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## SELECTION OF COCONUT SEEDLINGS THROUGH PHYSIOLOGICAL AND BIOCHEMICAL CRITERIA

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### ABSTRACT

In the adult West Coast Tall palms, the rate of photosynthesis, number of leaves, chlorophyll content, nitrate reductase activity and relative assimilation rate are significantly and positively correlated with mean annual yield of nuts. The efficiency of dry matter production and chlorophyll content are heritable. In the evaluation of hybrids, the results suggest that physiological and biochemical characters can be used to identify potential high-yielding hybrids in the one-year-old nursery.

### INTRODUCTION

The West Coast Tall (WCT) coconut palms exhibit wide variability in the annual yield of nuts, ranging from 30 to 400. Normally, more than 15 years after planting is required to evaluate the potential yield of a variety or hybrid. If the potential yield could be predicted at the nursery stage itself, coconut plantation with uniformly high yield could be established. A study was therefore conducted to characterise the high yield in the adult palms and to relate the same with the vigour of the one-year-old seedlings which are usually used for planting.

### MATERIALS AND METHODS

One hundred West Coast Tall palms (age: 35–40 years) growing in the CPCRI Research Farm were selected for the study. The rate of apparent photosynthesis was studied following the method of Forsyth and Hall (1965).

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The youngest fully unfolded leaf was found to be the most suitable leaf for sampling (Mathew and Ramadasan, 1974). The chlorophyll content was determined following the method described in AOAC (1966). For this purpose N/2 + 1th leaf was sampled as this leaf was found to be the most suitable tissue for sampling (Mathew and Ramadasan, 1973).

In an attempt to apply the growth analytical approach in adult palms, a method for determining the relative assimilation rate (RAR), instead of NAR (Watson, 1952) was standardized. Following this method, the RAR was determined in 40 adult WCT palms (Ramadasan *et al.*, 1984).

The nitrate reductase activity (NR) was determined following the method of Ferrari and Varner (1971). In the adult crown the activity was found increasing with maturity up to the fourteenth leaf, thereafter falling. Hence the fourteenth leaf was sampled. The enzyme activity was studied in 50 adult palms belonging to low and high yield groups.

Ten to 20 one-year-old seedlings were raised from each of a batch of 40 adult WCT palms consisting of low, medium and high yielders. Each of these 40 palms together with 10 to 20 seedlings from each palm formed one family unit. The RAR and chlorophyll contents in these 'families' were determined; in the seedlings the NAR was determined instead of RAR. The total shoot dry weight of one-year-old seedlings was determined non-destructively by the method of Satheesan *et al.* (1983). The morphological characters such as, annual yield and the number of leaves in the palms, the girth at collar, the total leaf area and height of the one-year-old progeny seedlings were also recorded.

In the hybrids, 1000 seedlings of five cross-combinations namely, Malayan Yellow Dwarf (MYD) × West Coast Tall (WCT), MYD × Kenyan Tall (KT), MYD × Zanzibar Tall (ZT), Malayan Orange Dwarf (MOD) × WCT and Chowghat Orange Dwarf (COD) × WCT were selected for the study. Besides recording the girth at collar, the number of leaves, the leaf area and shoot dry weight, the NR activity and the efficiency of accumulation of nitrate in the seedlings were also studied.

## RESULTS

In the adult WCT palms a significant positive correlation has been found between the annual yield and (i) the rate of apparent photosynthesis, (ii) the number of leaves on the crown, (iii) the RAR, (iv) the NR activity, (v) total chlorophyll content, and (vi) the leaf area index (LAI) (Table 30.1).

In the one-year-old progeny seedlings of WCT palms, significant positive correlation has been noticed between the shoot dry weight and (i) the total leaf area, (ii) girth at collar, (iii) NR activity, and (iv) NAR with girth at collar (Table 30.2).

The relationship of the height of seedling, the number of leaves and the girth at collar with the total leaf area and shoot dry weight was studied using the path coefficient analysis (Table 30.3). It was found that the height of the seedling had a negative effect on the shoot dry weight. The number of leaves also showed a negative effect on the shoot dry weight.

**Table 30.1:** Physiological/biochemical parameters related to annual yield of nuts in adult WCT and hybrid coconut palms

| Parameters                          | r' value  |
|-------------------------------------|-----------|
| 1. Rate of photosynthesis           | 0.6137*   |
| 2. No. of leaves on the crown       | 0.7028*** |
| 3. Relative assimilation rate (RAR) | 0.5800*   |
| 4. Nitrate reductase activity       | 0.6855*   |
| 5. Total chlorophyll content        | 0.2735**  |
| 6. Leaf area index (LAI)            | 0.5167*   |

**Table 30.2:** Physiological/biochemical and morphological characters related to vigour (shoot dry weight) of one-year old tall and hybrid seedlings

| Parameters                  | r' value  |
|-----------------------------|-----------|
| 1. Leaf area                | 0.9557**  |
| 2. Girth at collar          | 0.7730**  |
| 3. NR activity              | 0.4896**  |
| 4. NAR with girth at collar | 0.2016*** |

**Table 30.3:** Relative contribution of seedling characters to shoot weight in coconut

|                          | Shoot dry weight versus |         |               |           |
|--------------------------|-------------------------|---------|---------------|-----------|
|                          | Girth                   | Height  | No. of leaves | Leaf area |
| Correlation coefficient  | 0.9690                  | 0.8822  | 0.7439        | 0.9695    |
| Direct effect            | 0.4171                  | 0.0953  | -0.0862       | 0.5711    |
| Indirect effect via      |                         |         |               |           |
| Girth                    | -                       | 0.3411  | 0.3293        | 0.3812    |
| No. of leaves            | -0.0681                 | -0.0681 | -             | -0.0664   |
| Leaf area                | 0.5230                  | 0.5007  | 0.4400        | -         |
| Residual effect = 0.0306 |                         |         |               |           |

In the preliminary screening of the 1000 hybrid seedlings of the five cross-combinations, namely MYD × WCT, MOD × WCT, COD × WCT, KT × WCT and ZT × WCT, based on the leaf area and shoot dry weights (Table 30.4) three hybrid combinations namely COD × WCT, MOD × WCT and MYD × WCT were selected for further studies. The characters further studied were LAI, LAR and the nitrate reductase activity, nitrogen uptake efficiency as well as nitrogen accumulation (Shivashankar and Kasturi Bai, 1988). The results are presented in Tables 30.5 and 30.6.

The rate of leaf area development and dry matter accumulation in MYD × WCT were significantly higher than those in MOD × WCT and COD × WCT. Such trends are noticed in the case of LAI and LAR also.

The inducible NR activity, nitrate uptake and nitrogen accumulation are also significantly higher in MYD × WCT than in COD × WCT and MOD × WCT. The rate of nitrogen accumulation was significantly and positively correlated with dry matter production ( $r = 0.5782^{**}$ ).

Table 30.4: Leaf area and dry matter accumulation in coconut genotypes

| Hybrids   | 6th month             |         | 8th month            |        |
|-----------|-----------------------|---------|----------------------|--------|
|           | *LA (m <sup>2</sup> ) | *DM (g) | LA (m <sup>2</sup> ) | DM (g) |
| MYD × WCT | 4.57                  | 100.40  | 7.50                 | 176.50 |
| MYD × KT  | 3.84                  | 77.80   | 7.40                 | 172.50 |
| MYD × ZT  | 2.90                  | 62.00   | 6.39                 | 127.70 |
| MOD × WCT | 4.10                  | 79.96   | 7.10                 | 136.60 |
| COD × WCT | 2.50                  | 44.00   | 5.20                 | 90.00  |

\*LA = Leaf area; DM = Dry matter

Table 30.5: Growth parameters of hybrid seedlings

| Hybrid          | Girth (cm)     | Leaf area (m <sup>2</sup> ) | Shoot dry wt. (g)  | LAI             | LAR (cm <sup>2</sup> /g) |
|-----------------|----------------|-----------------------------|--------------------|-----------------|--------------------------|
| COD × WCT       | 13.4<br>(0.15) | 0.619<br>(0.003)            | 130.67<br>(10.225) | 6.97<br>(0.28)  | 45.2<br>(0.46)           |
| MOD × WCT       | 16.0<br>(0.63) | 0.822<br>(0.005)            | 154.08<br>(10.659) | 9.14<br>(0.55)  | 49.7<br>(2.69)           |
| MYD × WCT       | 17.8<br>(0.63) | 1.011<br>(0.119)            | 197.90<br>(15.128) | 11.51<br>(1.39) | 52.4<br>(2.45)           |
| C.D. (P = 0.05) | 1.6**          | 0.23**                      | —                  | 2.60**          | 5.40**                   |

Values are mean of 10 replicates

Figures in parentheses are SE of mean

\*\*Significant at 1% level

Table 30.6: Total nitrate reduced and N accumulated after 1 month of N application (50 g N/seedling)

| Hybrid          | % increase in shoot dry wt | Total shoot N (g) | Total nitrate reduced by shoot (millimoles) | % N contributed by shoot |
|-----------------|----------------------------|-------------------|---|--------------------------|
| COD × WCT       | 22.1                       | 0.698<br>±0.036   | 3.29<br>±0.34                               | 6.13                     |
| MOD × WCT       | 23.8                       | 1.240<br>±0.075   | 8.81<br>±2.35                               | 10.00                    |
| MYD × WCT       | 24.9                       | 1.901<br>±0.068   | 27.08<br>±4.32                              | 19.99                    |
| C.D. (P = 0.05) | —                          | 0.190             | —   | —                        |

\*N rate recommended at six months after field planting.

## DISCUSSION

In adult WCT palms the photosynthesis, the chlorophyll content and the efficiency of dry matter production are positively and significantly correlated with the mean annual yield of nuts. The heritability of the chlorophyll content and efficiency of dry matter production (RAR) were further tested in the progeny seedlings of WCT. A relatively high heritability has been noticed for these characters in the one-year-old progenies. This indicates that in the WCT palms, the efficiency of dry matter production together with the chlorophyll content are heritable (Table 30.7) (Ramadasan *et al.*, 1985).

Table 30.7: Mother palm and progeny characters and their heritability

| Characters                                       | Mean              |           | Heritability |
|--|-------------------|-----------|--------------|
|  | Mother palm       | Progenies |              |
| NAR (g/m <sup>2</sup> /week)                     | 4.07 <sup>*</sup> | 6.73      | 0.64         |
| Total chlorophyll content<br>(mg/g fresh weight) | 1.83              | 1.90      | 0.81         |
| Shoot dry weight (g)                             | 4.07 <sup>*</sup> | 118.37    | 0.74         |

<sup>\*</sup>RAR of adult palm (g/m<sup>2</sup>/week)

In WCT palms nursery the method presently followed for selection of seedlings for planting is based on (i) the height, (ii) the number of leaves, and (iii) early splitting of leaves. The path coefficient analysis showed that the first two characters, namely, the height and number of leaves do not significantly contribute to the leaf area and shoot dry weight characters which denote the index of vigour in the seedlings.

Among the morphological characters, only the leaf area and the girth at collar contribute significantly to the shoot dry weight and hence the girth at collar alone is found to be the most suitable character (Ramadasan *et al.*, 1980) (Table 30.3) that indicates the vigour of the seedling. Since the efficiency of dry matter production in adult palm is positively and significantly correlated with high yield, the selection of one-year-old planting material based on girth at collar alone will be highly beneficial. Based on the management adopted in the coconut nursery, all seedlings having a girth at collar of 10 cm and above would be potential high yielders, and the early leaf splitting ones would also be included among those having more than 10 cm as the girth at collar.

Presently the breeders conduct field evaluation for the performance of hybrids they produce. This is obviously a time-consuming procedure as the coconut hybrids stabilise the yield only after 15 years. However, the present results show that the hybrid vigour is indicated very early in the sixth month to one-year-old seedling. The characters associated with the hybrid vigour are the efficiency of dry matter accumulation and nitrogen use. Based on these results the hybrid MYD × WCT was selected and planted in the field along with MOD × WCT and COD × WCT. Three years after planting, the MYD × WCT hybrid continued to show the vigorous growth (Table 30.8). In all the

**Table 30.8:** Leaf area, leaf dry weight, rate of leaf production and NR activity in the three hybrid cultivars — three years old

|   | MOD x WCT | MYD x WCT | COD x WCT |
|---|-----------|-----------|-----------|
| 1. Rate of leaf production (No./year)       | 5.70      | 7.86      | 6.16      |
| 2. Leaf dry weight (g)                      | 163.54    | 206.11    | 191.50    |
| 3. Leaf area ( $\times 10^3 \text{ cm}^2$ ) | 31.27     | 44.32     | 39.00     |
| 4. NR activity (n. moles)                   | 22.47     | 36.24     | 33.05     |

characters studied, namely (i) rate of leaf production, (ii) leaf dry weight, (iii) leaf area, and (iv) NR activity, the MYD  $\times$  WCT is superior to the other two hybrids including the presently released hybrid, namely, COD  $\times$  WCT. At the age of six years in the field, the data reveal the same trend (Table 30.9). In the canopy area, dry weight of the crown, the number of functional leaves and in the age of commencement of first flowering, the MYD  $\times$  WCT continues to show superiority over the other two hybrids.

**Table 30.9:** Growth and flowering characters of six-year-old hybrids

| Hybrid           | Age at first flowering (months) | Canopy area ( $\text{m}^2$ ) | Dry weight of crown (kg) | Mean No. of functional leaves |
|------------------|---------------------------------|------------------------------|--------------------------|-------------------------------|
| MYD $\times$ WCT | 52                              | 129.9                        | 47.5                     | 23.8                          |
| MOD $\times$ WCT | 64                              | 112.9                        | 41.1                     | 21.6                          |
| COD $\times$ WCT | 73                              | 107.8                        | 42.9                     | 18.8                          |

Although the utility of the selection criteria of hybrids based on the physiological/biochemical methods adopted is to be finally established after relating the seedling characters to the yielding efficiency, the usefulness of the methods adopted is already established from the present studies.

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