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IDENTIFICATION AND CHARACTERIZATION OF *IN SITU* DROUGHT TOLERANT PALMS IN FARMERS' FIELDS IN DIFFERENT AGRO-CLIMATIC ZONES

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ABSTRACT

Coconut palms are mainly grown as rainfed crop, and are exposed to drought of different intensities and durations in various parts of the country. It is important to identify and conserve the ecotypes, which could withstand the vagaries of nature and still performed better in terms of growth and yield. Such efforts will ensure that the natural genetic variability and desirable traits are identified and conserved for further exploitation. With this in view present survey was undertaken in farmers' fields at different agro-climatic zones, viz., Western coastal area – hot sub-humid-per-humid (Ratnagiri – Maharastra), hot semi arid (Arisikere – Karnataka) and Eastern coastal plains- hot sub-humid (Ambajipeta- Andhra Pradesh), which represent the major coconut growing areas in India. These places faced periodical durought during last 15 years and the dry spell was longer in Ratnagiri (216 days) and Arsikere (202 days). During survey drought affected and apparently tolerant palms were selected based on morphology. The data indicate that *in situ* drought tolerant palms had more number of leaves, bunch and mature nuts compared to the affected palms. Gas exchange characters were also high in apparently tolerant palms. These palms also exhibited good water use efficiency. However, the biochemical composition did not show any definite trend between tolerant and susceptible types. The superiority of these palms in the photosynthetic parameters showed their capacity for drought tolerance and high yield. The tolerant palms can be used as mother palms in breeding programme for drought tolerance.

INTRODUCTION

Coconut palms, as rainfed crop, are exposed to drought of different intensities and durations in various parts of the country. The impact of drought on coconut persists for two to three years in view of the indeterminate flowering habit and perennial nature of crop. As coconut yields are closely linked to favorable weather conditions, occurrence of drought leads to significant reduction in yields thereby resulting in considerable economic loss to the growers. Impact of drought stress and palm response to tolerate drought was studied in India and abroad. Investigations based on physiological, anatomical and biochemical characters resulted in identification of some of the genotypes capable of withstanding drought conditions. It is important to identify and conserve the ecotypes which could withstand the vagaries of nature and still performed better in terms of growth and yield, particularly because of perennial nature of palms. Such efforts will ensure that the natural variability and desirable traits are identified and conserved for further exploitation, one of the major thrusts even for IPGRI research. With this in view present study was undertaken at different agro-climatic zones, which represent the major coconut growing areas in India.

MATERIALS AND METHODS

Survey was conducted in farmers' fields at different agro-climatic zones viz., Western coastal area – hot sub-humid-per-humid (Ratnagiri – Maharastra), hot semi arid (Arisikere – Karnataka) and Eastern coastal plains- hot sub-humid (Ambajipeta- Andhra Pradesh), representing major coconut growing areas. The survey area was in 40 Km radius from respective representative ARS centers.

Palms with best performance with desirable morphological growth were selected. Some more palms, representing the general performance of all other palms in the vicinity were selected from each location. Palms were marked for identification for periodical observations. Data on morphological growth (number of leaves in crown, number of bunches, number of female flowers and nuts per bunch) were collected. Physiological parameters like photosynthetic rates, transpiration rates were estimated using portable photosynthetic system

(ADC-LCA4, UK) in sixth leaf from top. Leaf lets from sixth leaf were used for estimation of biochemical parameters. The spectro-photometric estimations (UV-Vis 160 A, Shimadzu, Japan) of concentrations of protein (Lowrey *et al.*, 1951), free amino acids (Moore and Stein, 1948), starch (Hodge and Hofreiter, 1962), reducing sugars (Somogyi, 1952) and total carbohydrates (Dubois *et al.*, 1956) were done.

Data on all these parameters were collected during April-May period of 2001 and 2002. Standard procedures of statistical analysis as per Gomez and Gomez (1984) were followed.

RESULTS AND DISCUSSION

Agro-climatology of locations where palms were identified

1. ***Arsikere :*** This area receives an annual rainfall of 718 mm with rainy days spread over all 12 months of the year (Fig. 1). The rainfall was maximum during October (166 mm). Summer showers also occur with relatively higher rainfall during May (104 mm). Relative humidity ranged from 35-67 % during January-April period to 64-83% during September -October. Vapour pressure is lowest in January and highest in June. Pan-evaporation is high during February to May with a maximum during April (8.4 mm). It decreases after May and minimum pan evaporation was observed in October. Soil temperatures at 10 and 20cm depths were high in April. But at 30cm depth soil temperature was maximum in May. Soil temperatures were minimum in January and December.

2. ***Ratnagiri:*** Ratnagiri receives an average annual rainfall of 2803mm (Fig. 1). Rainfall was maximum during July (946.7 mm), however period from January to April receives no rain. Relative humidity was low during the first and last two months of the year and it was high in July (89.7%). Maximum temperature showed two peaks during May and November (32.8° C and 33.3° C) and it was low during July and August (28.6°C). Minimum temperature was low during January (19.3°C).

3. ***Ambajipeta:*** Ambajipeta receives an annual rainfall of 1140.7mm (Fig. 1) and highest rainfall is obtained during July and November (211.8 and 221.9 respectively). Relative humidity is lowest during February (78.9%) and highest during October (90%). Maximum and minimum temperatures were lowest during January (26.9/20.9°C) and highest during May (35.8/29.2° C).

From Fig. 1, depicting the 15 year annual rainfall in three centres, it is evident that some of the years were drought affected years. The dry spells, based on the beginning and end of rainfall during the cycle, were fluctuated over the years at each centre (Fig.2). When expressed as number of days, Dry spell was longer in Ratnagiri (216 days) and Arsikere (202 days).

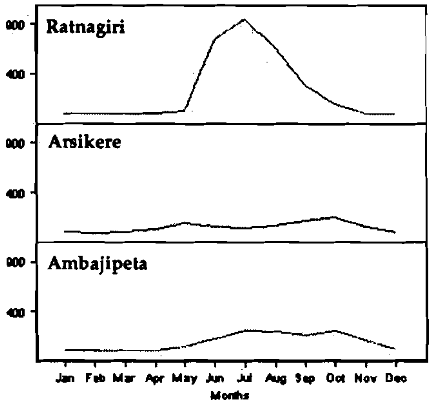

Fig. 1. Rainfall pattern of three locations representing different agro-climatic zones

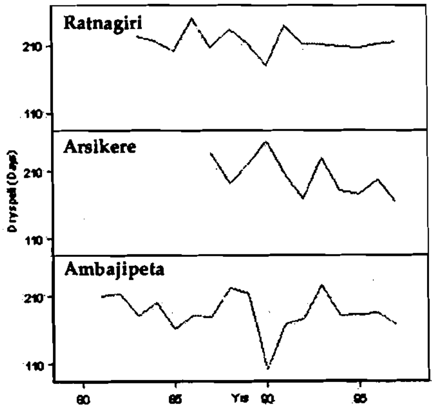

Fig. 2. Occurrence of dryspell during past two decades at three locations representing different agro-climatic zones

Identification of drought tolerant palms in farmers' fields

It is important to identify the palms, which survive and yield highly in drought prone locations. These palms may have desirable traits for drought tolerance, thus able to withstand drought and yield high. Identification of such palms will help in increasing the genetic variability for the crop, which can be used for crop improvement programme.

A survey was conducted in farmers' plot under rainfed condition at Arsikere, Ambajipeta and Ratnagiri to assess the impact of drought and to identify the relatively drought tolerant palms. Drought affected and apparently good palms were selected based on morphology from the same field and marked them. Details of locations, where palms were identified and approximate palm age are given in Table 1. The approximate age of palms were 45 years.

Physiological and biochemical characterization: Net photosynthetic (*Pn*) rates were high in palms, which were apparently drought tolerant with desirable morphological characters as compared those in other palms in the vicinity (Table 2). The transpiration rates (*E*) were also higher in these palms indicating the efficiency of palms to uptake water compared to other palms. Thus, apparently tolerant palms maintained high *gs*. The physiological water use efficiency (WUE –*Pn/E*) was maintained high in apparently tolerant palms. However, intrinsic WUE (*Pn/gs*) did not differ between tolerant and susceptible palms, indicating that the stomatal limitation was not the cause for lower *Pn* rates in susceptible palms. Lower Pn rates in these palms may be due to low carboxylation efficiency. Low transpiration rates caused high leaf-air temperature (D T) differences in susceptible palms. This might have cause photo-inhibition of photosynthesis in these palms.

Pn - Net photosynthetic rate (μmol.m^{-2}.s^{-1}); E - Transpiration rate (mmol.m^{-2}.s^{-1}) gs - Stomatal conductance (mol.m^{-2}.s^{-1}); Pn/E - Instantaneous water use efficiency (μmol(CO_2). mmol^{-1}(H_2O); Pn/gs - Intrinsic water use efficiency (μmol.mmol^{-1}); DT- *Leaf to air temperature difference (°C)*

The biochemical characters were estimated in leaflets of sixth leaf (Table 3). Data indicate that the total carbohydrates were high in tolerant palms at Arisikere and Ambajipeta, but reverse trends were observed at Ratnagiri. Reducing sugars varied significantly only in palms at Ambajipata, which were more in tolerant palms. The starch and protein concentrations were significantly more in tolerant palms at Ratnagiri. At Arsikere, tolerant palms were having low concentration of proteins and amino acids. However, free amino acids were also high in tolerant palms at Ratnagiri and Ambajipeta. These results on biochemical parameters indicated no definite trend for tolerance or susceptibility of palms to drought condition.

Morphological characterization: Basically palms were identified based on general morphology of palms (Table 4). The palms were sturdy in look and had good crown. The number of leaves was more than 30 in tolerant palms, a desirable character for high yielding palms. The number of bunches on crown was also more in these palms, indicating more production of bunches. But variations in harvest intervals also contribute to this factor. The palms, identified as tolerant were able to produce more pestillate flowers compared those in other palms in the vicinity. Mature nuts/ bunch were also higher in tolerant palms, indicating high yielding capacity of these palms.

Table 1. Details of sites where tolerant palms were identified at different centres

Centre	Agro-climatic zone	Location of identified plants	Soil type
Arsikere (Karnataka)	Hot semi -arid	Jayachamarajanagar village	Red sandy
Ratnagiri (Maharastra)	Western coastal area – hot sub-humid-per-humid	-	Coastal alluvium
Ambajipeta (Andhra Pradesh)	Eastern coastal plains- hot sub-humid	Edurlankarevu village	Coastal alluvium

Table 2. Photosynthetic characters of field tolerant and susceptible palms

Centres	Palm type	Pn		E		gs		Pn/E		Pn/gs		DT	
Arsikere	Tolerant palms	5.66	±0.34	2.09	±0.11	0.058	±0.004	2.68	±0.11	0.097	±0.003	3.75	±0.15
	Susceptible palms	3.89	±0.26	1.84	±0.12	0.044	±0.004	2.22	±0.09	0.094	±0.005	4.26	±0.14
Ratnagiri	Tolerant palms	6.08	±0.51	2.38	±0.12	0.051	±0.003	2.54	±0.11	0.119	±0.005	3.24	±0.17
	Susceptible palms	3.83	±0.78	1.68	±0.29	0.034	±0.007	2.21	±0.11	0.113	±0.006	3.80	±0.26
Ambajipeta	Tolerant palms	7.79	±0.39	2.82	±0.19	0.104	±0.009	2.79	±0.16	0.083	±0.004	3.30	±0.24
	Susceptible palms	6.33	±0.43	2.72	±0.14	0.090	±0.008	2.33	±0.15	0.085	±0.005	3.32	±0.32

Table 3. Leaflet biochemical components of field tolerant and susceptible palms

Centre	Palm type	Total carbohydrates (mg. g^{-1}dw)		Reducing sugars (mg. g^{-1}dw)		Starch (mg. g^{-1}dw)		Total Protein (mg. g^{-1}dw)		Free amino acids (mg. g^{-1}dw)	
Arsikere	Tolerant palms	134.21	±6.21	20.94	±3.50	52.89	±2.75	189.50	±7.60	10.47	±0.65
	Susceptible palms	151.83	±6.95	22.22	±3.39	55.29	±4.80	205.49	±7.05	12.10	±0.80
Ratnagiri	Tolerant palms	145.68	±5.64	22.51	±1.95	55.12	±2.10	241.70	±6.01	13.25	±0.67
	Susceptible palms	147.37	±10.53	22.59	±1.86	48.73	±2.81	222.34	±7.72	11.97	±0.27
Ambajipeta	Tolerant palms	130.72	±7.32	18.75	±5.12	57.01	±3.73	203.88	±2.96	13.01	±0.82
	Susceptible palms	122.39	3.69	14.34	±2.95	55.50	±2.00	202.64	±9.76	11.28	±0.52

Table 4. Morphological features of *in situ* field tolerant and susceptible palms

Centres	Palm type	Leaves (No.)	Bunches (No.)	Female flower production (No.)	Mature nuts/ bunch (No.)
Arsikere	Tolerant palms	33±2.03	14±0.70	20±3.30	11±1.59
	Susceptible palms	27±2.23	13±0.74	11±2.69	4±0.95
Ratnagiri	Tolerant palms	33±1.74	14±0.74	29±10.57	11±0.89
	Susceptible palms	27±1.38	12±1.18	21±4.05	6±1.71
Ambajipeta	Tolerant palms	31±1.02	10±0.63	36±8.58	7±1.38
	Susceptible palms	28±0.88	7±1.11	21±4.35	3±1.06

The data indicate that *in situ* drought tolerant palms had more number of leaves, bunch and mature nuts compared to the affected palms (Fig 3). Gas exchange characters were also high in apparently tolerant palms. These palms also exhibited good water use efficiency. However, the biochemical composition did not show any definite trend between tolerant and susceptible types. The superiority of these palms in the photosynthetic parameters showed their capacity for drought tolerance and high yield. The tolerant palms can be used as mother palms in breeding programme for drought tolerance.

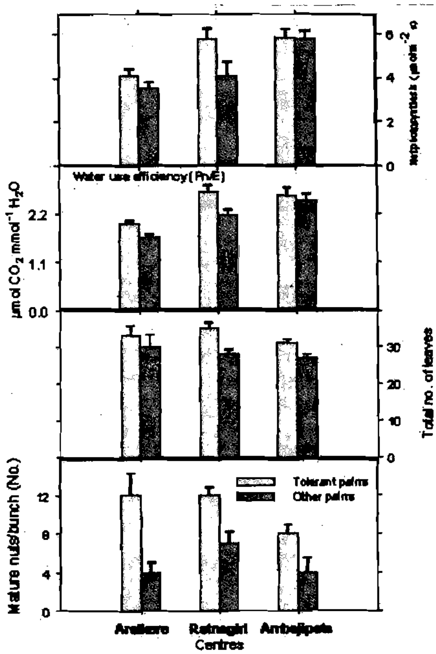

Fig. 3. Morpho-physiological characters of in situ tolerant palms and other palms in farmers field sat different agro-climatic locations

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