THE MANURING OF RUBBER GARDENS WITH ARTIFICIAL MANURES, IN JAVA.

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(Translated from Mededeeling No. 50 of the Proefstation Malang, by H. Ludowyk, Librarian, Department of Agriculture, Ceylon.)

When the cultivation was yet young and tapping was quite out of the question, inquiries were already being made as to whether increase in girth could be accelerated by manuring so as to hasten the maturity of the tree for tapping. Mr. Hamaker and those other pioneers of rational rubber cultivation sought my advice regarding this matter as early as the year 1910, and in the same year a comparative manurial experiment was initiated on the estate of the former. The result, which was an increase in girth of 1 cm. in 7 months, was published in 1912 in No. 1 of the Mededeelingen van het Besoekisch Proefstation. I also drew attention to the fact that 1½ years later the manured trees had gained 0·2 cm. from their backward condition. So, obviously, the manure (400 grammes bean cake + 200 grammes double superphosphate + 100 grammes sulphate of potash per tree) had been effective. To all appearances, it seemed as if the manure, to use a popular planters' expression, had given a stimulus that should be regularly repeated.

In the same year, a few months later, Mr. Zuiderhoff communicated the results of an experiment he had tried with Perlis-guano.† This fertiliser brought on no increase in girth as a result, possibly because Perlis-guano is in fact only a phosphoric acid containing fertiliser, and a nitrogenous manure in the first place is favourable to growth. A full manuring that was served on Taman Gloegah Estate in Besoeki gave even a less profitable result—only an increase of 0 2 cm. above the girth of the control trees after a period of one year. This is the reason why the results of this experiment have never been published by me in detail, just as the negative results of other experiments—we shall designate them later—which remain in the form of notes.

In 1913 De Jong published the records of detailed manurial experiments in which especially nitrogen (sulphate of ammonia) seemed to be favourable in effecting increase in girth. We are indebted to the same experimenter for the first experiment made in order to observe the influence that manuring has on yield. The fact that increase in girth follows as a result of manuring will be of little interest to us if we do not know that this increase is accompanied by higher production. The experiment was undertaken only on a small scale. The results, however, justified the starting of experiments on estates. But, after De Jong's publication in 1914, we have for years read nothing more on manurial experiments with rubber in the Netherlands Indies, and this, in spite of the fact that it is not so difficult to carry on such experiments.

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* Part of an address, "The Manuring of Coffee and Rubber Gardens with artificial manures," given before the general meeting of the Kedirisch Agricultural Union, on Saturday, 13 Dec., 1921, at Blitar.

† Publications of the Ned.—Ind. Agricultural Syndicate, 5th Year, 1913, pp. 109 and 395.

After De Jong's first experiment many others were started, but as the results were negative they were not published. Thus, manuring on a small scale with bean cake (1 Kg. per tree) on Poerwodjojo Estate, Besoeki, in 1917, did not result in any increase in production. Further, I found in the records of the Proefstation Malang the report of a manurial experiment undertaken on Gloensing Estate, begun by Mr. Menting, the Agriculturist of the Proefstation, and continued by Dr. Arens after the departure of the former. I think it desirable to reproduce here, verbatim, Dr. Arens's report of September, 1921.

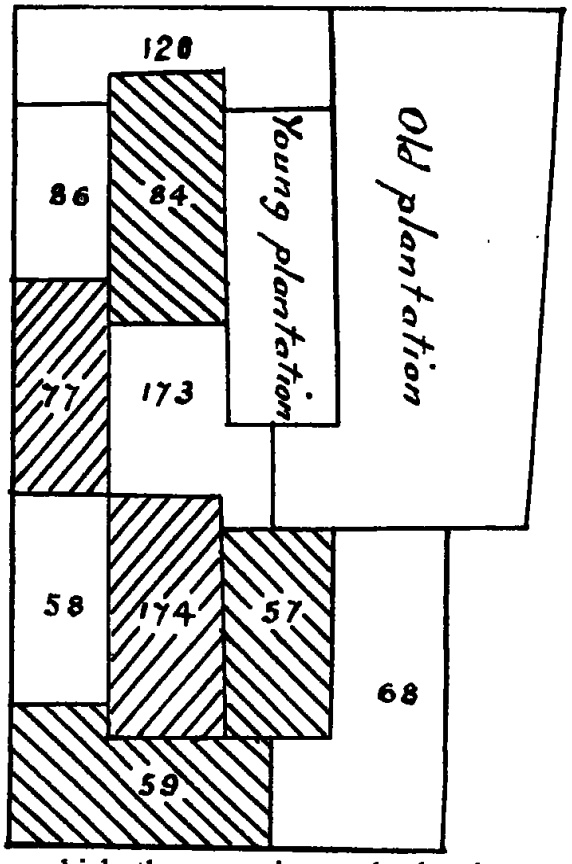
" Results of a Manurial Experiment conducted on Gloensing Estate in the years 1918-1920.

" The estate of Gloensing lies in the Zuidergeberte of Malang. Its soil consists of a heavy red clay that has originated from the weathering of tertiary coral banks and the materials of volcanic origin that are contained therein. The major part of the soils of the Zuidergeberte of Malang has thus originated.

" The experiment that is described below was started because preparations were being made to manure the estate of Gloensing and it was thought desirable to know beforehand whether the great expenditure to be involved would be profitably laid out.

" The experiment was begun by Mr. L. C. Menting, the then Agriculturist of the Proefstation Malang, and was continued by the writer after the departure of the former in May, 1919.

" In order to carry out the manurial experiment in the most simple manner a complete tapping task, instead of a certain number of trees, was chosen for each plot. Altogether there were ten such tapping tasks of which five were manured and five served as control plots. The division of the different plots may be observed in the accompanying sketch.



" The land on which the experimental plot lay was pretty flat. On the whole, the land sloped equally from East to West. In the plots 68, 84, 86 and 120 there were some steeper portions. The following reviews the lie of the land of each individual plot.

Plot 120.—Eastern portion fairly flat; on the west rather steep slopes.

Plot 84.—Rather undulating; rather steep slopes on the West.

Plot 86.—Northern portion having many small abrupt slopes; Southern portion flat.

Plot 77.—Fairly flat.

Plot 173.—Slopes gradually towards the West.

Plot 174.—Slopes gradually towards the West.

Plot 58.—Almost flat.

Plot 59.—Somewhat more sloping than 58.

Plot 57.—Fairly flat.

Plot 68.—Somewhat steeper than 57.

" The soils of the various plots was to all appearances the same. Since the sub-soil was poorly porous, the flat portions were provided with deep drains in order to avoid the stagnation of water on the land. The plots 120, 84 and 173 partly adjoined a young plantation. The number of trees in the various experimental plots were:

Plot.	In Tapping.	Not in Tapping.
120	357	81
86	356	37
84	373	49
77	364	27
173	329	44
58	355	37
174	306	44
57	321	16
68	287	5
59	326	46

" The plots 84, 77, 174, 57 and 59 were manured, and the plots 120, 86, 173, 58 and 68 served as control plots and were not manured. They underwent, however, precisely the same course of tilling as the manured fields.

" In order to ascertain the productivity of the various plots, starting from the 13th of April, before the manuring had begun, until the 13th of January, the produce of each plot was separately determined.

" The manure was applied from the 13th to the 16th of January, 1919, and, in the manured plots, every tree, whether tappable or not, received—

600 gr. of pure superphosphate
900 gr. of blood meal (12% N.)

" The manure was served in a shallow circular drain that was about one foot wide, and at a metre's distance from the tree. After the gardens were manured, the whole surface was lightly tilled. Tilling was done in the same manner on the control plots too.

" The yield was determined in the following way: As soon as the tappers returned, a specimen of 500 cc. of the latex brought by each tapper was taken and coagulated in a trough that was provided with the respective number of the experimental plot. At the same time the quantity of latex gathered was carefully taken over. Each sample was made into crêpe separately, marked, and, after it was dry, sent over to the Experiment Station for weighing. From the weight of the sample and the quantity of measured latex, the produce of each plot was reckoned.

" Since every one of the tappers did not turn up regularly through the whole period, and thus, in the statement of the total produce per month, a considerable number of tapping days would be left out of consideration in obtaining the result, the average daily yield, and not the total monthly yield, per experimental plot was reckoned. All tapping days on which there was rain during the tapping time were left out of the calculation.

" It is in this manner that the figures given in Table I were obtained.

TABLE I.

" Placing the collective produce of the five control plots at 100, we find that, for the total produce of the five experimental plots during the various months, we obtain the following relative figures:

Total Produce of the Experimental Plots—(Control Plot—100)

	Before manuring	1st Year after manuring	2nd Year after manuring
January	—	103·2	99·7
February	—	106·2	103·8
March	—	112·1	108·2
April	105·1	97 6	101·8
May	90·7	97 8	116·7
June	108·3	99·1	98·5
July	105·0	99·1	97·8
August	104·9	109·1	83·1
September	100·8	90 8	96·2
October	100·3	97 0	104·3
November	101·3	102·8	91·0
December	94·9	110·0	—
January	94·9	—	—
Average	101·0	102·3	100·5

" Manuring has therefore had no influence on the yield. It prominently appears in the first three months after manuring as if the yield of the manured experimental plots had increased, but the rise was probably due to chance, for we see in the second year after manuring some very high relative figures.

" Besides the records of the yield, notes were made of the fresh incidence of Brown Bast on the various plots.

"It was ascertained that in the control plots 22, 16, 11, 12, 8, and in the experimental plots 13, 20, 3, 12, 10, new infections of Brown Bast appeared. Therefore on an average there appeared in the control plots 13·10 + 2·16, and in the experimental plots 11·60 + 2·44 new cases. The difference between these two averages, 2·20±3·26, is therefore not appreciable. Therefore manuring has not had any influence even on the incidence of Brown Bast.

" It is quite singular that hitherto nearly all manurial experiments with Hevea, with one exception, have given a negative result. But when one considers that Hevea thrives even on poor soils on which other cultivated plants will not grow, and that therefore, Hevea probably makes a smaller demand than other plants on the nutrient salts of the soil, we would not be surprised that on soils on which other crops can be grown with success the manuring of Hevea is profitless.

" It will be well, therefore, before manuring is resorted to on a large scale on an estate, first, by means of an examination of the estate, to orientate one's position so as to be convinced that manuring will give real results and also that the money laid out is not spent in vain."

(Sgd.) P. ARENS.

According to our present knowledge the tapping experiments would perhaps have been carried out in a somewhat different way, and the reckoning of the results too would be done in a somewhat different method.

Mr. Hoedt, Agriculturist of our Experiment Station, has made the calculations according to the method employed at the present time and reports as follows.

" At first is reckoned to what extent (per cent.) the proportion of the two sets of five plots may vary as a result of chance within a period of five consecutive months.

" Therefore, primarily, the standard variation was reckoned from the relative figures of all the plots in the periods April—August, 1918, and September, 1918—January, 1919. This came to 9·9%.

" The mean error of the average of 5 relative figures will then be $\frac{9\,9}{\sqrt{-5}}=4\,1\%$.

" The mean error of the difference between two sets of five figures will therefore come to $\sqrt{(4\cdot1)^2+(4\cdot1)^2} = 4\cdot1\sqrt{2}=\pm5\cdot7\%$.

" Variations of $3 \times \pm 5\cdot7\% = 17\cdot1\%$ are therefore permitted so that greater differences show the influence of manuring favourably.

" Now the total yields of the experimental plots as well as those of the control plots for each of the periods of five consecutive months of the experiment were estimated.

" The results are summed up in the following table:

	Yield of Rubber		Proportion of Yield	
	Unmanured	Manured	Unmanured	Manured
January 1919—May	48.480	49,980	100	103·0
June—October	38,870	38.550	100	99·1
November—March, 1920	50.430	52.950	100	104·9
April—August	52.940	53,160	100	100·4

From this we may conclude that we cannot be certain in the least that the manure had effect."

Various articles that appeared in the August and September numbers of the 1924 volume of the *Archief Voor de Rubbercultuur*, which were instrumental in inducing estates in our district to evince a desire to undertake experiments, have been contributions of lively interest to the subject of Hevea manuring. Brilliant results were obtained on the so-called white clay soils that are peculiar to a portion of the East Coast of Sumatra. The yield which was originally *bad* could be increased, by the application of nitrogenous fertilisers, to more than three times that of the control plots. This was also accompanied by increase in the girth of the tree and an increase in the thickness of the renewed bark which was, in addition, richer in latex vessels.

Since this experiment, which is thoroughly trustworthy, was described very lately in the *Archief* I may here omit the details regarding it.

In the September number of the *Archief* for 1924 the photograph too, which makes one clearly see the difference in tree development between the unmanured plots and the plots 20 months after manuring, is interesting. In the manured plot are seen fine fully foliated crowns, while in the others is a typical retrograde plot much affected by Dieback.

It had already been remarked by Mr. Hamaker that the manured trees were recognisable even at a distance owing to the fine dark-green colour of their leaves, and also later experimenters have remarked how much more healthy a manured plot appears. It is therefore natural to conclude that manuring can make trees more resistant to diseases.

It is obvious that these favourable reports of the past two years incite us to undertake experiments, and this is a thing we should only rejoice over. However, we should not forget that the experiments which gave such fine results have been carried out on anything but ideal soil, and soils like those are luckily not common in our district. On the better, so-called red soils of the same estate on the East Coast of Sumatra manuring did not meet with any success. It is always dangerous to assume the rôle of a prophet, but I believe, however, that I am able correctly to foretell that there are few estates in our district on which the yield could be increased threefold as a result of manuring. We will, however, be satisfied with a less fine result, and the ardour for undertaking experiments will certainly not be cooled by my forecast. On the other hand, my aim was to spur you on to follow the example of some of your colleagues in our district and carry on experiments with manures upon your estates.

DEEP TAPPING *VERSUS* SHALLOW TAPPING.*

HERBERT ASHPLANT, A.R.C.S.,

Rubber Specialist, U.P.A.S.I.

A. INCIDENCE OF BROWN BAST.

Although, owing to the diversity of systems of tapping practised and their varying frequency and depth, nothing that could be termed real evidence has been available, on the influence of the quality of the tapping upon Brown Bast, one's general experience on estates has always suggested that deeply tapped trees are more liable to develop Brown Bast than trees that are lightly tapped. In order to settle the point an experiment was started in December, 1921, under the direction of the writer on the Mooply Experimental Station.

Two groups of fifty trees were selected, and the ordinary half sector divided by vertical channels into two equal regions (thus making two adjacent quarters). The back quarter of each of these trees was, during the course of the experiment, regularly tapped by means of a deep cut reaching to within about three-quarter to half millimetre from the Cambium. On the front quarter, which was always tapped on the same days as its fellow, the tapping was kept shallow. The instructions were that on the shallow sector the tapping should not go deeper than to within two or three millimetres from the cambium. One group of fifty trees was tapped by deep and shallow cuts in this way daily. The other group of fifty trees was similarly tapped on alternate days only. In view of Keuchenius's work on metastasis Brown Bast, the dividing channel between the deep and shallow sector was, on all trees, made right to the cambium in November, 1922.

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* Circular No. 2 of the Rubber Specialist, U. P. A. S. I.

From the start of the experiment until March 31 last, when the Station was closed, tapping on the alternate day trees has continued on the same side, but as by the end of January, 1925, the original sector on the trees in daily tapping had been exhausted, the cuts were changed over on this date to the opposite half. After the change over on the daily tapped trees, the dividing channel between the halves was also deepened to the cambium.

According to the Farm Manager, an examination of the trees in December, 1921, showed no Brown Bast to be present. The writer, however, is not able to guarantee this, as the trees had previously been in tapping for a time, and were unlikely to be entirely free from the affection. Although there is no reason to assume in regard to whatever Brown Bast was present originally that it affected one sector more than another, it may be best, in view of the uncertainty, to take May 1923 as the starting point. The percentages of Brown Bast recorded for this date were obtained by the writer personally in a very careful tree to tree inspection.

Examinations made on three occasions showed the percentages of Brown Bast present to be as follows:

	Daily Tapping		Alternate day Tapping	
	Deep Cut	Shallow Cut	Deep Cut	Shallow Cut
May 31, 1923	18%	18%	14%	8%
January 31, 1925	44%	30%	28%	18%
March 31, 1926	52%	36%	32%	20%

Comparative Yields from Deep and Shallow Tapped Cuts

Month		Daily Tapping		Alternate Day Tapping	
		Deep Cut lb.	Shallow Cut lb.	Deep Cut lb.	Shallow Cut lb.
January	1922	30·31	5·25	15·81	2·63
February	,,	25·13	5·25	13·25	2·50
March	,,	33·13	5·56	15·56	2·50
April	,,	46·25	6·25	23·31	3·19
May	,,	44·63	6·13	26·13	3·13
June	,,	30·06	5·63	20·56	3·06
July	,,	21·69	4·36	13·81	2·36
August	,,	27·94	4·44	16·88	2·44
September	,,	24·75	4·06	13·44	2·19
October	,,	26·56	4·75	16·00	2·50
November	,,	29·63	5·63	16·50	3·00
December	,,	33·36	6·13	19·56	3·13
	Total ...	373·50	63·44	210·81	32·63

Comparative Yields from Deep and Shallow Tapped Cuts:—(*Contd.*)

Month		Daily Tapping		Alternate Day Tapping	
		Deep Cut lb.	Shallow Cut lb.	Deep Cut lb.	Shallow Cut lb.
January	1923	19·31	4·94	12·63	2·69
February	,,	17·40	5·58	7·90	2·74
March	,,	30·36	10·44	12 90	4·68
April	,,	35·16	7·74	17·28	3 92
May	,,	32·96	5·96	18·00	3·24
June	,,	22·12	5·30	13 50	3 00
July	,,	15·26	5·16	8 56	2·54
August	,,	17·72	3·78	9·48	2·20
September	,,	24·10	5·50	14·70	2·82
October	,,	32 30	6·64	16·58	3·28
November	,,	29·16	6·14	16·20	3·10
December	,,	33·58	7·96	17·94	4·08
	Total	309·43	75·14	165·67	38·29
January	1924	28·80	7·64	16·28	4·26
February	,,	12·48	4·08	6·86	2·16
March	,,	19·20	5 08	9·68	2 46
April	,,	31·54	5 38	16·88	2·70
May	,,	31·92	7·60	21·78	4·06
June	,,	15·46	5·32	10 88	2·80
July	,,	10·66	3·18	7·06	2·04
August	,,	16·68	4·66	10·40	3·18
September	,,	18·56	4·88	12 88	3·42
October	,,	18·94	4·38	14·31	3·26
November	,,	19·82	4·34	17·41	3·15
December	,,	23·78	4·34	19·54	3·19
	Total	247·84	60·88	163·96	36·68
January	1925	17·88	3·72	18·70	3·13
February	,,	18·86	5·52	14·83	4·33
March	,,	23·12	5·82	16·87	4·67
April	,,	23·08	4·60	18·02	3·70
May	,,	29 86	5·58	22·72	4·94
June	,,	23·42	5·64	16·65	3·70
July	,,	20·78	5·20	17·54	3·22
August	,,	25·10	6·50	18·65	4·35
September	,,	27·32	7·00	21·50	5·00
October	,,	29 00	7 00	21·52	5·43
November	,,	30 70	6 04	22·28	4·43
December	,,	31·70	6·90	23·15	5·11
	Total	300 82	69·52	232·43	52 01
Grand Total for four years (from January 1922 to December, 1925)		1231·59	268·98	772·87	159·61
January	1926	27 00	6·50	17·93	4·27
February	,,	18·00	4·50	11·96	2·72
March	,,	18·50	5·10	11·85	2·72
	Total	63·50	16·10	41·74	9·79
Grand Total to end of March, 1926		1295·09	285·08	814·61	169·40
Comparative yield for 4¼ years taking deep cut daily as 100		100	22·12	62·90	13·08

It may not be very remarkable where the experiment has been carried out over a long period such as this to find how closely the relative yields from the deeply tapped alternate day and deep daily cuts agree with the well-known 60 to 100 ratio established by many previous experiments for alternate day and daily tappings. It is, however, of some interest to note, since it shows an unexpected uniformity in the tapping, that the yields from the shallow tapped alternate day cuts also work out at about sixty per cent. of those from the shallow tapped daily cuts. The actual proportion is 61 to 100.

The Brown Bast Results.—It is not proposed here to discuss at any length the Brown Bast results and their implications, but one or two comments are called for. The final condition of the different sectors permit of no doubt as to the main question under investigation. Even allowing a large margin for the inevitable errors of experiment and personal judgment, there is no escaping the conclusion that deep tapping is considerably more provocative of Brown Bast than shallow tapping of the same frequency.

There are some truths that in the interests of one's peace of mind are better left at the bottom of the proverbial well, and the particular truth revealed above will, by many rubber planters, be placed in this class. In so far as any satisfaction is to be derived from the results, it may be got from the demonstration that the now generally favoured system of deep alternate day tapping is no more conducive to Brown Bast than a shallow tapped system of daily frequency. Though so mild as seemingly to constitute no strain worth speaking of on the tree, these daily shallow tappings, which withdrew only from ¾ to 1 lb. of rubber per tree per annum provoked quite as much Brown Bast as the alternate day deeper tappings that withdrew from 3 to 4 lb. per tree. For comparative purposes, it may be useful to have the Brown Bast percentages and the annual yields in one table:

	Daily Tapping		Alternate day Tapping	
	Deep Cut	Shallow Cut	Deep Cut	Shallow Cut
Average Annual Yield per 100 trees (¼ cuts.)	lb. 616	134	386	80
Percentage of trees developing Brown Bast per annum	12 %	6·3 %	6·3 %	4·2 %

In calculating the annual percentage of Brown Bast the 1923 figures have been taken as the starting point.

According to these results, the tapping frequency would appear to be the most important factor in the causation of Brown Bast, though precisely in what way this upsets the mechanism of the tree, on any physiological theory, still remains as much of a mystery as ever. We have evidently to do with other factors than excessive latex withdrawals, for there is no proportionate relation between the percentage of Brown Bast and the amounts of latex removed. Frequent tapping, and deep tapping, have this in common, that with both, the interference with the normal processes of the tree

is accentuated. More conductive tracts are severed and more essential nutritive substances removed in the cell sap. There are also the abnormal excitation, and the exposure of the delicate cortical tissues, to consider as possible factors.

With regard to organismal theories of Brown Bast, deep tapping, not so much because it lays bare additional latex tubes, but because it exposes the more delicate internal cortex, obviously affords greater chances of infection than does shallow tapping. A perusal of the Stripe Canker results which follow, should leave no doubt on this point.

To any one who is inclined to look upon the greater percentage of Brown Bast associated with deep tapping as an argument in favour of lighter tapping, the relative yields of the two methods should be a sufficient deterrent. Only absolute immunity from Brown Bast would justify the mere contemplation of such uneconomic methods, and, as we have seen, even the shallowest alternate day tapping gave rise to 67 per cent. of the amount of Brown Bast provoked by deep tappings at the same interval. Had the shallow cuts been made slightly less shallow, it is probable that the Brown Bast proportion would have been higher. Owing to the peculiar disposition of the laticiferous system in Hevea, tapping, to be efficient, must be deep, and by this time most rubber planters recognize the necessity. The withdrawal of its latex from the Hevea tree is an unnatural operation which the tree apparently does not take kindly to. Be the tapping ever so mild and carefully done, we shall not escape a certain amount of Brown Bast. The lesson of this and other experiments is that Brown Bast is an inseparable concomitant of tapping in any form.

B. Incidence of Stripe Canker on Deep and Shallow Tapped Cuts.

Some data on this point derived from the experiment described above were reported during 1923. As this is the final report on the experiment, the Mooply Station now having been closed, it may be convenient to have all the results together in one paper:—

Percentage of Cuts progressively infected with Stripe Canker during the Monsoon.

Months	Daily Tapping		Alternate day Tapping	
	Deep Cuts	Shallow Cuts	Deep Cuts	Shallow Cuts
Up to end of June	36%	22%	22%	18%
,, July	90%	38%	82%	32%
,, August	100%	44%	96%	40%
,, September	100%	44%	96%	40%

Since the object of the experiment was to get reliable information on the relative chances of infection afforded by deep and shallow tapping, the preventative disinfection of the Cuts was not attempted owing to fear of invalidating the comparisons.—The Planters' Chronicle, Vol. XXI, No. 22.