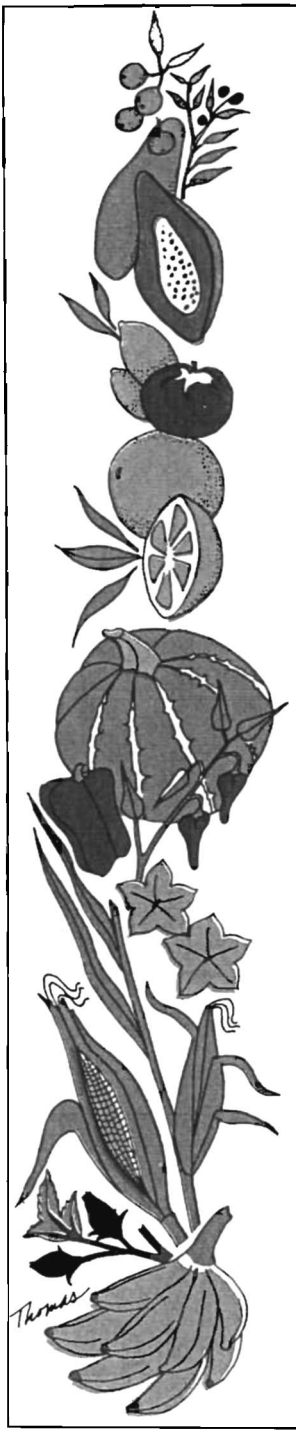

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PROMISING PAPAYA VARIETIES FOR THE CARIBBEAN

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ABSTRACT

Fourteen promising papaya (Carica papaya L.) varieties were identified in a germplasm characterization study established at the Lajas Experiment Station on 7 April 1993. The large fruited (> 2 kg) processing type cultivars 'Villalba', 'Giant Panama Eet' and 'Cartagena' had higher yields than the traditional commercial cultivar 'Puerto Rico 6-65'. 'Yuen Nong No. 1', 'Tainung No. 5', 'Khag Naun' and 'Solo 40' have elongated fruits of medium size (1-2 kg), and are well suited for production of immature or mature fruit for local consumption and/or export to Latin/Asian markets. Yield of solo type 'Rafael' was not significantly different from that of the commercial 'Sunrise' cultivar, but hermaphroditic plants of 'Rafael' had 99.3% marketable fruit compared to only 78% for 'Sunrise' due to a high frequency of carpellody. Papaya cultivars identified as desirable for home gardens and/or specialty markets include 'Paco', 'Washington 5', 'Cariflora', 'Honey Gold', 'Puerto Rico 6-65 Dwarf' and chlorophyll mutant HCAR 185.

INTRODUCTION

Papaya is a high value tropical fruit with great potential for increased production in the Caribbean region. However, despite favorable climate and proximity to major markets, Caribbean papaya production in recent years has experienced little growth or has actually declined. While world papaya production increased almost ten percent from 1990 to 1992, annual production in the Caribbean has remained stagnant at about 52,000 Mg (FAO, 1993). In Puerto Rico annual papaya production has declined steadily since 1986, dropping from 4,082 Mg to a low of 907 Mg in 1992 (Troche-Ducot, 1993).

Among the most important limiting factors contributing to low papaya production in the Caribbean are diseases and the scarcity of high quality seed of superior varieties available to the grower. Papaya ringspot virus (PRV) and papaya bunchy top (PBT) are destructive, vector-transmitted systemic diseases that affect papaya plantings in the Caribbean region (Hepperly and Esnard, 1991). Both diseases decrease the economic life of the orchard, increase costs of production, and result in reduced yield and fruit quality. No effective control exists for either disease. Growers in Puerto Rico also experience difficulty in obtaining quality seed of good papaya varieties. Very little papaya breeding or varietal evaluation has been done in Puerto Rico since the release of 'Puerto Rico 6-65' in 1966 (Singh Dhaliwal et al., 1966). 'Puerto Rico 6-65' and related landraces are still the dominant papaya genotypes grown in Puerto Rico, but are primarily processing types not well suited for marketing as fresh fruit; furthermore, available seed is highly heterogeneous and contains a high proportion of undesirable male plants. 'Sunrise' is the other commonly grown cultivar in Puerto Rico; it has a high quality fresh market fruit, but produces a large number of unmarketable, misshapen fruits due to a high frequency of carpellody. 'Sunrise' also has a small fruit size which is not suitable for all markets. Both 'Puerto Rico 6-65' and 'Sunrise' are susceptible to PRV and PBT.

Thus there is a need in the Caribbean for introduction and/or breeding of new papaya varieties with desirable characteristics: high yield, disease resistance, desirable fruit type and high fruit quality. The objective of this work was to screen diverse papaya germplasm to identify promising genotypes suitable for cultivation in the Caribbean or for use in breeding new cultivars for the region.

MATERIALS AND METHODS

A collection of diverse papaya germplasm was assembled comprising 45 genotypes from Puerto Rico, Florida, Hawaii and 8 foreign countries (Table 1).

Table 1. Origin of papaya germplasm used in the study.

Country	No. accessions
Puerto Rico (USA)	6
Florida (USA)	1
Hawaii (USA)	8
China	1
Dominican Republic	1
India	1
Nigeria	10
Panama	1
South Africa	1
Taiwan	1
Thailand	3
Unknown	11

Seeds were sown February 1, 1993 in plastic bags each containing 2048 cm^3 of a 1:1:1 Pro-Mix BX:sand:field soil mix. After germination, plants were maintained under 47% shadecloth and fertilized weekly with a commercial water soluble 20-20-20 fertilizer. Plants were transplanted to the field at the Lajas Experiment Station on April 7, 1993 on plastic-mulched rows with 1.52 m intrarow spacing and 3.7 m between rows. The soil is Fraternidad clay (udic cromusterts, very fine, montmorillonitic isohypothermic), with a pH of 6.7, 35.0 mg kg^{-1} P and 0.51, 18.33 and 15.84 cmol kg^{-1} K, Ca and Mg, respectively. Mean annual rainfall is 1100 mm.

Papaya genotypes were considered treatments, and experimental units of 4 plants were replicated 3 times in a randomized complete block design. Checks were 'Puerto Rico 6-65' and 'Sunrise', and borders consisted of 'Puerto Rico 6-65'. Weeds were controlled by cultivation and spot treatment with 1% glyphosate (Roundup). Malathion sprays were applied weekly to control insect vectors in an attempt to prevent early infection by PRV and PBT; spraying was discontinued after first harvest. Drip irrigation was applied as needed, and nutrients were applied through the drip system following a recommended fertilizer schedule (Anonymous, 1987). Urea (46% N) was used as a source of N, phosphoric acid (H_3PO_4) provided P and potassium nitrate (KNO_3) was used to supply N and K.

Data were recorded for traits of horticultural interest; total fruit yield, mean fruit weight, tree size and virus resistance score are reported in this paper. Plants were visually evaluated for virus symptoms using a 1 (highly resistant) to 9 (highly susceptible) scale where 1 = no symptoms; 3 = leaves normal size and shape, little distortion or mottling, fruit set normal; 5 = leaf size reduced, moderate distortion and/or mottling, fruit set reduced; 7 = leaf size reduced 50%, distortion and/or mottling, little or no fruit set; and 9 = leaf size severely reduced, severe distortion and/or mottling, no fruit set, eventual death. A virus score of less than 5 is considered a useful level of resistance. All plants had symptoms of virus infection at the time of evaluation. Analyses of variance (ANOVA) were calculated for quantitative variables, and means were separated using least significant differences (LSD).

RESULTS AND DISCUSSION

Of the 45 papaya genotypes compared in this field trial, 14 were selected for further evaluation based on superior performance, and are described in this paper. These genotypes may be grouped into processing, fresh market and specialty market/home garden classes depending on their principal use. Varieties grown primarily for processing purposes should have a high yield of large, thick-fleshed fruit; fruit quality is not of primary importance since sugar and other flavorings are added during processing. Fresh market papaya cultivars include small-fruited solo types, grown primarily for export as mature fruit to temperate zone markets, and cultivars with larger, elongate fruit suitable for local consumption or export to Latin/Asian markets either immature (green) or mature (ripe). Fresh market types should be high-yielding, and must have desirable size and shape, as well as high fruit quality, since they are consumed directly. High fruit quality is also important in papaya cultivars for specialty market and home gardens. Although disease resistance is desirable in all three classes, it is an especially important trait in specialty market types, where fruit may be produced organically, or in home garden situations, where chemical pest control is likely to be limited.

Processing Types

'Villalba', 'Giant Panama Eet' and 'Cartagena' had higher yields and larger mean fruit weight than the control, 'Puerto Rico 6-65' (Table 2). Of these, 'Villalba' was an outstanding producer, with a total yield of 104 Mg ha^{-1}. Trees of these three cultivars are large (>2.4 m), which is a disadvantage for harvesting; however, their superior yield and large fruit size make them ideal for production of papaya for processing. 'Cartagena' had a virus score of 4.6, which is a moderate but useful level of resistance. The other cultivars had low resistance to virus infection.

Table 2. Origin, mean fruit yield, fruit weight, tree size and virus score of processing type papaya cultivars grown at Lajas, Puerto Rico.

Genotype	Origin	Fruit yield	Fruit weight	Tree size†	Virus score‡
		Mg ha^{-1}	kg		
'Villalba'	Puerto Rico	104	2.3	L	6.2
'Giant Panama Eet'	Panama	86	2.6	L	6.0
'Cartagena'	Dom. Rep.	81	2.3	L	4.6
'Puerto Rico 6-65'	Puerto Rico	77	1.6	M	7.3
LSD (0.05)		26	0.3		1.3

† S = small (<1.8 m), M = medium (1.8 - 2.4 m), L = large (>2.4 m).
‡ Plants were visually evaluated for virus symptoms using a scale of 1 (highly resistant) to 9 (highly susceptible).

Fresh Market Types

'Sunrise' and 'Rafael' were identified as superior solo type fresh market papaya cultivars (Table 3). There was no significant difference between the two cultivars in fruit yield, fruit weight, tree size or virus score. Both have pyriform fruit typical of solo type papayas. The principal differentiating characteristic is percentage of carpellody in fruits of hermaphroditic trees. 'Sunrise' had a

frequency of 22% carpellody, resulting in unmarketable misshapen fruits, while 'Rafael' produced only 0.7% carpellodic fruits. Therefore, 'Rafael' may be a desirable alternative to 'Sunrise' where high frequency of carpellody is a problem.

Yields of fresh market elongate type papaya cultivars 'Yuen Nong No. 1', 'Tainung No. 5' and 'Khag Naun' were not significantly different from that of the control 'Puerto Rico 6-65' (Table 4). 'Solo 40' had a lower yield, but was selected for further evaluation fue to its high fruit quality and uniformity. All of the cultivars have a desirable fruit weight of approximately 1-2 kg, a narrowly ovoid to lanceoloid shaped fruit, and have short to medium trees, which facilitates harvest. All are susceptible to virus; 'Solo 40' is extremely susceptible, which probably contributed to its low yield.

Table 3. Origin, percent carpellody, mean total and marketable fruit yields, fruit weight, tree size and virus score of fresh market solo type papaya cultivars grown at Lajas, Puerto Rico.

Genotype	Origin	Percent carpellody	Fruit yield		Fruit weight	Tree size	Virus score‡
			Total	Marketable			
			Mg ha^{-1}		g		
'Sunrise'	Hawaii	22.0	51	44	351	L	8.3
'Rafael'	Puerto Rico	0.7	46	45	289	L	7.8
LSD (0.05)			26		300		1.3

† S = small (<1.8 m), M = medium (1.8 - 2.4 m), L = large (>2.4 m).
‡ Plants were visually evaluated for virus symptoms using a scale of 1 (highly resistant) to 9 (highly susceptible).

Table 4. Origin, mean fruit yield, fruit weight, tree size and virus scoreof fresh market elongate type papaya cultivars grown at Lajas, Puerto Rico.

Genotype	Origin	Fruit yield	Fruit weight	Tree size†	Virus score‡
		Mg ha^{-1}	kg		
'Puerto Rico 6-65'	Puerto Rico	77	1.6	M	7.3
'Yuen Nong No. 1'	China	72	1.9	M	6.8
'Tainung No. 5'	Taiwan	68	1.0	S	7.4
'Khag Naun'	Thailand	66	1.6	S	6.9
'Solo 40'	Hawaii	49	0.9	M	8.3
LSD (0.05)		26	0.3		1.3

† S = small (<1.8 m), M = medium (1.8 - 2.4 m), L = large (>2.4 m).
‡ Plants were visually evaluated for virus symptoms using a scale of 1 (highly resistant) to 9 (highly susceptible).

Specialty Market/Home Garden Types

'Paco', 'Washington 5' and 'Cariflora' are excellent cultivars for specialty markets and home

gardens. They produce high yields of high quality fruit on medium sized trees (Table 5). In addition to these desirable characteristics, 'Washington 5' and 'Cariflora' have good levels of virus resistance. The primary disadvantage of these cultivars in terms of commercial production is fruit shape; 'Paco has ovoid to spheroid fruits, and 'Washington 5' and 'Cariflora' have a spheroid fruit shape. Perhaps existing consumer preference for pyriform or elongate fruit could be modified with the introduction of these outstanding cultivars.

Table 5. Origin, mean fruit yield, fruit weight, tree size and virus score of specialty market home garden type papaya cultivars grown at Lajas, Puerto Rico.

Genotype	Origin	Fruit yield	Fruit weight	Tree size†	Virus score‡
		Mg ha^{-1}	kg		
'Paco'	Puerto Rico	75	1.1	M	5.6
'Washington 5'	India	72	0.8	M	3.7
'Cariflora'	Florida	65	0.6	M	3.8
'Honey Gold'	South Africa	49	0.9	L	5.4
'Puerto Rico 6-65 Dwarf'	Puerto Rico	46	0.4	S	8.6
HCAR 185	Hawaii	29	0.3	M	8.1
LSD (0.05)		26	0.3		1.3

† S = small (<1.8 m), M = medium (1.8 - 2.4 m), L = large (>2.4 m).
‡ Plants were visually evaluated for virus symptoms using a scale of 1 (highly resistant) to 9 (highly susceptible).

'Honey Gold', 'Puerto Rico 6-65 Dwarf' and chlorophyll mutant HCAR 185 are desirable a curiosities for the home garden. 'Honey Gold' bears a sweet fruit that is best eaten soon after harvest, as it ripens quickly and is very soft at maturity. 'Puerto Rico 6-65 Dwarf' is an extremely small plant (mean 135 cm height) well suited to small gardens or for use as edible landscaping. The immature fruit of chlorophyll mutant HCAR 185 have a golden yellow color; the abundance of these small fruits on a medium size tree has a very ornamental aspect. The fruit is edible and of fair quality.

CONCLUSIONS

In a field evaluation of 45 diverse papaya genotypes at Lajas, Puerto Rico, 14 cultivars were identified as having potential for cultivation in the Caribbean or for use in breeding new varieties adapted to local conditions. It is hoped that the introduction of new, superior cultivars will help to stimulate an increase in papaya production in the region.

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