Studies on certain characteristics of four papaya (*Carica papaya* L.) varieties[1]

Sirikul Wasee, Suranant Subhadrabandhu and Benjamas Silayoi[2]

ABSTRACT

Line 10 Solo, the introduced papaya variety from Hawaii, was compared with three local varieties widely grown in Thailand, namely Coaco, Khaek Dam and Sai Nam Phung. It appeared that in the hermaphroditic trees, Line 10 Solo, flowered the latest and its height as measured at time of the first flower when the first fruit was ripened was higher than the other varieties. Also the percent of total soluble solids and flesh firmness of the Line 10 Solo was higher than other varieties. Flesh firmness in variety Khaek Dam did not differ significantly from Line 10 Solo. The cavity size and the number of seeds per fruit of the four varieties did not differ significantly. The flesh from Line 10 Solo, when ripened, was yellow while the three local varieties were reddish orange in color. The Coaco and Khaek Dam plants tended to be dwarf while Sai Nam Phung was taller.

Among the three local varieties, the fruit number per tree, fruit size and fruit weight did not differ significantly, but these characters differed from those of Line 10 Solo. The study on pistillate tree, was done only on the three local varieties. It was found that the characters studied, were not different from the hermaphroditic trees except Sai Nam Phung which produced less fruits per tree.

The fruit quality, fruit size, fruit weight and flesh thickness were not different among the varieties studied, but total soluble solids, and cavity size were significantly different among the varieties. Khaek Dam had the most firmness of flesh, 16.17 kilograms per square centrimeter, which was significantly different from the Coaco and Sai Nam Phung. Sai Nam Phung had highest number of seeds, (278 seeds per fruit) which markedly differed from that of Coaco and Khaek Dam varieties which had 16 and 1 seed (s), respectively.

INTRODUCTION

Papaya (*Carica papaya* L.), an indigenous fruit of tropical America, is now widely grown in tropics and subtropics from 32°N to 32°S latitude (Mc Gregor, 1976). It grows rapidly at the temperature range of 20°–27°C (Naik, 1949). Large plantations of papaya are found in Hawaii, Florida, Brazil, South Africa, West Indies, Malaysia and Taiwan. In Thailand, it is grown throughout the provinces of Ratchaburi, Nakhon Pathom, Nakhon Ratchasima and Saraburi. The more favorable varieties are Khaek Dam, Coaco and Sai Nam Phung. The Khaek Dam variety is a dwarf tree, optimum in fruit size, cylindrical in shape, firm, sweet with red color flesh when ripened and small cavity containing less seeds. The Coaca variety is simi-

1. Approved for publication by the Horticulture Department, Kasetsart University as Journal Article No. Hort. 23-0003

2. Horticulture Department, Kasetsart University

lar to Khag Dam but the shape of fruit is not cylindrical because its apex is wider than the base and the cavity is bigger than Khag Dam. Sai Nam Phung variety is different from these two varieties, when ripened the fruit is long, sweet yellow-orange flesh color and rather soft. (Anupun, 1977). The varieties of papaya widely grown in Hawaii are Sunrise Solo, Waimanalo, and Line 10 Solo. Sunrise Solo has reddish-orange flesh, firm, and pear-shaped. Waimanalo has orange-yellow flesh, star-shaped cavity, good flavor, and thick flesh while Line 10 Solo has uniform fruit size with less carpelloid fruits. (Yee, et al., 1974)

Cultivars grown in Thailand were the large-fruited type. After an introduction of the small-fruited papaya from Hawaii the course of papaya development and the breeding objective of papaya in Thailand was changed.

MATERIALS AND METHODS

Materials : The four varieties of papaya, Coaco, Khaek Dam, Sai Nam Phung and Line 10 Solo were used in this experiment. The instruments used were hand sugar refractometer, metre tapeline, and balance.

Methods : Four varieties of papaya were planted in plots 6 × 42 metres in size at 2 × 3 metres spacing, a total of 10 trees per plot, at Department of Horticulture, Kasetsart University during October 1977 to October 1978. In this study, the sex forms of trees were separated into two types, female and hermaphrodite. The observations were made on height of first flower, age of the first flower, height and circumference of plant when first fruit was ripened, number of nodes of first fruit, and total number of fruits per tree. This was done by counting the fruits from the bottom to the top when first fruit is ripened.

To determine the quality of fruits, a hand sugar refractometer was used to determine percent of total soluble solids of the juice as an index of the sugar content of the fruit. Cavity percentage were calculated by using the formula :

$$\frac{\text{milliliters of water required to fill seed cavity}}{\text{milliliters of water displaced by whole fruit}} \times 100 = \text{percent cavity}$$

The whole fruit volume was displaced by water and cavity volume was derived by halving the fruit cross sectionally then removed the seeds and filled the cavities with water.

RESULTS

Pistillate plants

The position of the first flower and the number of nodes were not related to the earliness of the plants. Data for this trial as given in table 1 and 2 showed that Coaco variety produced the first flower and first fruit of the lower nodes, but the time of flowering was later than those from other varieties. The variety that gave the earliest flowering was Khaek Dam, while Sai Nam Phung was the tallest, having the first flower and fruit at the highest node position. When the first fruit was harvested, the circumference around the trunks and the height of Khaek Dam plants were greater and higher than that of Coaco. Yield per plant was low in Sai Nam Phung having the average of four fruits while Khaek

Dam and Coaco had twenty-one and twenty - five fruits per plant respectively.

Fruit weight and fruit size of the three varieties were shown in table 3. Sai Nam Phung gave the biggest fruit, Khaek Dam fruit was second and Coaco produced the smallest fruit. Statistical differences were found among the three varieties in weight, length and width of the fruits, with Sai Nam Phung had the longest fruit and Khaek Dam the shortest. For fruit width, Sai Nam Phung and Khaek Dam varieties were not statistically different but both varieties were greater than that of Coaco. There was no significant different in fruit cavity of the three varieties, however, Sai Nam Phung had a rather small cavity, (Table 4) indicating a thicker fleshed fruit in Sai Nam Phung (Table 3).

The average refractometer readings for total soluble solids content were given in Table4.No significant differences were found in the three local varieties. The firmness of the flesh, measured with penetrometer was also shown in Table 4. Khaek Dam fruit was the most firm with 16.17 kg/cm^2 and was statistically different from the others. The number of seeds per fruit in Coaco and Khaek Dam were similar but they were significantly less than that of Sai Nam Phung which had 278 seeds per fruit.

Hermaphroditic trees

Data for the studied characters of hermaphroditic trees were similar to that from pistillate plants. When the first fruit was ripened, plant height was the highest in Line 10 Solo, and the circumference around the trunk was the largest (Table 1). Khaek Dam had the lowest plant height and the least trunk circumference. The position of the first flower and first bearing fruit indicated that Coaco was more dwarf and earlier in age at first flowering. However, Coaco plants had more node number than Khaek Dam and Sai Nam Phung but less than Line 10 Solo plants (Table 2). The total number of fruits per tree was about the same in the three local varieties but less than those of Line 4 10 Solo (Table 2).

The fruit width and flesh thickness in Khaek Dam and Coaco varieties were not statistically different but they were differed from Sai Nam Phung and Line 10 Solo. (Table 3). The length and weight of Line 10 Solo fruits were significantly less than those from the three local varieties (Table 3). Khaek Dam and Line 10 Solo had high flesh firmness, and significantly higher than the two other varieties (Table 4). Line 10 Solo was the sweetest having the highest total soluble solid and Coaca with the least total soluble solid content. The cavity size and the seed number per fruit of all varieties were not significantly different (Table 4).

DISCUSSION

The results in this study showed Line 10 Solo plants to be taller than the local varieties, however this Line 10 Solo variety was reported dwarf when planted in Hawaii (Yee, et al., 1974). This phenomena changing in characters by environment was confirmed by the performance of Sunrise Solo, another Hawaiian papaya, in Malaysia. Sunrise Solo variety, when planted in Malaysia, showed rather high plant with

Table 1. Some characteristics of four papaya varieties.

Varieties	Height of plant when first fruit is ripened (cm) Female/Hermaphrodite		Circumference around the trunk when first fruit is ripened (cm) Female/Hermaphrodite		Height to 1st flower* (cm) Female/Hermaphrodite	
Coaco	122.5	148.3	34.0	39.5	44.5	42.0
Khaek Dam	158.2	147.0	40.1	37.0	53.8	59.0
Sai Nam Phung	-a	-	-	-	70.5	55.0
Line 10 Solo	-b	199.0	-	40.0	-	77.0

a. Plant died due to root rot.

b. No female tree in Line 10 Solo.

* in papaya usually the first few flowers were abscised.

Table 2. Some characteristics of four papaya varieties.

Varieties	Weeks to 1st flower Female/Hermaphrodite		Height to 1st fruit (cm) Female/Hermaphrodite		Number of nodes to 1st fruit Female/Hermaphrodite		Number of fruit per tree per crop Female/Hermaphrodite	
Coaco	11.5	10.0	64	65	33	32	25	23
Khaek Dam	9.6	11.5	66	68	26	25	21	25
Sai Nam Phung	10.5	10.7	110	84	35	29	4	29
Line 10 Solo	-	12.0	-	110	-	39	-	39

Table 3. Some characteristics of fuits of four papaya varieties.

Varieties	Width of fruit (cm) Female/Hermaphrodite		Length of fruit (cm) Female/Hermaphrodite		Fruit weight (kg) Female/Hermaphrodite		Thickness of flesh (cm) Female/Hermaphrodite	
Coaco	8.4a*	9.7x	16.3a	25.6x	0.54a	1.13x	1.7a	2.7x
Khaek Dam	10.9b	9.6x	10.1b	25.8x	0.88b	1.09x	2.1b	2.6x
Sai Nam Phung	12.1b	7.7y	27.3c	27.8x	1.49c	0.92x	2.3c	2.1y
Line 10 Solo	-	7.4y	-	10.3y	-	0.26y	-	2.0y

* Means within the same parameter follwed by similar letters are not significantly different at the 5 % level by Duncan's Multiple Range Test.

Table 4. Some characteristics of fruits of four papay varieties.

Varieties	Firmness of fruit (kg/cm^2) Female/Hermaphrodite		Total soluble solid (%) Female/Hermaphrodite		Cavity size (%) Female/Hermaphrodite		Number of seed per fruit Female/Hermaphrodite	
Coaco	10.56a*	9.91x	11.40a	10.20x	32.80a	19.12x	16a	195x
Khaek Dam	16.17b	13.93y	10.70a	11.60y	38.50a	16.71x	1a	130x
Sai Nam Phung	11.07a	9.41x	11.70a	12.10y	31.20a	19.44x	278b	127x
Line 10 Solo	-	14.74y	-	13.20z	-	14.38x	-	140x

* Means within the same parameter followed by the same letters are not significantly different at the 5 % level by Duncan's Multiple Range Test.

small fruit and late flowering compared with local varieties (Chan and Tee, 1975). Thus, is seemed that Line 10 Solo was selected and improved for the environment of Hawaii, when it was introduced to Thailand, the plant height, fruit size and the phenomenon of sterility and carpellody were all increased.

In our program, selection and breeding of papaya varieties had been directed toward a dwarf plant, first flower at low nodes, early flowering, high total soluble solids fruits, flesh firmness at harvest, attractiveness in flesh color and resistance to diseases and insects. The common varieties grown in Thailand were Coaco and Khaek Dam which had both female and hermaphroditic plants. For Thai market the hermaphroditic fruits are more favorable. Comparing fruits from hermaphroditic flowers of these two leading varieties, Coaco and Khaek Dam, Khaek Dam fruits were superior in total soluble solids and flesh firmness, with other characters were insignificantly different. Sai Nam Phung, the other local variety, had high total soluble solid but was not popular due to rather soft and yellow-orange flesh. Line 10 Solo, an introduced variety, had small fruit, yellow flesh, many seeds which are not favorable to the Thai market. However, this variety had firm and very sweet flesh which are very desirable characters to be incorporated in any breeding program.

SUMMARY

Studies on certain characters of Line 10 Solo papaya in comparison with the three local varieties can be concluded as follows:

A). The pistillate tree. The characters in the pistillate plants from the three local varieties, Coaco, Khag Dam and Sai Nam Phung were listed as.

1. The height of Coaco measured at the time of the first flower and when the first fruit was ripened were shortest while those of Sai Nam Phung were tallest.

2. Coaco variety produced the highest number of fruits per tree, and Sai Nam Phung gave the least number of fruits per tree.

3. Khaek Dam was the earliest variety to flower.

4. Fruit width, fruit length, fruit weight, thickness of the flesh and flesh firmness were smallest in the Coaco variety while Sai Nam Phung fruit were biggest.

5. The least number of seeds per fruit was found in Khaek Dam variety.

B) The hermaphroditic tree. The characters from Line 10 Solo compared with the three local varieties were.

1. Line 10 Solo was the latest to flower and produced the tallest tree.

2. Khaek Dam produced the highest yield per tree.

3. The Line 10 Solo produced the least figures in fruit length, fruit weight, percent fruit cavity and number of seeds per fruit.

4. The firmness of mature fruit and total soluble solid percentage of Line 10 Solo was higher than the other varieties. However, the flesh firmness of Line 10 Solo was not significantly different from that of Khag Dam.

REFERENCES

Anupum, P. 1977. Papaya. Horticulture Section. Department of Horticulture

publication. 1:30-38 (in Thai).

Chan, Y.K. and T.S. Tee. 1975. *Studies on Sunrise Solo papaya in Malaysia.* Lapuran MARDI Report. No. 36. 10 p.

Mc Gregor, S.E. 1976. Insect pollination of cultivated crop plants. Agricultural Handbook., Agricultural Research Service. USDA. 496:274-277.

Naik, K.C. 1949. *South India fruit and their culture.* P. Varadacharej and Co., Madras. 447 p.

Nakasone, H.Y. 1975. Papaya development in Hawaii. *Hort. Science* 10 (3) : 198.

Storey, W.B. 1938. The primary flower types papaya and the fruit types that develop from them. *Proc. Amer. Soc. Hort. Sci.* 35:83-85.

Yee, W., E.K. Akamine, G.M. Aoki, R.A. Hamilton, F.H. Haramoto, R.B. Hine, O.V. Holtzmann, J.T. Ishida, J.T. Kuler and H.Y. Nakasone. 1974. *Papaya in Hawaii.* Univ. Hawaii Coop. Exp. Serv. Circ. No. 436. 56p.