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BRIEF COMMUNICATION

Response of pigeon pea cultivars to water stress

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Abstract

Decrease in soil water potential during vegetative and flowering stages of two cultivars of pipeon pea (*Cajanus cajan*) caused higher decrease in relative water content in cv. ICPL-151 than in cv. H-77-216. Both cultivars showed partial recovery during rehydration. Cv. H-77-216 also accumulated more proline and carbohydrates during stress and showed better drought tolerance than cv. ICPL-151.

Most of the tropical grain legumes experience frequent drought of varying degree and duration during their growing period. Water is one of the major environmental factors, affecting almost all aspects of plant growth and metabolism (for reviews see *e.g.* Hsiao 1973, Kramer 1983). This study was undertaken to determine relative drought tolerance of two phenotypically different cultivars of pigeon pea based on various parameters of plant water status and osmotic adjustment in relation to proline and carbohydrates contents.

The plants of two cultivars of pigeon pea (*Cajanus cajan* (L.) Mill), cv. H-77-216 (indeterminate) and cv. ICPL-151 (determinate) were raised in pots under the greenhouse conditions. The plants were subjected to drought stress by withholding the irrigation at vegetative stage and at flowering stage, *i.e.*, 35 - 40 d and 65 - 70 d after sowing, respectively. The levels of stress were as described earlier (Nandwal *et al.* 1991).

The soil water potential was measured with dewpoint microvoltmeter (*HR-33T, Wescor*, Logan, USA) and soil moisture content (SMC) by gravimetric method.

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Abbreviations: ψ_w, - water potential; ψ_s, - osmotic potential; RWC - relative water content; SMC - soil moisture content; TSC - total soluble carbohydrates.

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The fourth fully expanded trifoliate leaf from the top was used to measure ψ_w with a pressure chamber (*Model-3005, Soil Moisture Equipment Corporation*, Santa Barbara, USA). A similar leaf was detached from the stem and crushed with the help of a glass rod flated at one end in a test tube. The extracted sap was used to determine the osmotic potential (ψ_s), with a psychrometric technique, using a *Vapour Pressure Osmometer* (*Model-5100, Wescor*, Logan, USA). Relative water content (RWC) was calculated as described by Weatherley (1950). These measurements were made between 09.00 and 11.00 (local time) during a sunny day under the photosynthetic photon flux density of 1150 ± 50 and 1020 ± 30 μmol m^{-2} s^{-1} and the mean temperature of 39 ± 2 and 36 ± 1 °C at vegetative and flowering stage, respectively.

Proline of the leaf was extracted in 3 % sulfosalicylic acid and estimated using method of Bates *et.al.* (1973). Total soluble carbohydrates (TSC) of leaf were determined with the method of Yemm and Willis (1954) using anthrone reagent.

Five replicates from each treatment were used to analyse the data statistically.

Exposing the plants to stress by withholding irrigation resulted in a considerable decrease in leaf ψ_w and ψ_s which were more obvious at the vegetative stage than at the flowering stage (Table 1). During rehydration of plants the values of leaf ψ_w and ψ_s increased, but did not reach the values of the control within 2 d. The values of leaf ψ_w and ψ_s of cv. H-77-216 were more negative as compared to cv. ICPL-151, at soil ψ_w -1.34 MPa.

Table 1. Effect of soil water potential (-0.37 MPa - control; -0.77 MPa - moderate water stress; -1.34 - severe water stress; -0.37 - rehydration) on leaf water and osmotic potentials and relative water content of pigeon pea cultivars.

	Vegetative stage						Flowering stage					
Soil	H-77-216			ICPL-151			H-77-216			ICPL-151		
ψ_w [-MPa]	ψ_w [-MPa]	ψ_s [-MPa]	RWC [%]	ψ_w [-MPa]	ψ_s [-MPa]	RWC [%]	ψ_w [-MPa]	ψ_s [-MPa]	RWC [%]	ψ_w [-MPa]	ψ_s [-MPa]	RWC [%]
0.37	0.98	1.74	87.3	0.83	1.58	86.3	0.64	1.26	80.3	0.71	1.44	79.2
0.77	2.35	2.70	62.8	1.94	2.39	60.5	1.88	2.25	60.8	1.80	1.89	62.0
1.34	3.08	3.56	50.4	2.81	2.92	44.8	2.50	2.87	39.6	2.10	2.33	36.9
0.37	1.00	2.05	82.9	0.90	1.89	80.9	0.73	1.58	76.3	0.77	1.53	71.8

C.D. at 5 % level

Vegetative stage:		Flowering stage:	
ψ_w	stress - 0.25; cultivar - 0.18	ψ_w	stress - 0.05; cultivar - 0.04
ψ_s	stress - 0.15; cultivar - 0.11	ψ_s	stress - 0.09; cultivar - 0.06
RWC	stress - 3.27; cultivar - 2.39	RWC	stress - 2.80; cultivar - 2.13

Drought stress resulted in a significant decrease of RWC (Table 1). This decrease was lower in cv. H-77-216 and also the rehydration was relatively better in cv. H-77-216 as compared to cv. ICPL-151.

The proline content of leaves increased with decrease in soil ψ_w at both stages. Cv. H-77-216 showed greater accumulation of proline than cv. ICPL-151. During rehydration proline declined rapidly. This increase in proline content has been shown to be beneficial for the osmotic adjustment (Jones *et al.* 1980). Earlier data also showed that accumulation of proline in cereal and legume crops during water stress is related to drought resistance (Singh *et al.* 1972; Singh and Gupta 1983). The comparison of cv. H-77-216 and cv. ICPL-151 confirms the above findings. At soil ψ_w -0.77 MPa, there was a decrease in TSC of leaf (Table 2) in both the cultivars.

Table 2. Effect of soil water potential (-0.37 MPa - control; -0.77 MPa - moderate water stress; -1.34 - severe water stress; -0.37 - rehydration) on proline [$\mu g\ g^{-1}$(d.m.)] and total soluble carbohydrate [$mg\ g^{-1}$(d.m.)] contents of pigeon pea cultivars.

	Vegetative stage				Flowering stage			
Soil	H-77-216		ICPL-151		H-77-216		ICPL-151	
ψ_w [-MPa]	proline	TSC	proline	TSC	proline	TSC	proline	TSC
0.37	405	32.8	207	32.3	301	45.8	251	33.9
0.77	987	27.0	524	20.4	473	32.6	649	26.6
1.34	2141	42.0	2005	36.4	2807	64.0	1183	39.9
0.37	477	30.8	373	30.4	716	41.8	555	30.0

C.D. at 5 % level

Vegetative stage:		Flowering stage:	
proline	stress - 204.2; cultivar - 103.5	proline	stress - 202.6; cultivar - 143.3
TSC	stress - 2.9; cultivar - 1.7	TSC	stress - 2.3; cultivar - 1.6

However, it consistantly increased at soil ψ_w of -1.34 MPa. After rehydration TSC sharply decreased. The TSC increased only during severe stress because its normal utilization is inhibited and accumulated carbohydrates have been accounted for a part of the osmotic adjustment (Riazi *et al.* 1985). Cv. H-77-216 accumulated more TSC in leaf than cv. ICPL-151. Thus relative contributions to osmotic adjustment made by changes in TSC was higher in cv. H-77-216 than cv. ICPL-151.

It is concluded that cv. H-77-216, an indeterminate type, maintained higher value of RWC under drought stress due to osmotic adjustment in consequence of accumulation of more proline and TSC in comparison with cv. ICPL-151, a determinate type.

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