useful for germplasm management. However, subsequently with increased availability of characterisation data the molecular characterisation results would be valuable for trait mapping, marker assisted selection and further genomic analyses which may be useful for enhancing the efficiency of breeding efforts (Lee 1995). Result in one crop species with a set of molecular techniques cannot be extrapolated to other species (Virk *et al.*, 2000). Thus far, molecular marker studies in cashew have been scarce and inadequate *vis-à-vis* its enormous importance in commerce. In conclusion, this study provides first insights into the molecular diversity in cashew accessions employing RAPD and AFLP techniques. Primers/pairs for AFLP and RAPD are designated for identification of accessions and to carry out future experiments with larger samples.

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Evaluation of Exotic Dura Germplasm for Water Use Efficiency in Oil Palm (*Elaeis guineensis* Jacq.)

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Key Words: Dura, Oil palm (*Elaeis guineensis* L.), Exotic germplasm, Water use efficiency

Targeted area expansion of oil palm, the highest oil yielding crop in states like Andhra Pradesh, Tamil Nadu, Karnataka and Gujarat under irrigated conditions and Kerala and Andaman and Nicobar Islands under rainfed conditions, requires the genotypes having high water use efficiency. Presently available commercial plantations of tenera hybrids [dura x pisifera] necessiate more irrigation, thereby increasing the expenditure on electricity by the growers. This increases the cost of cultivation, and thus, reduces the profit margin. The potential solution to this could be the development of tenera hybrids having high water use efficiency, which can thrive well under limited moisture conditions. With this background, an exploration was carried out in Zambia, Tanzania and Guinea-Bissau to select and collect drought-tolerant genotypes. The present investigation is based on the germplasm collected from these places to screen for their response to moisture stress.

Ten exotic dura genotypes were raised in randomized complete block design with three replications under two environments namely, irrigated and stress. The plot size was four palms/genotype/treatment planted in triangular design of planting at a spacing of 9 m between palms. The irrigation was managed through drip system. Fourteen-month-old seedlings were transplanted in field. Under irrigated conditions the IW/CPE ratio was one while under stress, it was kept at 0.8. The ablation (removal of inflorescences from the palms), as recommended, was done for two years. Observations were recorded on morphological characters like plant height (m), leaflet length (cm), leaflet width (cm), number of leaflets/ leaf, petiole width (mm), petiole depth (mm), and rachis length (m). Non-destructive growth analysis was carried out as per Corley *et al.* (1971). The physiological observations like stomatal conductance (mol/m^2/s), photosynthetic rate (μmol/m^2/s), transpiration rate (mmol/m^2/s), leaf temperature (°C) and photosynthetic assimilation rate (µmol/m²/s) were recorded using the portable photosynthesis system (LCA-4, ADC, UK). The water use efficiency was computed as the ratio of photosynthetic rate to transpiration rate (µmol CO_2/mmol H_2O). The analysis of variance was done following Panse and Sukhatme (1985).

Substantial variation among the germplasm was found for all the morphological and physiological parameters studied under two moisture regimes (Table 1). The means of morphological characters under irrigated conditions were not significantly different when compared with the stress environment. The means of all the physiological parameters except inter-cellular CO_2 concentration and leaf canopy temperature were higher under irrigated conditions when compared with the stress environment. The water use efficiency was recorded highest in dura genotype ZS 1 followed by ZS 3. The water use efficiency was highest in germplasm received from Zambia under both irrigated and stress environments. The positive and significant association (Table 2) was observed between water use efficiency and photosynthetic rate (r = 0.83) while it was negatively related with inter-cellular CO_2 concentration (r = -0.90). The leaf area had positive and significant association with number of leaflets/ leaf and petiole width. Taniputra and Manurung (1988) have also reported that the significance of rachis length and number of leaflets as the major components affecting bunch yield. On the other hand, leaf area has also been found associated with yield (Subronto and Taniputra, 1989).

Leaf dry weight was positively associated with petiole width and depth while negatively with stomatal conductance and transpiration. Leaf length and cross-section of the petiole were considered the most accurate indicators of stress caused by inter-plant competition (Sterling, 1996). The multiple regression coefficient between water use efficiency and eight independent physiological parameters was very high and significant (r = 0.99). The order of significance of physiological

Table 1. Genotypic means for different physiological and morphological characters under irrigated and stress environments in oil palm

Dura genotype	Leaflet length (cm)	Leaflet width (cm)	Number of leaflets	Petiole width (cm)	Petiole depth (cm)	Plant height (m)	Rachis length (m)	Leaf area (cm²)	Leaf dry weight (kg)	Photo-synthetic rate (µmol/ m²/s)	Stomatal conduct-ance (mol/m²/s)	Transpira-tion (mmol/ m²/s)	P.A.R (µmol/m²/ s	Leaf temper-ature (°C)	Intercell-ular CO_2 conc (ppm)	WUE (µmol CO_2/mmol H_2O)
IRRIGATED																
GB-22/311	62.88	3.05	140.0	2.80	2.05	3.68	2.25	2538	0.79	3.10	0.030	1.96	1713	41.9	246.0	1.58
GB/25/314	77.47	2.82	144.6	2.80	2.63	3.97	2.46	3194	0.96	1.88	0.040	2.17	1933	43.6	247.5	0.87
GB/21/310	65.45	2.48	140.5	2.80	2.15	4.30	2.77	2624	0.82	3.47	0.040	1.51	1529	40.1	181.9	2.29
ZS-1	58.73	2.66	180.0	3.68	2.50	4.19	2.44	3038	1.15	4.86	0.035	1.38	1517	40.7	74.4	3.54
ZS-2	64.94	3.59	187.3	3.87	2.67	4.33	2.98	3530	1.26	2.05	0.020	1.07	1990	42.4	159.0	1.92
ZS-3	60.12	3.83	173.5	3.93	2.85	4.43	2.83	3051	1.35	4.71	0.027	1.66	1926	44.6	126.9	2.84
ZS-5	61.03	3.22	169.3	3.77	2.90	4.07	2.63	2992	1.32	3.85	0.025	1.27	1612	41.4	89.4	3.03
ZS-8	62.98	2.77	199.3	4.03	2.40	4.03	2.41	3604	1.20	4.68	0.033	1.64	1861	42.4	94.1	2.86
TS-9	64.65	3.20	164.5	3.98	3.98	4.34	2.69	3069	1.82	1.21	0.007	0.75	1871	45.2	143.2	1.62
TS-11	68.70	2.95	211.3	4.03	3.10	4.68	2.82	4163	1.49	3.44	0.023	1.14	1855	41.4	85.2	3.01
Mean	64.69	3.06	171.0	3.57	2.72	4.20	2.63	3180	1.22	3.32	0.028	1.45	1780	42.4	144.7	2.35
SE (±)	1.60	0.13	7.36	0.16	0.16	0.08	0.07	144.0	0.09	0.38	0.003	0.13	52.3	0.50	19.2	0.25
STRESS																
GB-22/311	71.10	3.28	142.0	2.75	1.85	3.81	2.50	2904	0.73	2.58	0.025	1.49	1815	44.8	142.4	1.73
GB/25/314	70.78	2.83	140.0	2.77	2.17	3.40	2.35	2833	0.82	0.09	0.005	0.68	1879	47.0	290.7	0.13
GB/21/310	63.33	3.33	120.0	2.90	2.35	3.58	2.30	2199	0.90	0.25	0.005	0.91	1885	46.7	273.5	0.28
ZS-1	56.13	2.96	202.0	3.55	2.40	3.88	2.60	3281	1.08	0.10	0.000	0.42	1745	45.6	292.2	0.24
ZS-2	63.02	3.51	176.0	3.95	2.85	4.23	2.73	3219	1.36	1.85	0.010	0.68	1777	43.2	73.7	2.73
ZS-3	59.08	4.29	170.6	3.53	2.73	3.82	2.65	2974	1.19	0.17	0.015	1.27	1889	45.9	283.1	0.13
ZS-5	65.02	3.87	178.0	3.95	3.08	4.41	2.91	3372	1.45	2.70	0.020	1.55	1873	46.8	180.4	1.74
ZS-8	75.02	3.24	168.0	4.00	2.60	4.23	2.85	3615	1.27	2.01	0.017	0.78	1576	40.7	145.2	2.56
TS-9	64.31	3.43	185.5	4.08	2.63	4.45	2.85	3455	1.30	0.30	0.013	0.79	1648	41.9	296.0	0.38
TS-11	59.67	3.05	186.0	3.35	2.65	3.55	2.55	3207	1.11	0.43	0.010	1.08	1865	47.4	259.0	0.39
Mean	64.74	3.38	166.8	3.48	2.53	3.93	2.63	3106	1.12	1.05	0.01	0.96	1795	45.0	223.6	1.03
SE (±)	1.79	0.13	7.55	0.16	0.11	0.11	0.06	120.8	0.07	0.33	0.00	0.11	32.77	0.69	24.25	0.31

Table 2. Interrelationship among different physiological and morphological characters under irrigated (above diagonal) and stress (below diagonal) environments in oil palm

Dura genotype	Leaflet length	Leaflet width	Number of leaflets	Petiole width	Petiole depth	Plant height	Rachis length	Leaf area	Leaf dry weight	Photosynthetic rate	Stomatal conductance	Transpiration rate	P.A.R	Leaf temperature	Intercellular CO_2 conc	WUE
	LLL	LLW	NLL	PW	PD	PHt	RacL	LA	LDW	A	Cs	E		TL	Ci	WUE
LLL		**-0.25**	**-0.21**	**-0.42**	**0.07**	**-0.01**	**0.00**	**0.28**	**-0.15**	**-0.61**	**0.22**	**0.33**	**0.43**	**0.18**	**0.56**	**-0.69**
LLW	-0.22		**0.19**	**0.46**	**0.38**	**0.23**	**0.50**	**0.11**	**0.45**	**-0.12**	**-0.59**	**-0.23**	**0.60**	**0.60**	**-0.05**	**-0.05**
NLL	-0.51	0.10		**0.86**	**0.30**	**0.58**	**0.35**	**0.88**	**0.56**	**0.33**	**-0.32**	**-0.48**	**0.32**	**-0.03**	**-0.79**	**0.62**
PW	-0.14	0.39	0.72		**0.60**	**0.59**	**0.43**	**0.65**	**0.83**	**0.22**	**-0.63**	**-0.68**	**0.34**	**0.29**	**-0.83**	**0.57**
PD	-0.35	0.56	0.56	0.81		**0.52**	**0.40**	**0.34**	**0.94**	**-0.45**	**-0.83**	**-0.70**	**0.38**	**0.63**	**-0.33**	**-0.05**
PHt	0.10	0.43	0.50	0.87	0.59		**0.83**	**0.59**	**0.61**	**0.02**	**-0.38**	**-0.64**	**0.22**	**0.07**	**-0.54**	**0.39**
RacL	0.05	0.45	0.67	0.93	0.70	0.93		**0.38**	**0.46**	**-0.19**	**-0.42**	**-0.60**	**0.33**	**0.12**	**-0.28**	**0.13**
LA	0.09	0.05	0.81	0.80	0.48	0.70	0.87		**0.49**	**0.01**	**-0.25**	**-0.33**	**0.54**	**0.07**	**-0.49**	**0.26**
LDW	-0.22	0.51	0.66	0.95	0.95	0.80	0.88	0.68		**-0.22**	**-0.85**	**-0.79**	**0.39**	**0.55**	**-0.57**	**0.21**
A	0.52	0.22	-0.04	0.23	0.14	0.52	0.48	0.33	0.25		**0.46**	**0.23**	**-0.43**	**-0.43**	**-0.57**	**0.83**
Cs	0.49	0.49	-0.09	0.15	0.04	0.44	0.46	0.28	0.14	0.77		**0.79**	**-0.40**	**-0.54**	**0.26**	**0.06**
E	0.15	0.57	-0.22	-0.14	0.08	0.09	0.15	-0.10	0.00	0.54	0.81		**-0.02**	**-0.07**	**0.59**	**-0.31**
Q	-0.36	0.21	-0.38	-0.60	-0.05	-0.60	-0.57	-0.67	-0.35	-0.17	-0.10	0.44		**0.74**	**0.19**	**-0.44**
TL	-0.43	-0.03	-0.22	-0.60	-0.09	-0.67	-0.59	-0.57	-0.38	-0.30	-0.28	0.30	0.92		**0.19**	**-0.45**
Ci	-0.43	-0.14	0.03	-0.27	-0.16	-0.43	-0.37	-0.28	-0.26	-0.86	-0.53	-0.22	0.24	0.43		**-0.90**
WUE	0.51	0.13	0.05	0.43	0.25	0.57	0.52	0.43	0.39	0.87	0.52	0.15	-0.42	-0.57	-0.97	

parameters as assessed by stepwise regression analysis was inter-cellular CO_2 concentration> photosynthetic rate> leaf temperature> transpiration rate. Further, for leaf dry weight, the step-wise regression analysis revealed significant role played by petiole depth and petiole width.

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