Short scientific report *Journal of Plantation Crops, 2011, 39 (1): 210-212*

Photosynthetic characteristics in cashew accessions

(Manuscript Received: 20-12-10, Revised: 24-02-11, Accepted: 07-04-11)

Keywords: Cashew, carbon discrimination, Chlorophylls, photosynthesis, stomatal conductance, transpiration

Cashew is a native of northern part of South America and introduced into India in 16th century. It has gained economic importance because of its export potential. Photosynthetic studies on cashew was first reported by Balasimha (1991). The effect of leaf position, irradiance and environmental parameters were described. The photosynthetic rate (Pn) were studied in cashew in relation to plant density (Balasimha and Yadukumar, 1993), leaf position and radiation (Palanisamy and Yadukumar, 1993). Influence of leaf age and branch girdling (Schaper and Chacko, 1993); effects of drying and irrigation on gas exchange (Schaper *et al*., 1996; Blaikie *et al*.,2001) have been studied in Australia. In Brazil, photosynthetic responses to varying environmental conditions in young cashew plants are studied (Pereira de Souza, *et al*., 2005). Cashew is usually a rainfed crop, and known to be generally tolerant to drought conditions. However, there is no information on whether there are genetic differences in their drought tolerant behavior among the accessions. The proposed study will help to understand genetic diversity among cashew collections in relation to photosynthetic efficiency. The variations in these physiological parameters will help in identifying high photo-synthetically productive genotypes/varieties for high yield and drought tolerance.

The 23 accessions of cashew (*Anacardium occidentale* L) from the germplasm holding of DCR, Puttur were selected for the study. Three trees from each accession were used for measurements during summer season (April-May). Water potential (WP) was determined using Scholander's water pressure chamber. Photosynthetic characters were measured using LiCor - 6200 portable photosynthetic system as described earlier (Balasimha, 1991). The chlorophylls were extracted in acetone and determined spectrophotometrically. Epicuticular wax was removed from the leaf surface by dipping for brief period in acetone. Acetone was then evaporated and colour developed using dichromate reagent which was read at 460nm in a spectrophotometer. Carbon discrimination determinations were got analysed from the Facility at Department of Crop Physiology, UAS, Bangalore.

Photosynthetic characteristics of selected 23 accessions were done at Puttur (Table 1). Photosynthesis rates ranged from 1.77 to 7.18 µmol/m^2/s, while transpiration ranged from 3.22 to 10.07 mmol/m^2/s. Transpiration rate had positive correlation with stomatal conductance (Fig. 1). Similar relationships have been

Table 1. Photosynthetic parameters of cashew accessions

Accessions	Pn (µmol/m^2/s)	Transpiration (mol/m^2/s)	St.Cond. (mmol/m^2/s)	Intercellular CO2 (ppm)
M6/1	3.18	6.33	542.66	319.8
M16/1	6.38	7.02	560.33	320.4
T.No.1	2.27	6.38	445.66	315.1
T.No.40	5.01	7.63	663.00	339.1
BLA 256-1	2.67	7.78	598.33	325.5
BLA 273-1	2.60	5.90	317.50	328.0
H 4-7	2.02	5.33	311.33	333.6
K 27-1	3.48	5.33	229.33	285.6
T.No.176	2.89	3.32	86.00	258.3
Goa T.No.2	2.72	3.22	85.33	268.3
1/4 Ullal	7.18	6.18	355.66	265.5
Purple Genotype	3.28	5.88	228.66	300.5
A 18/4	6.24	9.11	389.00	286.4
I (BPP-3)	3.85	9.39	472.66	316.7
(BLA 139-1	4.41	7.58	396.33	296.8
5/12 Hy	2.09	8.35	413.33	323.5
Karkala-2	2.19	5.81	201.66	320.9
Puttur-7	1.91	5.66	188.33	312.5
Bulk-6	4.90	8.02	545.33	320.3
Ranpur	5.63	9.12	622.00	316.8
Lahanga	3.40	8.09	526.00	317.4
M 33/3,Vrid	5.56	10.07	758.33	301.7
C.putuka	1.77	4.73	122.33	348.9
F Value	3.24	3.35	4.33	4.57

Light ranged from 101 – 709 µmol/m^2/s; VPD 1.94 – 4.10 kPa

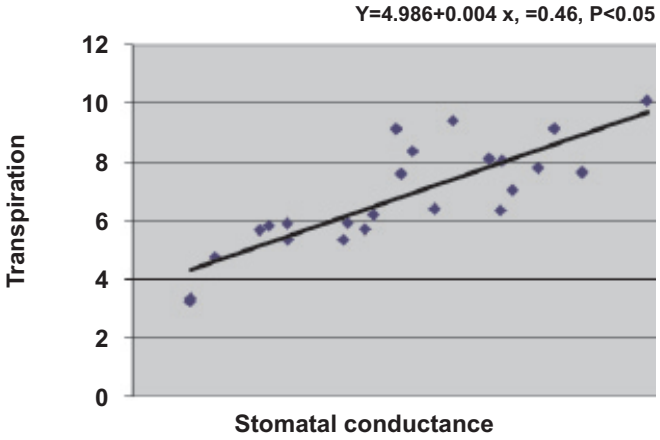

Fig. 1. Relationship of transpiration with stomatal conductance

reported in an earlier study (Balasimha, 1991). Even under dry summer conditions when VPD of 1.94-4.10 kPa were prevalent, the stomatal conductance was not affected appreciably. Increasing stomatal opening allows greater CO_2 diffusion with enhanced photosynthesis. When accessions were compared, 1/4 Ullal, M 16/1 and A18/4 showed highest stomatal conductance, Pn and transpiration rates. These also recorded highest WUE thus indicating these accessions to have very good photosynthetic efficiency. However, stomatal conductance did not show any trend directly with carbon isotope discrimination. The leaf water potential was generally high and did not show any effect of drought (Table 2). These responses of cashew accessions demonstrate high adaptability to dry environments. The carbon discrimination was determined in the same accessions, which showed variations (Table 2). Carbon isotope discrimination ($D^{13}C$) is a property that may be used to study water use efficiency (WUE). Water use efficiency (Pn/Tran) was also calculated and was in the range of 0.34 to 1.16. Water use efficiency showed inverse relationship with $D^{13}C$ although it was non-significant (Fig. 2). This indicates that the cashew plants are highly adopted to drought conditions by retaining higher levels

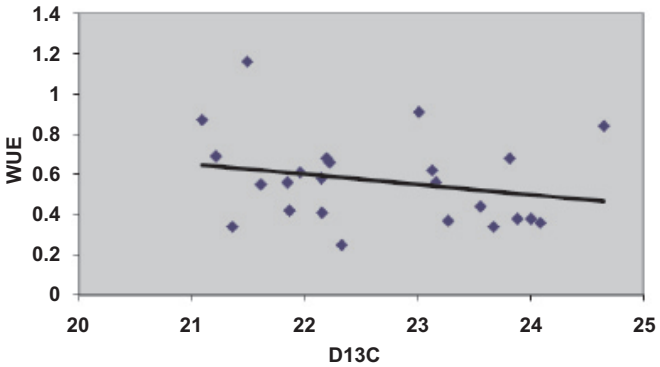

Fig.2. Relationship of WUE with $D^{13}C$

Table 2. Epicuticular wax content, Carbon isotopes discrimination, WUE and water potential of cashew accessions

Accessions	Epicuticular wax (µg/cm²)	$D^{13}C$	WUE(Pn/E)	WP(bar)
M6/1	78	21.848	0.56	-4.73
M16/1	65	23.013	0.91	-3.70
T.No.1	76	24.089	0.36	-3.53
T.No.40	67	22.222	0.66	-3.13
BLA 256-1	63	23.675	0.34	-4.10
BLA 273-1	107	23.558	0.44	-4.10
H 4-7	115	23.887	0.38	-4.26
K 27-1	83	21.215	0.69	-4.90
T.No.176	155	21.094	0.87	-2.90
Goa T.No.2	160	24.652	0.84	-3.83
1/4 Ullal	134	21.493	1.16	-2.96
Purple Genotype	103	23.164	0.56	-2.90
A 18/4	130	22.197	0.68	-3.70
I (BPP-3)	101	22.156	0.41	-3.23
(BLA 139-1	97	22.150	0.58	-4.83
5/12 Hy95	95	22.328	0.25	-3.63
Karkala-2	202	24.005	0.38	-2.00
Puttur-7	169	21.361	0.34	-2.03
Bulk-6	160	21.963	0.61	-2.30
Ranpur	138	23.130	0.62	-2.10
Lahanga	126	21.866	0.42	-3.00
M 33/3,Vrid	138	21.613	0.55	-4.03
C.putuka	176	23.273	0.37	-3.13
F Value	2.73	5.809		6.76

of leaf turgor and transpiration rates. Since cashew is adapted to semi-arid conditions, even under water deficits relatively high photosynthesis rate are reported (Bezerra

Table 3. Chlorophyll contents of cashew accessions (mg/g/FW)

Accessions	Chl a	Chl b	Chl a+b	Chl ratio a/b
M6/1	1.53	0.53	2.06	2.90
M16/1	1.27	0.40	1.67	3.14
T.No.1	1.64	0.53	2.18	3.10
T.No.40	1.31	0.47	1.78	2.93
BLA 256-1	1.74	0.60	2.34	2.93
BLA 273-1	1.60	0.49	2.09	3.23
H 4-7	1.83	0.68	2.52	2.68
K 27-1	0.74	0.54	2.63	2.47
T.No.176	1.99	0.64	2.63	3.11
Goa T.No.2	1.56	0.52	2.08	3.01
1/4 Ullal	1.75	0.64	2.39	2.73
Purple Genotype	1.61	0.58	2.20	2.74
A 18/4	1.27	0.35	1.62	3.56
I (BPP-3)	1.34	0.46	1.81	2.89
(BLA 139-1	1.77	0.66	2.43	2.66
5/12 Hy95	1.79	0.65	2.45	2.73
Karkala-2	1.76	0.60	2.36	2.93
Puttur-7	1.63	0.53	2.16	3.08
Bulk-6	2.38	0.78	3.17	3.04
Ranpur	1.57	0.43	2.00	3.65
Lahanga	1.37	0.42	1.80	3.25
M 33/3,Vrid	1.20	0.34	1.54	3.48
C.putuka	1.27	0.37	1.65	3.50
F Value	3.15	2.46	3.03	1.62

et al., 2007). The possible mechanism may be that plants are able to retain high leaf turgor due to very deep rooted system in cashew, similar to that reported for coffee (Pinheiro *et al.*, 2005). The effects of carbon discrimination are usually shown on diffusion of CO_2 and this relation indicates the relative tolerance of plants to drought. Thus, higher WUE and lower discrimination is considered as a positive trait.

The epicuticular wax contents of cashew showed wide differences ranging from 65 to 202 µg/cm^2 (Table 2). Chlorophyll contents in these accessions are given in Table 3. There were variations among the accessions. These parameters are also contributing factors for drought tolerance and higher values are positive traits. Thus, these results show an understanding of cashew physiology that will help in developing new cultivars with superior performance.

Acknowledgments

We thank ICAR for financial assistance through AP Cess Funding.

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