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PHOTOSYNTHETIC AND GROWTH CHARACTERISTICS OF HIGH YIELDING VARIETIES OF ARECANUT (*Areca catechu* L.)

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ABSTRACT

Photosynthesis, growth and development of three high yielding varieties namely Mangala, Sumangala and Sreemangala were studied during early years of crop growth. Mangala had significantly less set volume and maximum yield compared to all other varieties, without any difference in other growth or photosynthetic characteristics. Mangala's early bearing and high yield seemed to have resulted in less stem volume due to partitioning of more photosynthates to flowering and fruiting during the early years of growth.

INTRODUCTION

The arecanut (*Areca catechu* L.) variety Mangala is a high yielding, early bearing and semi tall variety (Bavappa, 1977, and Rekha *et. al.*, 1991). Its yield was reported to be around 12 kg ripe nuts per palm as against 8 kg per palm in the South Kanara Local (Rekha *et. al.*, 1991). The mean height of Mangala palm at 10th year was reported as 0.66 m, as against 3.15 mm of the local variety. (Bavappa, 1977).

Subsequently, Central Plantation Crops Research Institute has released two more high yielding varieties namely Sumangala and Sreemangala in 1985 with a yield potential of 15.9 and 15.6 kg ripe nuts per palm per year, respectively (Anonymous, 1985). Although the high yield habit of these varieties is well established as indicated by the popularity among the farmers, the physiological basis for the high yield potential has not been studied. The objective of the present study is to understand the physiological basis for high yield potential during the early years of crop growth.

MATERIALS AND METHODS

The study was conducted at the Central Plantation Crops Research Institute, Regional Station, Vittal. The location, soil characteristics and meteorological data for the Regional station were given by Balasimha *et al.* (1985). The original experiment consisted of four arecanut varieties and five levels of fertilizer application in a split plot design with varieties as main plots and replicated three times. The varieties included were Mangala, Sumangala, Sreemangala and South Kanara local. The fertilizer levels included were 0-0-0, 50-20-70, 100-40-140, 150-60-210 and 200-80-280 g N, P_2O_5 and K_2O respectively per palm per year as sub-plot treatment. There were six experimental palms per sub-plot. The spacing adopted was 2.7 x 2.7 m with a single row of border palms. The experimental palms were planted during September, 1985.

Growth : Plant height, girth at collar and mid point, number of green leaves and number of nodes were recorded once in a year during the month of November.

Photosynthetic Characteristics : In order to complete photosynthetic measurements within a short time of two hours, observations were limited to treatment with 50-20-70, 100-40-140

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and 200-80-280 g N, P_2O_5 and K_2O in each variety. In each of the treatments studied two detached leaves each from three randomly selected palms from different replications were used for measuring net photosynthesis using a portable photosynthesis system LI 6200 (LiCor Inc. Lincoln, NE, USA) as described earlier (Balasimha *et al.* 1991; Chowdappa and Balasimha, 1992). The sampling was done between 10.00 and 12.00 h during January and April of 1992 and 1993 and January, 1994. Chlorophyll fluorescence was also measured in the above leaves using the Plant Efficiency Analyser (Hansatech Instruments Ltd., Norfolk, UK) as described by Balasimha (1992).

Yield : Data on number and wet weight of ripe nuts per palm was recorded every year.

All the data were analysed as a split plot design, however, as the differences among fertilizer treatments and their interactions with varieties were not significant, the results and discussion will be confined to varietal performance as the objective was to understand the physiology of varieties.

RESULTS AND DISCUSSION

Photosynthesis : The data on photosynthesis (A) and the related parameters like internal CO_2 concentration (Ci), stomatal conductance (gs), transpiration (E) and water use efficiency are presented in Table I. The A was 5.14, 5.46, 5.20 and 4.04 $\mu mol/m^2/s$ in Mangala, Sumangala, Sree mangala and SK local respectively in January, 1992. S.K. local variety had significantly lower A as compared to other three varieties in January, 1992. During subsequent measurements in April, 1992. January and April 1993 and January, 1994; however, no difference in A among the varieties was observed. Pooled analysis of the five observations revealed that SK local and Sreemangala had significantly lower A

Table I. Photosynthesis and related parameters of different Areca varieties.

Parameter	Mangala	Sumangala	Sreemangala	SK Local	SEm +	CD	CV %
1. Aμ mol $m^{-2}s^{-1}$	5.81	6.12	5.40	5.24	0.21	0.59	23.9
2. gs mol $m^{-2}s^{-1}$	0.25	0.24	0.22	0.21	0.02	NS	46.2
3. E (mmol m^{-2} s^{-1})	6.0	5.28	5.41	5.64	0.299	NS	26.2
4. C_i (ppm)	270.20	267.20	267.80	267.40	4.83	NS	7.6
5. WUE (A/E)	1.06	1.37	1.12	1.08	0.094	NS	43.1
6. F_o	659.00	691.00	667.00	679.00	9.72	NS	7.5
7. F_m	3217.00	3326.00	3291.00	3217.00	78.16	NS	12.4
8. F_v	2555.00	2674.00	2625.00	2544.00	74.38	NS	14.9
9. F_v / F_m	0.792	0.785	0.783	0.785	0.011	NS	3.9

Photosynthesis and other parameters presented are pooled over five observations.

Note : A = Photosynthesis; gs = stomatal conductance; E = Transpiration;
Ci = Internal CO_2 concentration; WUE = Water Use Efficiency
F_0 = Initial fluorescence; F_m = Maximum fluorescence;
F_v = Variable fluorescence.

compared to Sumangala, while they were on par with Mangala (Table I). Mangala and Sumangala were on par in terms of A.

The data on other physiological parameters and water use efficiency (Table I) revealed that there was no significant difference among the different varieties. Similarly, the fluorescence characteristics as indicated by initial fluorescence (F_0), maximum fluorescence (F_m), variable fluorescence (F_v) and the ratio of variable fluorescence and maximum fluorescence, which indicates photosynthetic efficiency were not significantly different among the varieties.

Growth : The data on growth parameters like plant height, girth at collar and mid point, number of nodes, number of green leaves and stem volume at eight years after planting are given in Table II. Plant height varied between 3.7 to 5.9 m with Mangala being the shortest and Sumangala the tallest, but the differences were not significant. Bavappa (1977) has reported the height of ten year old Mangala as 0.66 m and of local variety as 3.15 m. He also noted that due to open pollinating nature in Mangala, variability was noticed in the second generation itself. It may be noted that while his paper does not indicate the fertility status of the soil, the present study consists of fertilizer application from the 50-20-70 to 200-80-280 g N, P_2O_5 and K_2O respectively.

The girth at collar varied between 48.3 and 50.4 cm, girth at mid point varied between 40.7 and 45.3 cm. The number of nodes varied between 36.6 and 40.1, lowest being in Sumangala and highest in Mangala, but the differences were not significant. Similarly, the number of leaves and leaf area did not differ among the different varieties. however, leaf area was lowest (20.37 m^2) in Mangala with a leaf number of 9. On the contrary, with the same leaf number (9.0) SK local had maximum leaf area (27.3 m^2).

Table II. Growth of high yielding varieties of arecanut at eight year after planting.

Variety	No. of leaves	No. of nodes	Height m	Girth cm	Girth at mid point (cm)	Leaf area m^2
Mangala	9.0	40.1	3.7	48.3	40.7	20.37
Sumangala	8.9	36.6	5.9	50.2	43.9	25.19
Sreemangala	9.2	39.7	5.4	50.4	45.3	24.90
SK Local	9.1	37.3	5.1	49.9	43.7	27.30
SEm	0.41	1.2	0.41	1.5	1.1	2.17
CD 5%	NS	NS	NS	NS	NS	NS
CV %	15.90	7.6	17.60	6.7	6.0	19.83

NS = Not significant at P = 0.05 level.

Stem volume data, which is a product of stem height upto crown and girth at mid point revealed that there is significant difference among varieties (Fig. 1). Mangala stem volume was significantly less than all the other three varieties. The annual increment in stem volume was lowest in Mangala as compared to other three varieties. The significantly less stem

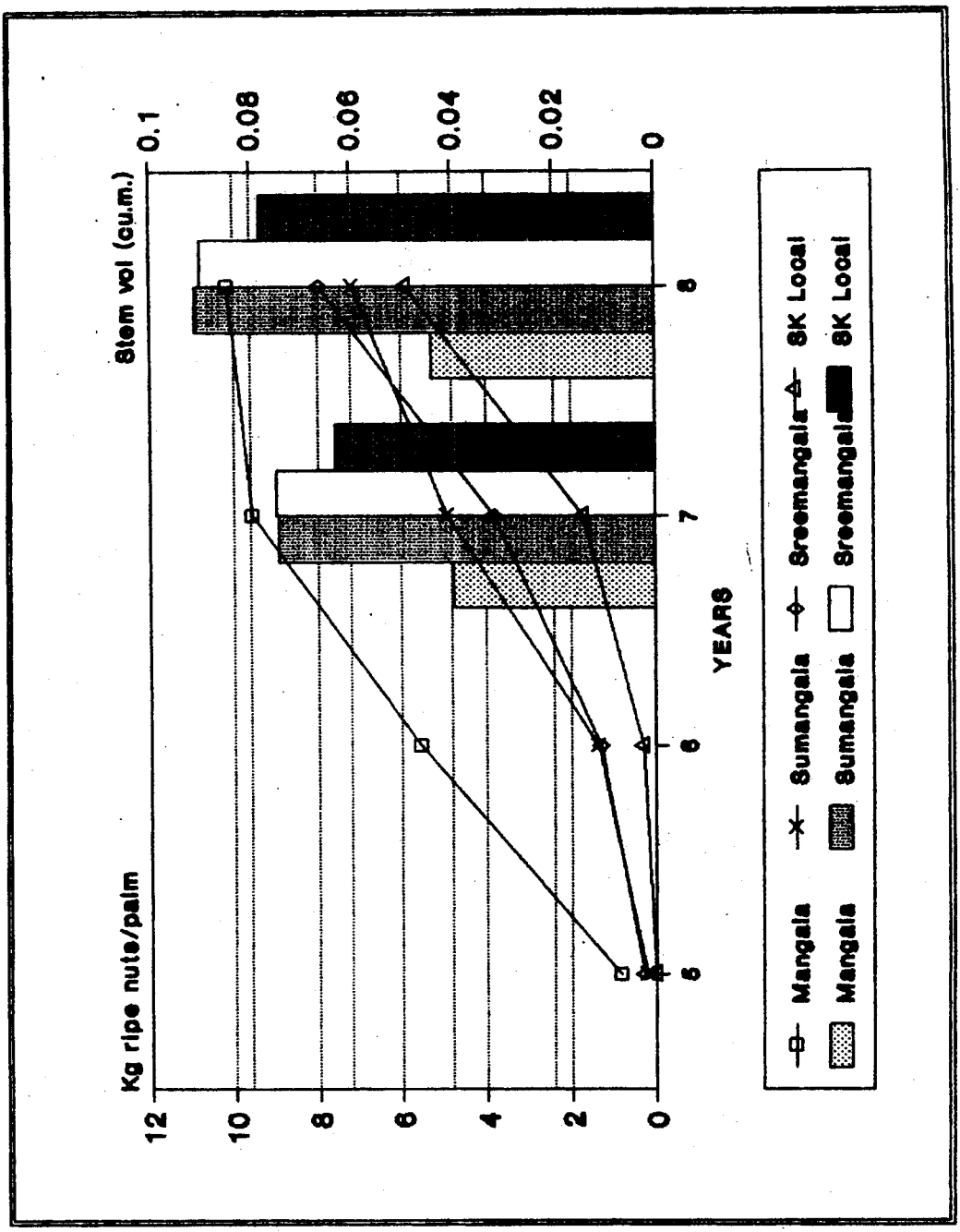

Figure 1. Yield and stem volume of different arecanut varieties (line graph represents yield and bar diagram represents stem volume)

volume of Mangala is product of short and thin stem, though these characteristics individually did not differ.

Yield : The yield data presented in Fig. 1 reveals that Mangala which is an early variety has given the highest yield during the early years and has almost reached the potential yield by eight year as compared to other three varieties.

These results confirm the earlier findings that Mangala is a semi-tall, early bearing compared to local and other two high yielding varieties. A significantly lower stem volume of Mangala as compared to the other three varieties suggests that due to early bearing, and high yielding habit, photosynthates are diverted to fruiting, resulting in fewer photosynthates available for stem building. Angiosperms have evolved physiological capabilities for very strong directed translocation or mobilisation of food stuffs for development of fruits (Leopold and Kriedmann, 1975). The differences between local variety, Sumangala and Sreemangala, which are late varieties, are not clear at this stage, though Sumangala had higher photosynthetic rate.

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