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NUTRITIONAL STUDIES ON INITIAL FLOWERING OF COCONUT (*VAR. TYPICA*). I. EFFECT OF MAGNESIUM DEFICIENCY AND Mg-P RELATIONSHIP

By M. A. T. De Silva, V. Abeywardena,
G. D. George

Coconut Research Institute, Lunuwila, Sri Lanka

AND

K. Balasubramaniam

Department of Biochemistry, University of Sri Lanka, Colombo

SUMMARY

Analyses of fronds from bearing and non bearing adult coconut palms of identical age, showed that the latter had significantly lower levels of N,P and Mg. The relatively higher density of tender primary roots in non bearing palms has been considered to be a compensatory mechanism to absorb more magnesium from a soil known to have a marginal magnesium status. However the observed deficiency of both magnesium and phosphorus in fronds of non bearing palms, viewed in relation to the observed accumulation of phosphorus in their roots, seems to indicate that the translocation of phosphorus from root to shoot could be adversely affected when the supply level of magnesium is low. P has been shown to have a profound influence on initial flowering of coconuts. Delayed flowering in these coconut palms at Bandirippuwa, Sri Lanka is thus attributed to an induced lowering of P in fronds, caused by a lower uptake of magnesium by roots.

Coconut palms (var. *typica*) are known to flower in about five to eight years after transplanting in the field. A delay in initial flowering is often observed in poorly managed plantations where palms may take as much as twelve years to commence flowering.

Abeywardena (1961) found that the frequency of initial flowering in coconut (var. *typica*) did not follow the normal distribution. It was suggested that the positive skewness in the distribution curve of initial flowering was an inherent feature in a coconut plantation grown under sub-optimal conditions, caused probably by competition for nutrients.

The present work was initiated to examine some of the nutritional factors which may affect initial flowering in coconut.

MATERIALS AND METHODS

Materials for this investigation were taken in August 1971 from an eleven year old coconut plantation at Bandirippuwa Estate, Lunuwila, Sri Lanka. The plantation which covered about 8 hectares, received annually a fertilizer mixture containing 2.3 kg of ammonium sulphate, 0.9 kg of saphos phosphate and 1.4 kg of muriate of potash in a dosage of 4.5 kg per palm. At the time of the investigation approximately 20 percent of the palms of this block had not commenced flowering.

The soil in this area is known to have a marginal magnesium status ,since extracts of the soil with 10^{-2} molar solutions of calcium chloride gave values less than 20×10^{-3} for the molar Mg : Ca ratio suggested as critical by Nethsinghe (1963). However, striking foliar symptoms were not evident.

Leaf samples

The 14th frond counting basipetally from the youngest fully opened leaf (1st leaf) was sampled from 10 bearing and 10 non bearing palms for the determination of major mineral nutrients. Twenty leaflets from the mid region of each frond were removed, and after separating the midribs, the middle third of the laminae were prepared for analysis.

Root counts and root samples.

The bases of 10 bearing and 10 non bearing palms were excavated to expose the rooting zone. The mature (lignified) and tender primary roots in the top 5.0 cm strip of the rooting zone on the bole of each palm were counted.

Samples of root tips 2.0 cm in length, were also taken from the tender roots of these palms, and analysed for calcium, magnesium and phosphorus. Earlier studies on the distribution of mineral nutrients in young roots showed that the highest concentration of each nutrient was present in the 2.0 cm length from the tip, indicating that this was the region of highest absorption (De Silva, unpublished).

Analytical methods.

Nitrogen was determined by Kjeldhal's method, phosphorus by the vanado—molybdate colorimetric method and potassium by flame photometry. Calcium and magnesium were estimated in ashed extracts with EDTA after separating phosphorus with zirconyl chloride (Derderian, 1961).

RESULTS

Nitrogen, phosphorus, potassium, calcium and magnesium in the laminae (14th frond) of bearing and non bearing coconut palms are expressed as percentages in Table I (a), and as total amounts in Table I (b).

The data in Table I (a) show that the percentages of magnesium and phosphorus in non bearing palms were significantly lower than in bearing palms, while there were no significant differences in nitrogen, potassium and calcium percentages between the two groups. It may also be noted that the magnesium levels in leaves of non bearing palms are well below the "critical level" of 0.300 per cent suggested by Fremond *et al.* (1966), while phosphorus concentrations lie in the neighbourhood of the suggested critical level of 0.120 per cent. On the other hand, in leaves of bearing palms, magnesium concentrations are marginal, while phosphorus concentrations may be considered to be optimal.

The same data when expressed as the total amounts present in laminae (Table 1 (b), showed that in addition to magnesium and phosphorus, nitrogen was also significantly low ($P = 0.05$) in the non bearing palms.

In Table 2 is summarised the distribution of mature and tender primary roots in the top 5.0 cm of the rooting zone on the bole of bearing and non bearing palms. A distinct feature of non bearing palms is the presence of fewer mature roots and a significantly greater number of tender primaries. The ratio of mature to tender roots is significantly higher in the bearing than in the non bearing trees.

The analytical data of root tips (Table 3) sampled from tender primary roots of the two categories of plants show that in non bearing palms, phosphorus and calcium were significantly higher than in those of the bearing palms. Therefore in these plants the phosphate status in roots was the reverse of that found in leaves. Although the magnesium contents in the root tips of bearing palms were generally higher than in those of non bearing palms, the differences were not statistically significant.

Table 1 (a) N, P, K, Ca and Mg in laminae of the 14th frond of bearing and non bearing coconut palms (percentage oven—dry matter).

		N	P	K	Ca	Mg
Bearing	Mean (%)	2.657	0.1736***	1.678	0.2540	0.1695**
	Range*	2.28—3.00	0.1569–0.1889	1.08–2.09	0.1158–0.3297	0.1166–0.3276
Non bearing	Mean (%)	2.462	0.1461	1.566	0.2601	0.0973
	Range	1.69–3.05	0.1159–0.1739	1.23–1.99	0.1788–0.3491	0.0259–0.1774

—Significant at P—0.01 *—Significant at P—0.001

Table 1 (b). Total amount in grams of the various elements present in the laminae of the 14th frond of bearing and non-bearing coconut palms.

	N	P	K	Ca	Mg
Bearing	36.969*	2.428***	23.830	3.535	2.326***
Non bearing	29.330	1.734	18.250	3.081	1.1338

*Significant at P=0.05 **Significant at P=0.01 ***Significant at P=0.001

Table 2. Distribution of mature and tender primary roots on the top 5.0 cm. of the rooting zone of bole in bearing and nonbearing coconut palms.

(*Mean of* 10 *palms in each category*)

	Tender *roots*	*Mature roots*	*Mature/Tender ratio*
Bearing palms	48.7***	186.7	5.45**
Non bearing palms	81.9	148.4	1.78

** Significant at P=0.01 *** Significant at P=0.001

Table 3. Phosphorus, calcium and magnesium contents in root tips of bearing and nonbearing palms expressed as contents per 100 g of the oven dry sample.

		P	Ca	Mg
Bearing palms	Mean :	0.5533**	0.0862***	0.1462
	Range :	0.5028–0.6922	0.0583–0.1071	0.1089–0.2194
Non bearing palms	Mean :	0.6579	0.0918	0.1299
	Range :	0.5407–0.7770	0.0625–0.1323	0.0853–0.2498

** Significant at P=0.01 *** Significant at P=0.001

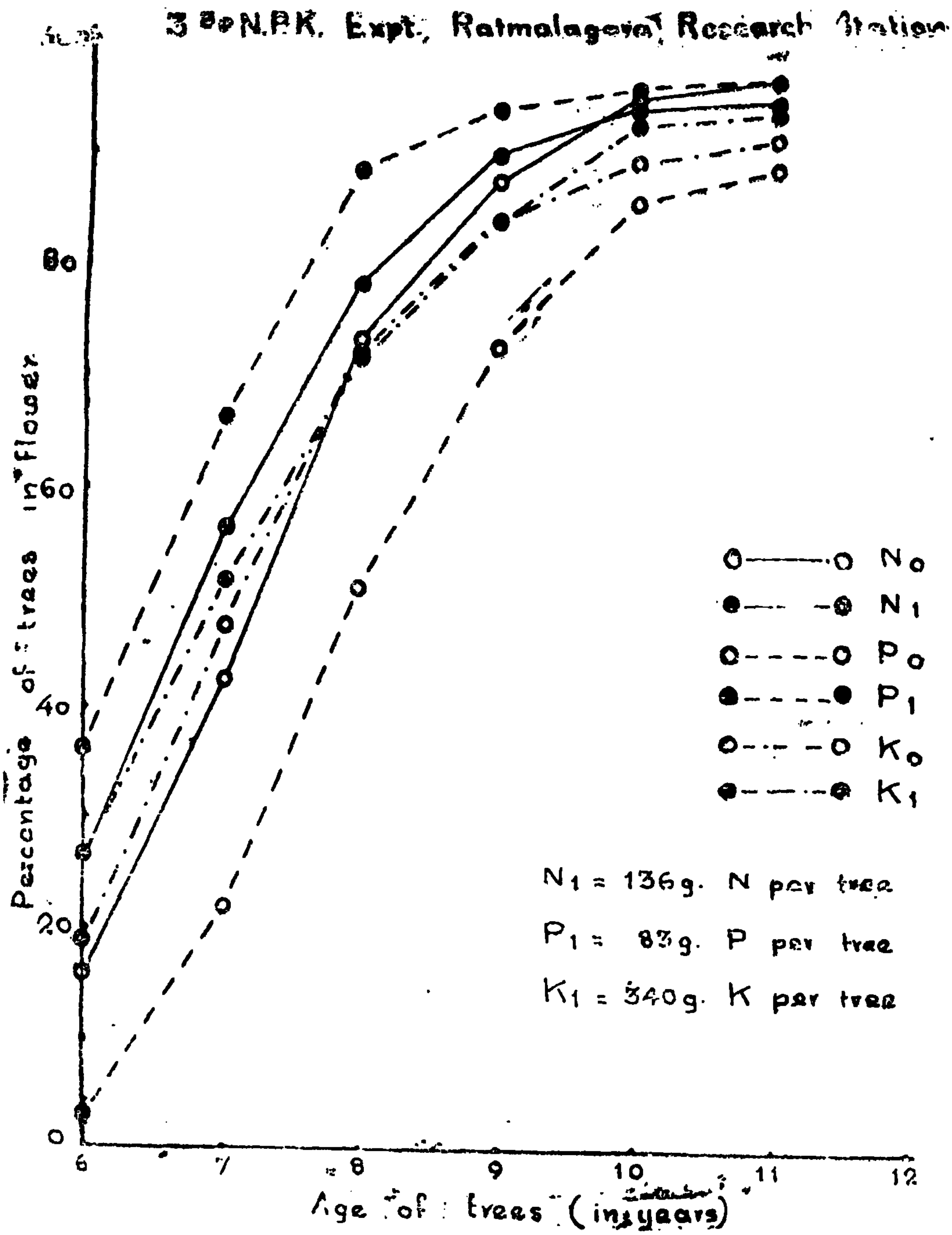

Fig. 1. Effects of N, P and K on initial flowering of coconut palms (var. *typica*), at Ratmalagara Research Station, Madampe.

Data extracted partly from unpublished records and partly from 'Reports of the Soil Chemist' appearing in Annual Reports of the Coconut Research Institute of Ceylon, for years 1954—59.

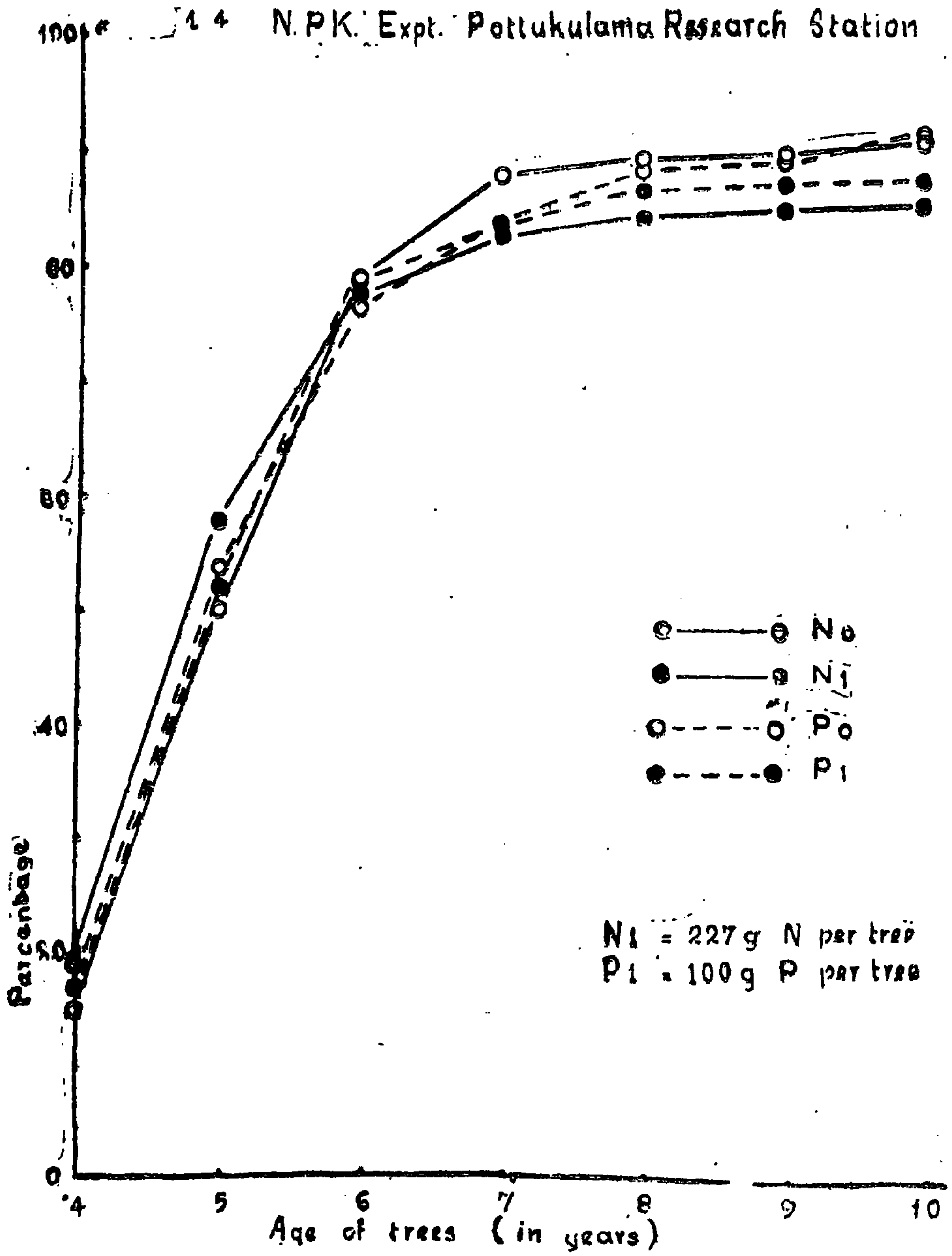

Fig. 2. Effects of N and P on initial flowering of coconut palms (var. *typica*), at Pottukulama Research Station.

Data extracted partly from unpublished records and partly from 'Reports of the Soil Chemist' appearing in Annual Reports of the Coconut Research Institute of Ceylon, for years 1965 and 1966.

The results presented in Figs. 1 and 2 are from long term fertilizer experiments carried out by the Coconut Research Institute of Sri Lanka. Fig. 1 depicts the influence of nitrogen, phosphorus and potassium fertilizers on initial flowering in coconut growing on a phosphate deficient soil (bicarbonate extractable P—4.6 ppm) at Madampe in north—west of Sri Lanka. Fig. 2 shows the influence of phosphorus on initial flowering of coconut growing on a soil at Pottukulama in north—west of Sri Lanka whose bicarbonate extractable phosphorus was 8.8 ppm. Fig. 1 clearly shows the stimulation of initial flowering of coconut palms by phosphorus.

DISCUSSION

In the present study it is noted that magnesium is relatively low in the fronds as well as in the roots of non bearing palms when compared with those of bearing palms. On the other hand phosphorus has been shown to be low in the fronds and high in the roots in non bearing palms when compared to those of bearing palms. It was likely therefore that due to a deficiency of magnesium (probably on account of low availability), movement of absorbed phosphorus from root to shoot in coconut palms was adversely affected causing in effect a "physiological" lowering of phosphorus in leaves and its accumulation in the roots. Such an inference would lend support to the "Carrier Theory" of Truog *et al.* (1947). They found that when the supply of magnesium to pea plants grown in water culture experiments was increased, a corresponding increase was observed of both magnesium and phosphorus in pea seeds; and this occurred regardless of the change in the supply level of phosphorus. Such observations led them to believe that magnesium could function as a "carrier" for phosphorus. However, Hewitt (1962) contended that this behaviour was due mainly to the almost universal importance of magnesium in the enzyme systems which are involved in all aspects of phosphorus metabolism.

As mentioned earlier, the bearing and non bearing palms selected for this study were from the same plot and received the identical fertilizer mixture containing N, P and K. Although these palms had a comparable background, the two categories behaved differently in respect of magnesium nutrition. The reason for this is not clear, but it is likely that a genetic factor was involved in which the non bearing palm behaved as a "magnesium—susceptible" genotype.

The ratio of mature to tender roots was higher in bearing than in non bearing palms. The greater number of tender primary roots on non bearing palms was probably a compensatory mechanism to absorb more magnesium from a soil which was known to have a marginal magnesium status. Apparently this adaptation did not have the desired effect, since magnesium levels in fronds on non bearing palms remained low. This decrease in magnesium resulted in the lowering of phosphorus in leaves of non bearing palms.

The information obtained from Figs. 1 and 2 clearly demonstrate the signal importance of phosphorus for the production of flowers in coconut palms. It may thus be concluded that a secondary deficiency of phosphorus in leaves induced by a primary deficiency of magnesium was a factor responsible for delayed production of reproductive structures in the plants under investigation.

As referred to earlier, apart from magnesium and phosphorus, the total nitrogen content in leaves of non bearing palms was also low. In collateral investigations, Balasubramaniam *et al.* (1974) have shown that a derangement in carbohydrate metabolism probably leads to this low nitrogen content in leaves of non bearing palms.

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