

Repeatability based on growth behavior of jaboticabeira tree genotypes

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Abstract - The aim of this study was to estimate the coefficients of repeatability and determination and the minimum number of evaluations able to provide certainty levels of prediction of the real value of these individuals through stem length and the length of primary shoots in 29 jaboticabeira genotypes. The stem length and the primary shoots were evaluated between July 2012 and June 2015, representing three growth cycles. The determination of the repeatability coefficients, determination coefficients and the number of measurements required to predict the genotypes true value were performed by multivariate principal component methods based on the variance and phenotype covariance matrix. The repeatability and determination coefficients obtained are relevant for the growth traits of jaboticabeira tree genotypes evaluated. With the three evaluations carried out, it is possible to select the jaboticabeira tree genotypes with 95% accuracy for a variable stem length and with 85% for the variable shoots length, but for the same level of significance would still require 5 more evaluations.

Index terms: *Plinia* sp. Main components. ANOVA.

Repetibilidade com base no comportamento de crescimento em genótipos de jaboticabeira

Resumo - O objetivo deste trabalho foi estimar os coeficientes de repetibilidade e de determinação e o número mínimo de avaliações capaz de proporcionar níveis de certeza da predição do valor real destes indivíduos, através do comprimento do caule e do comprimento das brotações primárias, em 29 genótipos de jaboticabeiras. Foram avaliados o comprimento do caule e o das brotações primárias, entre julho de 2012 e junho de 2015, representando três ciclos de crescimento. A determinação dos coeficientes de repetibilidade, coeficientes de determinação e do número de medições necessárias para predição, e o valor real dos genótipos foram realizados pelos métodos multivariados de componentes principais, com base na matriz de variâncias e covariâncias fenotípicas. Os coeficientes de repetibilidade e de determinação obtidos são relevantes para as características de crescimento de genótipos de jaboticabeira avaliadas. Com as três avaliações realizadas, é possível selecionar os genótipos de jaboticabeira com 95% de acurácia, para a variável comprimento do caule, e com 85%, para a variável comprimento das brotações; porém, para o mesmo nível de significância, ainda seriam necessárias mais 5 avaliações.

Termos para indexação: *Plinia* sp. Componentes principais. ANOVA.

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The jaboticabeira trees (*Plinia spp.*) have their origin in the Center-South of Brazil and occur predominantly in the Atlantic Forest Biome, they can also be found in Paraguay and Argentina. It is a plant of tropical and subtropical humid climate, do not supporting prolonged droughts and strong frost (CITADIN et al., 2010; KINUPP et al., 2011). The better known species are: *Plinia trunciflora* (Berg) Mattos (jaboticaba-de-cabinho); *Plinia cauliflora* (DC.) Berg (jaboticaba-paulista, pohnema or Açú); and *Plinia jaboticaba* (Vell.) Berg (jaboticaba-sabará).

The jaboticabeira tree has great economic potential, because the fruits are greatly appreciated and with mainly organoleptic quality, use in the pharmaceutical and food industry, and for presenting antioxidant compounds (CITADIN et al., 2010), even with all this potentiality, it is observed that much of its cultivation is carried out in the form of small orchards or through extractive exploitation.

The implantation of commercial orchards faces difficulty, since it presents high juvenile period when propagated via seeds, which does not attract the producer to the cultivation of this species. To better understand the species, there is a need to increase research on methods of vegetative propagation, as well as the molecular and phenotypic characterization of germplasm with agronomic interest.

One of the ways to determine the phenotypic characteristics is through the repeatability analysis, estimated through measurements of a characteristic in the same individual, as well as to determine the number of measurements necessary in each individual, so that there is efficiency in the phenotypic selection among the genotypes. These estimates assist breeders in the selection and can reduce labor costs in breeding programs (CRUZ et al., 2004).

The repeatability has been used in various species such as passion fruit (SANTOS et al., 2010), sweet orange (NEGREIROS et al., 2014), *Psidium cattleianum* and Surinam cherry (DANNER et al., 2010) in order to raise the efficiency index of the selection methods. For jaboticabeira tree, there are no references in the literature on the use of repeatability analyzes, that may favor the selection of materials to be introduced in commercial crops.

The objective of this study was to estimate the coefficients of repeatability and to determine the minimum number of evaluations capable of providing certainty levels of the prediction of the real value of these individuals through stem length and length of the primary shoots in 29 genotypes of jaboticabeira trees.

The study was carried out with 29 genotypes of jaboticabeira trees present in the collection of Native Fruit Trees, belonging to the Universidade Tecnológica Federal do Paraná - Campus Dois Vizinhos between July

2012 and June 2015.

The collection was implanted in November 2009, with two - year - old seedlings from seeds collected from fragments of the Forest with Araucaria, at different locations in the Southwest Region of Paraná, from the cities of Clevelândia, Vitorino, Chopinzinho, Coronel Vivida, Dois Vizinhos and Pato Branco, both classified as *P. cauliflora*, in addition to the city of Ibituva (*P. trunciflora*), which is located in the South Central Region of the state of Paraná and from the State of Minas Gerais, 'Silvestre' (*Plinia sp.*), 'Sabará' (*P. jaboticaba*), 'Açú' (*P. cauliflora*), from the Federal University of Viçosa.

The evaluations were carried out monthly, measuring the length of the stem and the primary shoots (cm), using tape measures, during the three years (2012/2013, 2013/2014, 2014/2015), being considered as three growth cycles. The length of the stem was measured from the neck of the plant to the apex of the largest vertical bud, while the length of the primary shoots from its beginning on the main stem to the apex of the stem.

Analyzes of variance were performed considering the average of the genotypes in each of the growth cycles. The determination of the repeatability coefficients (r), determination coefficients (R^2) and the number of measurements required (η_0) to predict the true value of the genotypes with pre-established determination coefficients of 80, 85, 90, 95 and 99% was realized based on the methodology described by Cruz et al. (2004), where multivariate method of principal components based on the matrix of variances and phenotypic covariance were used in the analysis. Negreiros et al. (2014) points out that the use of repeatability and determination coefficient estimates when using main component methods are more efficient compared to other methods such as analysis of variance and structural analysis based on the correlation matrix.

The analyzes were processed through the GENES software (CRUZ, 2013).

There was a significant effect among the jaboticabeira tree genotypes, by the F test ($p < 0.01$), for all variables evaluated. It was found that, for stem length, the values obtained were 0.8855 for the repeatability coefficient and 95.87% for the determination. For the length of primary shoots, the value of the repeatability coefficient was 0.7027 and the determination coefficient was 87.64%.

When the values of the repeatability coefficient are above 0.4000, they are considered as reliable values (BERGO et al., 2013). The high value obtained in this study indicates a regularity regarding the performance of the genotypes in the evaluations realized (CRUZ et al., 2004) and are relevant, since they have r greater than 0.7000 and R^2 above 85%.

Quintal et al. (2017) when evaluating guava productivity with 95 genotypes from a segregating population, based on the characteristics, fruit mass, number of fructose, yields of three harvests, observed that the coefficient of repeatability obtained ranged from 0.14 to 0.29, do not being possible the selection of the genotypes; but they pointed out that from 5 harvests it would be possible to obtain a coefficient of 0.50.

In Table 1, the estimates of the measurements number (η_0) required to predict the true value of the jaboticabeira trees genotypes, with a coefficient of 0.95, indicate that for the stem length, it is necessary 2.46 measurements to predict the real value of the genotype. As three evaluations of this variable were carried out, it is possible to select the genotype by means of this characteristic. For the length of shoots, it would take 8.04 measurements to obtain the same coefficient, thus requiring more evaluations of these genotypes, but if considered a coefficient of repeatability of 0.85, they could already be selected with the number of measurements performed ($\eta_0 = 2.40$).

In the evaluation of fruit quality, Negreiros et al. (2014) observed that, for 90% accuracy, 15 evaluations are required for peel thickness and soluble solids, and 11, 6, 3, 2 and 1 evaluations for average fruit mass, total acidity, technological index, juice yield and SS/TA ratio, respectively.

Bergo et al. (2013) when evaluating the mass in grams of the palm base, yield of the pupunha palm

of first and second quality, number of stem per tiller, diameter of the palm and number of plants per plot, observed that seven cycles are necessary, with accuracy of 85% of measurements to predict the true value of the progenies of the pupunha palm, by the main components method based on the matrix of variances and phenotypic covariance.

Cargnin (2016), when evaluating the repeatability regarding the number of grapevine clones, Chardonnay and Cabernet Sauvignon, found that three harvests are required for the selection, with predictability of the genotype real value above 80%.

For the evaluated characteristics, there is no similar study in the literature in native fruit species, where the repeatability is based on fruit quality characteristics such as those described by Danner et al. (2010) with *Psidium cattleianum* and Surinam cherry. The jaboticabeira tree, presents a long juvenile cycle, and although the evaluated genotypes are about eight years old, they do not yet have fruit, which limits the use of the fruits for the characterization.

The repeatability and determination coefficients obtained are relevant for the growth traits of jaboticabeira tree genotypes evaluated.

With the three evaluations realized, it is possible to select the jaboticabeira tree genotypes with 95% accuracy for the stem length variable and with 85% for the shoot length variable, but at the same level of significance, a further 5 evaluations would be necessary.

Table 1 -Variables, determination coefficients and respective estimates of the number of measurements required to predict the true value of the jaboticabeira tree genotypes from the UTFPR, Campus Dois Vizinhos, PR.

Variables	Determination coefficients				
	0.80	0.85	0.90	0.95	0.99
Stem length	0.52	0.73	1.16	2.46	12.81
Shoots Length	1.69	2.40	3.81	8.04	41.88

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