GROWTH CHARACTERS AND MINERAL NUTRIENT COMPOSITION OF ARECANUT SEEDLINGS AS RELATED TO THEIR CATION EXCHANGE CAPACITY

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Abstract

Root cation exchange capacity of some *Areca* cultivars at seedling stage was measured and its relationship with the morphological characters of plant and nutrient composition of leaf as well as root was evaluated. High CEC encouraged more concentration of phosphorus in plant tissue. The growth characters of seedlings were not significantly related to the root CEC. Although the ratio of monovalent to divalent ions showed certain trend with root CEC which was in accordance with the Donnan's principle, the CEC was not related to the cation composition of leaf. Thus, the applicability of CEC of *Areca* roots as one of the indices for the selection of seedlings in the nursery appears to be unreliable.

Introduction

Cation exchange capacity of roots is known to be correlated with the yield of crops (Mehrotra and Saksena, 1970; Chiranjivi Rao and Thuljaram Rao, 1971). Crooke (1964) reported that the root CEC differed from even plant to plant; whereas Chiranjivi Rao and Thuljaram Rao (1971) stated that it varied between varieties. Earlier, Huffaker and Wallace (1959) had observed that the root CEC did not vary within a species. According to Dhawan and Mahajan (1968), the CEC of high yielding varieties of crop plants are high. There is divergence of opinion on the significance of root cation exchange capacity in the mineral nutrition of plants. One group of workers are of the opinion that CEC of root is related to the mineral composition of plants (Ando *et al.*, 1969).

Arecanut (*Areca catechu* L.) is a perennial tropical palm and the selection of seedlings in the secondary nursery for final planting has a direct bearing on their future yield performances (Bavappa and Ramachander, 1968). Selection of seedlings is usually made on certain morphological characters correlated with yield. The present study was undertaken to examine the relationships if any existing among root CEC, and the growth characters and nutrient composition of seedlings of a few arecanut cultivars.

Material and Methods

The cation exchange capacity of root is affected by numerous factors beginning from the sampling of root material to the methods of estimation employed (Paliwal, 1969). Crooke and his associates (1960) found that the root tips recorded the highest CEC. Hence it was found necessary to standardize a sampling methodology for *Areca* roots before undertaking the actual experimental work.

An examination of the root system of a 2-year old arecanut seedling showed three distinct types of roots, *viz.*, fibrous root, main root, and lateral root (Fig. 1). Samples from fibrous and secondary roots were taken from 5 cm of the apex. The main root was divided into basal, middle and tip portions. The first 5 cm segments from the base and tip of the main root and the remaining middle portion were sampled separately. The sampling was done at random from three healthy seedlings and CEC determined from individual plants for each kind of roots. The details of the procedure followed for washing, drying, and grinding of roots and estimation of CEC were similar to those proposed by Crooke (1964).

The data (Table I) showed that the 5 cm tip of main root had the maximum CEC and the value decreased with the distance from the apex (Crooke *et al.*, 1960). The CEC

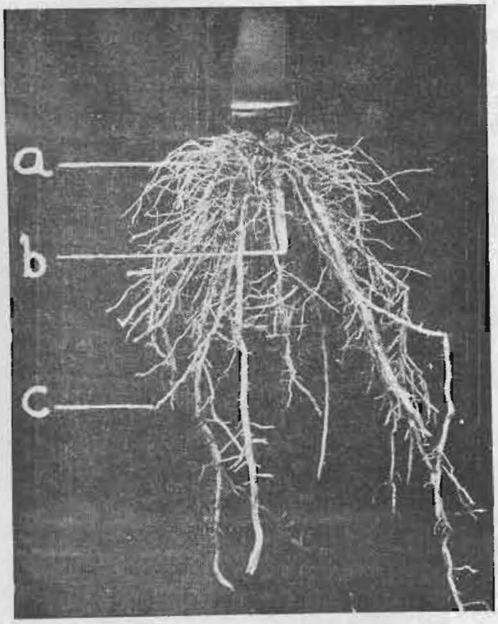

FIG. 1. Photograph of the roots of *Areca catechu* seedling, 5 times reduced from natural size.
Kinds of roots: *a*, fibrous; *b*, main; *c*, lateral.

TABLE I

Cation exchange capacity of different kinds and segments of Areca root

Kind of root	Segment	Root CEC (meq/100g)
Main root	Tip	14·29
Main root	Middle	13·16
Main root	Base	9·28
Fibrous root	Tip	11·98
Lateral root	Tip	12·94
LSD		0·92*

*Significant at 5% level of probability.

of the tip of three kinds of roots differed significantly from each other and was in the order of main root > lateral root > fibrous root. From the point of view of CEC, all the three kinds of roots appeared to be important in the case of arecanut. It is not known whether the variations in the thickness of roots have anything to do with the difference in their CEC. The subsequent samplings for root CEC in the present study were done from a homogenous sample of 5 cm long root tips representing all the three kinds of roots.

Thirteen cultivars of *Areca catechu* L. were selected. All the seedlings were not fertilized so as to satisfy the Donnan's requirement. Four 2-year old seedlings from each cultivar were removed from the nursery and roots separated. The root and leaf samples were collected replicate-wise. Cation exchange capacity was determined by potentiometric titration of roots with the help of Systronix pH meter (Crooke, 1964) and the result expressed as meq per 100 g of dry roots. Leaf samples were dried in an oven at 80° C and ground in a Wiley-type Indian made mill. A known weight of the finely powdered samples of root and leaf was digested in a mixture of perchloric and nitric acids. From an aliquot, K was estimated flame photometrically whereas Ca and Mg were determined as per the method of Cheng and Bray (1951).

RESULTS AND DISCUSSION

The root cation exchange capacity of the seedlings of all the arecanut cultivars under study differed significantly (Table II). The cultivars like VTL-13, VTL-3 and VTL 11 recorded higher CEC than the others. Since seedlings of all the cultivars were grown under identical conditions and of the same age group, any factor other than the biochemical make up of plant roots seems to be responsible for this variation. These findings do not subscribe to the thinking that the root CEC within a given species is more or less constant (Huffaker and Wallace, 1959). Of the three morphological characters, the girth at collar and height of the seedlings were positively correlated with CEC but the coefficients of correlation were statistically not significant (Table II).

In Table II are given the data for the sum of the cations and the ratio between K/Ca+Mg both in root and leaf together with their correlation coefficients with root CEC. There was positive relationship between CEC and P content of root and leaf, the former being significant at 5% level of probability. Increased uptake of phosphorus was earlier stated to be encouraged by the increase in the CEC of crop plants (Paliwal, 1969). It seems that the ability of plants to absorb native phosphorus increases with the increase of root CEC as seen here. The '*r*' value between the

JPC—5

TABLE II

Cation exchange capacity of root as related to morphological characters of arecanut seedlings and mineral composition of leaf and root

Introduction number	Origin	Root CEC (meq/100 g)	Morphological characters: Girth (cm)	Morphological characters: Leaf number	Morphological characters: Height (cm)	Mineral composition, Root: Ca+Mg+K (meq/100 g)	Mineral composition, Root: K/Ca+Mg	Mineral composition, Root: P (meq/100 g)	Mineral composition, Leaf: Ca+Mg+K (meq/100 g)	Mineral composition, Leaf: K/Ca+Mg (meq/100 g)	Mineral composition, Leaf: P (meq/100 g)
VTL–1	Fiji	7·82	0·90	4·67	60·00	76·06	3·25	6·80	71·13	0·25	11·17
VTL–3	China	9·31	2·33	5·00	65·00	57·11	2·90	9·71	70·59	0·22	16·02
VTL–5	Ceylon	7·40	2·27	5·00	65·00	57·43	2·83	9·71	77·12	0·26	13·11
VTL–11	Indonesia (1)	8·89	3·53	5·67	109·00	50·53	2·50	9·76	64·35	0·22	11·17
VTL–12	Saigon (1)	7·38	2·27	5·33	69·00	62·16	2·15	6·80	54·35	0·31	12·14
VTL–13	Saigon (2)	11·26	2·80	5·00	93·00	111·68	0·61	18·45	66.29	0·24	13·59
VTL–14	Saigon (3)	8·51	3·03	5·00	101·00	46·38	2·19	10·68	62·04	0·31	13·59
VTL–17	Singapore	7·74	3·03	6·00	88·00	105·90	1·00	13·59	66·85	0·42	10·68
VTL–18a	British Solomon Islands (1)	8·43	2·07	4·67	60·00	78·11	3·72	16·50	73·99	0·27	13·11
VTL–18b	British Solomon Islands (2)	7·75	2·50	4·67	79·00	52·80	3·63	8·25	67·09	0·31	12·14
VTL–18c	British Solomon Islands (3)	7·25	2·47	5·00	89·00	55·14	2·26	6·80	73·04	0·33	11·17
VTL–48	Indonesia (2)	7·27	3·20	5·33	89·00	65·14	1·87	8·74	97·17	0.26	10·68
VTL–Local	Vittal, India	7·25	2·50	5·00	81·00	63·16	2·05	13·59	64·50	0·26	12·14
'*r*' value			+0·24	−0·01	+0·28	+0·47	−0·34	*0·64*	−0·22	0·36	*0·51
			NS	NS	NS	NS	NS		NS	NS	NS
LSD (CEC of cultivars) 0·29 **											

*Significant at 5% level of probability; ** Significant at 1% level of probability; NS, non-significant.

root CEC and Ca+Mg+K contents of root was positive ($r = +0{\cdot}467$) but non-significant whereas it was negative in the case of leaf. These results lead us to assume that the ionic ratio of cations in the root is not reflected in the leaf probably because of some complex mechanisms involved in the course of their translocations (Crooke and Knight, 1962; Ando *et al.*, 1969). The coefficient of correlation between root CEC and K/Ca+Mg both in leaf and root were not significant but showed a negative relationship thereby indicating that in dilute soil solutions the relative absorption of monovalent to divalent cations by plants obey the Valence effect (Crooke and Knight, 1962). In general, it may be inferred from the present information that use of CEC as a yardstick for selection of seedlings in the nursery is of a doubtful value.

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