MANURIAL EXPERIMENTS ON HEVEA*

IN a previous paper† the results of various manuring experiments on the estates of the Hollandsch Amerikannsche Plantage Mij. were described. One of these experiments there called the "Second Nitrate Manuring Experiments" has been continued and three years' additional results are now available as shown in table 1. The results given by years are discussed below:

Sixth year, March 1924-February 1925.—On March 17th, 1924 the tapping system of the experiment was changed from one-third of the circumference tapped daily to one-half of the circumference tapped in alternate months, the bark consumption being increased from $1\frac{3}{4}$ per month to 2 in. per tapping month. The tapping cut was lengthened by extension in a downward direction. The renewal period remained at 6 years. As will be seen from the yields in table 1. no falling off in yield resulted from this change.

The C. plots received the usual annual applications of 5 lb. sodium nitrate per tree and reached a yield of 535 lb. per acre for the year, the highest reached up to that time.

The B. plots which had been five years without manuring and which as noted in the previous year were showing signs of deterioration again, were used for testing a new nitrogen manure, "Ammophos" applied at the rate of 5 lb. per tree in March. The grade of "Ammophos" used was the 20-20 *i.e.* 20% ammonia and 20% phosphoric acid ($P_2 O_5$). This form of "Ammophos" contains ammonium sulphate as well as ammonium phosphate. Although a slight improvement in the colour of the foliage was discernible no effect in the yield was noted and the results could not compare with the effect of ammonium sulphate.

The E. plots received their normal biennial application of ammonium sulphate, the quantity this year for the first time being reduced to 4 lb. per tree giving an amount of nitrogen equivalent to 5 lb. of sodium nitrate.

The D. plots received no treatment.

Seventh year, March 1925-February 1926.—The C. plots annually manured with sodium nitrate again reached a new high record yield of 550 lb. per acre. The control A. plots showed a slight rise of 13 lb. per acre due probably to an average lower tapping cut than the previous year. The deterioration in appearance of these plots continued.

The B. and E. plots were not manured.

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* By J. Grantham, *Archief voor de Rubbercultuur,* Jaargang 11, No. 10, October 1927.

† Manurial Experiments on Hevea, *Archief voor de Rubberculturr,* VIII Jaargang, No. 8, August 1924. (Summary published in *The Tropical Agriculturist,* Vol. LXIII, No. 5, November 1924).

Table I

Series	Treatment in 1924	1924 March 1 to 15	1924 March 17-April 15	1924 May 17-June 15	1924 July 17-Aug. 15	1924 Sept. 17-Oct. 15	1924 Nov. 17-Dec. 15	1925 Jan. 17-Feb. 15	Total March 1924-Feb. 1925	lb. per acre per year	Kg. per H.A. per year
A	Control	32·9 100	112·8 100	223·5 100	300·0 100	276·2 100	307·8 100	278·4 100	1532·5 100	255	286
B	5 lb. 20·20 Ammophos per tree—March	58 8 178·7	203 3 180·2	307 4 137·5	401·3 133·8	363·5 131·8	393·0 127·3	350·8 126·1	2078·1 135·6	346	388
C	5 lb. sodium nitrate per tree—March	115·9 352·3	358·6 317·9	472·1 211·2	588·4 196·1	530·0 191·1	585·2 189·6	561·9 201·8	3212·1 209·8	535	600
D	None	51·5 156·5	169 0 149·8	333·7 149·3	429 8 143·3	393·1 142 3	440·7 142·8	393·2 141·2	2211·0 144·3	368	412
E	4 lb. ammonium sulphate per tree—March	89·1 270·8	294·6 261·1	422·2 189·8	514·2 171·4	479·1 173·4	522·0 169·1	477·9 171·7	2799 0 182 0	466	522

Series	Treatment in 1925	1925 March 17-April 15	1925 May 17-June 15	1925 July 17-Aug. 15	1925 Sept. 17-Oct. 15	1925 Nov. 17-Dec. 15	1926 Jan. 17-Feb. 15	Total March 1925-Feb. 1926	Lb. per acre per year	Kg. per H. A. per year
A	Control	229·6 100	222·8 100	314·1 100	271·7 100	306·3 100	262·6 100	1607·1 100	268	300
B	None	312·6 136·1	319·2 143 3	418·6 133·3	361·2 132·9	372·3 121·5	351·2 133·7	2135·1 132·9	356	398
C	5 lb. nitrate of soda per tree—February	585·9 255·2	516·0 231·6	599·0 190·7	527·0 194·0	540·5 176·5	532·5 202·8	3300·9 205·4	550	616
D	2 lb. ammonium sulphate per tree—February	386·6 168·3	329·4 147·8	435·0 138·5	395·0 145·4	404·8 132·2	402·5 153·3	2353·3 146·4	392	439
E	None	433·2 188·7	425·7 191·0	548·3 174·5	470·5 173·2	493·7 161·2	467·1 177·9	2838·5 176·6	473	530

Series	Treatment in 1926	1926 March 17-April 15	1926 May 17-June 15	1926 July 17-Aug. 15	1926 Sept. 17-Oct. 15	1926 Nov. 17-Dec. 15	1927 Jan. 17-Feb. 15	Total March 1926-Feb. 1927	lb. per acre per year	Kg. per H. A. per year
A	Control	175·6 100	237·5 100	291 2 100	274·7 100	301·0 100	270·4 100	1550·4 100	258	289
B	4 lb. ammonium sulphate per tree—February	272·6 155·2	311·5 131·2	385·2 132·3	360·8 131·3	416·9 138·5	378 6 140·0	2125·6 137·1	354	397
C	5 lb. nitrate of soda per tree—February	463·7 264·1	538·9 226·9	636·0 218·4	571·8 208 2	654·2 217·3	618·4 228·7	3483·0 224·7	580	650
D	None	316·5 180 2	376·4 158·5	433·0 148·7	394·3 143·5	426·7 141·8	406·8 150 4	2353 7 151·8	392	440
E	4 lb. ammonium sulphate per tree—February	390·6 222·4	469 8 197·8	559·2 192·0	510·6 185·9	570·7 189·6	531·6 196·6	3032·5 195·6	505	566

N.B.—All yields given are 1st. latex plus lump only, scrap rubber not being included.

The D. plots previously used for calcium nitrate applications in alternate years, received 2 lb. of ammonium sulphate per tree, *i.e.*, half normal quantity, to be applied in alternate years in future, calcium nitrate beig no longer considered a suitable manure owing to its very hygroscopic nature and destructive action on the skin of the coolies handling it.

No residual effect of the "Ammophos" applied the year previously, appeared in the B plots, the increase in yield being inappreciable.

Eighth year, March 1926-February 1927.—Yet again the annually manured C. plots reached a new high record of 580 lb. per acre and this in spite of an average higher tapping cut, which was expected to cause some falling off in yield. Apparently the limit of increase in yield from nitrogen manuring is not yet reached in these plots.

The control A. plots continued to deteriorate in appearance, severe die-back of the main trunk being quite advanced in a large number of trees particularly in the centre of the plots. From the generally better appearance of the trees on the borders of the plots there is reason to believe that roots passing beneath the isolating drains secure some benefit from the manuring in adjacent plots. The effect is not one of the drains themselves since there are drains through the centres of the plots.

No effect having been shown by the "Ammophos" manuring, the B. series of plots received 4 lb. ammonium sulphate per tree and it is the intention in future to repeat this application annually.

The E. plots received their biennial application of 4 lb. of ammonium sulphate and gave a record yield for this series of 505 lb. per acre for the year.

All plots are now on a permanent manuring scheme which will be continued unmodified for a long period of years as summarised below:

A. Control = unmanured.

B. Annual manuring with ammonium sulphate 4 lb. per tree.

C. Annual manuring with sodium nitrate 5 lb. per tree.

D. Biennial manuring with ammonium sulphate 2 lb. per tree, (half normal quantity).

E. Biennial manuring with ammonium sulphate 4 lb. per tree.

It will of course be a few years before series B. and D. will be comparable with the other series, which have remained unchanged since the beginning of the experiment.

The results so far obtained have been considerably in excess of those originally anticipated and the response of white soil to nitrogen manuring is so favourable as to neutralise the natural superiority of the red ground.

As an example of the realization on a large scale of the increased yields indicated by the experiments it may be mentioned that the yield of the H.A.P.M. over an area exceeding 40,000 acres, of which about 85% is white soil, having reached a standstill at just below 300 lb. per acre in 1920 and commenced to fall back in 1921, showed a steady increase to 474 lb. an acre for the year 1926, following an expanding manurial program on the white soil during the years 1921 and 1923-1926.

Ammonium Sulphate (Time of Application) Experiment Soengei Baleh 1.—Ammonium sulphate was applied at fortnightly intervals from the beginning of December 1922 to the end of January 1923, to alternate fields in an area previously unmanured on Soengei Baleh Estate, with the idea of testing to what extent it was possible to apply the manure before the dry season in February, without risk of serious loss by leaching out by the heavy rains. The manure was broadcasted in the usual manner on the surface of the ground.

Alternate fields were treated with 4 lb. of ammonium sulphate per tree as shown in table II.

Table II

Field	Acres	Treatment	Yield in lb. of latex per acre	% Relation to adjoining controls
1 & 3	7·88	Ammonium sulphate—December 9, 1922.	1950	127
2 & 4	7·86	Control = Unmanured	1531	
5 & 7	7·53	Ammonium sulphate—December 17, 1922.	1669	130
6 & 8	8·32	Control = Unmanured	1268	
9 & 11	7·84	Ammonium sulphate—January 2, 1923.	1636	127
10 & 12	8·15	Control = Unmanured	1289	
13 & 15	7·76	Ammonium sulphate—January 17, 1923.	1404	113
14 & 16	8·15	Control = Unmanured	1245	
17	3·88	Ammonium sulphate—February 5, 1923	1393	119
18	4·66	Control = Unmanured	1173	
Total	34·79	Ammonium sulphate	1639	125
Total	37·20	Control = Unmanured	1309	

Equally striking results on appearance (denser dark-green foliage) within 2 to 3 months after wintering were obtained on all manured plots, even those on which heavy rain took place with 48 hours of the period of application. Some retardation of wintering occurred in all manured plots but was most pronounced in the later manured ones.

Records kept of the latex weight of the fields before the experiment started showed the yields to be reasonably uniform. The total yields on alternate month tapping on a half cut from March 1923 (the wintering period for which the application was made) to December 1924 are given in table II.

The experiment is from its nature not a very precise one as regards comparison of yields and no fine distinctions can be drawn between the various times of application, but it will be noted that the average increased yield of all plots over the controls is 25% for the 22 months of the experiment, and that the longest application before wintering, viz. the December 9th. application, gave 27% increase.

The effect of the ammonium sulphate is apparent on all plots and the conclusion is reached, that ammonium sulphate may be supplied a month or two before wintering without appreciable loss, and that the earliest application is at least as good as the latest.

Ammophos Experiment—Soengei Baleh 1.—In addition to the test with "20-20 Ammophos" carried out in the B. plots of the "Second Nitrate Manuring Experiment," a test was also made on a much larger scale in an area of 58 fields previously unmanured on Soengei Baleh Estate, on the opposite side of the road from the Experiment on the time of application of ammonium sulphate just described, 29 alternate fields were manured in the wintering period of March 1924 with 5 lb. per tree of ammophos, the other 29 fields being left unmanured as controls.

A very slight effect in the colour of the foliage was noted about 2 months after the application but as shown in table III, absolutely no effect was produced in the yield in contrast to the much darker colour and increased yields given by the ammonium sulphate on the either side of the road, the previous year.

Table III

Month		Average lb. of latex per acre		Per cent. relationship manured to unmanured
		29 manured fields Total 117 acres	29 manured fields Total 115 acres	
March-April	1924.	75·2	74·6	101
May-June	,,	115·2	116·6	99
July-August	,,	149·8	152·9	98
September-October	,,	119·9	122·1	98
November-December	,,	163·6	160·8	102
January-February	1925.	165·2	169·5	98
March-April	,,	138·8	143·6	97
May-June	,,	114·2	118·7	96
July-August	,,	163·9	168·8	97
September-October	,,	158·8	165·9	96
November-December	,,	143·0	147·4	97
Total	...	1,507·6	1540·9	98

It is not clear why "20-20 Ammophos" should have given no results, while ammonium sulphate on the adjoining land applied the previous year gave quite definite results.

In describing "20-20 Ammophos" the makers state that it differs from the 13-48 grade (which is almost entirely monoammonium phosphate) in being made with sulphuric acid in place of part of the phosphoric acid. An analysis showed a composition approximately equivalent to a mixture containing a molecule of ammonium sulphate $(NH_4)_2SO_4$ to each molecule of monoammonium phosphate $NH_4H_2PO_4$. Two-thirds of the nitrogen therefore appears to be in the form of ammonium sulphate. The 20-20 Ammophos is however more acid ($_pH=4·5$) than the ordinary ammonium sulphate alone ($_pH=5·0$) and possibly this exercises a prejudicial effect as was the case with calcium superphosphate in the D. plots of the "Second Nitrate Experiment" in 1920.

SUMMARY

1. The continued results of manuring with nitrogen fertilizers obtained in an experiment on Soengei Baleh Estate are given for the 6th., 7th., and 8th. years. The plots manured annually in the wintering period with sodium nitrate have reached a yield of 580 lb. per acre or 650 Kg. per H.A. for the year 1926-27 against a yield from the control unmanured plots of only 258 lbs. per acre or 289 Kg. per H.A. The plots manured once in two years with ammonium sulphate have reached a yield of 505 lb. per acre or 566 Kg. per H.A. The tendency of the yield of the manured plots is still upward.
2. It was shown that ammonium sulphate could be applied without loss in effectiveness up to 2 months before the commencement of the wintering period, even where heavy rain occurred soon after the application.
3. No increase in yield was obtained by the use of the fertilizer "Ammophos" grade 20-20 *i.e.* 20% ammonia (NH_3) and 20% phosphoric acid (P_2O_5).