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NUTRITIONAL STUDIES ON INITIAL FLOWERING OF COCONUT (VAR. *TYPICA*) II. FREE AMINO ACIDS IN LEAVES OF BEARING AND NON-BEARING PALMS

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SUMMARY

Glucose, free amino acids, total nitrogen, protein nitrogen and non-protein nitrogen were all strikingly lower in the laminae of non-bearing coconut palms than in bearing palms of similar age. The free amino acid content and the chromatographic pattern of amino acids of the laminae from 11 year old non-bearing palms were very similar to those of 18-month old nitrogen starved young palms grown in sand cultures. Results indicated that a derangement in carbohydrate metabolism due to Mg–P deficiencies leads to a defective nitrogen metabolism which was probably responsible for the observed delay in initial flowering of coconut palms.

In recent investigations on nutritional factors affecting initial flowering of coconut palms, De Silva *et al.* (1973) have observed that under conditions of low availability of magnesium, the efficiency of utilization of phosphorus was adversely affected causing in effect a "physiological lowering" of phosphorus in the fronds. This was strikingly seen in non-bearing plants which have been described as "magnesium-susceptible". In these non-bearing palms it was also observed that the total amount of nitrogen in the laminae was significantly lower than in bearing palms of identical age.

This paper describes some studies undertaken to explain the observed differences in the nitrogen content of the bearing and non-bearing palms, and also gives further information on the factors affecting initial flowering in coconut.

MATERIALS AND METHODS

The leaf samples for this investigation were collected in August 1971 from bearing and non-bearing coconut palms in an observation plot at Bandirippuwa Estate, Lunuwila, Sri Lanka. The plants in this plot were eleven years of age at the time of sampling, and had been fertilized annually as described by De Silva *et al.* (1973).

Samples were also taken from 18 month old young palms, which had been subjected to subtractive treatment of nitrogen, phosphorus and magnesium in sand cultures.

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Leaf samples

The youngest fully opened leaf (1st leaf) was sampled for the biochemical assay. Six leaflets were taken from the mid region of each frond and after removing the mid ribs, the middle third of the laminae was prepared for analysis. The material from 5 palms was composited to form a sample.

Analytical procedures

Fresh leaf material was homogenised (1 g in 3 ml of water) in a Waring blendor and strained through gauze.

Total nitrogen was determined in a 2.0 ml aliquot of this extract by the Kjeldahl method.

For the estimation of free amino acids, a protein free filtrate was prepared by mixing equal volumes of the aqueous extract and 10% trichloroacetic acid (TCA). The free amino acids were determined in one portion of the TCA filtrate using the ninhydrin method of Troll and Cannan (1953). The other portion was desalted using Dowex-50 as described by Smith (1958). The eluate was evaporated under reduced pressure in a rotary evaporator and the amino acids were separated by descending paper chromatography (Partridge, 1948).

The determination of glucose was carried out in the original water extract by the Somogyi's method (1952).

RESULTS

The total nitrogen, protein nitrogen and non-protein nitrogen in water extracts of leaves from bearing and non-bearing coconut palms are given in Table 1. It is clear that the 3 forms of nitrogen in leaves of bearing palms were at least 25 percent more than in leaves of non-bearing palms.

Table 1

Major fractions of nitrogen in water extracts of leaves from bearing and non-bearing adult coconut palms expressed in mg/100 g fresh material

	Total N	*Protein N*	*Non-protein N*
Non-bearing palms	25.2	19.2	6.0
Bearing palms	31.5	24.0	7.5

Table 2

Contents of glucose and free amino acids in leaves of bearing and non-bearing adult palms and in young palms grown in sand cultures

Sample	*Glucose*		*Free amino acid*	
	mg/100g fresh material	%	*m moles/100g fresh material*	%
Non-bearing adult palms	186	100	150	100
Bearing adult palms	250	134	228	152
Minus N young palms	227	122	120	80
Minus P young palms	ND*	—	360	240
Minus Mg young palms	ND	—	301	201
Plus all nutrients young palms	ND	—	480	320

*Not determined.

Table 2 shows the glucose and amino acid contents in leaves of bearing and non-bearing adult palms, compared with young palms subjected to subtractive treatment of N, P and Mg. The level of free amino acids in leaves of non-bearing adult palms was significantly lower than that of bearing palms and was of the same order as that in nitrogen starved young palms. It was also noted that the free amino acid contents in leaves of bearing palms were about 50 percent more than that found in leaves of non-bearing palms of identical age. The free amino acid contents in leaves of young palms deprived of magnesium and phosphorus, although lowe than in those receiving the full complement of nutrients in sand cultures, are much higher than in those of nitrogen starved plants. In contrast to the non-bearing adult palms growing in soils which are marginal in magnesium, the magnesium starved young palms growing in sand cultures have a higher content of free amino acids. This is probably due to the translocation of magnesium from the seednut reserves during early stages of growth.

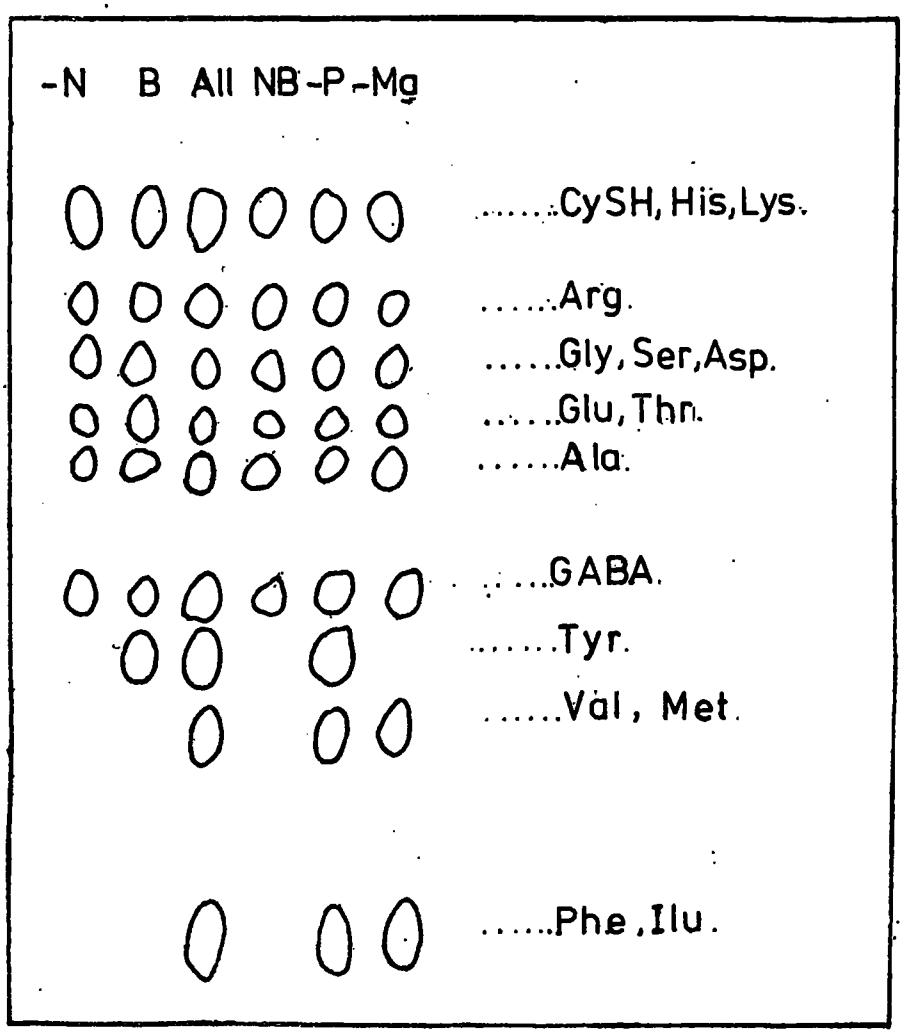

Fig. 1. The chromatographic pattern of free amino acids of laminae from minus nitrogen young palms (-N), bearing adult palms (B), all nutrient young palms (All), non-bearing adult palms (NB), minus phosphorus young palm (-P) and minus magnesium young palm (-Mg).
The standard amino acids chromatographed under identical conditions showed that the spots contained one or more amino acids as indicated on the chromatogram.

Fig. 1 illustrates the free amino acid pattern in the leaves of the 6 categories of palms. The chromatogram shows that the distribution and intensity of spots obtained from leaves of non-bearing adult palms were similar to those of nitrogen-deprived young palms. Amino acids like serine, aspartic, glutamic and alanine obtained from the glycolytic and Kreb's cycle intermediates were present in very much reduced amounts in both non-bearing adult palms and young palms deprived of nitrogen when compared to bearing palms. Further, tyrosine which was present in the leaves of bearing palms, was not detectable in leaves of either the non-bearing adult palms or the nitrogen starved young palms.

DISCUSSION

The data presented above indicate that the physiological state of the non-bearing adult palms under investigation was very similar to that of young palms which had been deprived of an external source of nitrogen.

De Silva *et al.* (1973), in an earlier investigation on the Mg-P relationship between bearing and non-bearing palms found evidence which suggested that non-bearing palms could in fact be a class of "magnesium-susceptible" genotypes. They also observed that as a result of this character, non-bearing palms were unable to make the best use of phosphate that was provided, leading to a state in which both magnesium and phosphorus were present in reduced amounts in leaves.

The role of magnesium and phosphorus in the carbohydrate metabolism is well known. Their combined deficiency in leaves of non-bearing palms could therefore be expected to reduce not only the synthesis of glucose (Table 2) but also its further metabolism. This in conjunction with the observed decreases in total and non-protein nitrogen, could explain the incidence of decreased amounts of certain amino acids like aspartic, glutamic, alanine and serine observed in the non-bearing and nitrogen starved palms. The decrease in protein nitrogen is probably a consequence of the lower amounts of free amino acids.

These results therefore indicate that in the non-bearing adult palms under investigation, a derangement in carbohydrate and nitrogen metabolism probably established a physiological state which was not conducive to the production of reproductive structures.

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