

## THE PERFORMANCE OF F<sub>1</sub> HYBRID COCONUTS IN JAMAICA

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### ABSTRACT

Dwarf × tall, tall × dwarf and tall × tall F<sub>1</sub> hybrid coconuts in Jamaica have characteristics that are intermediate between those of their parents. Each parent is deficient in at least one of the characteristics considered (disease resistance, precocity, leaf production, bunch production, palm size, nut number, nut weight and copra production) so that the overall performance of the F<sub>1</sub> hybrid is better than that of either parent. Only when considering lethal yellowing disease does the intermediate level of resistance constitute a barrier to the widest use of hybrids.

### INTRODUCTION

THE first demand made of any coconut variety or hybrid, that may be considered for growing in Jamaica, is that it should have high resistance to lethal yellowing disease. This disease, which has reached devastating proportions in Jamaica (Romney, 1972), has suppressed the coconut industries in neighbouring Caribbean islands and is a serious threat to the remunerative tourist industry in Miami, Florida, on the North American continent (Parthasarathy and Fisher, 1974). In terms of world-wide commercial coconut production for copra, lethal yellowing is not an immediate threat, but in view of the high susceptibility of most of the foreign coconut varieties introduced and tested in Jamaica (Whitehead 1968; Harries, 1973) there is no reason for complacency. The occurrence of other diseases of obscure etiology in some of the major coconut growing countries of Asia, as well as in Africa, indicates that experience gained in Jamaica may be applicable on a broader front.

Fortunately, resistance to lethal yellowing disease was recognised in the Malayan Dwarf variety in time for this to become the basis of a massive replanting programme in Jamaica. However, because of the inevitable delay in establishing a perennial crop, many Jamaican farmers suffer serious reduction in their income from copra and the entire industry is going through a period of low production. In the face of the financial problems that accompany lethal yellowing disease, the Coconut Industry Board has nevertheless supported a Research Department charged with the responsibility of improving yield by

devising more efficient cultural methods and by plant breeding. The breeding programme has to control the quality of the Malayan Dwarf seedlings that are distributed to farmers, seek new sources of lethal yellowing resistance and develop improved planting material.

The result of fifteen years of continuous breeding research is, in short, that whilst only the Malayan Dwarf variety, in its red, yellow, and green colour forms, can provide the necessary large numbers of lethal yellowing resistant plants to meet the immediate demand, the use of certain dwarf × tall F<sub>1</sub> hybrids can play an increasingly important part in rehabilitating the coconut industry. Methods to produce large numbers of hybrid seedlings have been devised, the first hybrid has been named for commercial production and a range of hitherto untried hybrids are being produced for field scale trials.

### PERFORMANCE OF F<sub>1</sub> HYBRIDS

#### *Lethal Yellowing Resistance :*

It is not possible to infect coconut palms with lethal yellowing disease so that tests for resistance depend on field exposure, which is time-consuming and expensive for perennial crops. Since the severity of disease cannot be controlled the possibility of palms escaping infection and being counted as resistant cannot be overlooked. However, by planting a number of replicated trials with both hybrids and known resistant and susceptible varieties, and by keeping these under constant monthly surveillance, it has become clear that whilst many tall varieties are highly

susceptible, some tall varieties and hybrids have a degree of resistance. In fact, hybrids have an intermediate degree of resistance between that of their parents. Detailed annual statements of disease incidence have been published in Research Department reports since 1967 and selected recent data are summarised in Table I.

TABLE I  
*Incidence of lethal yellowing at 3 sites (Fair Prospect, Kildare, Woodstock) over a 5 year period (1968 to 1973)*

| Variety            | Cumulative incidence of lethal yellowing (%) |               |
|--------------------|--|---------------|
|                    | After 1 year                                 | After 5 years |
| Jamaica Tall (JT)  | 38   | 84            |
| JT × PT            | 11   | 47            |
| PT × JT            | 3  | 50            |
| Panama Tall (PT)   | 10   | 44            |
| JT × MD            | 9  | 34            |
| MD × JT            | 5  | 22            |
| PT × MD            | 2  | 12            |
| Maypan (MD × PT)   | 3  | 10            |
| Malayan Dwarf (MD) | 1  | 5             |

It has been established that the Panama Tall has a degree of resistance that lies between the high resistance of the Malayan Dwarf and the high susceptibility of the Jamaica Tall. Hybrids between the two tall varieties maintain the intermediate level of resistance but this level is not sufficient for these to be considered for commercial planting. Likewise, the hybrid Malayan Dwarf × Jamaica Tall (and the reciprocal), though slightly more resistant than Jamaica Tall × Panama Tall, is still not satisfactory. The Maypan (Malayan Dwarf × Panama Tall) and its reciprocal most nearly approach the resistance of the Malayan Dwarf. These data were obtained from small plots exposed to a high intensity of lethal yellowing infection where the incidence of disease in the Malayan Dwarf was higher than that observed under commercial conditions. There is evidence to suggest that large plots of hybrids have a lower incidence of disease, perhaps due to mutual protection from the pathogen or the vector. For these reasons, the cross Malayan Dwarf × Panama Tall has been commercially released under the name Maypan (Harries and Romney, 1974) and any future dwarf × tall hybrids will be made

using tall varieties having resistance similar to that of the Panama Tall.

#### *Windstorm :*

With 39 major hurricanes since 1689, and with the main coconut growing areas in the most exposed eastern section of the island, it is important that any variety should be able to come into bearing quickly to ensure the quickest possible return to production after a hurricane and the longest possible productive life before the next. Large quantities of Malayan Dwarf seed were therefore imported after the 1944 and 1951 hurricanes, long before the lethal yellowing resistance was even considered.

As well as precocity, the stature of the palm may be of importance. For example, after the 1951 hurricane one area planted with Panama Tall was observed to have suffered less than the neighbouring Jamaica Tall. However, the reasons for any differences are hard to assess and desirable qualities such as a high number of large nuts may well increase the risk of windthrow. Whilst the lesser height of the Malayan Dwarf may afford it some safety in sheltered locations the high number of nuts and the insignificant bole may both reduce its stability. Evidence from a localised high wind in 1971 did not give a clear indication whether Malayan Dwarf or Malayan Dwarf × Jamaica Tall had different resistance to wind damage (Research Department Report 12, p. 30), but in New Hebrides hybrids appeared to be better than dwarfs (Manciot, 1972).

A hurricane force wind will probably blow down anything in its track. Thin soils, such as those over coral, or the protection afforded by hills or forest will modify the associated destruction significantly. Overall it would seem that hybrids may combine favourable characters; the precocity of the Malayan Dwarf and the large bole size of tall varieties such as the Panama Tall. In particular the Malayan Dwarf × Fiii Dwarf (first produced by Marechal in Fiii, in 1928) might be an extremely favourable combination.

#### *Earliness of Bearing :*

For a perennial crop exposed to hurricane and in countries such as the Philippines, to decline diseases, earliness of bearing is of primary importance. Unfortunately, coconut

TABLE II

Comparative leaf production for pre-bearing palms expressed as a percentage of the value for the yellow Malayan Dwarf (after Harries, Romney and Smith, 1968)

| Dwarf parent  |        | Dwarf × tall hybrid |                    | Tall parent       |
|---------------|--------|---------------------|--------------------|-------------------|
| Malayan Dwarf | yellow | 100.0               | 94.1               | 79.0              |
|               | red    | 86.3 (a)            | 96.3               | 79.0 Jamaica Tall |
|               | green  | 93.8                | 92.6               | 79.0              |
| Malayan Dwarf | yellow | 100.0               | 91.2               | 77.9              |
|               | red    | 86.3 (a)            | 87.6               | 77.9 Panama Tall  |
|               | green  | 93.8                | 88.5               | 77.9              |
| M.D.          | yellow | 100.0               | 91.7               | 86.1 Rennel Tall  |
| Mean          |        | 94.3                | 91.7               | 79.3              |
| Tall parent   |        |                     | Tall × tall hybrid | Tall parent       |
| Jamaica Tall  |        | 79.0                | 82.4               | 85.2              |
| Panama Tall   |        | 77.9                | 82.0               | 85.2 Rennel Tall  |
| Mean          |        | 78.5                | 82.2               | 85.2              |

(a) Low production as a result of poor establishment.

establishment often takes second place to the cultivation of other crops (in Jamaica to bananas) and palms are overshadowed in the early years and often not fertilized. This has led to the erroneous belief that the coconut takes a long time to come into bearing. The use of F<sub>1</sub> hybrids should not be considered as a means to improve early bearing without at the same time improving establishment by adequate weed control and correct fertilization.

Where establishment is good, early growth, as measured by the number of leaves produced, is excellent for the Malayan Dwarf and for dwarf × tall hybrids. Tall varieties and tall × tall hybrids are slow in comparison. Where establishment of Malayan Dwarf has been poor the palms have suffered from leaf spot diseases which have been less severe on the hybrids. In general terms both dwarf × tall and tall × tall hybrids show rates of leaf production intermediate between those of their respective parents (Table II).

Unfortunately, almost all of the variety trials were affected by lethal yellowing disease during the period in which they began to flower so that much information on the onset of bearing was lost. However, at one trial, Plantain Garden, the period over which the palms flowered has been recorded (Table III). It is possible to see that the dwarf is the earliest, the tall the latest and the hybrids, again, are intermediate. The lateness of the Panama Tall is noticeable in its hybrids and is remarkable in view of the rapid germination of this variety (Whitehead, 1965). Once in full bearing the

TABLE III

Flowering period: Composite values from two trials at Plantain Garden

| Variety       | Period from planting to flowering (years) |                            |
|---------------|---|----------------------------|
|               | Less than 10% of the palms                | More than 90% of the palms |
| Malayan Dwarf | 2½  | 4½                         |
| MD × JT       | 3   | 4½                         |
| MD × RT       | 3   | 4½                         |
| MD × PT       | 3½  | 6                          |
| JT × RT       | 4   | 5½                         |
| PT × RT       | 4   | 5½                         |
| Jamaica Tall  | 4   | 6                          |
| Rennel Tall   | 4   | 6                          |
| Panama Tall   | 6   | 8                          |

number of bunches produced annually corresponds closely to the number of leaves produced and the hybrids are again intermediate between the parents (see below).

#### Palm Size :

An important consideration for successful establishment is the correct spacing and this is determined by the ultimate size of the palms and whether or not they are intercropped. In these trials it was necessary to choose one spacing, regardless of variety and without foreknowledge. A triangular spacing of 7.3 m (25 ft) has proved suitable for mature hybrids but is too wide for dwarf and too close for tall varieties. Spacing trials indicate that closer spacing favours establishment (Smith, 1971) and the yield per hectare when mature (Whitehead and Smith, 1968).

TABLE IV  
Plantain Garden : Palm size at age 5 years

| Variety        | No. sampled | Bole girth (m) | Leaf length       |                   |                   | Leaflets          |            | Leaflets/leaf | Leaves in crown |
|----------------|-------------|----------------|-------------------|-------------------|-------------------|-------------------|------------|---------------|-----------------|
|                |             |                | Petiole (m)       | Rachis (m)        | Total (m)         | Length (m)        | Width (cm) |               |                 |
| Malayan Dwarf  | 12          | 1.26           | 1.34 <sup>a</sup> | 2.83 <sup>a</sup> | 4.18 <sup>a</sup> | 1.06 <sup>a</sup> | 4.95       | 82.9          | 26.4            |
| Rennel Tall    | 12          | 1.94           | 1.90              | 3.64              | 5.55              | 1.04              | 5.99       | 95.8          | 23.4            |
| JT×RT          | 12          | 1.96           | 1.92              | 4.43              | 6.35              | 1.22              | 5.61       | 101.6         | 26.1            |
| MD×JT          | 12          | 1.59           | 1.57              | 3.45              | 5.01              | 1.05              | 5.38       | 92.6          | 28.8            |
| Maypan (MD×PT) | 12          | 1.64           | 1.62              | 3.66              | 5.28              | 1.16              | 5.38       | 93.5          | 23.9            |
| MD×RT          | 12          | 1.57           | 1.71              | 3.63              | 5.34              | 1.11              | 5.03       | 92.9          | 24.4            |
| PT×RT          | 12          | 2.00           | 1.94              | 3.96              | 5.91              | 1.10              | 5.54       | 95.1          | 24.8            |
| LSD @ P=0.05   |             | 0.06           | 0.07              | 0.14              | 0.18              | Not significant   |            | 3.9           | 2.4             |

<sup>a</sup> Data incomplete; treated as missing plot.

TABLE V  
Rodney Hall : Palm size at age 5 years

| Variety        | No. sampled | Bole girth (m) | Leaf length |            |           | Leaflets   |            | Leaflets/leaf | Leaves in crown |
|----------------|-------------|----------------|-------------|------------|-----------|------------|------------|---------------|-----------------|
|                |             |                | Petiole (m) | Rachis (m) | Total (m) | Length (m) | Width (cm) |               |                 |
| Malayan Dwarf  | 15          | 1.01           | 1.06        | 2.30       | 3.36      | 0.82       | 4.03       | 76.9          | 23.1            |
| MD×JT          | 15          | 1.41           | 1.34        | 3.27       | 4.60      | 1.02       | 4.73       | 97.0          | 26.1            |
| Maypan (MD×PT) | 15          | 1.47           | 1.29        | 3.18       | 4.47      | 1.02       | 4.46       | 94.9          | 23.2            |
| MD×RT          | 14          | 1.47           | 1.47        | 3.20       | 4.67      | 0.97       | 4.25       | 92.4          | 25.4            |
| LSD @ P=0.05   |             | 0.10           | 0.07        | 0.12       | 0.15      | 0.06       | 0.31       | 2.1           | 1.4             |

Close spacing of the Malayan Dwarf is one of the features of its successful performance. From the data in Tables IV and V, it can be seen that for palm size dwarf × tall hybrids are also intermediate between the parental types.

#### Production :

Production records at Plantain Garden (Table VI) take into account all nuts set and every bunch produced during the period of production. At the other trials (Tables VII, VIII & IX) nuts and bunches are counted only once a year and thus four immature bunches are excluded.

At Plantain Garden (Table VI) the Malayan Dwarf tends to be overshadowed by the neighbouring plots of tall and hybrids but the number of nuts per palm is high, as is the number of bunches produced per year (c.f. leaf production). Nut weight is low but in estimating total yield it should be remembered that planting density would normally be 40% greater than for hybrid varieties.

TABLE VI

Yield components for local, introduced and F<sub>1</sub> hybrid varieties at Plantain Garden. 8½ years old at June, 1974 (4 replicate 9 palms/plot)

| Variety        | Nuts/ Bunches/ palm |      | Nuts/ bunch (a) | Nut wt. (K) (b) | Per. copra/ nut (b) |
|----------------|---------------------|------|-----------------|-----------------|---------------------|
|                | (a)                 | (a)  |                 |                 |                     |
| Malayan Dwarf  | 77.2                | 15.3 | 5.1             | 0.61            | 25.4                |
| Rennel Tall    | 46.4                | 12.4 | 3.7             | 1.50            | 23.4                |
| JT×RT          | 64.9                | 14.2 | 4.6             | 1.14            | 27.8                |
| MD×JT          | 79.8                | 15.1 | 5.3             | 0.81            | 28.9                |
| Maypan (MD×PT) | 97.7                | 13.9 | 7.0             | 1.01            | 27.0                |
| MD×RT          | 79.7                | 13.6 | 5.8             | 1.33            | 23.9                |
| PT×RT          | 59.2                | 12.3 | 4.8             | 1.47            | 24.8                |
| LSD @ P=0.05   | 6.5                 | 0.6  | 0.4             | 0.09            | Not determined      |

(a) Average of quarterly nut counts for 4 years July 1970-June 1974.

(b) Average of 10 sample reappings over the same 4 year period.

TABLE VII  
Yield components of dwarf and hybrid varieties at Rodney Hall (9 years old at June, 1974)

| Variety        | No. palms sampled | Nuts/ palm<br>(a) | Bunches/ palm<br>(a) | Nuts/ bunch<br>(a) | Nut wt.<br>(K) | Per cent. copra/ nut |
|----------------|-------------------|-------------------|----------------------|--------------------|----------------|----------------------|
| Malayan Dwarf  | 58                | 69.2              | 11.4                 | 6.0                | 0.58           | 28.1                 |
| MD×JT          | 56                | 65.2              | 11.4                 | 5.7                | 0.80           | 29.5                 |
| Maypan (MD×PT) | 53                | 69.5              | 10.8                 | 6.4                | 1.00           | 25.1                 |
| MD×RT          | 43                | 61.5              | 10.9                 | 5.6                | 1.17           | 25.2                 |

(a) Mean of 4 annual counts 1971-74.

TABLE VIII  
Yield components of dwarf and hybrid varieties at Woodstock (9 years old at June, 1974)

| Variety        | No. palms sampled | Nuts/ palm<br>(a) | Bunches/ palm<br>(a) | Nuts/ bunch<br>(a) | Nut wt.<br>(K) | Per cent. copra/ nut |
|----------------|-------------------|-------------------|----------------------|--------------------|----------------|----------------------|
| Malayan Dwarf  | 42                | 69.8              | 11.7                 | 5.9                | 0.77           | 27.8                 |
| JT×MD          | 31                | 82.1              | 12.2                 | 6.7                | no data        | no data              |
| MD×JT          | 27                | 74.6              | 11.6                 | 6.4                | 1.00           | 26.3                 |
| Maypan (MD×PT) | 41                | 74.9              | 10.8                 | 7.0                | 1.00           | 26.3                 |
| PT×MD          | 34                | 72.9              | 10.7                 | 6.8                | 1.27           | 25.6                 |

(a) Mean of 4 annual counts 1971-74.

TABLE IX  
Yield components of three tall × tall hybrids at Potosi (8½ years old at June, 1974)

| Variety | No. palms sampled | Nuts/ palm<br>(a) | Bunches/ palm<br>(a) | Nuts/ bunch<br>(a) | Nut wt.<br>(K) | Per cent. copra/ nut |
|---------|-------------------|-------------------|----------------------|--------------------|----------------|----------------------|
| JT×PT   | 56                | 49.5              | 11.4                 | 4.3                | 1.14           | 25.4                 |
| JT×RT   | 56                | 40.8              | 10.9                 | 3.8                | 1.30           | 24.6                 |
| PT×RT   | 56                | 47.9              | 10.3                 | 4.7                | 1.60           | 23.5                 |

(a) Mean of 2 annual counts 1972-73.

The Rennell Tall does not do well by comparison; total nut number and number of bunches are low. (The same is true of other tall varieties in an adjoining trial). Only nut size of the Rennell Tall is good and this influence is noticed in the hybrids where

even the Malayan Dwarf × Rennell Tall has good size fruit. The proportion of copra in the Rennell Tall and its hybrids is low and this characteristic is noticeable in other large fruited varieties such as the Panama Tall (Research Department Report 4, p. 42). The characters of the dwarf × tall hybrids are strongly influenced by the tall parents even to the extent of the visual appearance of the fruit. Of the hybrids, the Maypan tends to have a large number of nuts on the bunch, the nuts having a good size and adequate copra out-turn. The Malayan Dwarf × Jamaica Tall has as many bunches and nuts per bunch as the Malayan Dwarf, nut size is good and copra out-turn is the nearest to the excellent values of the Jamaica Tall parent (about 32%). It is clear that in most countries any of these hybrids would be worth testing on a larger scale; only in Jamaica it is necessary to prefer one over the others because of disease resistance.

Due to the incidence of lethal yellowing disease, yield components in the other trials in which hybrids are planted cannot be statistically treated but, in general, the observations substantiate the above findings as do the year to year comparisons (see Consecutive Research Department Reports). At Rodney Hall (Table VII), the hybrids do as well as the Malayan Dwarf in nut production and have better nut size. The Jamaica Tall planted in this trial all died from lethal yellowing disease before they came into bearing.

At Woodstock (Table VIII), the data gives the same picture but does not disclose the results of a recent period of drought on the alluvial soil where the water table may also have been lowered by the construction of a river bank. The effect, in late 1973, was that many of the Malayan Dwarf suffered severely and some died, whereas few of the hybrids succumbed.

A small planting of tall × tall hybrids at Potosi (Table IX), also at a triangular spacing of 7.3 m, allows a comparison to be drawn with tall × tall hybrids at Plantain Garden (Table VI). Allowing for the different method of counting nuts and bunches, the results are similar. It is clear that tall × tall hybrids are less productive than dwarf × tall hybrids even though they may be superior to either tall parent.

When considering the reciprocal tall × dwarf crosses, these also perform very satis-

factorily, but since they are more difficult to produce in quantity they will not be considered for commercial production. They will continue to be observed for any evidence of possible material cytoplasmic inheritance.

#### DISCUSSION

In all, 2,400 experimental hybrids, representing 19 parental combinations, were produced by controlled hand-pollination from 1961 to 1965. They were planted at sites throughout the coconut-growing area and their performance allows a clear decision to be reached; namely, that dwarf  $\times$  tall hybrids hold the greatest promise. These have many advantages over both tall and dwarf varieties and will undoubtedly play an important role in future replanting. Although the actual yields per hectare that might be achieved should not be extrapolated from the small experimental plots, there is every reason to anticipate better yields from the hybrids than from tall varieties, under most conditions, and better yields than the Malayan Dwarf under poor conditions. Such information will be forthcoming from large-scale field trials currently being planted. Unlike most other countries the choice of suitable hybrids for Jamaica will be limited by their resistance to lethal yellowing disease. With the present state of knowledge, dwarf  $\times$  tall hybrids will involve the highly resistant Malayan Dwarf and individually surviving palms from those tall varieties identified as having an intermediate level of resistance.

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