Estimation of Repeatability and Number of Evaluations for Characterization of Mango Germplasm

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Abstract

This work aimed estimate the coefficient of repeatability for total fruit numbers per tree (TFT) fruit production per tree (FPT), fruit weight average (FWA), pulp weight (PW), skin weight (SW), stone weight (STW), fruit longitudinal diameter (FLD), fruit transversal diameter (FTD), FLD/FTD ratio, stone longitudinal diameter (SLD), stone transversal diameter (STD), SLD/STD ratio, and to determine the necessary number of evaluations for mango germplasm characterization. Repeatability estimates were carried out by principal component analysis from the correlation matrix during four years for TFT, FPT and FWA and four evaluations at the same year for the other characters. Coefficient estimates of repeatability FLD, FTD, FLD/FTD ratio and SLD characteristics showed that it was necessary only two evaluations to obtain 95% of R^2, four for PW and SW, and five for FWA and STD. While for TFT and FPT a minimal of six and five evaluations are necessary, respectively, to obtain 87% of precision.

INTRODUCTION

Germplasm characterization is time and labor consuming in perennial crops like mango (*Mangifera indica* L). This species shows a long juvenile period and alternate bearing (Donadio, 1996a, 1996b; Manica, 1996), which make it difficult to perform the evaluations along its development in order to obtain genetic parameters on genetic resources and mango improvement. Thus, measuring number needed in time and space, determined by repeatability coefficient estimates is fundamental to achieve accurate results, besides cutting time and unnecessary labor.

The repeatability coefficient is a statistic that allow to evaluate plant characteristics in perennial crops with a required precision. High values of this coefficient show that is possible to predict individual real value for plant characters with a relative small number of replications (Cornacchia et al., 1995) and that few precision of some statistics in perennial crop improvement would be enhanced by increasing the number of repetitions (Falconer, 1987). However, when repeatability is low, a great number of repetitions will be necessary to reach a satisfactory determining value.

The study of repeatability is important for perennial plants breeders, because represents a maximum inheritance value a plant character can reach (Falconer, 1987; Cruz and Regazzi, 1994), and can be used to determine the phenotypic observation number for each individual to determine an efficiently genotypic discrimination and then reducing cost and labor. Thus, this work is aimed to estimate minimal number of evaluations needed to characterize mango germplasm.

MATERIAL AND METHODS

The study was carried out by using mango accessions from Embrapa Semi-Árid Germplasm Bank, at Mandacaru Experimental Station, in Juazeiro, BA State (9º 24' Latitude, 40º 24' longitude and 375.5 m high above the sea level). The semi-arid weather, according to Koppen classification, shows 26.3º as annual temperature average, 570 mm of rainfall average and 61.7% of relative humidity. The soil is vertisols of clay texture.

The accessions were planted in 1994, using Espada variety as rootstock, spaced 10 m x 10 m, with four trees per cultivar. It has been measured the characteristics of total fruit number per tree (TFT), fruit production per tree (FPT), fruit weight average (FWA), pulp weight (PW), skin weight (SW), stone weight (STW), longitudinal fruit diameter (LFD), transversal fruit diameter (TFD), and LFD/TFD ratio, stone longitudinal diameter (SLD), stone transversal diameter (STD) and SLD/STD ratio.

The repeatability coefficient estimates (r) were obtained by principal component method, based on genotypes correlation matrix through which each pair of measurement determines normalized auto-values and auto-vectors. The auto-vector, whose elements show the same signal and proximal magnitudes, is the one that expresses genetic tendencies of keeping their relative positions several times (Cruz and Regazzi, 1994). Genotypic determination coefficient (R^2), that represents the predictable value of the selected individual choosed by η observations and minimal number of necessary measurements to predict individuals real value, based on a pre-established determination coefficient (R^2), was calculated according to Cruz and Regazzi (1994) and Cruz (2001).

Data statistical analyses were carried out by using GENES computer program (Cruz, 2001).

RESULTS AND DISCUSSION

Repeatability coefficient estimates and number of measurements associated to several determination coefficients are shown in the Tables 1 and 2.

The characteristics number and production of fruits for plant showed repeatability estimates of 0.51 and 0.53, respectively, indicating some regularity of character repetition from one cycle to the other. For these characteristics, it is not worthwhile the increase in the measurements aiming a higher accuracy level to predict real individual’s value. Although, with six measures would be possible obtain a determination coefficient over 85%. The low precision to predict real individual’s value for these characteristics shows that they are greatly influenced by environment, and therefore are not good genotype discriminators.

The repeatability estimates for fruit weight average 0.81, pulp weight 0.84, skin weight 0.82, fruit longitudinal diameter 0.91, fruit transversal diameter 0.91, fruit longitudinal diameter/fruit transversal diameter ratio 0.91, stone longitudinal diameter 0.91, and stone transversal diameter 0.78. These estimates showed good accuracy in their measurements, with high regularity on the individual superiority from one cycle to other, and that the phenotypic expression of the characteristics has a high genetic component. These high levels show that environmental changes for these characteristics were relatively low compared with the variance between plants. Determination coefficients of 95% were obtained by only two measurements for fruit longitudinal diameter, fruit transversal diameter, fruit longitudinal diameter/fruit transversal diameter; four measurements for pulp weight and skin weight and five measurements for fruit weight average and stone transversal diameter. For skin weight and stone longitudinal diameter/stone transversal diameter ratio achieve determination coefficients over 90% with four and five measurements, respectively.

Repeatability allows estimate how many phenotypic observations have to be done in each individual to make the selection efficiently with minimal labor, being easier to estimate, because it does not need neither to control breeding nor progenies (Falconer, 1987). Since little is known about inheritance of different productive mango characters (Cilliers et al., 1997), the repeatability estimates became important for breeding programs of this crop.

The difference between repeatability and inheritance is because the genotypic variance used to estimate the repeatability is not only from genetic source, once the component of the environmental variance remains between individuals, which confound with them. So, to evaluate repeatability it is important that variance of the environmental effects be minimized. If genotypic estimated variance were only from genetic source then, the repeatability estimate coefficients would correspond the characteristic inheritance.

CONCLUSIONS

In general, the results indicate that with four evaluations is possible infer with accuracy near to 80% for number of fruits per tree and fruit production per tree, 89% for longitudinal diameter/transversal stone diameter ratio and over 90% for the other characters. Taking in account the saving of labor and time as well as data accuracy, except for total number of fruits and fruit production per tree, all the other characters had efficient discrimination of the mango acessions.

The estimates of repeatability coefficient showed that to obtain a 95% of R^2 are necessary two evaluations for fruit longitudinal diameter/fruit transversal diameter ratio; four evaluations for pulp weight; and five for fruit weight average.

For stone longitudinal diameter/stone transversal diameter ratio, five evaluations are necessary to obtain 90% of R^2.

It was concluded that the characteristics of total number of fruits and fruit production per tree, as they are environmental influenced, are not the most appropriated for mango germplasm characterization since six and five evaluations, respectively, are necessary to obtain 85% of R^2.

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Tables

Table 1. Repeatability coefficient estimates (r) and their respective determinations coefficient (R^2) of mango characters. Petrolina, PE, 2002.

Character	r	R^2
Total fruit number per tree – TFT	0.51	0.80
Fruit production/tree (kg) – FPT	0.53	0.82
Fruit weight average (g) – FWA	0.81	0.94
Pulp weight (g) – PW	0.84	0.95
Skin weight (g) – SW	0.82	0.95
Stone weight (g) – STW	0.72	0.91
Fruit longitudinal diameter – FLD- (cm)	0.91	0.98
Fruit transversal diameter – FTD- (cm)	0.91	0.98
FLD/FTD ratio	0.91	0.97
Stone longitudinal diameter – SLD - (cm)	0.91	0.97
Stone transversal diameter – STD - (cm)	0.78	0.93
SLD/STD ratio	0.65	0.89

Table 2. Number of measurements associated to several determination coefficients (R^2) for characterization of mango germplasm, based on estimated repeatability for twelve characters . Petrolina, PE, 2002.

Characters	r	R^2 =0.85	R^2 =0.90	R^2 =0.95
TFT	0.51	6[1] (5.5)	9[1] (8.7)	19[1] (18.5)
FPT (kg)	0.53	5 (5.1)	8 (8.1)	17 (17.1)
FWA (g)	0.81	2 (1.3)	3 (2.1)	5 (4.5)
PW (g)	0.84	1 (1.1)	2 (1.7)	4 (3.6)
SW (g)	0.82	1 (1.2)	2 (1.9)	4 (4.2)
STW (g)	0.72	2 (2.2)	4 (3.5)	7 (7.4)
FLD (cm)	0.91	1 (0.6)	1 (0.9)	2 (1.9)
FTD (cm)	0.91	1 (0.6)	1 (0.9)	2 (1.9)
FLD/FTD	0.91	1 (0.6)	1 (0.9)	2 (1.9)
SLD (cm)	0.91	1 (0.6)	1 (0.9)	2 (1.9)
STD (cm)	0.78	2 (1.6)	3 (2.5)	5 (5.4)
SLD/STD	0.65	3 (3.1)	5 (4.8)	10 (10.2)

[1]Rounded number.