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RECENT DEVELOPMENTS IN THE NUTRITION OF *HEVEA* IN WEST MALAYSIA

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There is considerable variability in the physical and chemical characteristics of soils under rubber in West Malayasia (Rubber Research Institute of Malaya, 1971 a & b). The influence of these two factors and their interaction on performance of *Hevea* have been discussed by Pushparajah & Guha (1968) and Chan & Pushparajah (1972). Guha *et al*. (1971) have shown how the soil survey classification and analysis interpolated with leaf nutrient data were used to provide discriminatory fertiliezr recommendations for rubber in large plantations of West Malaysia. Chan (1971), besides providing more detailed descriptions, showed that this approach ensured better returns, and Chan & Pushparajah (1972) also showed that implementations of the best management inputs, of which proper fertilizer use is one essential practice, are a pre-requisite for maximum yields.

This paper attempts to summarise the more recent developments on the nutrition of *Hevea* interpolated with the capabilities of soils to optimise management inputs for best profits.

Effect of soil on yield

Chan & Pushparajah (1972) showed that a broad pattern of yields was evident for the different soils (Table 1). For example, the mean yield per year for any of the given clones is always highest on the shale derived Munchong series soil and lowest on the marine alluvial clay soil of the Selangor series. A similar pattern of yield variations according to soils was obtained on panel B tapping.

The variation in yield was traced mainly to soil variations and was not seen to be so dependent on climatic variations such as rainfall; the difference due to rainfall was about 75 kg/ha./yr while that due to soil was kg/ha./yr (Table 2).

TABLE I

SOIL RANKING BY MEAN YIELD (KG/HA./YR) IN PANEL A

Yield levels (kg/ha./yr)	Clones and mean yield (kg/ha./yr)			
	RRIM 600	GT 1	PR 107	PB 5/51
1500	Munchong-1736	—	—	—
1351-1500	—	Munchong-1452	Munchong-1446	—
1251-1350	Holyrood -1290	Rengam -1349	—	Munchong-1270
1001-1250	Rengam -1248	Malacca -1214 Serdang -1119 Holyrood -1102	Rengam -1185 Serdang -1098	Rengam -1234 Malacca -1157 Serdang -1136 Holyrood -1125
800-1000	Selangor -897	Selangor -984	Selangor -895	Selangor -872

Based on Chan & Pushparajah (1972)

TABLE 2

YIELD OF PR 107 IN RELATION TO CLIMATE AND SOIL

Region	Rainfall cm³ per yr	Soil Series	Mean yield per yr (kg/ha.) for 2nd to 10th year
Johore	212	Rengam	1392
Selangor	240	Rengam	1467
Selangor	240	Selangor	1207

The soils under rubber have been grouped under various productivity potential classes.

The yield patterns have been found to be consistent with soil properties. Yields are high on Munchong and Rengam soils which have very good physical properties and are poorest on soils of the Selangor and Batu Anam series which have poor physical conditions although fairly high in nutrient contents. Physical and chemical properties of the Serdang and Holyrood series *etc.* are intermediate as are the yields. The yield obtained on the Malacca series soil in particular is found to be variable and this is probably due to the variation in the depth to which the soil medium occurs before reaching the hard iron pan layer which is present in this soil series.

This hard iron pan layer is attributed to be the main cause of poor tap root formation and hence anchorage of the trees. Percentage tree losses by uprooting was 12·7% for RRIM 600 while for PB 5/51 which had a much higher canopy, it was only 1.3%. Losses due to uprooting on the deeper soils were absent. Such effects would therefore influence the yield obtained on this particular soil.

Details investigations on the data presented in Table 1 showed that the yield trends reflected the ability of a clone to adapt itself to a particular soil; for example the mean yield of RRIM 600 on Munchong series soil was 1736 kg while that of GT 1 was 1452 kg. On the other hand, on Rengam series, the mean yield of GT 1 was 1349 kg which was about 100 kg more than that obtained from RRIM 600 on the same soil. Based on this, a 'first approximation' order of priority from Class I clones for selection according to soil series has been formulated (Table 3). Implementation of planting on such a basis would therefore enable maximum exploitation of inherent properties of soil and clone by the use of proper management inputs.

Scope for improvement of yields

The yields given earlier in Table 1 were the mean yields of the clones on a particular soil for the first five years of tapping with comparable husbandry. However, when yields comparisons covering different management levels for a particular soil were made, large variations in yield trends occurred. There were larger yield variations on the better structured soils of the Munchong, Jerangau and Rengam series, while on the poor structured soils, like Selangor series, the yield variation was small (Fig. 1). The large variations in minimum and maximum yields obtained in the Munchong, Jerangau and Rengam series were found to be a reflection of the different management inputs and hence on these soils, additional management inputs in terms of fertilizers and cover management would have beneficial effects which would be very economical on the better structured soils, while the benefits by increasing fertilizer and cover inputs under poorer structured soils would be much less effective. Similar patterns were also obtained for other clones.

TABLE 3

SOIL PRODUCTIVITY RATINGS AND RECOMMENDED ORDER OF PRIORITY OF CLASS I CLONES FOR THE COMMON WEST MALAYSIAN RUBBER-GROWING SOILS

'A FIRST APPROXIMATION'

Yield categories (kg/ha.)	Soil productivity classes	Soil series [a]	Recommended order of priority for Class I clones
High yielding (>1350)	Class I(*a*)	Munchong, Prang [c] Kuantan [c] Segamat [c]	RRIM 600, GT 1, PR 107, PB 5/51
Above average yielding (1250-1350)	Class I(b)	Rengam, Jerangau, Young Peng [c]	GT 1, RRIM 600, PB 5/51, PR 107
Average yielding (1000-1250)	Class II(*a*)	Klau, Harimau [c] Bungor [c]	RRIM 600, PR 107, PB 5/51, GT 1
	Class II(*b*)	Serdang	RRIM 600 [b] PB 5/51, GT 1, PR 107
	Class II(*c*)	Subang [c]	RRIM 600, PB 5/51, GT 1, PR 107
	Class III	Holyrood, Tampoi [c]	RRIM 600, PR 107, PB 5/51, GT 1
	Class IV(*a*)	Batu Anam/Durian	PB 5/51, GT 1, PR 107, RRIM 600
		Sogomana/Sitiawan [c]	
		Seremban, Apek/Marang [c]	
		Kedah [c], Kulai [c] Ulu Tiram [c]	
	Class IV(*b*)	Malacca/Gajah Mati/Tavy	
Below average to low (<1000)	Class V(*a*)	Briah [c] Selangor, Linau [c]	GT 1, RRIM 600, PR 107, PB 5/51
	Class V(*b*)	Sungei Buloh [c]	RRIM 600, PR 107, PB 5/51, GT 1
	Class V(*c*)	Peat	PB 5/51, GT 1, PR 107

a It is qualified that there are soil variations like soil texture existing within a soil series. The physiograph of the soil series can also vary, *e.g.* slope and soil depth. These variations influence growth and yield Chua, *et al.* (1972). As such, the soil series mentioned in this Table are the model or standard soil series only. Further investigations of such variations on *Hevea* performance will provide the basis for updating and revising these recommendations to incorporate other necessary refinements. For current practice and purpose, it is sufficient if a plantation has its property properly soil-mapped at the series level. This is an essential pre-requisite for any initial proper management-planning.

b Based on very limited data, not presented.

c These soils have been included on the basis of very limited data and their close likeness of physical and chemical properties to the ones studied.

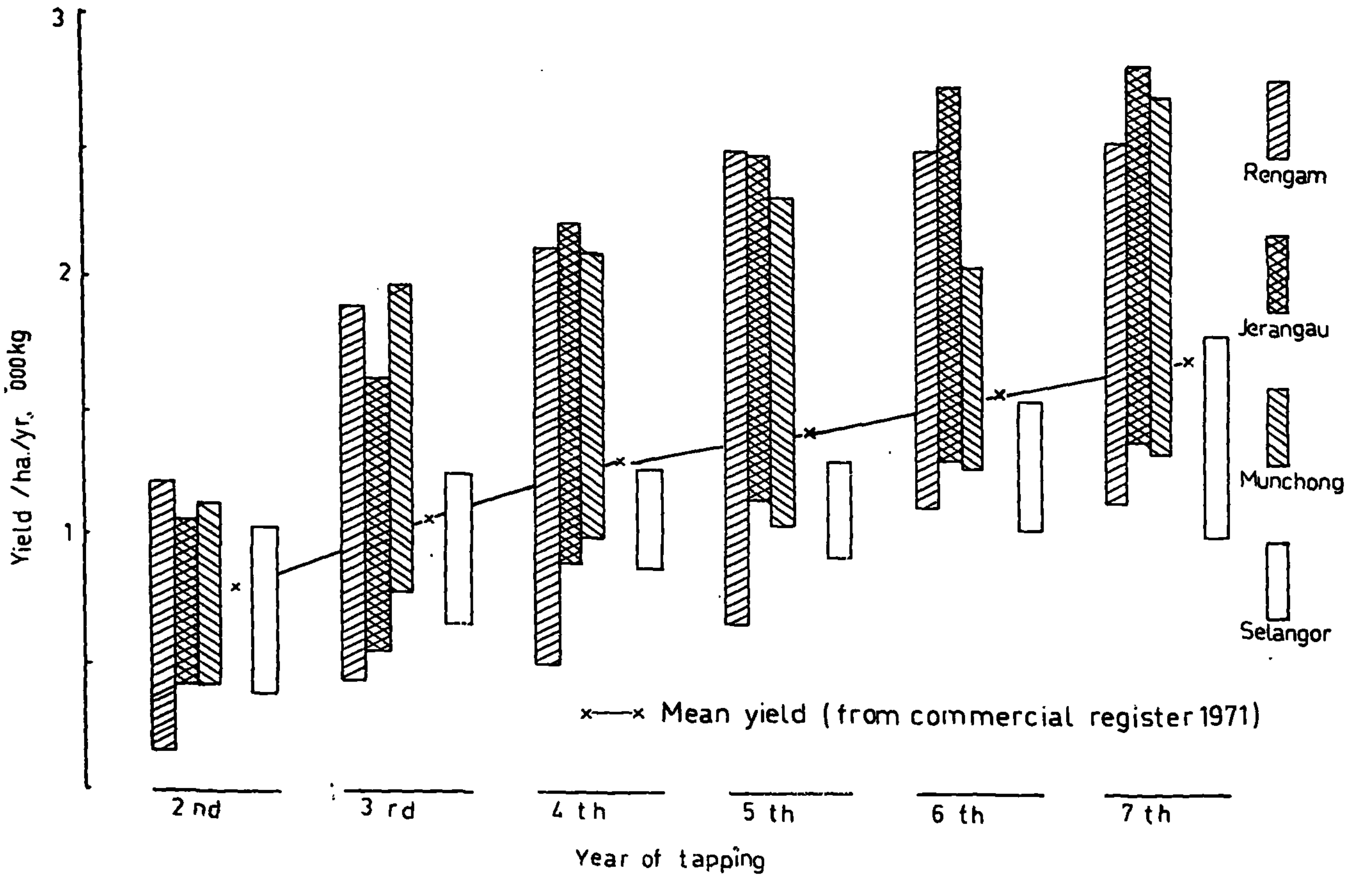

Fig.1 Maximum minimum and mean yield trends of PR 107 on contrasting rubber-growing soils

Improvement in performance of rubber by management practice immature rubber

The effect of ground covers on the length of immature period and early yield performance have been demonstrated(Watson *et al.* 1964; Mainstone, 1969; Pushparajah & Chellapah, 1969). These reports showed that during the early immature period, pure legumes gave consistent advantage over non-legume covers. At the same time however, for non-legume covers, it was shown (Pushparajah & Chellapah, 1969) that compensatory applications of nitrogen could give similar growth and yield of rubber as that in legume covers.

An economic assessment (Ti *et al.*, 1971) of the early returns obtained in the trials reported by Pushparajah & Chellapah (1969) has shown that there where the cover was a non-leguminous cover, increasing the level of nitrogen fertilizer applied from the usual recommended dose (Rubber Research Institute of Malaya, 1963) up to 3 times the amount recommended resulted in increased returns (Table 4).

TABLE 4

CUMULATIVE YIELDS AND CUMULATIVE DISCOUNTED RETURNS

Cover	Cumulative yield (a)				Cumulative discounted (b) returns (s/ha.)			
	n_0	n_1	n_2	n_3	n_0	n_1	n_2	n_3
Legume	6068	6121	6229	6560	1469	1281	1140	1088
Grass	4649	5035	5728	6398	925	873	962	1046

Note : (a) for 4½ years of tapping

(b) at 10% per year from commencement of treatments 9½ years earlier

n_0, n_1 *etc.* refers to levels of nitrogen used

Hence, in the discriminatory approach to fertilizer use in immature rubber, additional compensatory fertilizers at rates shown below (Table 5) are usually added in replantings.

TABLE 5

EXTRA NITROGEN APPLIED TO RUBBER IN NON-LEGUME AREAS

Months after planting or budding	12	18	24	30	36	42	54	66
Ammonium sulphate (g/tree)	170	170	255	255	510	908	908	908

Thereafter the amounts of nitrogen added were based on soil and leaf analysis.

Mature rubber under normal exploitation

Adequacy of current rates: Consideration of nutrient reserves in the soil nutrients immobilised in the tree and removed in the latex, balanced by nutrients added as fertilizers and leaching losses showed that generally, there was a definite need for increasing the fertilizer rates used previously on some inland soils, particularly for high yielding clones (Table 6).

TABLE 6

BUDGET FOR N AND K REQUIRED BY MATURE *Hevea* (FROM 7TH TO 25TH YR)

Soil series	Added (a) kg/ha.		Deficit (b) kg/ha.			
	N	K	N	K	N	K
Rengam	868	850	— 33	+103	—196	— 16
Holyrood	689	774	—212	+ 27	—375	— 92
Malacca	876	736	+ 75	— 11	— 88	—130
Munchong	780	680	—121	— 67	—284	—186
Total required by rubber (19 yr)			901	747	1064	866

(a) based on Chan (1971) on fertilizers applied, returns by leaf litter (Shorrocks, 1965) and 15% leaching losses allowed for (Sivanadyan, 1972).

(b) based on removal in latex (for PB 86 yield was 1390 kg/ac./yr and for RRIM 600 yield was 2570 kg/ac./yr) and immobilsation in tree (Shorrocks, 1965).

For Rengam series, the estimated deficit is 33 to 196 kg of N, while for Malacca series soil, the deficit for N is 88 lb and for K, 11 to 130 kg for the two clones considered.

Leaf nutrient levels: With the view to assess the benefits of increased fertilizer use on some of these clones, various fertilizer trials were conducted which showed that the current limits of sufficiency/deficiency (Table 7) were not satisfactory for all clones (Pushparajah & Tan King Teng, 1972).

TABLE 7

"CRITICAL" LEAF NUTRIENT CONTENTS OF *Hevea* (AS % OF OVEN DRY MATERIAL)

Nutrient	Leaves in the shade of canopy	
	Nutrient level above which response likely	Nutrient level below which response unlikely
Nitrogen	3.30	3.70
Phosphorus	.21	.27
Potassium	1.30	1.50
Magnesium	.25	.28

Clones RRIM 600 and GT 1 generally tended to show a higher leaf nitrogen level and also nitrogen requirements. On the other hand, for clones, RRIM 600 and PB 5/51 showed good responses to potassium even though the leaf potassium was higher than the value which was normally considered to be above satisfactory levels.

In clones PB 86 and PB 5/51, even when leaf potassium ranged from 1.5—1.8%, response to potassium was obtained. The order of response obtained in PB 5/51 to application of potassium in the presence of nitrogen is given in Table 8. In clones GT 1 and RRIM 600, when leaf nitrogen in control plots ranged from 3.5%—3.7%, similar responses in yield were obtained to applications of nitrogen.

These findings indicate that the so-called critical levels for N and K differ from the normal in some situations. For manganese, only tentative threshold values of 50 ppm had been suggested earlier (Shorrocks, 1964). This has now been confirmed by field experiments in two areas, with leave manganese contents of about 60 ppm and 34 ppm respectively. Significant responses in girth increment as shown in Table 9 were obtained only in the latter area.

TABLE 8

RESPONSES* TO POTASSIUM FERTILIZERS IN AREAS HIGH IN LEAF POTASSIUM

Treatment	% K in "low" shade leaves		Yield (kg/ha./yr) from commencement of manuring				
	(i)	(ii)	1st year	2nd year	3rd year	4th year	5th year
Nil K	1.71	1.90	940	1,205	1,330	1,500	1,610
Muriate of potash (kg/ha./yr)							
90	1.70	1.97	910	1,345	1,380	1,636	1,620
170	1.76	2.15	965	1,390	1,470	1,690	1,775
260	1.77	2.14	1,030	1,450	1,530	1,800	1,970

(i) In 1976 samplings done in July, leaf Ca approximately 0.6%

(ii) In 1970

*Based on Sivanadyan (1972)

TABLE 9

EFFECT OF MANGANESE APPLICATION ON A DEFICIENT STAND OF LCB 1320

Treatment	Mn content in leaves (ppm)	Girth increment in 5 years (cm)	Final yield g/tree/yr
Nil manganese	34	22.9	20.4
Manganese sulphate	153	24.5	21.2
S. E.	8.9	0.31.	1.13
Min. sig. diff. (p<0.5)	26	0.90	3.40

Optimum leaf nutrient contents : Based on the above considerations, a range of values for the various nutrient elements for various clonal groups have been prepared as a guide for assessment of nutrient sufficiency/deficiency *etc*. (Table 10.)

TABLE 10

RANGE OF NUTRIENT CONTENT IN LEAVES AT OPTIMUM AGE IN THE SHADE OF CANOPY

Nutrient	Group	Low	Medium	High	Very high
N, %	I II III	3.30 3.20 2.90	3.31-3.70 3.12-3.50 2.91-3.20	3.71-3.90 3.51-3.70 3.21-3.40	3.91 3.71 3.41
K, %	I II	1.35 1.25	1.36-1.65 1.26-1.50	1.66-1.85 1.51-1.65	1.86 1.66
P, %		0.19	0.20-0.25	0.26-0.27	0.28
Mg, %		0.20	0.21-0.25	0.26-0.29	0.30
Mn, ppm		45	45-150	151	

The various classes are relative to the desired optimum status and the classifications are :—

(1) low- levels are well below sun-optimal tending to visual deficiencies

(2) medium-levels are sub-optimal

(3) high-levels are "optimal" and beyond these levels responses are unlikely

(4) very high-levels can be considered "luxury levels"

In addition to the above range classes, tentative clonal grouping have been forme. for nitrogen and potassium values.

For nitrogen, they are :—

Group I — clones RRIM 600, GT 1 and for those clones in Group II where leaf P, K and Mg are not at "high" levels. Generally, the "high" leaf P,K and Mg values are obtained in in trees grown on soils high in these elements, *e.g.* Selangor series.

Group II — All clones except those in Group I and III (*i.e.* except RRIM 600, GT 1 and the wind susceptible clones, *e.g.* RRIM 501, RRIM 513, RRIM 603, RRIM 605, RRIM 623 *etc.*)

Group III — Clones susceptible to trunk snap and branch breakage, *e.g.* RRIM 501, RRIM 513, RRIM 603, RRIM 605, RRIM 623 *etc.* It is emphasised here that nutritionally, the values of leaf N at all classes in this group could be considered low, but the levels are a compromise between optimum need and a reduction in susceptibility to wind damage to heavy canopy.

For potassium, initially, only two clonal groups are proposed. They are :—

Group I — clones RRIM 600, GT 1, PB 5/51, PB 86

Group II — all other clones

The above levels for any element are applicable only when the levels of the other nutrients are satisfactory. Further investigations currently underway may lead to additional refinements.

Factors affecting leaf nutrient levels: In addition to the differential requirements of different clones shown above, there are other factors which could influence the levels of leaf nutrient content. The well known and often reported factor influencing nutrient content in leaves is the influence of soil and the position of leaf.

The influence of covers would have to be considered separately, for generally, the organic material returned from the covers is on the surface of the soil and often not included in the analysis. With the more presistent species, the covers would compete for moisture and nutrients and these nutrients would be locked away in the covers. The influence of covers on leaf nutrient content on mature rubber can be considerable as shown below :—

Cover	*Percentage N in leaves*
Bare	3.63
Ottachloa	3.62
Nephrolepis	3.47

Applications of fertilizers would influence not only the content of a particular leaf nutrient element which is contained in the fertilizers, but also that of the other leaf nutrient elements as shown in Table 11.

TABLE 11

EFFECT OF FERTILIZERS ON LEAF NUTRIENT CONTENT

Fertilizer	Nutrient element in leaf*				
	N	P	K	Mg	Ca
Ammonium sulphate	+	o/+	—	o/—	—
Muriate of potash	o	o	+	—	—
Rock phosphate	o	+	o	o	+
Kieserite	o	o	—	+	o

* Note : o indicates nil to variable
— indicates depression
+ indicates increase

Thus ammonium sulphate, a nitrogenous fertilizer is seen to positively influence nitrogen and negatively influence potassium and calcium in leaf levels.

The timing of application of fertilizers, particularly nitrogen is also an important factor. Where fertilizers were applied up to five months after leaf emergence, there was found to be uptake of nitrogen but where the fertilizer application was done much later than five months, there was little to no uptake of nitrogen and this was reflected in leaf nutrient levels.

In addition to this, the type of crown irrespective of the trunk is an important factor influencing levels of leaf nutrient contents. This is clearly demonstrated in the leaf nutrient levels shown in Table 12.

TABLE 12

INFLUENCE OF CROWN ON LEAF NUTRIENT CONTENT

(RRIM 600 CROWN-BUDDED IN 1968)

Leaf sampled in March 1972

Crown	N, %	P, %	K, %	Ca, %	Mg, %	Mn, ppm
GT 1	3.89	0.23	1.22	0.40	0.24	181
CH 30	3.82	0.23	1.26	0.43	0.25	161
RRIM 612	3.82	0.21	1.03	0.49	0.25	235
RRIM 600	3.86	0.24	1.17	0.42	0.27	146
PR 107	3.71	0.23	1.26	0.49	0.26	236

The leaves in the RRIM 612 crown on RRIM 600 trunk have very much lower P and K than the other crowns. In this case, as the trees were not yet in tapping, the difference in leaf nutrient content observed could not be due to the yield characteristics, but to an inherent factor in the clone.

The level of yield obtained and the exploitation method used are seen to be other factors which could also greatly influence the leaf nutrient content for any given type of fertilizer use. This is discussed later. In addition to this, the age of the leaf is shown to clearly affected the leaf nutrient content, particularly of nitrogen and potassium. Generally, the levels of leaf nitrogen and potassium tend to decrease with leaf age.

Correction factors for such induced variations: Whereas adjustments for the influence of soils, covers, yield levels, clones, *etc.* can be based on experimental evidence and other collated information, adjustments for leaf age infleuncing assessment of sufficiency/deficiency *etc.* can only be made by using correction factors.

Guha & Narayanan (1969) had shown that there was a relationship between leaf calcium and age of leaves exposed to light. This relationship enabled them to assess the leaf nutrient content at optimum age. However, in most of the leaf sampling or recommendations of fertilizer use, the leaves used for mature rubber are low shade leaves. In investigations with low shade leaves from areas with different soil calcium values, (Pushparajah & Tan, 1972) it was shown that the leaf calcium at optimum age of about 100 days, varied from 0.6-0.8 per cent. Based on this work, correction factors have been introduced. The corrections are calcutated to be as follows :—

(1) For areas (a) high in calcium or (b) medium in calcium and/or receiving normal calcium in phosphatic fertilizers:

(a) when leaf calcium is higher than 0.6% for common clones except RRIM 501 and PR 107, increase N values observed by 0.087 and K content observed by 0.052 for every 0.1% by which the calcium value is above 0.80%.

(b) increase the leaf N and the leaf K values observed at the level indicated in (a) for every 0.1% by which the calcium value is above 0.6%. For RRIM 501 and PR 107 under group B, calcium at optimum age would be 0.4% and 0.5% respectively.

(2) For areas low in calcium and/or not receiving calcium-containing fertilizers, increase the observed values of leaf N and K by 0.19 and 0.076 respectively for every 0.1% by which the observed calcium is higher than 0.6%.

In the interpolation of leaf nutrient levels to determine the sufficiency/deficiency of nutrients, the observed leaf values have to be adjusted using the correction values given above and then compared with the values given in Table 10 earlier.

Soil analysis: Chemical analysis of soils have proved to be useful for increasing the efficiency of nutrient requirements of *Hevea*. For nitrogen, total soil nitrogen and C/N ratio of the 0-15 cm depth of the soil were seen to correlate best with leaf indices (Tan, 1972). For potassium exchangeable K and to a lesser extent total K correlated best with both leaf and yield of rubber while the thermodynamic index I_o (Singh, 1970) did not show any correlation with the plant indices (Lau *et al.*, 1972). For phosphorus, the ammonium fluoride extractable "available P" fraction as suggested earlier by Owen (1953) has been confirmed to be the most suitable index (Lau, 1973).

Recommendations by soil and leaf nutrient assessments: General fertilizer formulations based on such principles for *Hevea* on the commoner soils in West Malaysia have been worked out (Chan *et al.*, 1972) and such general recommendations (Table 13) can be used in the absence of comprehensive soil and foliar nutrient surveys.

Mature rubber under exploitation with Ethrel stimulation

The nutrient drainage by increased yields with Ethrel stimulation in much larger than the nutrient drainage under normal exploitation. This increase is reflected not only in the total extra drainage, but also in the intensity of nutrients drained (Table 14). Hence, if the fertilizer regine used for stimulated areas is similar to that applied for areas under normal exploitation and normal yield levels, the deficiency of the fertilizer applied would be very much more acute. Continued increase in drainage can result in a decrease in the response to stimulation and indications are that such decrease can lead to leaf nutrient status and yield levels eventually falling below the unstimulated values (Pushparajah *et al.*, 1971). Again as the nutrient drainage per unit latex resulting from stimulation is different for different clones (Sivanadyan *et al.*, 1972), additional fertilizer requirements to cater for the extra drainage have been formulated (Table 15). These additional fertilizers would have to be given as supplementary fertilizers to the recommendations based on soil and leaf nutrient levels in order to maintain a favourable response to stimulation.

TABLE 13

PROPOSED RECOMMENDATIONS OF NUTRIENT REQUIREMENTS (KG/HA.) OF MATURE RUBBER FOR COMMON WEST MALAYSIAN SOILS

Soil series/Association	Group 1[c] clones (All clones except Groups 2 and 3)		Group 2 clones (PRIM 600, GT1)		Group 3 clones (Clones susceptible to branch and trunk snap *e. g.* RRIM 605 623 and 501)		Group 1—3 (All clones)	
	N	K_2O	N	K_2O	N	K_2O	P_2O_5	MgO
Rengam/Jerangau	16	94	20	118	8	9	28	10
Munchong/Prang	16	59	20	94	8	59	21	10
Malacca/Gajah Mati/Tavy	20	59	24	94	8[a]	59	21	10
Batu/Anam/Durian	20	59	24	94	19	59	21	10
Serdang	16	94	20	118[b]	12	94	21	10
Holyrood	16	141[b]	28	176[b]	12[a]	141	28[b]	15
Selangor	20	—	24	47	12[a]	—	—	—

Assumed mean yield is 1500 kg per ha; after 1500 kg per ha. yields, for every additional 1000 kg per ha. obtained, apply 11 kg of N + 17 kg of K_2O (based particularly on nutrient drainage besides other factors).

a—The levels of N are kept low, although leaf N is low in some cases, so as not to increase canopy weight which, if too heavy, is susceptible to tree damage by windstorms.

b—Takes into consideration also soil leaching losses.

c—PB 5/51 in particular the amount of K_2O applied should be as shown in Group 2

TABLE 14

NUTRIENTS DRAINED THROUGH LATEX (PANEL C TAPPING)

Clone	Treatment	Yield kg/ha./yr	Nutrients drained (kg/ha./yr)			
Tjir 1	US	1570	10.2	9.5	2.4	1.6
	S	1957	13.7	15.4	4.0	2.8
	Increase*	387 (25)	3.5(34)	5.9(62)	1.6(67)	1.2 (75)
PB 86	US	1512	8.9	8.2	1.9	1.5
	S	2638	20.1	19.9	6.0	4.1
	Increase*	1126 (75)	11.2(126)	11.7(143)	4.1(216)	2.6(173)
RRIM 600	US	2243	18.2	16.1	4.7	21.5
	S	5076	44.2	42.6	12.7	7.1
	Increase*	2833(126)	26.0(143)	26.5(165)	8.0(170)	4.6(184)

Based on Sivanadyan *et al.* (1972)

* Figures within barackets indicate percentage increase

US—Unstimulated

S—Stimulated

TABLE 15

EXTRA FERTILIZERS RECOMMENDED FOR SOME CLONES UNDER ETHREL STIMULATION

Clones	Extra nutrients (kg/ha.) for every 1,000 kg of dry rubber obtained (a)			
	N	K	P	Mg
RRIM 600 PB 86 PR 107	11.0	12.0	3.5	1.5
Tjir 1 GT 1	9.0	11.0	3.5	1.5
RRIM 623 RRIM 605	(b) 7.0-9.5	10.0	3.5	1.5

(a) Those are for trees tapped on panel C & D

(b) N to be adjusted according to susceptibility to tree damage by trunk snap *etc.*

CONCLUSIONS

In order to maximise yields of rubber, optimum nutrition is a pre-requisite. Towards meeting this, fertilizer applications should be discriminated not only for nutrient status of the soil and the trees but also discriminated for clone, cover condition, yield potential and exploitation methods. For areas to be established or replanted, selection of clones should be made to optimise the soils potential.

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