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Relative Importance of Fertiliser Application during Pre- and Post-Tapping Phases of Hevea

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The paper reports the results of a long-term fertiliser trial to assess the response to continued application of fertiliser dressings (NPK) during the productive phase, as distinct from the response during the immature period. Growth and yield responses over seven years of immaturity seven and half years of tapping are discussed.

The results provide direct evidence of the beneficial effects of fertiliser dressings applied to the same stand of Hevea *before and after commencement of tapping. Comparison of responses shows that the continued application of fertiliser during the first seven years of the productive phase could account for about two-fifths of the response in growth and for about half to three-fifths of the response in yield. However, in the light of the fact that responses of this order were realised only on material which had received adequate dressings of fertiliser during the immature period and in terms of the greater returns per unit input of fertiliser applied during the immature being of fundaperiod, application of fertiliser dressings during the pre-tapping phase should be regarded as mental importance.*

In the cultivation of *Hevea*, the beneficial role of fertiliser dressings (NPK) applied during immaturity has been established experimentally under a wide range of conditions. The same has not been the case regarding the continued application of fertiliser dressings to clonal rubber in production. Information available on this up to 1961 has been reviewed by COMPAGNON (1962). BOLTON (1964) pointed out that 'experience throughout the East has been that continuous manuring of mature rubber gives few direct results and there has been no consistent proof of its value'. Evidence available has been more implied than direct.

CONSTABLE (1953), describing the results of the first long-term fertiliser trial on clonal material in Ceylon, said: 'Manuring with NPK fertilisers during the immature phase together with manuring during the early years of the productive phase resulted in a significant yield response equivalent to 135 pounds dry rubber per acre per year over the first eight years of tapping on material which gave an average yield of the order of 500 pounds per acre per year without manuring'.

The contribution made by fertilisers applied during the period of immaturity to the total response recorded could not be distinguished from the response resulting from fertiliser application during the early productive phase. In the absence of a significant response in growth resulting from fertilisers applied during the productive phase, the role of fertilisers applied after the area came into tapping appeared to be questionable.

The situation warranted a careful assessment of the usefulness or otherwise of continued application of fertiliser dressings during the productive phase. An experiment specially designed with this objective has been in progress since 1952 at one of the experimental stations of the Rubber Research Institute of Ceylon.

The growth and yield data recorded in this experiment over seven years of immaturity and seven and half years of production are presented and discussed in this paper.

DETAILS OF EXPERIMENT

The essential details of the experiment are set out in *Table 1A*.

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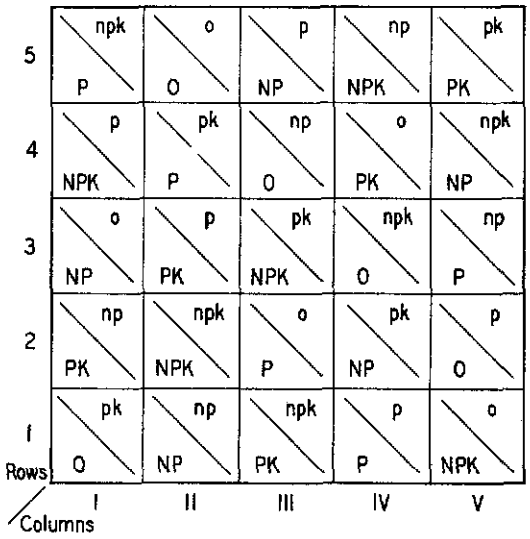

Figure 1. Capital notations O, P, NP, PK and NPK signify the treatments before tapping. Simple notations o, p, np, pk and npk signify the treatments after the commencement of tapping.

Only five out of the eight fertiliser treatments of a 2^3 NPK factorial lay-out, namely O, P, NP, PK and NPK were included in the trial. The object of the trial, in so far as different fertiliser treatments were concerned, was to test the effects of N and K in the presence of P, since it was believed that the necessity for phosphate was sufficiently proved to eliminate the need for a full NPK trial.

The five main plot fertiliser treatments, each made up of four sub-plots of four different clonal materials, were to be tested on a latin-square design; the four clonal materials were PB 86, PB 86 crown-budded with LCB 870, LCB 870 and AVROS 255.

Location

The experiment was sited at the Institute's experimental station at Hedigalla, on a new planting from jungle land leased from the Government.

The topography of the area can best be described as being dissected with boulders of rocks and rocky outcrops at the surface. All the experimental plots were sited on sloping terrain.

Planting was done on individual contour platforms which were joined later by narrow contour ledges.

Soil

The soil may be broadly described as falling under the category called red-yellow latosols, the most important soil complex on which most of the rubber is grown in Ceylon.

Fertiliser Applications

The fertilisers used and the dosage rates at which they were applied are shown in *Table 1B.*

During the immature period (1952–1958), the fertiliser treatments were applied according to the lay-out indicated by O, P, NP, PK and NPK in *Figure 1.* The treatments after commencement of tapping were applied as indicated by o, p, np, pk and npk.

Magnesium in the form of commercial epsom salt was applied to all treatments receiving potassium from 1956/57 onwards.

The fertiliser dosages for each year were applied in four equal instalments during the immature phase and in two equal instalments during the mature phase. Method of application was envelope forking at different points around the base of the trees.

RESULTS

The results of the experiment under discussion have been periodically reported by CONSTABLE (1955–1958) and JEEVARATNAM (1959–1967).

TABLE 1A. DETAILS OF THE EXPERIMENT

Design	Latin square
Fertiliser treatments	O, P, NP, PK, NPK
Sub-plots	Planted with AVROS 255, PB 86, PB 86 crown-budded with LCB 870, LCB 870
Planting material	Budded stumps
Year of planting	1952
Plot size	80 tree points per plot divided into 4 clonal sub-plots each of 20 points
Tapping system	Half-spiral alternate daily (S/2.d/2.100%)

TABLE 1B. SCHEDULE OF FERTILISER APPLICATIONS (OZ/TREE)

Phase and year	N Sulphate of ammonia (21% N)	P Rock phosphate (28% P_2O_5)	K Muriate of potash (50% K_2O)	Mg Commercial epsom salt (16% MgO)	Total
Immature					
1952/53	4	4	2.0	–	10.0
1953/54	6	6	3.0	–	15.0
1954/55	12	12	6.0	–	30.0
1955/56	12	12	6.0	–	30.0
1956/57	16	16	8.0	8.0	48.0
1957/58	16	16	8.0	8.0	48.0
1958/59	16	16	8.0	8.0	48.0
Total	82	82	41.0	24.0	229.0
Mature					
1959/60 to 1965/66	16*	16*	8*	8*	48*
Total	112	112	56	56	336

*oz per tree per year

Effect of Fertilisers During Immature Period

Growth. The response in terms of growth to fertilisers applied during the immature period may be gauged from the yearly mean girth per treatment commencing from two years after planting up to the time the area was brought into tapping (1954 to 1959). *Table 2A* outlines the responses.

The pattern of response was very much the same as recorded in most fertiliser trials of similar nature on *Hevea*. There was a marked response to phosphate, with smaller response to nitrogen and little evidence of any additional benefit from potassium, though there were indications of a positive NK interaction.

This accounts for the fact that the best growth was recorded in the NPK plots which showed a significant increase of 4.8″ in girth over the control. This amounted to a 30% increase in girth over the control.

Girth being the criterion for tappability, all plants that had reached a girth of 30″ and over at a height of 42″ from the bud union were brought into tapping in July 1959 when 60% of the trees over the whole experimental area had reached the required girth as in most commercial plantings.

TABLE 2A. MEAN GIRTH (INCHES) OF THE FOUR CLONAL MATERIALS 1954–1965 (ORIGINAL LAY-OUT)

Year	O	P	NP	PK	NPK	NPK minus O
1954	5.5	6.1	6.3	5.8	6.4	0.9*
1955	6.8	8.9	8.6	7.4	8.5	1.7*
1956	9 4	11.7	12.6	11.3	12.7	3.3*
1957	11.1	14.2	14.9	13.8	15.1	4.0*
1958	13.2	16.9	17.6	16.7	17.9	4.7*
1959	16.0	19.8	20.4	19.6	20.8	4.8*
1961	18.2	22.1	22.5	21.8	22.9	4.7*
1963	23.1	26.4	26.9	26.3	27.1	4.0*
1965	24.8	27.6	28.2	27.5	28.4	3.6*
Increment 1959–1965	8.8	7.8	7.8	7.9	7.6	−1.2

* $P < 0.05$

TABLE 2B. MEAN GIRTH (INCHES) OF THE FOUR CLONAL MATERIALS 1959–1965 (ROTATED LAY-OUT)

Year	o	p	np	pk	npk	npk minus o
1959	19.6	19.6	19.3	19.0	19.0	−0.6
1961	21.7	21.9	21.4	21.2	21.3	−0.4
1963	25.8	26.3	25.8	25.8	26.1	0.3
1965	27.1	27.5	27.3	27.1	27.5	0.4
Increment 1959–1965	7.5	7.9	8.0	8.1	8.5	1.0

Yield. The yields recorded in the first six months of tapping (during the latter half of 1959) give an indication of the returns realised from such a practice *(Table 3A)*. The increased yield/tree/plot/tapping in the plots that received the complete fertiliser dressings during the immature phase was of the order of 9.8 g of dry rubber. In terms of absolute yield, this is approximately equivalent to 225 lb of dry rubber/acre for the six months.

The yields recorded during 1960 when 80% of the trees in the experimental area were in tapping are considered as giving the most objective estimate of initial response to fertilisers applied during the immature period.

The yield was of the order of 2.8 g dry rubber/tree/tapping or roughly 125 lb/acre/year which was 22% higher than the control.

Effect of Fertilisers During the Early Productive Phase

Growth. By virtue of the fact that the treatments were rotated in 1959, just prior to the area being brought into tapping, and if it can be assumed that the interaction between fertiliser treatments applied during the immature phase and those applied during early mature phase affected the experimental blocks equally, it is possible to disregard the effect of fertilisers applied during the immature phase in the assessment of the effect of fertilisers applied during the early mature phase.

The close agreement of the girths recorded in 1959, recalculated on the basis of the rotated lay-out *(Table 2B)* would seem to justify this.

The mean girth/tree/treatment as recorded in 1961, 1963 and 1965 are reported in *Table 2B*.

It would appear that application of NPK fertilisers during the first seven years of the productive phase has resulted in an increase of only one inch of girth per tree over this period.

At this stage therefore it is of interest to note that the difference in girth between manured and unmanured plots on the basis of the original treatments continued to show a significant difference of 3.6″ per tree even as late as in 1965. This prolonged effect of fertilisers applied during the immature phase is an indication of the time taken for the full effects of fertilisers to be reflected on growth of *Hevea*.

Yield. No differences in yields were recorded between the NPK plots and the control plots up to 1962 *(Table 3B)*. The yields of the

TABLE 3A. MEAN YIELD (G/TREE/TAPPING) OF THE FOUR CLONAL MATERIALS (ORIGINAL LAY-OUT)

Year	O	P	NP	PK	NPK	NPK minus O
		July – December				
1959	3.0	10.1	12.6	9.0	12.8	9.8*
		January – December				
1960	12.9	14.3	16.1	13.9	15.7	2.8*
		January – December				
1961	15.4	16.7	18.3	16.8	18.3	2.9*
1962	15.8	17.2	19.2	17.5	19.4	3.6*
1963	18.4	21.1	23.5	21.8	22.5	4.1*
1964	19.6	22.0	26.2	22.4	24.1	4.5*
1965	19.0	21.4	24.2	21.5	23.0	4.0
1966	19.0	21.4	21.9	21.7	21.5	2.5
Total	107.2	119.8	133.3	121.7	128.8	21.6
Average	17.9	20.0	22.2	20.3	21.4	3.5

*P<0.05

TABLE 3B. MEAN YIELD (G/TREE/TAPPING) OF THE FOUR CLONAL MATERIALS (ROTATED LAY-OUT)

Year	o	p	np	pk	npk	npk minus o
1961	17.4	16.5	17.4	16.9	17.4	0.0
1962	18.6	16.9	17.6	17.5	18.5	−0.1
1963	20.5	21.4	21.1	20.9	23.3	2.8
1964	21.6	22.5	23.8	22.2	24.1	2.5
1965	21.1	21.0	22.4	21.1	23.3	2.1
1966	20.4	20.8	20.5	20.3	23.9	3.5*
Total	119.7	119.1	122.8	118.9	130.5	10.8
Average	20.0	19.9	20.5	19.8	21.7	1.7

*P<0.05

manured plots showed an increase from 1963 onwards, but it was only in 1966 that the increase was statistically significant. The increase in yield in 1966 was 3.5 g dry rubber/tree/tapping, or approximately 150 lb dry rubber/acre/year.

DISCUSSION

Separate assessments on the effects of fertilisers applied before and after tapping confirm that application of fertilisers during the early mature phase does have a beneficial influence on the yield of *Hevea*. This, of course, is in addition to the confirmation of the significant initial response both in growth and yield to fertilisers applied during the immature period.

Neither of these findings nor the actual response recorded would in themselves add anything to the information already available, but for the fact that in the experiment under discussion, the effects of fertilisers applied during the two phases have been assessed separately on the very same material. These responses have also been obtained without having to deviate from the practices generally adopted on commercial plantings.

The design of the experiment does not permit the sum of responses recorded to be regarded as the total response that is likely to result from fertiliser applications during both phases.

This drawback precludes any possibility of comparing the responses recorded during the two phases for a proper evaluation of the relative usefulness of the fertilisers applied during the two phases.

In this regard, comparison of growth and yield data recorded in the presence and absence of fertilisers during the immature and mature phases respectively provide some useful indications *(Table 4B)*. Comparing the growth data for the relevant treatment combinations, viz O/o; O/npk; NPK/o and NPK/npk for the years 1959 and 1966 *(Table 4A)*, the growth response that may be ascribed to fertiliser application during the production phase as deduced from the total growth response recorded in 1965 minus the initial growth response as recorded in 1959, is only of the order of 1″ girth.

TABLE 4A. GROWTH RESPONSE TO NPK FERTILISER APPLIED BEFORE AND AFTER TAPPING—MEAN GIRTH (INCHES) OF FOUR CLONAL MATERIALS

Year	O/o	NPK/o	NPK/npk	O/npk	NPK/npk minus O/o
1959	16.7	21.3	20.9	13.7	4.2
1966	24.6	27.9	29.9	24.3	5.3
		3.3[a]	2.0[b]		
Increment 1959 – 1966	7.9	6.6	9.0	10.6	1.1
		−1.3[a]	2.4[b]	1.6[c]	

TABLE 4B. GROWTH AND YIELD RESPONSE TO NPK FERTILISER APPLIED BEFORE AND AFTER TAPPING—MEAN YIELD (G/TREE/TAPPING) OF FOUR CLONAL MATERIALS

Year	O/o	NPK/o	NPK/npk	O/npk	NPK/npk minus O/o
1959	3.4	13.7	14.6	0.8	11.2
1960	13.4	17.8	17.0	11.9	3.6
1966	17.0	22.0	28.2	21.0	11.2
		5.0[a]	6.2[b]		
Mean yield 1961 – 1966	17.7	21.7	26.3	17.0	8.6
		4.0[a]	4.6[b]		
Mean annual increment 1960 – 1966	4.3	3.9	9.3	5.1	5.0
		−0.4[a]	5.4[b]	−4.2[c]	

a = NPK/o minus O/o
b = NPK/npk minus NPK/o
c = O/npk minus NPK/npk

But when the growth data for the treatment combinations NPK/o and NPK/npk are examined, it will be noted that the growth response that must be ascribed to fertiliser application during the mature phase should be of the order of 2.4″ of girth.

The yield data for the relevant plots for 1960 and 1966 *(Table 4B)* also indicate a similar feature. Whereas the yield increase that could be ascribed to fertiliser application during the mature phase, as assessed by the difference between the total response less the initial response is of the order of 5 g/tree/tapping, the actual increase is of the order of 5.4 g/tree/tapping.

It seems likely that continued application of fertilisers may account for at least two-fifths of the total response in growth , and about half to three-fifths of the total response in yield (2/5.3 for girth and 6.2/11.2 for yield).

It would also appear that the greater response in yield resulting from fertiliser application during the production phase is partly due to a direct effect of fertiliser on yield as well.

As against this, the response to fertilisers applied only during the production phase, is not as great as the response resulting from continued application. This helps to establish the fundamental importance of application of fertiliser dressings during immaturity, apart from the greater returns per unit input of fertiliser applied during that period.

Continued application of fertilisers results in additional response in growth as well as yield, which can be of the order of 40% and 50–60% respectively, as assessed up to about 15 years from planting.

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DISCUSSION

Chairman: Dr. P. Compagnon

Mr. E.C. Paardekooper suggested that the relationship of yield to girth was more correctly represented by a quadratic than by a linear equation, although the latter had been used in several papers on fertilisers and ground covers to estimate yield responses from observations on growth. Mr. E. Bellis considered that no such generalisation was possible, because there were cases when they all broke down; for example, the good response in growth and poor response in yield to magnesium reported by the Rubber Research Institute of Malaya in its Annual Report for 1966.