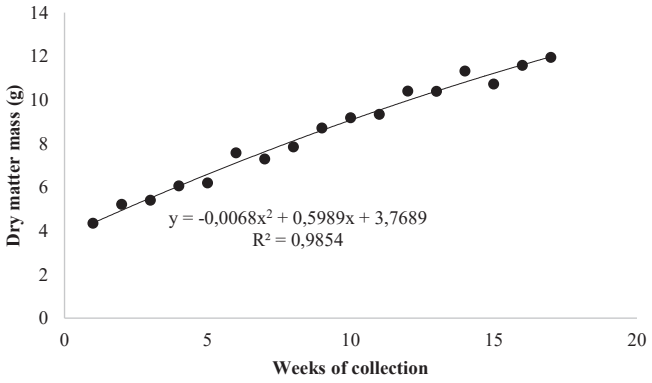


Figure 4. Water content of Anadenanthera colubrina seeds in the different weeks of collection in Botucatu, SP.

In the Figure 5, the correct unity in the axis Y is g.



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