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EFFECT OF NUTRITION ON LEAF NUTRIENT CONCENTRATION IN OIL PALM (*ELAEIS GUINEENSIS* JACQ)

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ABSTRACT

A field study on the effect of graded levels of N, P, K, Ca and Mg on the leaf tissue concentration in oil palm was conducted at the plantations of the Oil Palm (India) Ltd. at Bharathipuram (Kerala) during 1978 and 1979. The study revealed that nitrogen fertilisation increased leaf concentration of all the elements (N, P, K, Ca and Mg) under trial and reduced the chlorine concentration. It was observed that there was a two way antagonism between the leaf concentration of K and Ca+Mg. Similarly, an antagonism of chlorine on the uptake of potassium was also observed in the present study.

INTRODUCTION

Foliar analysis to detect mineral deficiencies as an aid for interpretation of the agronomic experiments is generally practised in all the perennial crops, where responses to fertilisers will take a longer time (Hartley, 1977). Foliar analysis can be considered as a diagnostic tool to study the uptake pattern of individual plant nutrients and its consequent effect on growth and yield. Chapman and Gray (1949), Broeshart (1957); Prevot and Ollagnier (1959); Ollagnier, Ochs and Martin (1970); Tan (1973), Warriar and Piggot (1973), Umar Akbar et al. (1976), Nair (1981) and Nair and Sreedharan (1982) studied the leaf nutrient concentration in oil palm under various situations. The leaf nutrient concentrations vary according to soil conditions, planting materials, season and also previous manuring history. The critical values of nutrient concentrations in oil palm are arrived independently in different parts of the world. But such results are not available under the Indian conditions. The present investigation was undertaken to study the effect of graded levels of N, P, K, Ca and Mg on the leaf nutrient concentration of the respective elements in oil palm.

MATERIALS AND METHODS

The investigations were carried out in the plantations of the Oil Palm (India) Ltd. at Bharathipuram, Kerala State. Oil Palm C. V. *Tenera* planted in 1972 was used for the experiment

Three levels of each of nitrogen (400, 800 and 1200 g) as urea, phosphorus (200, 400, 600g) as rock phosphate, potassium (600, 1200, 1800g) as

muriate of potash and two levels each of Ca (0 and 500g) as Calcium Oxide and Magnesium (0 and 500g) as Magnesium Sulphate were applied per palm per year. The design was a $3^3 \times 2^2$ split plot with a single replication, laid out in three blocks of nine major treatments plus one treatment of absolute control. Each main plot treatment consisted of 27 combinations of N, P and K and four combinations of Ca and Mg. Each main plot treatment consisted of 20 palms and each sub plot 5 palms.

Calcium and magnesium were applied in March-April. N, P and K fertilisers were applied in two equal splits during May and October respectively. Leaf samples from the 17th leaf of all the palms in a treatment were collected for two years during September 1978 and 1979. The sampling procedure adopted were that described by Poon (1969). Six leaflets from each side of the middle portion of the rachis were taken and thoroughly cleaned. The midrib and marginal 2 mm of the laminae were removed. Middle portion of the laminae consisting of 20–30 cm was taken and dried at 65°C – 75°C for about 5hr in a hot air oven and used for estimation.

Leaf nitrogen was estimated by digesting the sample with concentrated sulphuric acid and read colorimetrically (Jackson, 1967). Phosphorus, potassium, calcium and magnesium were estimated by the wet oxidation of the leaf tissues by triacid mixture as suggested by Jackson (1967). Chlorine in the leaf tissues was estimated by the dry ash method (Jackson, 1967).

RESULTS AND DISCUSSION

Nitrogen application significantly increased the leaf N concentrations (Tables I, II and Fig. 1). The N_3 level gave a higher tissue N concentration than N_2 level. There was also a significant increase in the leaf P concentration by N application. Similarly, N application had increased leaf K, Ca and Mg concentration. But it was noticed that there was a significant reduction in the chlorine concentration as the level of nitrogen increased. The increase in the leaf P concentration by N fertilisation may be attributed to the general relationship of N on P since both being constituents of plant proteins, their concentration must remain constant. If concentration of N increases or decreases, the protein can keep its normal composition only if P also correspondingly increases or decreases (Ollagnier, Ochs and Martin, 1970). The significant reduction in chlorine concentration by increased N application may be due to antagonistic effect of N on chlorine (Anonymous, 1974). The increase of K, Ca and Mg in leaf tissue proves the synergistic effect of N on the above nutrients.

Further, it can be seen that (Tables I, II and Fig. 1) phosphorus application, increased N and P concentrations in leaf tissue. There was also an increase in leaf tissue Ca and Mg concentrations but not significant. Hartley (1977) also reported similar effects of P fertilisation on the leaf concentration of the above nutrients in oil palm.

When the effect of the fertilisers on the leaf nutrient concentration of cationic elements (K, Ca and Mg) are considered

Table I. *Effect of fertilisers on leaf tissue nutrient concentration (%) (September, 1978)*

	N	P	K	Ca	Mg	Cl
N_1	2.314	0.134	0.798	0.639	0.269	0.444
N_2	2.415	0.141	0.813	0.746	0.317	0.437
N_3	2.586	0.143	0.836	0.742	0.364	0.422
CD	0.223*	0.005*	NS	NS	NS	0.018
P_1	2.339	0.135	0.854	0.662	0.289	0.429
P_2	2.500	0.140	0.827	0.710	0.305	0.445
P_3	2.476	0.143	0.767	0.756	0.357	0.429
CD	NS	0.005*	NS	NS	NS	NS
K_1	2.401	0.137	0.780	0.724	0.369	0.387
K_2	2.427	0.142	0.825	0.707	0.299	0.428
K_3	2.488	0.139	0.843	0.696	0.289	0.489
CD	NS	NS	NS	NS	NS	0.018*
Ca_0	2.459	0.139	0.806	0.701	0.289	0.432
Ca_1	2.418	0.139	0.826	0.707	0.345	0.436
CD	NS	NS	NS	NS	0.029*	NS
Mg_0	2.453	0.140	0.854	0.686	0.282	0.432
Mg_1	2.424	0.139	0.774	0.733	0.312	0.436
CD	NS	NS	0.033*	0.068*	0.029*	NS
General mean	2.438	0.139	0.816	0.709	0.312	0.434
Absolute control	1.638	0.129	0.478	0.607	0.212	0.190
Treatment *Vs.* Absolute control	Sig**	NS	Sig**	NS	NS	Sig**

NS – Not significant
* Significant at 5 per cent level
** Significant at 1 per cent level

(Tables I, II and Fig. 1), an antagonism between K and Ca + Mg was observed. As per the observations, the increase in leaf tissue K concentration consequent to K fertilisation had reduced the leaf concentration of Ca and Mg and *vice versa*. In this connection, the work of Prevot and Ollagnier (1954) is relevant which indicated that the sum of the K + Ca + Mg concentration in leaf always remains at two per cent, irrespective of the balance between them. Further, it was observed that a deficiency of K is expressed not only by a low K concentration in the leaf, but equally by Ca and Mg concentrations above their critical levels (Ollagnier et al. 1970). This fact is also substantiated from the present finding (Tables I and II) wherein, the sum of the K + Ca + Mg remains around two per cent. Within this level, two-way antagonism between the leaf concentrations of K and Ca + Mg occurs due to fertilisation of the respective

Table II. *Effect of fertilisers on leaf tissue nutrient concentration (%) (September, 1979)*

	N	P	K	Ca	Mg	Cl
N_1	2.363	0.138	0.896	0.717	0.298	0.420
N_2	2.612	0.139	0.903	0.724	0.304	0.419
N_3	2.686	0.145	0.911	0.695	0.323	0.404
CD	0.130**	0.005**	NS	NS	NS	0.015*
P_1	2.515	0.136	0.927	0.688	0.297	0.397
P_2	2.593	0.141	0.903	0.702	0.307	0.427
P_3	2.552	0.144	0.879	0.746	0.320	0.420
CD	NS	0.005*	NS	NS	NS	0.015*
K_1	2.546	0.138	0.859	0.717	0.311	0.362
K_2	2.564	0.143	0.906	0.717	0.307	0.407
K_3	2.551	0.141	0.944	0.706	0.307	0 475
CD	NS	NS	NS	NS	NS	0.015**
Ca_0	2.527	0.140	0.892	0.695	0.289	0.416
Ca_1	2.580	0.141	0.914	0.729	0.328	0.413
CD	NS	NS	NS	0.024**	0.038**	NS
Mg_0	2.529	0.141	0.911	0.712	0.309	0.412
Mg_1	2.579	0.140	0.896	0.712	0.308	0.418
CD	NS	NS	NS	NS	NS	NS
General mean	2.559	0.140	0.903	0.712	0.308	0.415
Absolute control	1.554	0.125	0.627	0.508	0.239	0.197
Treatment *Vs.* Absolute control	Sig**	Sig**	Sig**	Sig	NS	Sig**

NS – Not significant

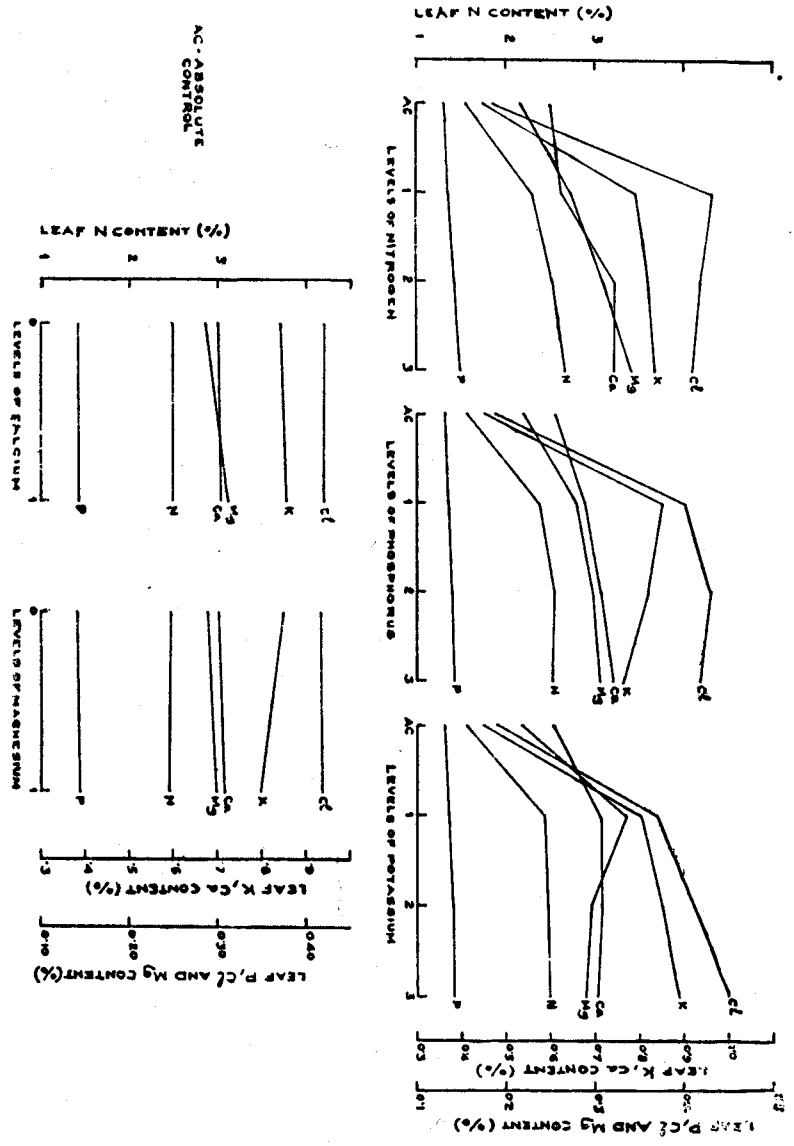
* Significant at 5 per cent level

** Significant at one per cent level

nutrients. It may be mentioned here that the accepted critical levels for the tissue concentration of K, Ca and Mg are 1.00, 0.60 and 0.24 per cent respectively in leaf 17. (Ollagnier et al., 1970). Whenever there is an increase in leaf tissue concentration of Ca and Mg above critical levels, there is always a corresponding decrease in the K concentration. Similarly an excess of leaf tissue concentration of K would automatically result in a corresponding reduction in leaf Ca and Mg concentration.

Unlike N and P and contrary to what is normally observed, the application of Potassium (as muriate of potash) did not significantly increase the leaf tissue K concentration. This behaviour can be explained by K × Ca antagonism

FIG. 1. EFFECT OF FERTILISERS ON LEAF NUTRIENT CONTENT (MEAN OF SEPTEMBER 1978 AND 1979)



exhibited in the presence of chlorine. The work of Ollagnier (1973) reveals that the chlorine in KCl decreased the leaf tissue K concentration and increased the Ca concentration. Lack of significant increase in the K concentration in the leaf tissues in the present investigation might be due to this antagonism of chlorine on the uptake of potassium. The higher leaf Ca and Mg concentration

above the suggested critical levels also substantiates this phenomenon. The leaf nutrient concentration of K + Ca + Mg, almost remaining at two per cent, it is possible that when the K concentration is lowered the Ca + Mg concentrations are correspondingly increased.

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REFERENCES

ANONYMOUS, 1974. I. R. H. O. Rapport d' activities 1972–73. Document 1138, Paris.

BROESHART, H. 1957. The application of foliar diagnosis to oil palm cultivation. IV. The diagnosis of multiple deficiencies. *Trop. Agricult.* **34**: 269–276.

CHAPMAN, G. W. and GRAY, H. M. 1949. Leaf analysis and the nutrition of the oil palm. *Ann. Bot.* **13**: 415–433.

HARTLEY, C. W. S. 1977. *The Oil Palm.* 2nd edition. Longman Group Ltd., London. pp 495.

JACKSON, M. L. 1967. *Soil Chemical Analysis.* Prentice Hall of India, New Delhi. pp. 498.

NAIR, ACHUTHAN, M. 1981. Nutritional studies on oil palm *(Elaeis guineensis* Jacq.) Ph.D thesis. Kerala Agricultural University, Trichur, India. pp. 110.

NAIR, ACHUTHAN, M. and SREEDHARAN, C. 1982. Nutritional requirements of oil palm *(Elaeis guineensis* Jacq.) *J. Plant. Crops.* **10**: 45–52.

OLLAGNIER, M. 1973. Anionic nutrition of the oil palm – Application to the fertiliser polycyin North Sumatra. pp. 227–238. In *Advances in Oil Palm Cultivation.* eds. R. L. Wastie and D. A. Earp. Incorporated Society of Planters, Kuala Lumpur.

OLLAGNIER, M., OCHS, R. and MARTIN, G. 1970. Manuring of oil palms in the world. *Fertilite.* **36**: 3–63.

POON, Y. C. 1969. An outline of the technique of oil palm foliar analysis. *Planter.* **45**: 452.

PREVOT, P. and OLLAGNIER, M. 1954. Pea nut and oil palm foliar diagnosis–interrelations of N, P, K, Ca and Mg. *Pl. Physiol.* **29**: 26–34.

PREVOT, P. and OLLAGNIER, M. 1954. Law of minimum and balanced mineral nutrition. pp. 257–277. In *Plant Analysis and Fertiliser Problems.* American Inst. Biol. Sci., Washington.

TAN, K. S. 1973. Fertiliser trials on oil palms in inland soils in dunlop estates. pp. 248–279. In *Advances in Oil Palm cultivation.* eds. R. L. Wastie and D. A. Earp. Incorporated Society of Planters, Kuala Lumpur.

UMAR AKBAR, TAMPUBOLON, F. H., AMISUDDIN, D. and OLLAGNIER, M. 1976. Fertiliser experimentation on oil palm in oil palm in North Sumatra. *Oleagineux.* **31**: 305–316.

WARRIAR, S. M. and PIGGOT, C. J. 1973. Rehabilitation of oil palms by corrective manuring based on leaf analysis. pp. 289–305. In *Advances in Oil Palm Cultivation.* eds. R. L. Wastie and D. A. Earp. Incorporated Society of Planters, Kuala Lumpur.