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An Evaluation of twenty-five varieties of mangoes for commercial planting in Puerto Rico — W. Pennock

During the past twenty years we have observed slightly over 150 varieties in Puerto Rico. Slightly less than half of these, consisting mostly of old indian varieties and some local selections, were discarded eight years ago when we abandoned the old collection in Rio Piedras and started the new one near Ponce .The new collection comprises at present 78 varieties. These include 30 of the best indian varieties, 25 introduced from the state of Florida, 10 fairly recent local selections and 13 varieties introduced fairly recently from other areas but mostly from the West Indies, the Phillipines and Hawaii.

After some preliminary observations 19 varieties have been included in at least one of 3 varietal experimental plantings and 6 additional varieties have been planted in sufficient number (20 trees or more) so that we have been able to obtain reliable information regarding their performance under our conditions in Puerto Rico. All of these 25 varieties have been in production for several years and we have been able to carry out market tests and pannel tasting experiments with most of them. Most of these 25 varieties are still in our opinion among the very best in the collection but we did include 3 which we now consider rather mediocre. We now also have about 12 new additions to the collection which are very promissing but require further observations and study before their performance can be evaluated.

Although we are interested in their processing properties and have carried out numerous tests on this matter, our principal aim is to market mangoes as fresh fruit both in the U. S. mainland and our local market. The largest volume and best prices will, of course, be found in the export market. However, the local market can serve for placing slightly blemished fruit of good quality.

Because of the West indian fruit fly, *Anastrepha fraterculens*, mango fruits must be fumigated with ethylene dibromide before they can be exported to the U. S. mainland. This is normally done in the government owned and operated fumigating plant. The fruit is fumigated after it is packed in ventillated boxes but the operation requires unlaoding and treatment for two hours. The fruit may then be reloaded and taken to the boat or other carrier for transport to the U. S. mainland. In routine fumigation practice, however, treatment must be carefully programmed and fumigation usually delays 12 to 24 hours. Air freight is prohibitively expensive for shipping mangoes. The fruit is therefore usually shipped by boat under mild refrigeration in which the temperature should not drop below 50°F. Refrigerated semi-trailer units operated by the Seatrain or scaland companies are now the usual means of transport.

As may be inferred from the above a good commercial variety of mango must therefore possess the capacity of permitting harvesting of the fruit before it ripens on the tree. Moreover the longer the interval of time between picking and ripening of the fruit the better, provided, however that flavor or some other characteristic is not impaired thereby. However, this is not the only attribute of a good commercial variety and we have studied both fruit and tree characteristics in making our evaluation.

In table 1, we give a comparative, descriptive summary of all twenty-five varieties with regard to thirteen different fruit characteristics. These include ripening season, fruit size, skin colour, visual sales appeal, fiber content, skin thickness, flavor intensity, texture of ripe flesh, ripening pattern, leeway in packing maturity, shelf life, observed Anastrepha infestation and anthracnose susceptibility. Our purpose here is primarily to describe the varieties and to point out in some detail their principal advantages as well as their disadvantages. It will be noted, however, that some of these different characteristics are interrelated one with the other. Visual sales appeal for example, depends almost entirely on the fruit size and skin colour and may be regarded as a sort of combination of these two characteristics. A large fruit with red and yellow colour has a high visual sales appeal. A small fruit with green colour has very low sales appeal. You will appreciate that fiber content, flavor intensity, texture of ripe flesh and ripening pattern are all related to some extent with eating quality of the fruit but that possibly the most important element of the fruit quality, the desirability or general appeal or popularity of its taste and flavor has not been included. This is because taste appreciation differs greatly respect to mangoes. Despite many tasting sessions we simply do not have reliable data with respect to this characteristic.

As concerns the term shelf-life, this refers to a combination of the time interval involved in "Picking leeway" plus the time interval extending beyond initial ripeness to slightly overripe but with good flavor. "Picking leeway" provides the principal time interval for shipping and selling but additional "shelf life" will eventually contribute to improve repeat sales.

Regarding Anastrepha infestation, we have noted some interrelationship with skin thickness. With the sole exception of the variety Zill, a thick skin is generally associated with low Anastrepha larval infestation. We have also noted that varieties with abundant caustic latex such as Colombo kidney have a low incidence of larval infestation despite thin skin. We have also noted that when an early variety is highly subject to infestation a build-up of the fly population occurs and later varieties suffer in consequence. We reduced fly infestation greatly in our Isabela Substation by eliminating all trees of the Cambodiana variety which is both early and highly susceptible and not valuable commercially.

In the second table we give a comparative descriptive summary of these same 25 varieties with respect to 9 tree characteristics. These are as follows : Tree size, rate of growth, type of foliar canopy, development of fruiting capacity, bearing season, bearing habit, fruit number per panicle, yield capacity, and anthracnose injury to leaves in one column and to flowers in another. In this case there are also some interrelationships between the different characteristics. Tree size and rate of growth are obviously interrelated since large trees usually get that way through rapid growth. However, rate of growth is also related to development of fruiting capacity, to bearing season, bearing habit, and yield capacity. The julie tree for example, is small because of a slow growth rate. Its rate of growth is slowed up because so many flushes produce flowers instead of leaves. Obviously this coincides with its precocity, with very early consistent bearing and with high yielding capacity. A high number of fruits per panicle generally coincides with

high yielding capacity. Colombo kidney and Lippens which are both cluster bearers are also of the most prolific. The bearing season which we give as a tree characteristic coincides exactly with the season when the fruit is ripe. We have included this same information in both tables simply to reduce the necessity of having to consult both tables at once.

Bearing season is also related to bearing habit which in turn affects average yield capacity. The principal distinction between an early and a late variety is the length of the time interval between pollination and ripe fruit. An early variety such as Colombo kidney delays 100 to 110 days fom pollination to ripe fruit. A late variety such as Palmer delays 125 — 135 days from pollination to ripe fruit. There is also some tendency for early varieties to bloom earlier and sometimes completely out of season but nevertheless early and late varieties frequently bloom at the same time. Obviously an early variety has more time to prepare itself for next year's bloom than does a late variety.
Farly varieties in general are therefore more consistent bearers than late varieties which are more likely to be alternate bearers.

Both table 1 and table 2 are informative with respect to the virtues and faults of these varieties and give a good general picture of their individual performance under Puerto Rican conditions. However, the information is made up of many components and these are qualitative rather than quantitative in nature. It therefore, becomes obvious that simplification and some sort of manipulation or transformation will be needed before these data can become the basis for a yardstick to be used in selecting and discarding varieties.

By way of simplification we will give special importance to the matter of bearing or ripening season by selecting some of the best early varieties, some of the best mid-season varieties and some of the best late varieties thereby disposing of this characteristic from further consideration. In view of the above discussion we can also dispose of many of the other characteristics by selecting and utilizing only those few which are most inclusive and of commercial import. We believe that can best be done by reducing the characteristics to four component parts of approximately equal importance as follows :

Components Parts	*Importance expressed as percent of whole*
1. Yield	25%
2. Sales appeal	25%
3. Shelf life	25%
4. Combination of other characteristics	Eating quality 15% Insect resistance 5% Fungus resistance 5%

We propose to codify most of the information in tables 1 and 2 by assigning each variety a numerical value as the score of its performance with respects to each of these different characteristics. A perfect variety would score 25 points on yield ; 25 points on sales appeal ; 25 points on shelf life ; 15 points on eating quality, and 5 points in both insect and fungus resistance.

The question will undoubtedly be asked why is eating quality given

less importance than the first three characteristics. The answer lies in the fact that all of these varieties are of good quality and we are measuring that difference rather than an absolute value. Half of the range of 15 points covers the difference between the variety of lowest quality (Lippens or Davis Haden) and that of the highest qaulity (Edward). The other half of the 15 point range stands for the difference in eating quality between the variety Lippens and the worst mango in our collection (Shalimar or Hato Tejas). Why 15 points instead of 25? Even Shalimar and Hato Tejas taste pretty good when there are no other mangoes. We have also had one or two visitors who thought these varieties were rather choice!

With respect to yield, the points correspond fairly closely to the worded rating given under average yield capacity in table 2. To arrive at these we had extensive yield records for all of the varieties included in varietal experiments and fairly trustworthy records for all others except Bombay green and Cubano. On these two varieties, which we have included because some of our farmers are specifically interested, our data were rather skimpy but sufficient to facilitate a good approximation. To facilitate the scoring we first rated each variety according to numbers from 1 to 10 and thereafter multiplied this rating by 2.5. Colombo Kidney,, the highest yielding variety was given a perfect score.

With respect to sales appeal and shelf life our scoring directly derived from the corresponding worded ratings under these same two titles in table 1. The worded rating was first converted into a numercial rating from 1 to 10 and thereafter multiplied by 2.5. Jacquelin was given a perfect score for sales appeal and Edward for Shelf-life.

With respect to insect and fungus resistance, the worded ratings of both tree and fruit were taken into account. Those pertaining to insects and those pertaining to fungi were coded separately as a numerical index from 1 to 10 and in each case were subsequently multiplied by 0.5.

In the case of eating quality we frankly had some difficulty because our tasting panels gave us such varied results and we were unable to compare early varieties with late ones. This category of eating quality reflects to some extent the fiber content and the flavor intensity. For example julie which is otherwise a top quality fruit lost 1½ points because of fiber and 1½ points because of very strong flavor. This may not seem justifiable to a julie enthusiast who does not mind a little fibre and prefers its strong, delicious flavor. Commercially, however, our best customer is the average American who has eaten few if any mangoes. He does not like fibre because it upsets his stomach and a strong flavor is too exotic for a beginner. We simply rated eating quality as best we could and in the last analysis our own personal preference undoubted manifested itself. We hope the ratings are somewhere within gunshot of the truth.

In the spirit of an accountant striking a trial balance we present table 3 which constitutes a numercial evalation of the commercial characteristics of all 25 varieties.

It may be observed that the total index varied from 60.5 for the variety Carrie to 80.5 for the varieties Edward and Irwin which tied for first place. We were agreeable surprised that a comparison of the total is in rough agreement with our own preconceived opinion. Thus the highest 12 scores were as follows :

Total score index	*Variety*	*Season*
80.5	Edward	Very early
80.5	Irwin	Midseason
79.5	Jacquelin	Medium late
78.5	Palmer	Late
77.5	Ruby	Late
77.0	Parvin	Medium late
76.0	Keitt	Late
75.5	Manzano T.N.	Early
74.0	Haden	Early
74.0	Kent	Late
74.0	Sensation	Medium late
74.0	Zill	Early

If we were asked to select the best 12 varieties we would select these same ones though not necessarily in that order. It may also be appreciated that the first 12 include 4 early varieties namely Edward, Manzano T.N., Haden and Zill ; 4 midseason or medium late varieties namely Irwin, Jacquelin, Parvin, and Sensation and 4 late varieties namely Palmer, Ruby, Keitt, and Kent.

The variety Colombo Kidney which is recommended for dooryard planting in the North Coast obtained a low commercial rating because it lacks sales appeal and shelf-life.

Table 2

Tree Characteristics of Twenty-five Varieties of Mango Having Possible Commercial Value in Puerto Rico

Variety	Tree Size	Rate of Growth	Type of Foliar Canopy	Development of Fruiting Capacity	Bearing Season	Bearing Habits	Usual No. of Fruits per Panicle	Average yield Capacity	Severity of Injury Caused by Anthracnose on leaves /2	Severity of Injury Caused by Anthracnose on flowers
Adams	Large & Tall	Fast	Open	Average	Fairly early	Consistent	Several	High	None observed	Moderate
Bombay Green	Large	,,	Dense	,,	Med. Late	Erratic	One	Low	,, ,,	,,
Carrie	Large	Moderate	Dense	Somewhat Precocious	Fairly early	,,	One	Fairly High	,, ,,	,,
Colombo Kidney	Large	,,	Open	Average	Very early /1	Consistent	Several	Very High	,, ,,	Slight
Cubano	Large	,,	Medium	,,	Fairly early	,,	One	High	Numerous lesions	Severe
Davis Haden	Large	,,	Open	,,	Med. Late	Alternate	One	Fairly High	None observed	Considerable
Edward	Large	Fast	Dense	,,	Very early /1	Somewhat erratic	One	Fairly Low	,, ,,	Moderate
Eldon	Large	Moderate	Medium	,,	Midseason	Alternate	One	Fairly High	Numerous lesions	Considerable
Florigon	Large	,,	Medium	,,	Early	Consistent	One	High	None observed	Slight
Haden	Large	Fast	Dense	,,	Early	Alternate	One	Fairly Low	,, ,,	Considerable
Irwin	Medium	Mod Slow	Medium	,,	Midseason	Consistent	One to few	High	Few lesions	Severe
Jacquelin	Medium	Moderate	Dense	,,	Med. Late	Alternate	One	Fairly Low	None observed	Considerable
Julie	Small	Very Slow	Very Dense	Precocious	Very early /1	Consistent	One	High	Few lesions	,,
Keitt	Large	Moderate	Open	Average	Very late	Alternate	One	Fairly High	None observed	Moderate
Kent	Large	,,	Dense	,,	Late	Alternate	One	Fairly High	,, ,,	Considerable
Lippens	Medium	,,	Medium	,,	Midseason	Consistent	Several	High	,, ,,	,,
Manzano Tete Nene	Small	Slow	Dense	Precocious	Very early /1	Consistent	One	High	,, ,,	,,
Palmer	Large & Tall	Fast	Open	Somewhat Delayed	Late	Alternate	One	Fairly High	,, ,,	,,
Parvin	Large	Moderate	Medium	Average	Med. Late	Alternate	One	Fairly High	,, ,,	,,
Pillsbury	Medium	Moderate	Medium	Average	Med. Late	Consistent	One to few	High	None observed	Moderate
Ruby	Medium	,,	Medium	,,	Late	Consistent	One to few	High	,, ,,	,,
Santaella	Medium	Slow	Dense	Delayed	Midseason	Somewhat erratic	One	Fairly Low	,, ,,	Considerable
Sensation	Medium	Slow	Medium	Average	Med. Late	Consistent	One to few	High	,, ,,	Moderate
Springfells	Large	Moderate	Open	,,	,, ,,	Alternate	One	Fairly High	,, ,,	Considerable
Zill	Large	,,	Open	,,	Early	Consistent	One to few	High	,, ,,	,,

1) Varieties marked very early frequently give two crops per year and on some years produce small quantities of completely off-season fruit.
2) Foliar lessions presumably provide a supplementary source of "Mass innoculum" increasing the difficulty of control by spraying.

TABLE 3

Numercial Evaluation of the Commercial Characteristic of twenty-five Mango Varieties

Variety	Yield	Sales Appeal	Shelf Life	Eating Quality	Resistant to Anastrepha	Resistant to Anthracnose	Total Index 4/
	Score 1/	Score 1/	Score 1/	Score 2/	Score 3/	Score 3/	
Adams	22.5	15.0	17.5	10.5	4.0	4.0	73.5
Bombay G.	17.5	12.5	20.0	10.5	4.0	4.0	68.5
Carie	20.0	12.5	10.0	10.5	4.0	3.5	60.5
Colombo K.	25.0	7.5	7.5	12.0	5.0	5.0	62.0
Cubano	22.5	12.5	20.0	10.5	4.0	1.5	71.0
D. Haden	17.5	20.0	20.0	7.5	4.0	2.5	71.5
Edward	12.5	20.0	25.0	15.0	4.0	4.0	80.5
Eldon	15.0	20.0	17.5	9.0	4.0	3.5	69.0
Florigon	20.0	12.5	12.5	10.5	3.0	4.5	63.0
Haden	12.5	22.5	20.0	12.0	4.5	2.5	74.0
Irwin	22.5	20.0	20.0	12.0	3.5	2.5	80.5
Jacquelin	12.5	25.0	20.0	13.5	4.5	4.0	79.5
Julie	20.0	12.5	20.0	12.0	4.5	3.0	72.0
Keitt	17.5	20.0	20.0	10.5	4.0	4.0	76.0
Kent	17.5	20.0	17.5	12.0	4.0	3.0	74.0
Lippens	22.5	12.5	17.5	7.5	2.5	3.0	65.5
Manzano T. N.	20.0	15.0	20.0	13.5	3.5	3.5	75.5
Palmer	15.0	22.5	20.0	13.5	3.5	4.0	78.5
Parvin	17.5	20.0	20.0	12.0	4.0	3.5	77.0
Pillsbury	22.5	10.0	17.5	10.5	4.0	3.5	68.0
Ruby	20.0	17.5	20.0	12.0	4.0	4.0	77.5
Santaella	15.0	15.0	22.5	12.0	4.0	3.5	72.0
Sensation	20.0	20.0	15.0	10.5	4.5	4.0	74.0
Springfels	17.5	22.5	17.5	9.0	3.5	3.5	73.5
Zill	20.0	17.5	17.5	12.0	3.5	3.5	74.0

1/ Possible maximum 25 points.
2/ Possible maximum 15 points.
3/ Possible maximum 5 points.
4/ Possible maximum 100 points.