

EFFECT OF YELLOW LEAF DISEASE ON THE PHYSIOLOGY OF ARECA PALMS (*ARECA CATECHU* L.)

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The yellow leaf disease is a highly destructive disease of areca palms in South Kerala. The disease is characterised by yellowing of the foliage, premature nut-fall, discolouration and non-hardening of endosperm and morphological aberrations like retarded growth of essential vegetative parts, root decay, tapering of the crown, decreased yield leading to complete sterility in advanced stages of the disease and final death of the affected palms (Nair and Aravindakshan 1970). It is, however, not known how far the disease affects the physiology of the palms and hence the studies presented in this paper were undertaken. These studies included estimation of amino acids, protein, organic acids, chlorophyll and pH in healthy and diseased palms.

Materials and Methods

The samples of plant materials required for the studies were obtained from healthy and diseased palms growing under identical conditions at Palode in Trivandrum district. Estimation of amino acids was done by circular paper chromatography (Giri and Rao 1952). The chromatogram was run in n-butanol-acetic acid-water 4:1:5 (V:V:V) and was sprayed with ninhydrin (triketo-hydrindene hydrate) as detecting reagent. Quantitative estimation was done colorimetrically. Organic acids were separated chromatographically; the solvent system used being n-butanol-formic acid-water 10:1:5 (V:V:V) the detecting reagent being that of Paskova Munk (1960); a semi-quantitative method of analysis of Block *et al* (1955) was used for detecting the acids. Protein estimation was done by the microkjeldahl method (Hawk 1947) and the quantities calculated from the nitrogen values. Chlorophyll 'a' and 'b' were estimated from fresh leaf samples, after extraction in acetone (Mackinney 1960). For pH estimation, different fresh plant parts were macerated and sap extracted and pH values of the sap read with a Beckman pH meter.

Results and Discussion

Amino acids: Table 1 gives the free amino acid contents of healthy and diseased areca leaves. It may be seen that cystine, the sulphur containing amino acid known to be involved in the detoxication mechanism of living organisms showed a wide variation in diseased and healthy plants. The average cystine

Table 1
Free amino acid contents in mg per 100 g of leaf of areca palm

Amino acid	Healthy leaf	Diseased leaf - stages		
		Initial	Intermediate	Acute
Cystin	202.8	180.6	64.0	611.1
Aspartic acid	48.5	40.6	32.7	159.4
Lysine	21.0	37.1	46.8	90.0
Arginine	12.5	14.6	18.8	19.8
Threonine	220.0	Trace	100.0	100.0
Alanine	1.9	Trace	Trace	Trace
Methionine	Trace	Trace	Trace	3.2
Tyrosine	Trace	Trace	15.5	Trace
Phenylalanine	4.8	Trace	Trace	Trace

contents of a healthy plant was of the order of 202.8 mg/100 g leaf. During the initial stages of the disease, the free cystine content in the leaf fell to an average of 180.6 mg and when the disease advanced cystine suffered a further depletion as low as 64 mg/100g. But, as the disease advanced still further, the cystine contents shot up to as high as 611.1 mg/100g. The fight of the plant against the pathogenic condition created by the disease is thus evidenced in this phenomenon. Aspartic acid also showed a similar pattern in the healthy and diseased plants. Threonine contents too showed an initial decrease followed by an increase with advancement of the disease, the latter increase, however, did not reach up to the healthy levels. Lysine and arginine contents increased gradually with increase in the intensity of the disease.

Table 2 shows the amino acid contents of inflorescences and nuts of healthy and diseased palms. The amino acids serine, histidine, and cystine were abundantly present in the inflorescence and nuts of healthy trees while serine and glutamic acid were more in those of diseased plants. The contents of cystine, serine and glutamic acid increased considerably and histidine reduced when the palms became diseased. The contents of lysine, asparagine, alanine, arginine, glutamic acid, methionine and hydroxy-proline were very low in the inflorescence of healthy plants, while in diseased plants their quantities were built up to substantial levels. It is interesting to note that glutamic acid, which occurred in traces in healthy plants, appeared in large quantities in the diseased material. Another feature is that the two aromatic amino acids tryptophan and tyrosine present in the healthy inflorescence almost disappeared in the diseased samples. The same was the case with valine and histidine also. It thus appeared that the diseased inflorescence failed to utilise

Table 2

Free amino acid contents in mg per 100 g of inflorescence and nuts of healthy and diseased areca palms

Amino acid	Healthy	Diseased
Cystine	75.0	122.2
Serine	116.7	520.0
Lysine	Trace	13.6
Histidine	75.5	Trace
Asparagine	Trace	36.2
Alanine	9.0	28.4
Glycine	47.7	23.1
Arginine	Trace	12.1
Glutamic	Trace	384.0
Tryptophan	16.6	Trace
Tyrosine	10.2	Trace
Methionine	Trace	6.8
Valine	14.3	Trace
Hydroxy-proline	Trace	28.8

such amino acids as cystine, serine and glutamic acid and functioned in such a way, metabolically, so as to get them unassimilated. Tryptophan, tyrosine, valine and histidine on the other hand, appeared to have been utilised fully by the diseased plant.

The data on the amino acid contents of areca stem is given below in Table 3. The amino acid pattern of the stem was different from that of the other parts of the palm. The most important amino acid of the

Table 3

Free amino acid contents in mg per 100 g of stem of healthy and diseased areca palms.

Amino acid	Healthy	Diseased
Serine	4566.7	708.3
Arginine	160.4	21.9
Threonine	25.5	3.4
Alanine	16.3	Trace
Hydroxy-proline	10.2	Trace

stem was found to be serine followed by arginine, threonine, alanine and hydroxy-proline. There was a gradual decline in the above amino acid contents as the palms became diseased. During the diseased condition the total amino acid contents of the stem fell to a very low value.

Table 4
Free amino acid contents in mg per 100 g roots of healthy and diseased palms

Amino acid	Healthy	Diseased		
		Initial	Intermediate	Acute
Cystine	319.45	Trace	36.11	22.22
Histidine	39.62	9.50	5.70	Trace
Proline	360.00	Trace	120.00	Trace
Glycine	Trace	Trace	Trace	Trace
Alanine	3.85	Trace	1.30	Trace
Threonine	Trace	Trace	Trace	Trace
Tyrosine	Trace	Trace	Trace	Trace
Hydroxy-proline	Trace	Trace	Trace	Trace
Isoleucine	Trace	Trace	Trace	Trace

Table 4 represents the data on the amino acid set up of healthy and diseased roots of areca palms. The roots of healthy palms contained fairly large quantities of proline, cystine and histidine. Among them proline was specific to roots. Due to the onset of the disease, the above three amino acids recorded a fall in concentration and in the advanced stages these three almost disappeared.

Organic acids: Table 5 gives the results of estimations of organic acids present in healthy and diseased leaves of areca palms. It is observed that the contents of oxalic acid, succinic acid and tannic acid were considerably higher in leaves of diseased palms than in those of healthy palms.

Table 5
Organic acid contents in leaves of healthy and diseased areca palms

Organic acid	Healthy	Diseased
Malic acid	+	++
Tartaric acid	+	++
Oxalic acid	+	+++
Succinic acid	+	+++
Tannic acid	++	+++

+ Low; ++ Medium; +++ High

Table 6

Protein contents in mg/10g of different parts of healthy and diseased areca palms

Plant part	Healthy		Diseased
Leaf	2.375	Initial:	2.062
		Intermediate:	2.425
		Acute:	3.937
Inflorescence	3.937	.	4.250
Nut	4.937		4.250
Stem	Trace		Trace
Root	1.125		Trace

Protein: The results of estimation of protein are given in Table 6. In the leaf there was a decrease in the protein contents during the initial stages of the disease followed by an abnormally high leaf protein contents in the highly diseased plant. This high protein contents may be attributed to the non-utilization of proteins formed during anabolism for the production of nuts. A similar feature was manifested in the inflorescence also.

Chlorophylls: Estimation of chlorophyll 'a' and 'b' in healthy and diseased leaves showed that the healthy leaves contained an average of 93.62 g of chlorophyll 'a' and 73.99 g of chlorophyll 'b' per 10 mg of leaf while their contents in the diseased leaves were 29.94 and 23.66 g per 10 mg of leaf respectively.

pH: Determination of pH of the sap extracts of the different parts of healthy and diseased plants showed that there was no significant difference in pH between the healthy (4.215 average) and diseased (4.150 average).

Summary

Effect of the yellow leaf disease on the physiology of areca palms was studied by estimation of the contents of amino acids, organic acids, protein, chlorophylls and pH of healthy and diseased plants. In the leaves the contents of cystine, aspartic acid and lysine increased considerably when the plants became diseased; the increase in the case of arginine and methionine was only slight. Threonine suffered a drastic reduction due to the disease; phenylalanine and alanine also showed reductions.

In inflorescence the contents of cystine, glutamic acid and serine increased considerably when diseased, the increase being smaller in the case

of lysine, asparagine, arginine, methionine and hydroxy-proline. Reduction with disease occurred in the case of histidine, glycine, tryptophan, tyrosine and valine.

In the stem all the five amino acids detected viz., serine, arginine, threonine, alanine and hydroxy-proline suffered reduction when disease set in.

In the roots the chief amino acids were cystine, histidine and proline and all these suffered a set back when the plants became diseased; proline was found specific to roots.

The contents of the organic acids viz. malic acid, tartaric acid, oxalic acid, succinic acid and tannic acid increased with the disease.

Higher protein contents in diseased over the healthy palms were seen in leaf and inflorescence.

pH of sap was not affected significantly by the disease.

Acknowledgements

The authors wish to express their thanks to Mr. K. V. Ahamed Bavappa, Director, Central Plantation Crop Research Institute Kasargod and to Prof. P. Kumara Pillai, Principal (Retired), Agricultural College, Vellayani, for their interest and kind encouragements given in the execution of the work. They are also indebted to Dr. Sadasivan Pillai, University of Kerala and to Mr. N. Chitaranjan Nair, Agricultural College, Vellayani, for the helps rendered during the course of the investigations.

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(Accepted: 7-6-1972)