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Influence of saline environment on the incidence of stem bleeding in coconut (*Cocos nucifera* L.)

Stem bleeding in coconut occurs under varying situations[1,2]. This communication reports a case study on location-specific saline-prone environment in a coconut grove with a large number of palms affected by stem bleeding of which the worst affected ones were killed by the disease. The area of the garden was found to be a low-lying one, just on the bank of the river Chandragiri at Korakod village of Kasaragod (Kerala) where the river gets highly salinised due to tidal action. The river would tend to go dry almost to its bed level due to a long spell of dry weather period (December-May ; Av. Temp. 31.7°C ; Av. evoporation 5.1 mm/day). From an old tannery found situated in one side of the garden highly saline tannery effluents[3] get discharged into the river. Saline seepage into the garden seemed inevitable. Further, the river would swell up and enormously inundate the garden consequent to heavy monsoonal rains (3158 mm, June-September). Salinity aspects[4-7] of soil and water in the above context deserved particular attention and salient results are presented.

By and large, soil in the garden was found to be predominantly sandy clay loam in such of those locations under the stem bleeding affected palms, whereas it was seen to be sandy clay to clay loam in those under the unaffected (apparently healthy) ones.

At different soil depths (25 cm each upto 100 cm) soil EC$\times 10^6$ (in 1 : 1 soil water suspension). Na^+ and Cl^- themselves (ionic concentrations expressed as meq/l) were found both at the commencement (C. S, December) and at the peak of dry weather period (P. S, April) to be higher in the stem bleeding affected locations, proximal to saline precursor situations (namely, on the sides of the river and channel linked with the river lying adjacent to a boundary of the garden and on the side of the tannery) than in the unaffected ones situated away from the sources. This trend was much pronounced in April. Apart from this the results viewed from the angle of involving Na^+, K^+, Ca^{2+} and Mg^{2+} (all on meq/l basis) as cationic ratios or systems such as (1) $\frac{Na^+}{K^+}$, (2) $\frac{Na^+ (Ca^{2+}+Mg^{2+})}{Na^+ + K^+}$, (3) sodium absorption ratio (SAR) and (4) soluble sodium percentage (SSP) at the soil Cl^- and HCO_3^- levels (both expressed as meq/l) revealed (Table 1a) a similar trend. It was also observed that in the majority of cases lower depths of soil (50-100 cm) showed higher salinization. In April the value of the index (1) at Cl^- was 7.1 times and the same at HCO_3^- was 2.25 times greater in the stem bleeding affected locations than in the unaffected ones. Similarly, in December itself the values of the indices : (2), (3) and (4) at Cl^- levels were 1.64, 1.52 and 1.33 times more whereas, the same at HCO_3^- levels were 3.00, 1.03 and 6.00 times more respectively in the former than in the latter locations. Besides, the mean soil EC$\times 10^6$ values were higher by 2.28 and 3.74 times in December and April respectively in the case of the former as compared to the latter.

Salinity statuses of river and ground waters (collected from points relevant to saline precursor situations inclusive of the point of discharge of tannery effluents) were indeed high and particularly in April the waters' salinity increased much higher to exceed safe limits from the point of view of parameters such as EC$\times 10^6$, sodium adsorption ratio (SAR), Doneen's potential salinity ($Cl^- + \frac{1}{2} So_4^{2-}$) and Kelley's ratio $\left(\frac{Na^+}{Ca^{2+} + Mg^{2+}}\right)$ (Table 1b). Water salinity class of river water was C_3S_2-C_5S_2 (medium

TABLE 1 (a): Soil salinity indices for stem bleeding affected and unaffected locations at the commencement (C.S) and peak of dry weather period (P.S.)

Locations in the coconut garden under palms	EC x 10^6@		$\frac{Na^+}{K^+}$@ (the above each at the level of)				$\frac{Na^+ (Ca^{2+} + Mg^{2+})}{Na^+ + K^+}$@				SAR@	SSP@
			Cl^-		HCO_3^-		Cl^-	HCO_3^-	Cl^-	HCO_3^-	Cl^-	HCO_3^-
	C.S	P.S	C.S	P.S	C.S	P.S	C.S	C.S	C.S	C.S	C.S	C.S
*Affected (A)	305	1831	19	613	10	36	18	18	141	75	4	12
+Unaffected (AU)	134	490	17	86	11	16	11	6	93	73	3	2
A/AU	2.3	3.7	1.1	7.1	0.9	2.3	1.6	3	1.5	1.1	1.3	6

@See text
* Mean of 7 location and 4 depths 25 cm each 0-100 cm
+Mean of 3 locations and 4 depths 25 cm each 0-100 cm

TABLE 1 (b) : Water salinity in and on the sides o the coconut garden

Water sample	EC × 10^6	SAR@	Doneen's@ potential salinity	Kelley's ratio@
River water+				
C.S*	2,872	13	23	4.3
P.S.*	39,573	88	784	10.2
P.S/C.S	13.8	6.8	34.1	2.4
Ground water				
C.S*	1,008	5	8	1.7
P.S*	9,360	20	151	3.0
P.S/C.S	9.3	4	18.9	1.8

* See table 1 (a) ; @ See text ; + Mean of 3 points.

high salinity and medium sodium water to high salinity and medium sodium water) and that of ground water was C_3S_1 (medium-high salinity and low sodium water) in December; but both these waters got transformed to C_6S_4 (excessive salinity and very high sodium water) in April.

All these results suggest the role of excessive salinity in the problem of stem bleeding in coconut under the inter-connected complex of saline stress conditions just described. The semi-halophytic and salt tolerant nature of the palm has been well-recognised ; but as has been observed by Poljakoff-Mayber and Gale[8] even the most halophytic plants do not seem to thrive under highly saline conditions, although at best plants may tolerate, strategically avoid or cope with salinity. They also opined that plants suffer damage caused by high salinity due to specific ion and osmotic effects.

In the light of observations made by Milburn and Zimmermann[9] on sap transport and by Zimmermann[10] on sap exudation in coconut, stem bleeding in palm could be analogous to osmotic bleeding phase of sap exudation. As has been reported[3] it is a physiological disorder or abnormality occurring under different stress situations each one of which cannot be generalised. However, conceptually the injury to the highly vulnerable sap conducting elements might trigger off exudation symptoms of stem bleeding. In the present context highly saline-prone stress conditions have been implied. Stem bleeding disease has been characterised by these symptoms (exudation of dark reddish-brown fluid through the cracks on the stem) decaying of underneath tissues (internal rot) resulting in the gradual decline in the health of the palm and in extreme cases its eventual death. Follow-up studies would be worth undertaking.

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M. NAGARAJAN

Soil Science Division,
Central Plantation Crops
Research Institute,
Kasaragod-670 124, Kerala.
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