Evaluation of Morphological Differences and Yielding Ability of Nut Colour Based Phenotypes of Sri Lanka Tall Coconut

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ABSTRACT

The colour of the nut in variety typica, form typica shows a continuous variation ranging from green to brownish red (*rathi*). According to the growers perception *rathi* seedlings are more vigorous and higher yielding than the phenotype with green nuts. A study was conducted to evaluate and compare the nut and copra yield, seedling vigour, stem and leaf morphology and seedling drought tolerance of phenotypic groups of *green*, *rathi* and *intermediate* coloured nuts. Secondary data for nut yield over 21 years, husked nut weight of 30 nuts per palm collected over a year and primary data for seedling girth, height, leaf number, stem girth and leaf measurements of adult palms were recorded in sample sizes of 30 palms per each phenotype. Leaf water potential of seven months old seedlings was measured to test drought tolerance of *green* and *rathi* forms. The nut and copra yield of the three phenotypes did not reveal a significant difference over the years. *Rathi* and *intermediate* palms are smaller than *green* palms with respect to the stem girth and in addition *intermediate* palms produce smaller crowns compared to *green* or *rathi* phenotypes. The study revealed that the *rathi* seedlings are more vigorous at the seedling stage as indicated by the thicker stem compared to the *green* coloured seedlings, but does not show any difference in nut and copra yield among the different nut colour phenotypes of variety typica, form typica when grown in highly suitable soils for growing coconut. Both *green* and *rathi* forms are physiologically adapted for drought as there was no significant difference in drought tolerance between the two forms.

KEY WORDS: Coconut phenotype, Morphology, Water potential, Yield

INTRODUCTION

Coconut (*Cocos nucifera* L.) is a perennial tree crop well adapted to the hot and humid conditions of the tropics. Several varieties of coconut have existed in Sri Lanka from very early times. The major classification of the coconut palm (Liyanage, 1958) in Sri Lanka is based on morphological characters & breeding behaviour. The first distinction into varieties is based on the stature of the plant and nut color. The variety Typica is tall in stature with nuts ranging from green through shades of olive color to brown & characterized by its late flowering nature. Initially eight forms of the tall variety ,Typica (common Sri Lankan Tall – (SLT), Navasi, Gon thembili, Ran thembili, Porapol, Bodiri, Kamandala, and Dikiri-pol) have been identified on distinguishable phenotypic differences. Variety Nana is dwarf in stature and variety Auriantiaca is semi tall with bright orange coloured fruits. The hardy and widely adapted SLT is the mainstay of the coconut industry in Sri Lanka and varieties of this group are subjected to the most variation, because they normally are cross pollinated by insect or wind. The tall coconuts usually are the types selected for commercial planting because of their general superiority in copra production both in quality and quantity.

SLT palms grown commercially live productively for about 60 years giving a yield around 7400-9880 nuts/ ha /year depending on the age, soil, climate and management after reaching the yield stability at 16-18 years (Liyanage and Abeywardena, 1958).

Coconut Research Institute has been involved in the development of coconut hybrids mainly for yield and precocity. CRI has so far released four improved cultivars, namely CRIC60 (SLTxSLT), CRIC65 (Sri Lanka Dwarf GreenxSLT), CRISL98 (SLTxSanRaman), and Kapruwana (Dwarf GreenxSan Raman) and one estate selection (Morock) for growers.

Continuous variation for nut colour ranging from green through shades of brownish yellow to redish brown can be observed within the form typica, var.Typica of coconut. In order to make discrete phenotypic groups based on the nut colour 3 different phenotypes depending on nut color have been identified; namly "green" "intermediate" and "*rathi*"/brown for the current study. These three forms are present within the Isolated Seed Garden at Ambakelle and are equally used as parents in the production of the cultivars CRIC60, CRIC65 and CRISL98.

The perspective of many growers is that the phenotype "*rathi*" is superior to green phenotype in nut production and general vigour of the palm. As a result there is a higher demand for "*rathi*" seedlings in comparison to green seedlings, at the nursery. Therefore the current study was conducted with the objective of determining whether there are any differences in yield, morphology and drought tolerance among the three phenotypes green, intermediate and *rathi*.

MATERIALS AND METHODS

The study was conducted at the Genetics and Plant Breeding Division of the Coconut Research Institute, Lunuwila, Sri Lanka during the period of December 2005 to August 2006.

Yield and fruit components

A total of 90 palms representing 30 palms each from the three phenotypes (*rathi*, *intermediate* and *green*) was selected from field No: 4 of Isolated Seed Garden, Ambakelle for obtaining secondary yield data and fruit component data. All the selected palms were all of the same age and were under similar management practices. Annual nut production of each of the selected palms was obtained for the periods of 1975 to 1986 and 1992 to 2000. Fruit component data since in 1975 as an average of five nuts per palm were also obtained from the records maintained at the Genetics and Plant Breeding Division of the Coconut Research Institute.

Leaf and stem Morphology

The same 90 palms selected for yield recording were used to study leaf and stem morphology. Descriptors for coconut outlined by the International Plant Genetic Resource Institute (IPGRI) were followed in recording leaf and stem morphology. The measurements scored were girth at 20cm above soil level, girth at 1.5m height, petiole length (from the base to the most proximal leaflet), petiole width, rachis length (from the base of the petiole to the tip), number of leaflets (count on one side of the frond that has the first leaflet closest to the base), average width of 4 leaflets, average length of 4 leaflets, petiole thickness (measured at insertion of first leaflet).

Seedling traits at nursery

A total of 60 seedlings representing 30 palms each from *green* and *rathi* phenotypes of the same age which are maintained at Mahayaya nursery of the Coconut Cultivation Board were selected for measuring nursery data. Height, Girth and the number of leaves of each seedling were recorded.

Measurement for drought tolerance

Ten seedlings each from *rathi* and *green* were used for screening for drought tolerance. Seven month old five seedlings of each type were subjected to artificial drought in a rain out shelter while the other seedlings were irrigated with three liters of water at three days interval. Leaf water potential was measured using pressure chamber technique (De Costa, 2001) at five day interval. Measurement was replicated three times per treated per form at each day of measurement.

Data analysis

The effects of different treatments were estimated by performing Analysis of Variance among variables. The statistical software package MINITAB was used.

RESULTS AND DISCUSSION

Nut yield data

The analysis of variance for annual nut yield per palm from 1975 to 1986 and 1992 to 2000 did not reveal any statistically significant difference among the three phenotypes. However it was observed that the percentage yield drop of *rathi* and *intermediate* was low compared to that of *green* in the year which recorded the lowest nut yield of all the years considered for the analysis (Figure 1). This observation of the lower percentage drop in yield in *rathi* in stressful period gives an indication that "*rathi*" is better adapted to stress condition than *green*. However further research is needed for a firm conclusion.

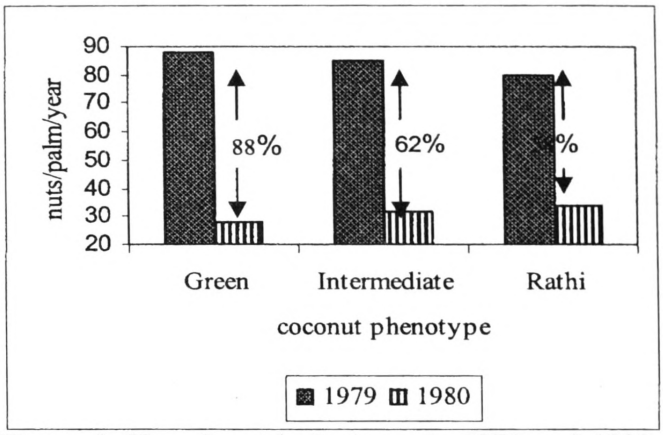

Figure 1- No. of nuts/palm/year in 1979 and 1980 and the percentages of yield drop in *green*, *intermediate* and *rathi* phenotypes

Fruit component analysis

Husked nut weight is the most important fruit component in relation to copra production. The analysis of husked nut weight of the 3 phenotypes did not reveal any statistically significant difference among the three phenotypes. This indicates that the nuts of all the three phenotypes are similar in their capacity for copra production.

Stem and leaf measurements

The girth of the stem at 1.5 m from the ground level was significantly smaller in *rathi* and *intermediate* than *green* phenotype (Table 1). Furthermore, a significant difference among the phenotypes was observed for the rachis length. Accordingly the rachis length of *intermediate* palms is smaller than that of either *green* or *rathi* phenotypes. *Rathi* and *intermediate* palms are smaller than *green* palms with respect to the stem girth and in addition *intermediate* palms produce smaller crowns compared to *green* or *rathi* phenotypes.

Table 1 - Girth at 1.5m and rachis length of phenotypes *rathi*, *green* and *intermediate*:

Trait	Green	Intermediate	Rathi
Girth at 1.5m			
Mean	119.05	108.66	106.10
SD	19.05[a]	11.33[b]	17.23[b]
Rachis length			
Mean	444.66	404.80	449.01
SD	30.69[c]	93.40[d]	31.69[c]

Means with the same letter are not significantly different (*p>0.05)

Nursery seedling measurements

Girth of the seedling at base is significantly higher in *rathi* than *green*. The number of leaves and the height of the seedling are greater in *rathi* they are not significantly different between the two phenotypes (Table 2). Larger girth is one of the most important parameters in determining the vigour of a seedling. Therefore *rathi* seedlings appear to be more vigorous and this may be a reason for the greater preference of growers for *rathi* seedlings at the nursery.

Table 2 - Nursery traits of the phenotypes green and *rathi* :

Trait	Green	Rathi
Girth (cm)*	9.93	10.67
Height (cm)	104.30	112.03
No. of leaves	4.5	4.8

Means with the same letter are not significantly different (*p>0.05)

Drought tolerance

In both *rathi* and *green* forms, leaf water potential was reduced significantly when subjected to artificial drought compared to irrigated treatment (Figure 2 & 3). As the difference in leaf water potential between irrigated and drought treatment is a measure of drought tolerance, the results indicate the greater physiological adjustment of both *green* and *rathi* forms to drought. There was no significant superiority in drought adjustment between two forms. However, more leaf water potential reduction in *rathi* form in later sampling dates shows its comparable adaptation to drought than *green* form. However for a further conclusion water potential should be measured for extended time period than the present study. Greater physiological adjustment for drought in *rathi* form may be the reason for lower yield reduction in the most susceptible year (Figure 1) than the *green* form. Drought tolerance in *rathi* seedlings may be due to its more vigorous nature (Table 2).

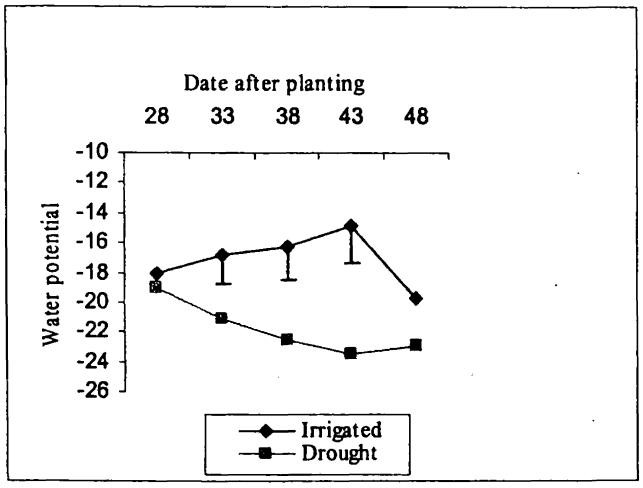

Figure 2 - Leaf water potential difference between irrigated (open) and drought (solid) of "green" with time

The palms used for recording yield and fruit component data are located at Isolated Seed Garden, Ambakelle which is a very favourable location for growing coconuts with highly suitable soils for coconut. The current analysis for yield can be applied to the relevant phenotypes grown in similar environments. However, the performance of palms grown in marginal soils may differ and further research is needed for a better understanding.

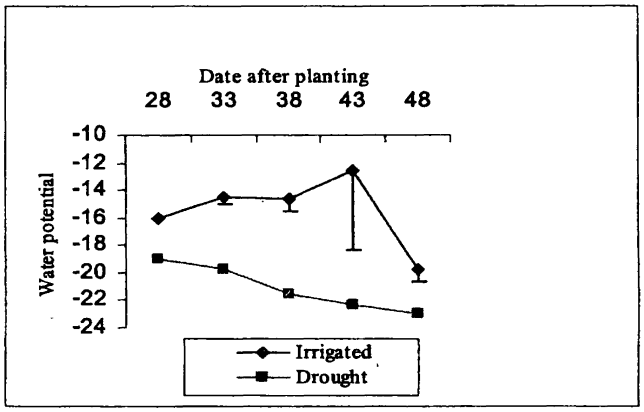

Figure 3 - Leaf water potential difference between irrigated (open) and drought (solid) of "*rathi*" with time

CONCLUSIONS

There is no significant difference among the *green*, *intermediate* and *rathi* palms in terms of nut and copra production when grown in highly suitable soils for coconut. However there are some significant stem and leaf morphological differences even under the same environmental conditions. *Rathi* seedlings are more vigorous at the seedling stage (than the *green* seedlings) and showed significantly more tolerance to drought. Further research is needed to understand the performance of different phenotypes in marginal soils.

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