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Characterization of rambutan plants by foliar aspects

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The present study was conducted to verify the possible distinct genotypes and material sexes of rambutanusing foliar aspects, enabling the recognition of plants in the early stages of development. Ten productive plants and ten male plants were selected, and they were named according to their arrangement in the orchard. They were evaluated for leaf and leaflet size (length and width in cm), leaflet area (cm^2), the number of leaflets, rachis length (cm), length gaps between the leaves (cm), and the color (L*, a*, b*, C* e H*) of the leaflets (superior and inferior surfaces). The data were subjected to an analysis of variance using an F test, and the means were compared using the Scott-Knott test ($p<0.05$). A cluster analysis of twenty genotypes was performed from the matrix of Euclidean distances. Based on the results obtained in this experiment, it can be concluded that the characteristics related to the color of the leaflets can be a leaf differential aspect in production plants as observed in the plants LB10_F, LB11_F and LB91_F. The multivariate analyses showed that there is low genetic distance between the studied plants; based on the foliar aspects analyzed, it was not possible to identify a discriminatory feature for all plants of the same sex.

Key words: Leaves, leaflets, *Nephelium lappaceum,* morphology.

INTRODUCTION

Fruits provide a means of plant reproduction and dispersal, and they are the hallmarks of the angiosperm lifestyle. The development of flowers and fruits has been attributed to the success of angiosperm evolution, as exemplified by a great diversity in species found around the world (Monfrote et al., 2014); among these species is the rambutan. Belonging to the family Sapindaceae, rambutan (*Nephelium lappaceum* L.) is native to Malaysia and Indonesia (Tindall, 1994), and it is grown throughout Southeast Asia, Australia, South America and Africa (Sousa et al., 1994).

According to Andrade et al. (2008), the largest Brazilian consumer market is the state of São Paulo, and producers have established cultivars through seedlings that originated from seeds with high genetic variability, but there is no information on the regional behavior. This behavior is because consumers purchase the fruit based on the type rather than the cultivar, as with mangos, apples, bananas and the like.

However, there is an obstacle in the implementation of this cultivation because the species has three types of plants: Male flowers, functionally female hermaphroditic

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flowers and hermaphroditic flowers producing some functional females and some functional males (Valmayor et al., 1970). However, this plant sexuality condition is only noticed as individuals enter maturity. This can be a great inconvenience because the males represent approximately fifty percent of the population originating from seeds; thus, four to five years could be wasted on male plants from planting to gender detection upon flowering. Thus, an alternative is to plant three seedlings per pit until the sex of the plants can be identified during flowering (Sacramento and Luna, 2004). However, the maintenance of three plants per pit requires time and costs.

Therefore, morphological characters can be used as signatures of identity varietal purity and genetic (Ambiel et al., 2008) and for several fruit trees; the distinction between plants can be performed based on foliar aspects differentiating them even before they flourish or blossom (GalánSaúco and Menini, 1989). This method has been used by several authors,such as Andrade and Martins (2007) in carambolasand Andrade et al. (2009) in rambutan cultivation.

Thus, this study aimed to verify the possible distinct genotypes and material sexes of rambutanbased on foliar aspects to enable the recognition of plants in the early stages of development.

MATERIALS AND METHODS

Selection and collection of materials

The work was conductedusing twelve-year-old plants in production from an orchard in the city of Taquaritinga, São Paulo, Brazil. The orchard is located atthe coordinates 21°26'45,5"south latitude and 48°37'57,4" west longitude atheighten elevation of 493 m.Under the Köeppen classification system, the climate is Aw and characterized as rainy tropical with dry winters.

The orchard was formed by seedlings from Bahia State, which resulted in great variability in the characteristics of these plants, including the leaf. The cultivar, at a spacing of 7 × 4 m, is drip irrigated whenever the drought exceeds thirty days and receives fertilizer N:P:K – 19:10:19 (1 kg plant^{-1}) during February and October. From a total of 288 plants, 148 productive and 140 male, 10 productive and 10 male plants were selected and named as follows according to the provision in the orchard: LA13, LA113, LB01, LB10, LB11, B62, LB87, LB91, LC13, LD120 – productive plants (F) and LA02, LA30, LA91, LA114, LB04, LB17, LB43, LC09, LD51 and LD92- male plants (M).At the time of collection the plants were in a vegetative stage. The female plants were chosen for their history of high productivity, low susceptibility to cold and presentation of a red inner bark, considered by the producer to be the most appropriate for the market.From each plant, five samples of ten leaves were obtained during the full stage of development throughout the periphery of the top, totaling 50 leaves per plant. One plant was collected per visit to the orchard, and the leaves were held in the early morning hours to avoid dehydration of the material. These leaves were placed in polystyrene boxes (Styrofoam) and taken immediately to the laboratory for evaluation.

The evaluations were performed in the Department of Plant Production, Faculty of Agriculture Sciences and Veterinary, Universidade Estadual Paulista (UNESP) Jaboticabal Campus, São Paulo State, for evaluations on leaf size (length (LL) and width (LW) in cm), leaflet area (LFA) (cm^2), leaflet number (NLF) and size of leaflets (length (LFL) and width (LFW) in cm), length of the rachis (LR) (cm), length of the intervals between the leaflets (IL) (cm), and upper (upp) and lower (low) color of the leaflets (L*, a*, b*, C* and H*).

The lengths and widths were measured with the aid of a graduated ruler using the measured length from base to tip and the width at the widest point of the leaves and leaflets. The area of the leaflets was obtained with the LI-3100 Area Meter. The color was measured at the upper and lower surface of each leaflet using the calorimeter Konica Minolta (Chroma Meter CR-400), and the values were expressed in the system CIELAB. The observed values were L*, C*, H*, a*,and b*, signifying brightness, which ranges from zero to 100 (black/white); saturation; Hue angle (0° is pure red; 90^o is pure yellow; 180° pure green and 270° pure blue); intensity of red/green (+/-) and intensity of yellow/blue (+/-), respectively. Instrument calibration was performed using a white ceramic plate.

Statistical analyses

The experimental design was completely randomized, consisting of 20 plants (10 productive and 10 male) with 5 replicates of 10 leaves, resulting in 50 leaves per plant and totaling 1,000 leaves.The data were subjected to an analysis of variance using a F test, and the means were compared with aScott-Knott test ($p < 0.05$). A cluster analysis of 20 genotypes was performed from the matrix of Euclidean distances as dissimilarity measures according to the method of WARD. The importance of the characteristics for the study of divergence was obtained from the major component analysis assuming that the least important features were those with the higher eigenvector coefficients from the last major component until an associated eigenvalue of 0.7 was found (Cruz and Carneiro, 2003). Genetically different accessions were identified in the dendrogram from the average Euclidean distance between all pairs of genotypes. The analyses were performed with the statistical program GENES (Cruz, 2008), and the dendrogram was obtained by the program Statistica 7.0 (STATSOFT, 2007).The data of leaflets lenght (LFL) were transformed into log (x) for analysis purposes.

RESULTS AND DISCUSSION

The lengths and widths of the leaves, area, number, length and width of the leaflets, and lengths of the rachis were significantly different (Table 1), and these values coincide with the results of other researchers such as Tindall (1994) and Andrade et al. (2009). However, these differences are so minute that they cannot be used toappropriately differentiate a plant in practice.

Color of leaflets

In Table 2, it can be seen that asignificant difference was found for hue angle (H) at the bottom of the leaflets, indicating that there is low variability among the studied plants. Because of this, the use of multivariate techniques can help to quantify this dissimilarity (Cruz and Carneiro, 2003). Colorimetry has been used to characterize different color pigments such as anthocyanins (Montes et al., 2005), chlorophyll (Sinneckeret al., 2002) and

Table 1. Mean values per plant for the characteristics leaf length (LL) and leaf width (LW); leaflets area (LFA); number of leaflets (NLF); length (LFL) and width (LFW) of the leaflets; total length of the rachis (LR) and the intervals between leaflets (IL) between petioles in rambutan plants.

Plant	LL** (cm)	LW** (cm)	LFA** (cm^2)	NLF**	LFL** (cm)*	LFW** (cm)	LR** (cm)	IL**(cm)
LA13_F	29.12[a]	25.74[c]	44.01[b]	6.40[a]	10.74[b]	5.59[a]	16.42[a]	2.92[a]
LA113_F	28.43[a]	30.12[a]	42.90 [b]	6.04[b]	11.90[a]	5.05[b]	13.43[b]	2.85[a]
LB01_F	22.84[c]	24.53[c]	37.67[c]	5.74[c]	10.06[b]	4.89[c]	9.94[d]	2.36[b]
LB10_F	22.80[c]	21.58[d]	24.88[d]	5.06[c]	9.79[b]	4.67[c]	10.75[d]	2.59[b]
LB11_F	20.19[d]	16.96e	25.01[d]	5.92[b]	8.17[b]	3.90[d]	11.24[d]	2.59[b]
LB62_F	24.13[b]	24.13[c]	32.49[c]	5.92[b]	9.46[b]	4.62[c]	11.86[c]	2.51[b]
LB87_F	23.91[b]	24.88[c]	33.18[c]	5.66[c]	9.89[b]	4.64[c]	11.49[d]	2.61[b]
LB91_F	27.19[a]	28.05[b]	43.50[b]	5.64[c]	10.72[b]	5.65[a]	12.60[c]	2.67[b]
LC13_F	27.63[a]	27.09[c]	35.96[c]	6.17[b]	10.97[b]	4.80[c]	13.36[d]	2.73[b]
LD120_F	22.70[c]	22.51[d]	26.62[d]	5.72[c]	8.88[b]	4.25[d]	11.09[c]	2.51[a]
LA02_M	28.69[a]	26.45[c]	37.39[c]	6.08[b]	10.22[b]	5.45[a]	15.09[a]	2.96[b]
LA30_M	23.41[c]	24.99[c]	33.27[c]	5.40[c]	9.91[b]	4.44[c]	10.64[d]	2.74[a]
LA91_M	23.17[c]	24.65[c]	38.75[c]	5.34[c]	9.87[b]	5.12[b]	10.97[d]	2.43[a]
LA114_M	23.08[c]	25.55[c]	34.09[c]	5.48[c]	10.27[b]	4.53[c]	10.30[d]	2.47[b]
LB04_M	29.06[a]	26.53[c]	46.10[b]	6.80[a]	10.98[b]	5.44[a]	14.88[a]	2.89[b]
LB17_M	25.87[b]	26.21[c]	36.84[c]	5.66[c]	10.31[b]	4.82[c]	12.35[c]	3.06[a]
LB43_M	24.94[b]	26.10[c]	35.30[c]	5.44[c]	16.16[a]	4.66[c]	11.54[d]	2.90[a]
LC09_M	24.19[b]	25.58[c]	32.21[c]	5.80[c]	10.01[b]	4.98[c]	11.40[d]	2.47[b]
LD51_M	29.02[a]	31.32[a]	52.53[a]	6.28[b]	12.50[a]	5.67[a]	13.95[b]	2.92[a]
LD92_M	25.64[b]	26.08[c]	41.56[b]	5.92[b]	10.28[b]	5.25[b]	12.65[c]	3.08[a]
CV (%)	7.08	6.33	15.04	6.65	6.50	7.87	9.87	10.58

Means followed by the same letter do not differ in the test Scott-Knott (p> 0.05). *Original data** Significant (p <0.01).

carotenoids (Meléndez-Martínez et al., 2003), and it has been widely used in studies related to food quality. It is the first criterion used in consumer acceptance of the product; therefore, it is an important attribute in the food industry (Batista, 1994). Its use in possibly differentiating between plants and sexes is still not very widespread, but it can become an important tool for studies in this direction as the presence or intensity of color in the leaves can be an advantage to plants that produce fruits or not, as is the case in the present study.

The highest average related to Luminosity (L) on the upper surface of the leaflets was obtained in the LB11_F productive plant and later in LB10_F, that is, they exhibited lighter colors than the other genotypes in study (Table 2). The highest average for the same plants along with the LB91_F and LC13_F genotypes, all productive,were repeated for Chromaticity (C), and the plants are brighter compared with the others. As for hue angle (H), on the upper surface these plants had the lowest values compared with the others.The male plants were observed to have the highest values of this angle; therefore, in the genotypes closer to pure green, no significant effect for the inferior surface was found.Negative values of the color parameter a* indicated the presence of the green component in the leaves studied, as expected because this component is more intense on the inferior surface of the leaflets. Positive values of b* characterized the presence of a yellow color in the leaflets, which was also higher on the underside. The LB10_F, LB11_F and LB91_F plants were selected as some of the best in the orchard and classified as highly productive, with agronomic and higher market characteristics.Producers register at least one out of the three as being cultivated. These same plants were the only ones with statistically higher means in all characteristics related to a lower color inthe leaflets; thus, we can infer that the plants exhibiting all color means (L *, C *, H *, a * and b *) on the inferior surface of the leaflets with statistically higher values, that is, all classified as "a," are likely to be productive. They should therefore be selected for the establishment of orchards because the description of the morphological characteristics is the usual methodology accepted from a legal point of view for patenting and registering varieties (Badenes et al., 1998).

Genetic divergence between plants

It is noted that the most similar plants (shortest distance) are LA30_M and LA114_M (1.72) and LB62_F and LB87_F (1.74), and the most divergent (longest distance) are LA113_F and LB11_F (11.21) (Table 3). However, it is very difficult to determine which plants are more or less

Table 2. Mean values per plant for characteristics related to color of the leaflets in the upper (L = brightness, C = saturation; H = hue angle; a = intensity red / green b = intensity of yellow / blue).

Plant	Upper					Lower				
	L **	C**	H**	a**	b**	L**	C**	H ns	a**	b**
LA13_F	32.24^{c}	15.11^{c}	124.16^{b}	-8.27^{b}	12.45^{c}	41.51^{b}	22.39^{b}	117.34^{a}	-9.96^{b}	19.42^{c}
LA113_F	31.20^{d}	13.64^{c}	124.98^{b}	-7.75^{b}	11.25^{c}	39.58^{c}	22.91^{b}	118.60^{a}	-10.92^{a}	20.05^{c}
LB01_F	30.38^{d}	14.88^{c}	127.68^{a}	-8.69^{b}	11.44^{c}	39.34^{c}	22.80^{b}	119.33^{a}	-11.23^{a}	19.86^{c}
LB10_F	34.99^{b}	19.43^{a}	122.64^{c}	-10.10^{a}	16.53^{a}	**43.61^{a}**	**27.68^{a}**	**117.31^{a}**	**-12.41^{a}**	**24.57^{a}**
LB11_F	36.33^{a}	21.29^{a}	121.03^{c}	-10.83^{a}	18.27^{a}	**43.27^{a}**	**28.02^{a}**	**116.51^{a}**	**-12.24^{a}**	**24.95^{a}**
LB62_F	31.10^{d}	15.65^{c}	127.04^{a}	-8.73^{b}	12.77^{c}	40.47^{b}	23.59^{b}	117.53^{a}	-10.43^{b}	20.45^{c}
LB87_F	31.40^{d}	15.11^{c}	127.41^{a}	-9.10^{b}	12.17^{c}	39.86^{c}	21.92^{b}	117.53^{a}	-10.10^{b}	19.27^{c}
LB91_F	33.87^{b}	19.16^{a}	123.75^{b}	-9.84^{a}	15.37^{b}	**43.45^{a}**	**26.56^{a}**	**116.70^{a}**	**-11.61^{a}**	**23.78^{a}**
LC13_F	33.88^{b}	19.59^{a}	123.71^{b}	-10.13^{a}	17.49^{a}	43.78^{a}	24.56^{b}	116.67^{a}	-11.01^{a}	21.95^{b}
LD120_F	32.53^{c}	17.16^{b}	124.74^{b}	-7.96^{b}	13.25^{c}	41.13^{b}	23.12^{b}	116.90^{a}	-9.00^{b}	20.98^{b}
LA02_M	30.86^{d}	16.64^{c}	128.29^{a}	-10.16^{a}	13.08^{c}	43.20^{a}	25.21^{b}	118.33^{a}	-11.92^{a}	22.17^{b}
LA30_M	30.64^{d}	14.86^{c}	127.82^{a}	-9.06^{b}	11.76^{c}	40.09^{c}	24.68^{b}	119.34^{a}	-12.08^{a}	21.35^{b}
LA91_M	30.93^{d}	15.28^{c}	126.23^{a}	-8.90^{b}	12.37^{c}	39.56^{c}	23.77^{b}	117.29^{a}	-11.10^{a}	20.97^{b}
LA114_M	31.86^{c}	15.27^{c}	126.87^{a}	-9.10^{b}	12.23^{c}	39.78^{c}	24.00^{b}	119.49^{a}	-11.80^{a}	20.88^{b}
LB04_M	32.72^{c}	17.52^{b}	128.33^{a}	-10.79^{a}	13.77^{c}	42.45^{a}	24.70^{b}	118.54^{a}	-11.81^{a}	21.66^{b}
LB17_M	32.41^{c}	17.58^{b}	125.18^{b}	-11.81^{a}	14.60^{b}	40.95^{b}	25.88^{a}	124.56^{a}	-9.78^{b}	19.70^{c}
LB43_M	33.98^{b}	18.52^{b}	120.71^{c}	-9.14^{a}	15.79^{b}	41.27^{b}	24.30^{b}	114.28^{a}	-10.23^{b}	22.26^{b}
LC09_M	32.21^{c}	17.19^{b}	126.85^{a}	-10.26^{a}	13.77^{c}	41.14^{b}	24.68^{b}	117.85^{a}	-11.75^{a}	21.70^{b}
LD51_M	32.67^{c}	18.31^{b}	125.96^{a}	-10.30^{a}	14.47^{b}	41.24^{b}	24.90^{b}	118.06^{a}	-11.55^{a}	21.51^{b}
LD92_M	30.88^{d}	15.43^{c}	128.52^{a}	-9.19^{b}	11.62^{c}	41.21^{b}	23.18^{b}	118.46^{a}	-11.04^{a}	20.36^{c}
CV (%)	3.67	12.11	1.32	14.45	13.66	2.50	9.83	3.36	9.77	6.50

Means followed by the same letter do not differ in the test Scott-Knott (p> 0.05) . ** Significant (p <0.01) ^{ns} not significant.

Table 3. Euclidean distance (longer and shortest) between twenty rambutan plants for eighteen leaf traits.

Plant	Longer		Shortest	
LA13_F	10.829	(LB11_F)	3.599	(LA113_F)
LA113_F	11.216	(LB11_F)	3.450	(LD92_M)
LB01_F	9.800	(LB11_F)	2.100	(LA114_M)
LB10_F	9.344	(LA13_F)	3.882	(LB11_F)
LB11_F	11.216	(LA113_F)	3.882	(LB10_F)
LB62_F	8.458	(LB11_F)	1.742	(LB87_F)
LB87_F	9.467	(LB11_F)	1.742	(LB62_F)
LB91_F	7.337	(LB11_F)	3.281	(LC13_F)
LC13_F	7.035	(LB01_F)	3.281	(LB91_F)
LD120_F	8.023	(LD51_M)	2.868	(LB62_F)
LA02_M	9.132	(LB11_F)	2.749	(LB04_M)
LA30_M	8.651	(LB11_F)	1.720	(LA114_M)
LA91_M	8.920	(LB11_F)	2.109	(LB01_F)
LA114_M	8.441	(LB11_F)	1.720	(LA30_M)
LB04_M	9.339	(LB11_F)	2.749	(LA02_M)
LB17_M	9.130	(LB11_F)	5.360	(LD92_M)
LB43_M	8.290	(LB11_F)	4.995	(LC13_F)
LC09_M	7.174	(LB11_F)	2.628	(LA114_M)
LD51_M	10.097	(LB11_F)	2.966	(LB04_M)
LD92_M	9.946	(LB11_F)	3.394	(LA02_M)

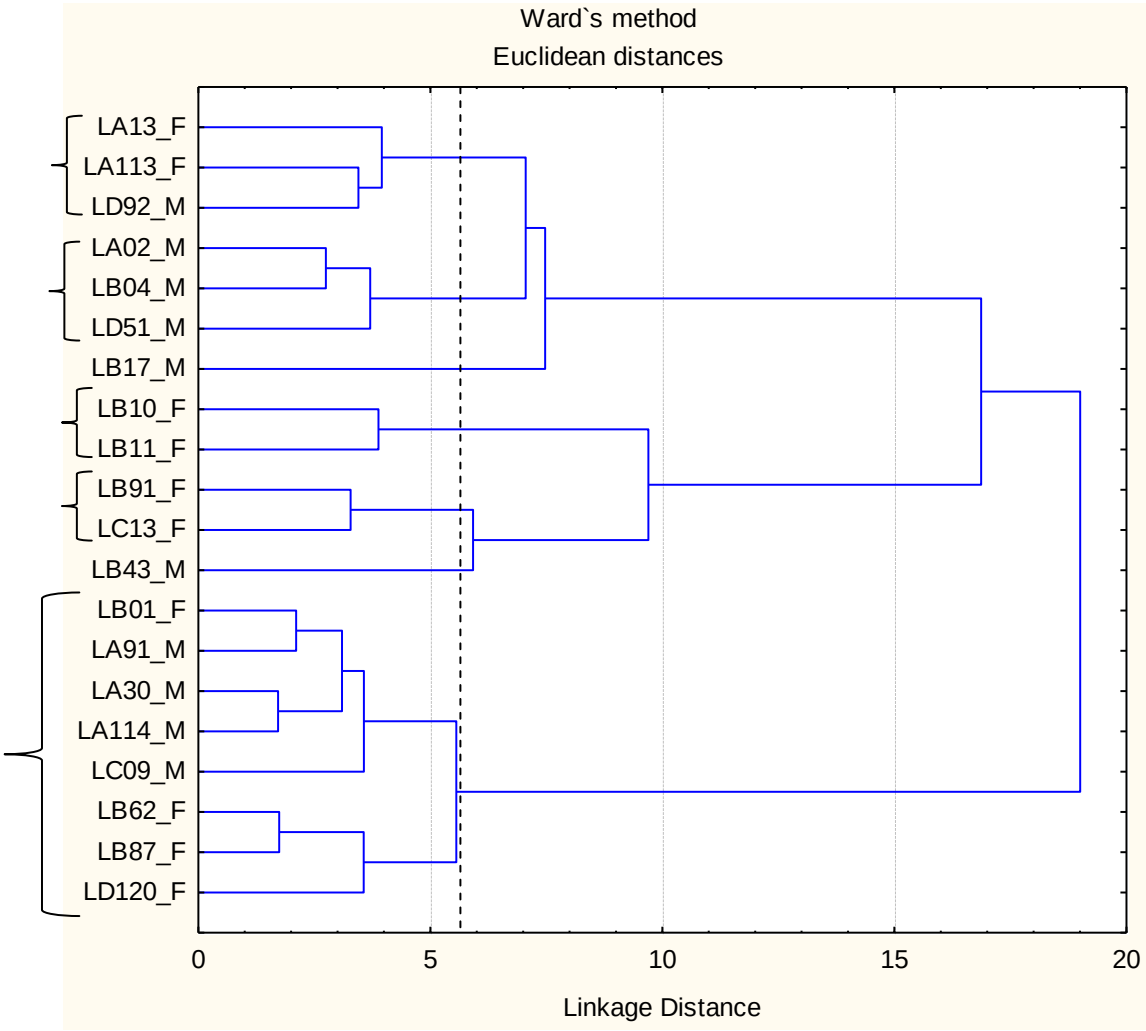

Figure 1. Dendrogram of genetic divergence (Ward Method - –Euclidian distance) among 20 rambutan obtained with a set of 18 leaf features.

similar using only the analysis of the distances between pairs; it is necessary to perform a cluster analysis (Paula, 2007). For the group promoted by the Ward method in relation to the 20 plants studied, the set of 18 features can be seen in Figure 1. Seven groups were formed from the cutting line drawn by estimating the average arithmetic complement line (5, 7) (Sokal and Rohlf, 1962). The first group was formed by a subgroup consisting of LA13_F, LA113_F and LD92_M materials; the second by LA02_M, LB04_M and LD51_M_M, the third by LB17_M plant, the fourth by LB10_F and LB11_F, the fifth by LB91_F and LC13_F, the sixth by LB43_M materials, and the seventh gathering several subgroups related to the other plants analyzed (LB01_F, LA91_M, LA30_M, LA114_M, LC09_M, LB62_F, LB87_F and LD120_F), with small genetic distances among them. The dissimilarity between some plants was very small, as observed in the formed groups; as observed by Andrade et al. (2009) in studies of the same species, despite not finding any similar material, the genetic distance between some plants was also small (less than 10%). In studies with 20 accesses of *Nephelium lappaceum* L. through 8 leaf features, Andrade et al. (2009) found two large groups by bringing together various subgroups with small distances. With 18 plants of the same species, Andrade et al. (2011) also found two large groups with great genetic variability when all of the variables were analyzed together. In this work, despite the small distance between some plants, therewere a large number of aspects evaluated together; therefore, the contribution of each variable must be verified by analyzing them separately toensure that the variables contribute differently to the observed results. Morphological characterization continues to be the first step for the description and classification of germplasm, and statistical methods such as principal components analysis (PCA) are useful tools for screening the accessions of a collection (Cantini et al., 1999; Badenes et al., 2000). The Principal Component

Table 4. Principal components (PC), estimates of eigenvalues, variance (Var) and cumulative variance (Cum. Variance) obtained from the correlation matrix between the characteristics: leaflet area (LFA, in m^2), leaf length (LL in cm), leaf width (LW in cm), number of leaflets (NLF), leaflet length (LFL in cm), leaflet width (LFW in cm), length of the rachis (LR in cm), length of the intervals between leaflets (IL in cm), coloring of the upper surface of the leaflet (L*_upp, C*_upp, H*_upp, a*_upp e b*_upp) and coloring on the lower surface (L*_low, C*_low, H*_low, a*_low e b*_low) evaluated in 20 rambutan plants (*Nephelium lappaceum* L).

Principal components	Eigen value	Var (%)	Cum. variance (%)	Elements of the eigenvectors associated to																
				LFA	LL	LW	NLF	LFL	LFW	LR	IL	L*_upp	C*_upp	H*_upp	L*_low	C*_low	H*_low	a*_upp	b*_upp	a*_low	b*_low
PC1	6.82	37.9	37.9	-0.24	-0.2	-0.26	-0.13	-0.07	-0.2	-0.14	-0.1	0.33	0.33	-0.26	0.25	0.32	-0.13	-0.18	0.33	-0.14	0.34
PC2	4.92	27.34	65.23	0.29	0.37	0.24	0.28	0.2	0.31	0.37	0.32	0.15	0.19	-0.08	0.28	0.14	-0.03	-0.22	0.18	-0.08	0.12
PC3	2	11.1	76.34	0.01	-0.03	-0.06	0.05	-0.42	0.06	-0.03	0.02	-0.16	-0.02	0.41	0.05	0.25	0.5	-0.4	-0.09	-0.37	0.03
PC4	1.28	7.1	83.44	-0.19	0	-0.23	0.23	-0.2	-0.26	0.19	0.28	0.1	0.08	-0.12	0.04	-0.1	0.34	-0.17	0.12	0.59	-0.3
PC5	1.2	6.64	90.08	0.08	-0.05	0.28	-0.45	0.46	-0.06	-0.3	0.24	0.01	0.03	-0.16	-0.24	0.16	0.39	-0.26	0.06	0.07	-0.08
PC6	0.5	2.78	92.86	-0.29	0.06	-0.2	-0.33	0	-0.06	0.22	**0.62**	-0.14	-0.26	-0.03	0.22	0.13	-0.03	0.28	-0.23	-0.14	0.17
PC7	0.42	2.34	95.19	-0.02	-0.13	-0.16	0.47	0.4	**-0.48**	-0.04	0.26	0.01	-0.03	0.17	-0.24	-0.12	-0.14	-0.15	0.00	-0.37	-0.02
PC8	0.32	1.75	96.95	0.29	-0.01	-0.1	0.17	-0.18	-0.04	0.14	-0.05	0.28	-0.21	**-0.53**	-0.33	0.21	0.32	0.31	-0.09	-0.24	0.02
PC9	0.22	1.2	98.15	-0.37	0.38	**0.53**	0.09	-0.02	-0.45	0.02	-0.22	-0.03	-0.08	-0.02	0.2	0.00	0.22	0.22	0.13	-0.14	0.01
PC10	0.13	0.74	98.89	0.36	-0.14	0.3	0.12	-0.32	-0.22	**-0.37**	0.37	0.03	0.27	0.18	0.02	0.09	-0.07	0.31	-0.06	0.19	0.25
PC11	0.07	0.41	99.3	-0.12	0.06	-0.12	0.27	0.29	0.02	0.07	-0.22	-0.31	0.07	0.06	-0.14	**0.49**	0.1	0.07	-0.26	0.37	0.41
PC12	0.06	0.31	99.61	-0.04	-0.01	-0.22	0.17	0.31	0.21	-0.36	-0.05	0.33	0.04	0.11	**0.44**	-0.21	0.39	0.27	-0.23	-0.04	-0.01
PC13	0.04	0.22	99.83	-0.27	0.06	0.23	-0.05	-0.07	0.05	0.1	0.02	**0.67**	-0.1	0.23	-0.26	0.02	-0.15	-0.2	-0.41	0.12	0.14
PC14	0.02	0.09	99.92	**0.49**	0.28	-0.28	-0.34	0.11	-0.42	0.2	-0.2	0.19	-0.14	0.35	0.12	0.07	0.02	0.03	0.07	0.13	0.04
PC15	0.01	0.04	99.96	0.07	0.24	-0.05	0.18	-0.11	0.01	-0.48	0.05	-0.02	**-0.65**	-0.19	0.17	0.08	-0.19	-0.3	0.06	0.15	0.11
PC16	0	0.03	99.99	-0.15	0.03	-0.05	0.07	0.05	0.2	-0.12	0.08	0.17	-0.11	0.33	-0.14	**0.52**	-0.12	0.31	0.39	0	-0.45
PC17	0	0.01	100	0.15	**-0.47**	0.25	0.05	0.08	-0.17	0.16	-0.12	0.00	-0.12	-0.1	0.44	0.33	-0.13	-0.11	-0.34	0.02	-0.38
PC18	0	0	100	0.00	**-0.52**	0.18	0.05	0.09	0.11	0.25	-0.01	0.07	-0.41	0.18	0.04	-0.16	0.19	0.07	0.43	0.13	0.38

(PC) with major contributions to the analysis of plant diversity were PC1 (37.90%), PC2 (27.33%), PC3 (11.11%), PC4 (7.10%) and PC5 (6.64%); 90.08% of the divergence was explained by the first five components, and the first three components explained 76.34% of the divergence (Table 4). Thus, making the analysis of the last 13 eigenvectors, that is, after the last principal component to that in which the associated eigenvalue assumed value of 0.7 (Cruz and Carneiro, 2003), was identified in the study, the characters LL, C * _low, C * _upp, LA, L * _upp, L * _low, LR, LW, H * _upp, LFW and IL as possible disposal in future studies, by small contribution of phenotypic diversity (Dias et al., 1997; Sousa, 2003). Studying the morphological diversity of the rambutan plant, Andrade et al. (2009) observed that the length component of the leaflets had a greater influence (22.79%) and was of great importance in studies of divergence for the cultivar, as observed in this work. According to these authors, a lower influence was exerted by leaf width – LW (7.75%); in this study, the LW contributed only 1.2%. Morphological characterization has been used in different species, such as baru (Ferreira et al., 1998), guariroba (Nascente, 2003) and purple passion fruit (Meletti et al., 2005). This shows the importance of the use of visual and measurable characteristics in the differentiation of plants. Therefore, given the observed results, morphological characterization is of great importance. It consists of identifying each material using data to study the genetic variability of each sample (Ramos and Queiroz, 1999). This type of analysis is simpler and less costly (Ballve et al., 1997) but has limitations related to characteristics that have additive heritage, which are highly influenced by the environment, and cultivars with great phenotypic similarity (Oliveira et al., 2000), as observed in the rambutan leaves.

In the literature, no studies aimed at gender

distinction from leaf characteristics were found. However, the results of this study indicated low genetic divergence between the materials when grouped by foliar aspects, rendering the visual distinction of materials difficult.

According to the results obtained, we can conclude that the productive plants LB10_F, LB11_F and LB91_F all had statistically higher means in all characteristics related to the lower color of the leaflets; in other words, the color of the leaflets can be a differential leaf aspect in productive plants.

Multivariate analyses indicate that there is low genetic divergence between the plants studied; based on the foliar aspects analyzed, it was not possible to identify a discriminatory feature for all plants of the same sex.

Conflict of Interest

The authors have not declared any conflict of interest.

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