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Evaluation of new papaya hybrids

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To augment a narrow genetic base in papaya, this study aimed to evaluate the performance of new hybrids produced by Caliman Agrícola® S.A. The experiment was carried out in a randomized complete block design, with 12 treatments four replications and ten plants per plot. The treatments were the variety THB and the hybrids were CR1 × São Mateus, CR1 × 72/12, CR2 × São Mateus, CR3 × São Mateus, CR1 × Maradol, CR2 × Sekati, CR3 × Maradol, CR1 × UENF/Caliman 01, CR3 × Sekati, CR1 × SSAM and Baixinho (dwarf) × Pecíolo Curto (short petiole). Ten hermaphroditic plants per plot were evaluated at 8 and 12 months after transplanting. Data were recorded for sixteen characteristics related to morphology of plants and biometry of fruits harvested at maturity stage II (fruit with up to 25% yellow skin). The analysis of variance and the subsequent Scott-Knott's mean clustering test showed significant differences between cultivars for all the characteristics. The characteristic soluble solids grouped the variety THB and five medium-sized hybrids with potential for exploitation: CP1 × UENF/Caliman 01, Baixinho × Pecíolo Curto, CP1 × 72/12, CP1 × SSAM, and CP1 × São Mateus. The estimated average yield of marketable fruits in 12 months grouped the two hybrids with the highest averages: CP3 × Sekati and CP2 × Sekati. The analysis of the new hybrids revealed interesting productivity and fruit quality characteristics, suggesting that they should undergo value for cultivation and use (VCU) testing for future release as commercial hybrids.

Key words: *Carica papaya* L., plant breeding, genetic variability.

INTRODUCTION

Papaya (*Carica papaya* L.) is one of the most important and widely distributed crops in tropical and subtropical countries. Brazil's production stood out among the world's largest in 2016 and was concentrated in an area of

30,372 ha, mainly distributed in southern Bahia, northern Espírito Santo, Ceará, and Rio Grande do Norte, with the first two considered the main producing regions (IBGE, 2016).

The crop has a narrow genetic base (Kim et al., 2002; Ma et al., 2004; Silva et al., 2008; Silva et al., 2017), which is one of the main threats to its sustainability. A feasible approach for increasing the number of commercial varieties and hybrids is to expand the genetic base of papaya by exploiting the variability existing in germplasm banks (Quintal et al., 2012; Vivas et al., 2015; Silva et al., 2017) and creating new hybrids in breeding programs (Pereira et al., 2002). Efforts should be made to broaden the genetic base and develop cultivars that meet the requirements of domestic and foreign markets and are less susceptible to pests and diseases and more resistant to biotic and abiotic stresses (Vivas et al., 2012, 2014, 2015).

Recent efforts in Brazil have studied hybrids of crosses between the groups Solo and Formosa (Silva et al., 2007; Ide et al., 2009; Dantas et al., 2015; Luz et al., 2015). In addition, Vivas et al. (2013) found variability and possible hybrid combinations within the Solo group.

New hybrids are also important to increase yield and production of fruits with potential to meet the domestic and international markets. The search for cultivars with good sensory qualities are expanding strongly with the purpose of stimulating papaya consumption (Santana et al., 2004), as well as to provide the farmers with new cultivars with commercial characteristics demanded by the market.

Therefore, the objective of this work was to carry out the agronomic evaluation of new hybrids of papaya from Caliman Agrícola SA, for the purpose of selecting superior genotypes to be included into the papaya production system in Brazil.

MATERIALS AND METHODS

The study was carried out at Santa Terezinha Farm (Caliman Agrícola SA), 19° 11' 49' S latitude and 40° 05' 52" W longitude, 30 m altitude in the municipality of Linhares, Espírito Santo, between July 2012 and July 2013. The climate of the region is type AWi (tropical humid), with rainy summer and dry winter (Rolim et al., 1999).

The experiment was arranged in a randomized block design, with 12 treatments consisting of 11 new hybrids and one commercial variety (THB) in four replicates of 10 plants per genotype. The hybrids derive from crosses between parents from the germplasm bank of Caliman Agrícola® SA (CP1, CP2, and CP3) and cultivars already exploited and adapted to the conditions of northern Espírito Santo and with characteristics of interest to domestic and international markets: CP1 × São Mateus; CP1 × 72/12; CP2 × São Mateus; CP3 × São Mateus; CP1 × Maradol; CP2 × Sekati; CP3 × Maradol; CP1 × UENF/Caliman 01; CP3 × Sekati; CP1 × SSAM; and Baixinho × Pecíolo Curto. Cultivars São Mateus, 72/12, Baixinho, and Pecíolo Curto belong to the "Solo" group.

The hybrid seeds were obtained from crosses performed by collecting hermaphroditic flowers before anthesis and transferring pollen manually to the stigma of female flowers, also before anthesis. The plants, previously labeled, and their flowers were individually protected with waterproof paper bags to prevent contamination with undesirable pollen and crosses were identified with plastic labels. Fruits were harvested at 135 to 150 days after pollination at maturation stage 1 (1/4 of the fruit was yellow) and stored for 7 to 10 days at room temperature, according to Martins et al. (2006) and Aroucha et al. (2005), with enough time to allow seeds to reach the point of total physiological maturity and maximum germination and vigor.

Seedling production was carried out in a nursery covered with polyolefin screens (50% shade). Seeds were sown, 2 seeds per cell, in 96-cell plug trays (50 cm^3) filled with Bioplant® substrate fortified with 10 kg of Basacot mini 3M® per m^3 of substrate, according to Paixão et al. (2012).

After acclimatization, about 40 days after sowing, seedlings (12 to 15 cm in height) were transplanted to the field, in July. Three seedlings were planted per hole to ensure a greater number of hermaphrodite plants. For each treatment, holes were spaced 3.6 m between rows and 1.5 m within rows. The soil of the experimental area is classified as red-yellow podzolic with clay-sandy texture. Sexing of the papaya trees was initiated three months after transplanting, and one seedling was maintained per hole, preferably a hermaphroditic plant.

The evaluations were performed at 8 and 12 months after transplanting, using 10 hermaphrodite plants per plot. At 8 months, the following variables were evaluated: plant height in cm (PH) from ground level to the insertion point of the newest leaf; first fruit insertion height in cm (FFIH) from ground level to the peduncle of the first fruit; and stem diameter in cm (SD) taken at 20 cm from ground level using a caliper. The following characteristics were measured at 8 and 12 months: total number of marketable fruits (TNMF), the sum of all fruits complying with marketing standard per plant at 8 and 12 months; fruit mass in grams (FRM), measured on precision scale with three decimal places; fruit length in cm (FRL); fruit equatorial diameter in cm (FRD); smallest thickness of fruit in cm (STP); greatest thickness of fruit in cm (GTP); equatorial diameter of the fruit cavity in cm (DFC), measured on a cross section of the fruit in the central region; soluble solids in °Brix at 8 months (SS-8) and at 12 months (SS-12) measured at maturation stage II (fruits with up to 25% yellow skin) by bench refractometer; internal fruit firmness in kg cm^{-2} at 8 months (FIRM-8) and at 12 months (FIRM-12), determined by cross-sectioning the fruit and measuring the resistance of the pulp at three points spaced equidistantly around the circumference using a penetrometer (Instrutherm, model PTR-100) with a 7.9 mm diameter tip. All fruit-related characteristics (FRM, FRL, FRD, STP, GTP, DFC, SS and FIRM) were derived from measurements of ten fruits, taking one fruit from each of 10 plants per plot. Subsequently, the products of TNMF and FRM were used and stand to obtain the estimated average yield of marketable fruits in t ha^{-1} during 12 months of production (YIELD).

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Table 1. Analysis of variance of the characteristics evaluated with the respective means and coefficient of variation (CV) for 12 cultivars of *Carica papaya* L.

Characteristics[1]	Mean square			Overall mean	CV (%)
	Block	Cultivar	Error		
PH	463.97	1730.27**	99.78	174.64	5.72
FFIH	284.98	534.64**	47.88	80.11	8.64
SD	0.27	3.52**	0.28	10.10	5.20
TNMF	56.90	2514.50**	57.04	50.79	14.87
FRM	28514.22	2749993.24**	61045.95	1558.85	15.84
FRL	0.50	113.61**	1.69	21.89	5.94
FRD	0.62	15.48**	0.35	11.39	5.20
FRL/FRD	0.01	0.20**	0.01	1.91	5.95
GTP	0.053	0.75**	0.03	3.18	5.75
STP	0.05	0.54**	0.13	2.36	15.06
DFC	0.17	4.24**	0.20	6.26	7.21
SS-8	1.03	3.97**	0.60	10.04	7.74
FIRM-8	0.50	2.14**	0.61	12.08	6.48
SS-12	2.33	9.14**	1.56	12.25	10.20
FIRM-12	4.07	10.18**	4.33	10.69	19.47
YIELD	310.04	2333.39**	366.35	114.89	16.66

**Significant at 1% by the F test. Degree of freedom: Block = 3; Cultivar = 11; and Error = 33. [1]PH: Plant height, cm; FFIH: first fruit insertion height, cm; SD: stem diameter, cm; TNMF: total number of marketable fruits; FRM: fruit mass, grams; FRL: fruit length, cm; FRD: fruit diameter, cm; FRL/FRD: fruit length and fruit diameter ratio; GTP: greatest thickness of fruit, cm; STP: smallest thickness of fruit, cm; DFC: diameter of fruit cavity, cm; SS-8: soluble solids at 8 months, ºBrix; FIRM-8: fruit firmness at 8 months, kg cm^{-2}; SS-12: soluble solids at 12 months, ºBrix; FIRM-12: fruit firmness at 12 months, kg cm^{-2}; and YIELD: estimated average yield of marketable fruits in 12 months, t ha^{-1}.

Data were examined by analysis of variance followed by the Scott-Knott (1974) mean clustering test, at 5% probability. The analyses were performed using the computational resources of the Genes software program (Cruz, 2016).

RESULTS AND DISCUSSION

The analysis of variance of the characteristics showed significant differences between the means of the 12 cultivars evaluated at alpha level of 1% (Table 1). The coefficients of variation (CV) were between 5.20 and 19.47% and are considered low to medium for the variables (Ferreira et al., 2016).

The means of the characteristics were compared by the Scott-Knott test (Table 2). Four groups were formed for plant height (PH). The group with the lowest means was formed by the variety THB and the crosses CP3 × Sekati and CP3 × Maradol, ranging from 140.65 to 154.00 cm. The other cultivars had higher means, ranging from 167.15 to 209.60 cm. It is desirable that the plant grow with shortened internodes and less space between the fruits, resulting in a longer harvestable life and greater yield. Papaya breeding aims to decrease plant height by selecting shorter genotypes that maintain vigor (Marin et al., 2003).

The Scott-Knott method formed four groups for the characteristic FFIH, with means ranging from 58.05 cm (CP3 × Maradol) to 94.10 cm (CP1 × 72/12). The low insertion height of the first fruit may be interesting because it can be associated with precocity (Storey, 1953; Dias et al., 2011), if flower initiation occurs earlier after production of fewer vegetative nodes. This allows a longer harvest season and, thus, a greater production per plant and the exploitation of longer cycles of the crop (Dantas and Lima, 2001). Therefore, the selection of cultivars that initiate the insertion of the first flower at a lower height is preferable (Alonso et al., 2008). In the selection of cultivars of the Solo group for the growing conditions of northern Espírito Santo, Marin et al. (1989) established the insertion height of the first flowers to be below 70 cm in the winter and up to 90 cm in the summer, with production capacity of over 80 perfect fruits per plant.

The characteristic SD had an overall mean of 10.11 cm, ranging from 8.37 to 11.29 cm and formed four groups, in agreement with the mean range found by Rodolfo Jr. et al. (2007) of 10.95 cm (Formosa) and 8.68 cm (Solo). Rodríguez and Rosell (2005) argued that this characteristic is positively correlated with vigor and is an important relationship to be considered in cultivar selection.

TNMF ranged from 27.36 to 112.75 and formed four groups. The hybrid Baixinho × Pecíolo Curto (TNMF = 112.75), representing group "a" with the highest mean,

Table 2. Means of the characteristics evaluated in 12 cultivars of papaya (*Carica papaya* L.).

Cultivar	Characteristic[1]					
	PH	**FFIH**	**SD**	**TNMF**	**FRM**	
CP1 × São Mateus	171.29[c2]	80.19[b]	11.29[a]	37.54[d]	1249.83[e]	
CP1 × 72/12	207.00[a]	94.1[a]	10.90[a]	51.15[c]	1054.36[e]	
CP2 × São Mateus	178.90[c]	81.60[b]	11.12[a]	35.35[d]	1644.36[d]	
CP3 × São Mateus	175.35[c]	79.15[b]	10.50[b]	42.70[d]	1585.38[d]	
CP1 × Maradol	173.19[c]	87.19[b]	9.59[c]	34.21[d]	2434.61[b]	
CP2 × Sekati	167.15[c]	71.35[c]	10.22[b]	28.80[d]	2572.25[b]	
CP3 × Maradol	140.65[d]	58.05[d]	8.57[d]	27.36[d]	3056.40[a]	
CP1 × UENF/Caliman 01	191.54[a]	85.61[b]	10.75[a]	52.49[c]	1100.77[e]	
CP3 × Sekati	151.55[d]	67.25[c]	8.37[d]	41.80[d]	2072.25[c]	
CP1 × SSAM	209.60[a]	98.7[a]	10.22[b]	61.69[c]	998.91[e]	
Baixinho × Pecíolo Curto	175.52[c]	86.64[b]	10.24[b]	112.75[a]	497.83[f]	
THB	154.00[d]	71.50[c]	9.47[c]	83.75[b]	438.76[f]	
	FRL	**FRD**	**FRL/FRD**	**GTP**	**STP**	**DFC**
CP1 × São Mateus	19.69[d]	11.22[d]	1.76[c]	3.24[c]	2.35[a]	6.31[b]
CP1 × 72/12	19.06[d]	10.90[d]	1.75[c]	2.94[d]	2.03[b]	6.51[b]
CP2 × São Mateus	24.27[c]	11.58[c]	2.10[b]	3.27[c]	2.52[a]	6.22[b]
CP3 × São Mateus	21.65[d]	11.81[c]	1.83[c]	3.37[c]	2.50[a]	6.43[b]
CP1 × Maradol	25.77[c]	14.11[a]	1.82[c]	3.58[b]	2.79[a]	7.76[a]
CP2 × Sekati	30.26[a]	12.88[b]	2.35[a]	4.02[a]	2.86[a]	7.13[a]
CP3 × Maradol	27.76[b]	14.47[a]	1.92[c]	3.20[c]	2.67[a]	7.27[a]
CP1 × UENF/Caliman 01	20.41[d]	11.00[d]	1.87[c]	2.85[d]	2.17[b]	6.23[b]
CP3 × Sekati	27.24[b]	11.94[c]	2.28[a]	3.61[b]	2.50[a]	5.97[b]
CP1 × SSAM	19.41[d]	10.63[d]	1.82[c]	2.93[d]	2.44[a]	6.64[b]
Baixinho × Pecíolo Curto	13.27[e]	8.24[e]	1.61[c]	2.56[e]	1.75[b]	4.33[c]
THB	13.96[e]	7.91[e]	1.76[c]	2.59[e]	1.74[b]	4.37[c]
	SS-8	**FIRM-8**	**SS-12**	**FIRM-12**	**YIELD**	
CP1 × São Mateus	10.27[a]	11.07[b]	13.75[a]	10.50[a]	89.91[c]	
CP1 × 72/12	10.88[a]	10.50[b]	14.25[a]	9.25[b]	99.41[c]	
CP2 × São Mateus	9.09[b]	12.65[a]	12.50[a]	12.67[a]	110.84[c]	
CP3 × São Mateus	9.44[b]	12.45[a]	11.50[b]	8.00[b]	112.50[c]	
CP1 × Maradol	9.12[b]	12.08[a]	13.00[a]	11.75[a]	130.22[b]	
CP2 × Sekati	8.85[b]	12.26[a]	9.75[b]	11.75[a]	146.67[a]	
CP3 × Maradol	8.86[b]	12.33[a]	9.75[b]	11.75[a]	124.54[b]	
CP1 × UENF/Caliman 01	11.73[a]	11.55[b]	12.75[a]	9.05[b]	101.06[c]	
CP3 × Sekati	9.74[b]	12.58[a]	11.00[b]	11.00[a]	159.34[a]	
CP1 × SSAM	10.88[a]	12.14[a]	14.00[a]	11.35[a]	125.42[b]	
Baixinho × Pecíolo Curto	11.29[a]	12.12[a]	12.75[a]	8.60[b]	106.97[c]	
THB	10.29[a]	13.21[a]	12.00[a]	12.67[a]	71.85[c]	

[1]PH: Plant height, cm; FFIH: first fruit insertion height, cm; SD: stem diameter, cm; TNMF: total number of marketable fruits; FRM: fruit mass, grams; FRL: fruit length, cm; FRD: fruit diameter, cm; FRL/FRD: fruit length and fruit diameter ratio; GTP: greatest thickness of fruit, cm; STP: smallest thickness of fruit, cm; DFC: diameter of fruit cavity, cm; SS-8: soluble solids at 8 months, ºBrix; FIRM-8: fruit firmness at 8 months, kg cm^{-2}; SS-12: soluble solids at 12 months, ºBrix; FIRM-12: fruit firmness at 12 months, kg cm^{-2}; and YIELD: estimated average yield of marketable fruits in 12 months, t ha^{-1}. [2]Means followed by equal letter in the column are not significantly different by the Scott-Knott test at 5% probability.

was followed by variety THB (TNMF = 83.75), representing group "b". These cultivars belong to the Solo group, which shows high TNMF and low FRM. Groups "c" and "d" comprise more than 80% of the cultivars evaluated, belonging to the Formosa group, with TNMF ranging from 27.36 to 61.69. Papaya cultivars in Brazil

are divided into two groups based on the average fruit weight: the Formosa group, weighing from 800 to 1,100 g and the Solo group from 350 to 600 g (Dantas et al., 2002).

FRM varied from 438.76 to 3056.40 g, with more than 80% of the cultivars weighing between 998.91 and 3056.40 g. The small fruit size means of hybrid Baixinho × Pecíolo Curto and the variety THB were not statistically different, and at least for Baixinho × Pecíolo Curto, was somewhat compensated for by a greater number of fruits per plant. FRM has variable classification standards, and the “optimum fruit” will also depend on its shape, which must facilitate packaging and transportation, and ultimately on consumer acceptance.

According to Dias et al. (2011), fruit mass between 800 and 1500 g serves the domestic Brazilian market, while the international markets still require fruit mass around 500 g. Dantas and Lima (2001) reported mean fruit mass from 280 to 850 g in genotypes of the Solo group and 710 to 2200 g in the Formosa group. These results point out the market expectations for commercializing new hybrids in the domestic and international markets.

In Latin America, there is a strong preference in domestic markets for large fruits (Ferreguetti, 2003). Alonso et al. (2009) evaluated papaya hybrids in Cuba and found mean weight with low variability, ranging from 1456.7 to 1682.4 g.

Ferreguetti (2003) observed that the consumer market for Formosa papayas was growing significantly. One example of this is that there is substantial growth in sales of these fruits in Europe, Canada, and the United States, with cultivar Maradol accounting for about 75% of papaya consumption. Therefore, the development of new resistant genotypes with commercial characteristics required by the market is important (Esquivel et al., 2008; Vivas et al., 2013). In this context, CP2 × Sekati, CP2 × Sekati, CP1 × Maradol and CP3 × Maradol hybrids may become interesting, since, in addition to high productivity (Table 2), they use the Sekati or Maradol genotypes as one of the parents, which, according to Vivas et al. (2013) are promising in relation to phoma spot resistance.

The characteristics FRL and FRD ranged from 13.27 to 30.26 cm and 7.91 to 14.47 cm, respectively. Variety THB and hybrid Baixinho × Pecíolo Curto showed the lowest means for FRL (13.96 and 7.91 cm, respectively) and FRD (13.27 and 8.24 cm, respectively), which is typical of Solo papayas.

The FRL/FRD ratio formed three groups, with more than 70% of the hybrids comprising the group with the lowest means, ranging from 1.61 to 1.92. The group with the highest means consists of the two hybrids CP2 × Sekati (2.35) and CP3 × Sekati (2.28), and the group of intermediate means consisted only of the hybrid CP2 × São Mateus. The FRL/FRD ratio is useful as an approximate indication of fruit shape.

GTP and STP ranged from 2.56 to 4.02 and 1.74 to 2.86 cm, respectively, between the evaluated cultivars, with means close to 2.0 cm (Table 2), which is the thickness considered ideal for commercialization (Martins et al., 2006). Oliveira et al. (2010) observed a significant and positive correlation, although low (0.42), between pulp thickness and fruit firmness.

DFC ranged from 4.33 to 7.76 cm, yielding three groups: 'a' group with the highest means formed by the hybrids CP1 × Maradol (8.08 cm), CP3 × Maradol (7.92 cm) and CP2 × Sekati (7.13 cm); 'b' group consisted of 58% of the cultivars evaluated; and 'c' group with the lowest means formed by the variety THB and the hybrid Baixinho × Pecíolo Curto. Fioravanço et al. (1992) and Dias et al. (2011) suggested that DFC is related to fruit quality, since fruits with smaller cavity diameter generally have a greater percentage of their total volume composed of edible pulp and are more resistant to postharvest damage during transport to distant markets.

The cultivars showed SS-8 and SS-12 ranging from 8.85 to 11.73 and 9.75 to 14.25 °Brix, respectively. The Scott-Knott analysis separated two groups of cultivars within the variables SS-8 and SS-12. The cultivars in the high SS-8 group, consisting of CP1 × UEN/Caliman 01, Baixinho × Pecíolo Curto, CP1 × SSAM, CP1 × 72/12, THB, and CP1 × São Mateus, all appeared in the high SS-12 group, as well. The results found in this study are consistent with the characteristics of Solo fruits required by the market, around 11.5 °Brix (Fagundes and Yamanishi, 2001). Variability of soluble solids content in papaya fruits was also verified in the evaluation of different new genotypes obtained by breeding work (Marin et al., 2006; Oliveira et al., 2010; Dias et al., 2011).

FIRM-8 and FIRM-12 varied from 10.50 to 13.21 kgf cm^{-2} and 8.00 to 12.67 kgf cm^{-2}, respectively, and Scott-Knott analysis revealed two groups. The groups of the highest means for the characteristics FIRM-8 and FIRM-12 comprised 75 and 63% of the cultivars with means ranging from 12.08 to 13.21 kgf cm^{-2} and 10.50 to 12.67 kgf cm^{-2}, respectively, indicating that the fruits met a good firmness standard. Evaluating improved papaya genotypes, Viana et al. (2015) found a satisfactory result with maximum firmness of 8.35 kgf cm^{-2}. Less firm fruits require greater care, being less resistant to transportation, storage, and handling damage (Fagundes and Yamanishi, 2001; Morais et al., 2007).

The characteristic YIELD ranged from 71.85 to 159.34 t ha^{-1} and Scott-Knott analysis revealed three groups. Group 'a' with the highest means comprises the hybrids CP3 × Sekati (159.34 t ha^{-1}) and CP2 × Sekati (146.67 t ha^{-1}) which, although categorized in the lowest TNMF group, showed the highest YIELD means, because of large individual fruit size. Group "b" with intermediate means comprises the hybrids CP1 × Maradol (130.22 t ha^{-1}), CP1 × SSAM (125.42 t ha^{-1}), and CP3 × Maradol (124.54 t ha^{-1}). The remaining 58% of the evaluated

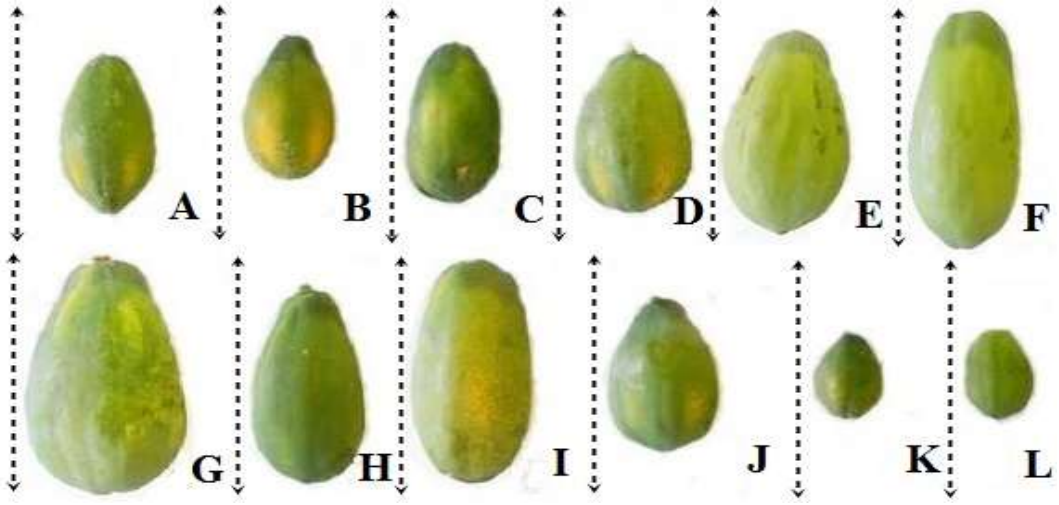

Figure 1. Fruits of 12 cultivars of papaya (*Carica papaya* L.) at 1/4 maturation stage. (A) CP1 × São Mateus; (B) CP1 × 72/12; (C) CP2 × São Mateus; (D) CP3 × São Mateus; (E) CP1 × Maradol; (F) CP2 × Sekati; (G) CP3 × Maradol; (H) CP1 × UENF/Caliman 01; I – CP3 × Sekati; (J) CP1 × SSAM; (K) Baixinho × Pecíolo Curto; (L) THB. *The dotted arrow to the left of the photo represents 40 cm in length.

cultivars belong to group "c", with the lowest YIELD means, ranging from 71.85 to 112.50 t ha^{-1}. Among the hybrids with the highest productivity, CR3 × Sekati shows promise with a fruit weight of around 2 kg, small internal cavity, good pulp thickness and good firmness of the pulp, besides presenting smooth peel fruits with good visual appearance (Figure 1). Because it has large fruits, this hybrid is not suitable for export, but it is a good option for the domestic market to serve the pulp processing market.

In contrast, even though the hybrid Baixinho × Pecíolo Curto and the variety THB had the highest TNMF means, they were grouped with the cultivars of the lowest YIELD means. This result is due to the low FRM means of both cultivars, which characterize them as belonging to the Solo group. However, the hybrid Baixinho × Pecíolo Curto should be studied further because it has important characteristics to be explored, such as fruits with mass around 0.5 kg and smaller diameter of the internal cavity of all hybrids evaluated (Figure 2), good soluble solids content, characteristics sought for *in natura* consumption, internal and external market.

The YIELD of the 12 cultivars evaluated was very satisfactory when compared with other hybrids with similar fruit sizes such as Tainung 01. This cultivar showed, in response to irrigation depths and soil covers, yield varying from 138.1 to 175.7 ton ha^{-1}, with each plant producing, on average, 55.6 fruits throughout the cycle (Gomes Filho et al., 2008).

Marin et al. (2003) stated that the growers' preference is for hermaphroditic plants with pear-shaped and/or elongated fruits, small fruit cavity and greater pulp thickness. This set of characteristics gives greater commercial value to the fruit in the market. Photographs of fruit phenotypes of the twelve evaluated cultivars are provided in Figures 1 and 2.

The shape of the ovarian cavity depends on the carpel formation. Ruggiero (1988) discussed that a small cavity is preferred, as it provides a greater amount of pulp and the seeds are easy to remove. An example among the hybrids we evaluated is Baixinho × Pecíolo Curto, with a very small ovarian cavity (Figure 2).

Overall, the most new hybrids studied have phenotypic characteristics that are acceptable to the domestic and international consumer market of papaya. The results of this study indicate that we can use the papaya cultivars as alternatives with potential to meet the demands of both consumers and producers. Further research is indicated to check the resistance to diseases that affect the crop.

Conclusions

Among the hybrids evaluated, characteristics of fruit production and fruit quality of interest were found suggesting that they should undergo value for cultivation and use testing for future release as commercial hybrids.

The hybrid CP3 × Sekati was shown to be promising because of the highest estimated average yield of marketable fruits in 12 months, which is directly related to production and sustainability of the papaya crop. It is also

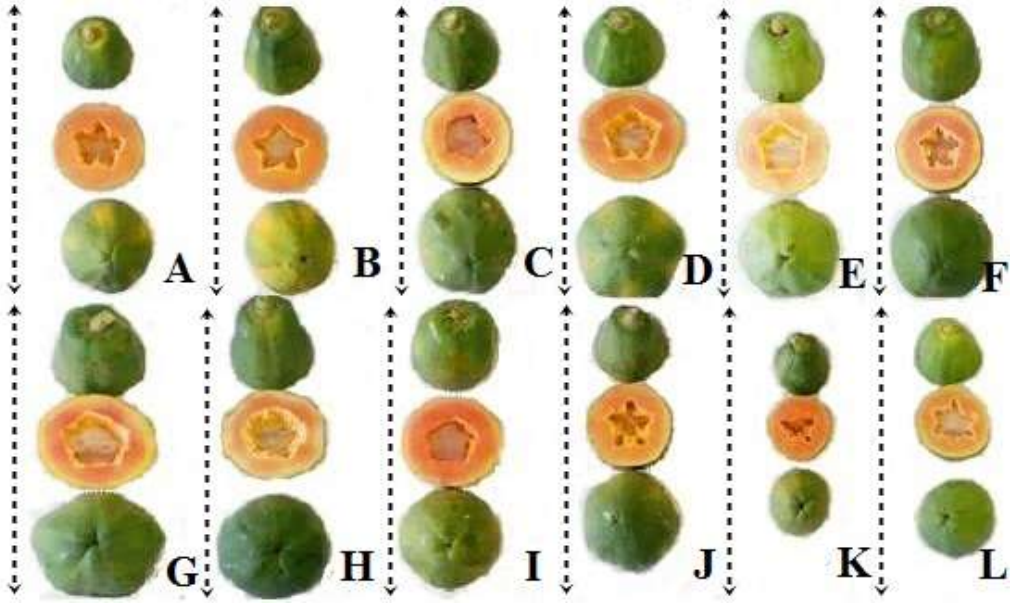

Figure 2. Fruits representation, in cut, of the 3/4 maturation stage of the 11 papaya hybrids (*Carica papaya* L.). (A) CP1 × São Mateus; (B) CP1 × 72/12; (C) CP2 × São Mateus; (D) CP3 × São Mateus; (E) CP1 × Maradol; (F) CP2 × Sekati; (G) CP3 × Maradol; (H) CP1 × UENF/Caliman 01; I – CP3 × Sekati; (J) CP1 × SSAM; (K) Baixinho × Pecíolo Curto; (L) THB. *The dotted arrow to the left of the photo represents 40 cm in length.

indicated that the hybrid Baixinho × Pecíolo Curto, that presents fruits with quality acceptable for the internal and external market. Another four hybrids merit attention in new studies, because they present fruits around 1 kg and good content of soluble solids: CP1 × UENF/Caliman 01, CP1 × 72/12, CP1 × SSAM, and CP1 × São Mateus.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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