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EVALUATION OF COCONUT CULTIVARS AND HYBRIDS FOR DRY MATTER PRODUCTION

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ABSTRACT

Coconut cultivars/hybrids comprising three talls, one dwarf and five hybrids were evaluated for dry matter (DM) production and yield. The talls excelled in the vegetative dry matter production (VDM) characteristics, whereas the hybrids were superior in the reproductive dry matter production (RDM) and nut yield. Among the hybrids, West Coast Tall (WCT) x Chowghat Orange Dwarf (COD), Laccadive Ordinary (LO) x Gangabondam (GB) and LO x COD performed better than the other two (WCT x WCT and COD x WCT). Copra out-turn was related significantly to RDM as well as total dry matter (TDM) production. Attempt was made to understand the harvest index (HI) in coconut. Traits for higher DM production also were evaluated by correlation studies which indicated the higher dependence of HI on RDM rather than on VDM. Water use efficiency (WUE) also contributed significantly to higher DM production.

INTRODUCTION

Coconut is a tree crop of long life with continuous vegetative and reproductive phases of growth. It is influenced considerably in its productive features by the environmental variables. In Kerala (India) the unprecedented drought of 1982-1983, adversely affected some of the cultivars/ hybrids, whereas some performed better with relatively good yield (Bhaskara Rao *et al.* 1991) though the reason for such an adaptation was not known. With increasing importance of coconut in the national economy there is a need to identify the cultivars/hybrids which can perform better under water limited environment. Earlier Rajagopal *et al.*, (1990) have classified the cultivars/hybrids into drought tolerant and susceptible types based on water relation components and further established the relationship between these components with yield (Rajagopal *et al.* 1992). Some of the hybrids viz., WCT x COD, LO x GB and LO x COD, which showed higher tolerance to drought also revealed higher yield stability during severe drought of 1982-1983 (Bhaskara Rao *et al.*, 1991). But the information was lacking on the mechanism underlying higher yield stability in these hybrids. Hence the objectives of the present study were to evaluate the coconut cultivars/hybrids for higher DM production and yield and to identify the criteria which lead to higher yield under water limited environment.

MATERIALS AND METHODS

Coconut palms comprising of talls, dwarfs and hybrids maintained by the Crop Improvement Division of the Institute as monocrop for yield trial was the material selected for the investigations. The observations were carried out from three talls - West Coast Tall (WCT), Philippines Ordinary (PO) and Andaman Ordinary (AO), one dwarf - Malayan Yellow Dwarf (MYD) and five hybrids - WCT × WCT, WCT × Chowghat Orange Dwarf (COD), COD × WCT, Laccadive Ordinary (LO) × Gangabondam (GB) and LO x COD. These cultivars/hybrids have been tested for their differential response to drought stress (Rajagopal *et al.* 1990, Chempakam *et al.* 1993). From each cultivar/hybrid five palms were selected for

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the observation. The palms (18 to 22 year age group) have come to stabilized yield condition and were growing under rainfed condition with uniform management. Annual increment in dry matter production (vegetative dry matter, and reproductive dry matter,) and yield components were monitored during summer months (February/March) for three consecutive years as per the methods described by Ramadasan and Mathew (1987) and Rajagopal *et al.* (1989). The method employed is briefly described below. For the estimation of VDM (stem DM + leaf DM) observations on the annual increment in stem growth, number of leaf scars and number of leaves produced per year were recorded. By employing the equation $Y = -133.44 + 93.67 X$ ($r^2 = 0.831$) the stem DM production was calculated, where Y is the stem DM and X is the height of the stem segment with three leaf scars. Leaf DM was determined by the destructive sampling of six leaflets from the middle portion of the leaf. The leaflets were dried to constant weight at 80°C and substituting this in the regression equation $Y = -3.438 + 0.0197 X1 + 0.020 X2 \times X3$ ($r^2 = 0.74$), where Y is the leaf DM, x1 is the dry weight of six leaflets, X2 is the total number of leaflets $leaf^{-1}$ and X3 is the annual leaf produced, the total leaf DM was calculated. For the RDM, weight of spathes, bunches and nuts produced during the period was determined by oven drying the samples to constant weight.

Water use efficiency (WUE), considered here as the ratio of net CO_2 assimilation rate to transpiration rate (Peng and Krieg, 1992), was determined by the gas exchange measurements (Portable photosynthesis system -Li-6200, Li-Cor, USA) two to three times during a particular period and is expressed in µmol CO_2m mol H_2O^{-1}. WUE based on the DM accumulation was also determined by dividing total dry matter produced by water used (mm) taking into consideration the effective rainfall (1446 mm) during the period (Rajagopal *et al.* 1989).

Due to practical difficulty in estimating the root DM production in the present study, HI was determined based on the annual TDM production (above ground) and its partitioning towards the economic produce i.e. annual copra out turn. Since HI was calculated based on the annual increments in dry weights, Ramadasan and Mathew (1987) coined the word annual productivity index (API) instead of HI.

RESULTS AND DISCUSSION

Dry matter production

Dry matter production characteristics were evaluated among the cultivars and hybrids and are given in Table 1. Talls produced higher VDM (stem + leaf) than the hybrids and the dwarfs. The annual RDM production showed significant difference with higher production in the three hybrids viz. WCT x COD, LO x GB and LO x COD (61 kg to 73 kg) than the other cultivars and hybrids. In coconut, due to the indeterminate flowering habit there is no clear cut demarcation between vegetative and reproductive phases of growth. Hence partitioning of the assimilate is a continuous process and is interlinked to each other during the entire span of its life. RDM is the sum of the dry weights of spathes, spadices and nuts which include the dry weights of husk, shell and copra. Dry weights of the spadices and the spathes constituted about five percent of the total RDM and did not show any difference between the cultivars/hybrids. This is in agreement with an earlier report by Ouvrier and Ochs (1980). Hence RDM production depends mainly on the nut production and partitioning of nut DM towards its components viz. husk, shell and copra.

Nut composition showed significant difference between the cultivars and hybrids (Table 2) which reflected on the partitioning of nut dry matter towards its component viz., husk (40 to 53%), shell (20 to 27%) and copra (27 to 35%). Partitioning towards the husk was higher in LO x GB (53%) and low

Table 1. ***Dry matter production (Kg. palm^{-1}) in coconut. (Mean of five palms and for three years)***

Cultivar/ Hybrid	VDM		RDM	TDM	Economic yield	
	Stem DM	Leaf DM			Copra out-turn	Nut DM
WCT	3.0	32.2	52.6	87.8	16.6	48.1 (87)
PO	2.8	33.0	29.3	65.1	8.4	25.4 (36)
AO	2.8	27.8	36.4	67.0	10.9	31.2 (47)
MYD	1.8	17.9	24.5	44.2	7.6	21.4 (52)
WCT × WCT	2.2	32.1	48.3	82.6	13.3	43.9 (71)
WCT × COD	2.4	24.8	73.3	100.5	23.0	67.7 (130)
COD × WCT	2.1	19.8	33.7	55.6	11.0	29.8 (63)
LO × GB	2.5	25.8	65.5	93.8	19.9	62.2 (146)
LO × COD	2.1	25.3	60.9	88.3	20.0	56.7 (147)
Gen Mean	2.30	26.5	47.2	76.0	14.5	42.9
SE.plot^{-1}	0.42	3.0	13.0	15.2	4.5	12.9
CV (%)	18.10	12.1	28.6	20.0	30.7	30.0
CD (P = 0.05)	0.54	3.8	19.6	22.0	6.5	18.7

Figures in bracket indicate nut yield palm^{-1} year^{-1}

in COD x WCT (40%), whereas partitioning towards the shell and copra showed a reverse trend. The need for selection of parents for hybridization based on the husk and shell content for higher hybrid recovery has been stressed by Satyabalan and Rajagopal (1987).

Table 2. ***Nut composition (g D.wt. nut^{-1}) of coconut cultivars/hybrids***

Cultivar/Hybrid	Husk	Shell	Copra	Total
WCT	310.6	147.3	191.4	649.3
PO	300.6	181.1	228.1	709.8
AO	286.8	149.0	221.4	647.2
MYD	170.7	91.0	135.8	397.5
WCT × WCT	317.2	148.1	184.3	649.6
WCT × COD	271.9	146.7	187.9	586.4
COD × WCT	229.3	154.0	152.6	567.0
LO × GB	300.9	113.5	142.1	567.0
LO × COD	120.6	111.7	188.5	484.4
Gen. Mean	268.7	138.1	180.2	584.8
SE Plot^{-1}	57.2	28.7	34.6	96.1
CV (%)	21.3	10.8	19.2	16.4
CD (P = 0.05)	73.4	36.9	44.4	123.3

The importance of increased partitioning of the total nut DM towards the copra at the expense of other nut components for yield improvement has been highlighted by Corley (1983). It is evident that the observed higher RDM production in WCT x COD, LO x GB and LO x COD was mainly due to the high production of nuts (Table 1). Although total nut production was higher in LO x GB and LO x COD, TDM production was higher in WCT x COD (100.5 kg) which comes to around 17t. ha^{-1} year^{-1}. However, the highest value reported is 30 t. ha^{-1} year^{-1} in Dwarf x West African Tall hybrid in the Ivory Coast (Corley, 1983). TDM production was comparatively lower in MYD (43.2 kg). Although total nut DM year^{-1} was more or less the same in both COD x WCT and PO (Table 1) the copra out turn was about 31% more in COD x WCT indicating better nut composition in this hybrid than PO. Copra out turn was comparatively lower in MYD. The susceptibility of this dwarf cultivar to water stress has been reported by Rajagopal *et al.* (1990) Chempakam *et al* (1993) and Repellin *et al.* (1994).

Water use efficiency

The potential of palms for higher DM production is reflected on the WUE. WUE (μmol CO_2 mmol H_2O^{-1}) showed significant difference between the cultivars and hybrids. The hybrids WCT × COD, LO × GB and LO × COD exhibited higher WUE than the rest (Table 3). The WUE determined based on DM production (g.DM. mm water^{-1} used) also showed similar trend, thus indicating a strong relationship between the measurement of single leaf WUE and the whole canopy WUE. The WUE values reported here based on the DM production corresponded well with the values reported in the WCT cultivar under rainfed condition (Rajagopal *et al.* 1989).

Harvest index

Significant differences in the HI were observed between the cultivars/hybrids (Table 3.) The hybrids recorded significantly higher HI except WCT × WCT. The values of HI reported here for WCT × COD, LO × GB and LO × COD corresponded nearly with the values reported for the outstanding hybrid coconuts of Ivory Coast, Solomon Islands and Malaysia (Corley, 1983). Although the hybrid COD × WCT possessed higher WUE it was found highly susceptible to severe stress condition (Rajagopal *et al.* 1990, Bhaskara Rao *et al.* 1991). The HI of WCT was on par with that of the hybrid WCT × WCT. Selection for higher HI in oilpalm for increasing oil yield has been suggested by Corely *et al.* (1971).

Table 3. ***WUE (μmol CO_2 mmol H_2O^{-1}) and HI in coconut***

Cultivar/Hybrid	WUE		HI
WCT	1.68	(61.3)	0.19
PO	1.63	(55.0)	0.13
AO	1.64	(46.3)	0.16
MYD	1.43	(28.8)	0.16
WCT × WCT	1.55	(57.3)	0.16
WCT × COD	1.66	(69.3)	0.23
COD × WCT	1.34	(38.5)	0.21
LO × GB	1.91	(64.8)	0.21
LO × COD	1.94	(60.5)	0.23
Gen. Mean	1.64	(52.5)	0.19
SE plot^{-1}	0.25	(10.5)	0.03
CV (%)	15.2	(19.9)	18.2
CD (P = 0.05)	0.37	(15.3)	0.05

Figures in bracket indicate WUE expressed in g DM mm water^{-1} used palm^{-1} year^{-1}.

Traits for higher DM production

From the foregoing results it is evident that DM production is an important yield component in coconut and significant differences existed in this parameter between the cultivars and hybrids. The importance of studies on DM production for improving the productivity of coconut has also been highlighted by Foale (1993). The possible relationship between the DM production characteristics was examined by working out correlations (Table 4). HI is the main route through which yield of various crop species has been improved by plant breeders (Donald and Hamblin, 1976). It was found to be positively associated with grain yield under water limitation (Fischer and Turner, 1978). In the present study also a high correlation has been observed between HI and copra out turn (r^2 = 0.736). The higher dependence of HI on RDM rather than on VDM is also obvious from the correlation (r^2 = 0.565). The association of low VDM with high HI in coconut has been reported by Friend and Corley (1994). In oil palm Corley *et al.* (1971) demonstrated increased bunch index by reducing VDM without changing leaf area per palm. The high correlation observed between TDM with copra out turn (r^2 = 0.915) and HI (r^2 = 0.454) indicate that high DM production is a useful trait under rainfed cultivation. In an earlier work Rajagopal *et al.* (1989) observed higher WUE in coconut

Table 4. ***Correlation matrix (r^2) for WUE and DM production characteristics***

	WUE	VDM	RDM	TDM	Copra out turn
VDM	NS				
RDM	0.387**	0.519**			
TDM	0.396**	0.696**	0.975**		
Copra out turn	0.485**	0.421*	0.959**	0.915**	
HI	0.399*	NS	0.565**	0.454*	0.736**

*, ** indicate significant at 5% and 1% level and NS indicate nonsignificant.

palm under rainfed condition than those receiving irrigation. The high correlation observed between WUE and DM production as well as HI (Table 4) indicate that the higher DM production leading to higher HI could be attributed to the efficient regulation of stomata in lowering the transpiration rate and increasing the WUE.

At the leaf level WUE is influenced by increase in stomatal resistance (rs) (Jones, 1985) and cuticular wax content (ECW) (Blum 1975). The higher rs and ECW content observed in the three hybrids viz., WCT × COD, LO × GB and LO × COD (Rajagopal *et al.* 1990) as well as the positive correlation observed between these parameters with yield (Rajagopal, *et al.* 1992) clearly indicate that rs and ECW content are important traits for higher DM production in coconut.

The higher positive correlation observed between WUE and dry matter production characteristics such as RDM, TDM and copra outturn highlight the importance of WUE in terms of gain in dry matter in water limited environment. However breeding for increased WUE has been limited due to lack of screening criteria (Hall *et al.* 1992). Since at the leaf level WUE is influenced by rs and ECW content these parameters can be used as selection criteria for the evaluation of coconut cultivars and hybrids for higher DM production leading to higher HI. This approach will assist the breeders in the long run to select the most suitable cross combinations from the existing germplasm and produce material for large scale planting to increase the productivity in coconut.

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