

LOSSES OF SULPHATE OF AMMONIA DURING RAIN

P. A. KEILLER, F.I.C., F.C.S.,
ANALYST, COLOMBO COMMERCIAL CO., LTD.

AN idea has been prevalent in Ceylon for many years that soluble fertilisers, such as sulphate of ammonia and nitrate of soda, are very liable to loss should rain follow soon after their application, and the increasing use of sulphate of ammonia as a fertiliser for rubber has aroused interest in the question whether it is sound practice to broadcast this without forking it in.

The loss, if there is any, caused by rainfall may be due to the sulphate of ammonia being washed right through the soil until it reaches the underground water level and is carried completely away, or it may be because it is carried off the surface of the soil by the water which runs off and does not penetrate. This article deals only with the second possibility, but as regards the first it may be noted that it does not happen with any rapidity or completeness. The texture of a soil is very far from being that of a sieve through which water can run unchecked, and the downward movement of water through an average soil is very slow. Moreover, although sulphate of ammonia is readily soluble in water it quickly enters into combination with the clay and humus in the soil and becomes fixed in a much less soluble form and is not found in quantity in the underground drainage water.

In considering the second possibility we are only concerned with the mechanical removal of sulphate of ammonia by water running off the surface of the soil, and it is clear that until water begins to run-off there can be none of this loss. However, hard and sun-baked the soil may be, the first of the rain that falls on it does not run-off; it soaks in. This happens whether the rain is heavy or light—whether it develops into a “ five-inch

plump" or ceases as a light shower; the first of it soaks in and an appreciable time elapses before it begins to run-off the surface.

Now suppose sulphate of ammonia had been broadcast immediately before the rain started. It is very soluble in water and the first drops of rain which fall on it dissolve it. If the rain lasted for only ten seconds it would be impossible to find undissolved sulphate of ammonia on the ground on which the rain had fallen. Having dissolved the sulphate of ammonia this first rain soaks into the soil and takes the sulphate of ammonia with it, and once the fertiliser is below the surface it is safe from surface wash.

If we consider the other extreme and suppose that some insoluble fertiliser, say groundnut cake, had been similarly broadcast, let us see what would happen. Being insoluble in water it will not be dissolved and carried into the soil but will remain on the surface during the time when the rain is soaking in. If the rain continues until water begins to run-off the surface, the particles of groundnut cake are liable to be moved down the slope just as small particles of soil are moved down, and eventually the fertiliser may be entirely washed off the surface into the drains, like so much silt.

We are led to the conclusion, therefore, that the fertilisers liable to be washed off the surface and lost are not those which are readily soluble but those which are insoluble, and that the more quickly soluble a fertiliser is the less chance there is of loss during rain.

A practical demonstration of the truth or fallacy of this would be useful, and the following is a description of some experiments designed for this purpose.

A sloping path, cut out of a cabook (lateritic) formation, was divided down the middle by strips of iron sheeting embedded in the ground, similar strips being placed as outside boundaries to confine the water to the path. At the bottom of the slope a channel was cut diagonally across each half of the path, to lead the run-off into a pit at either side where it could be collected in a suitable vessel. The arrangement is shown in Plate I.

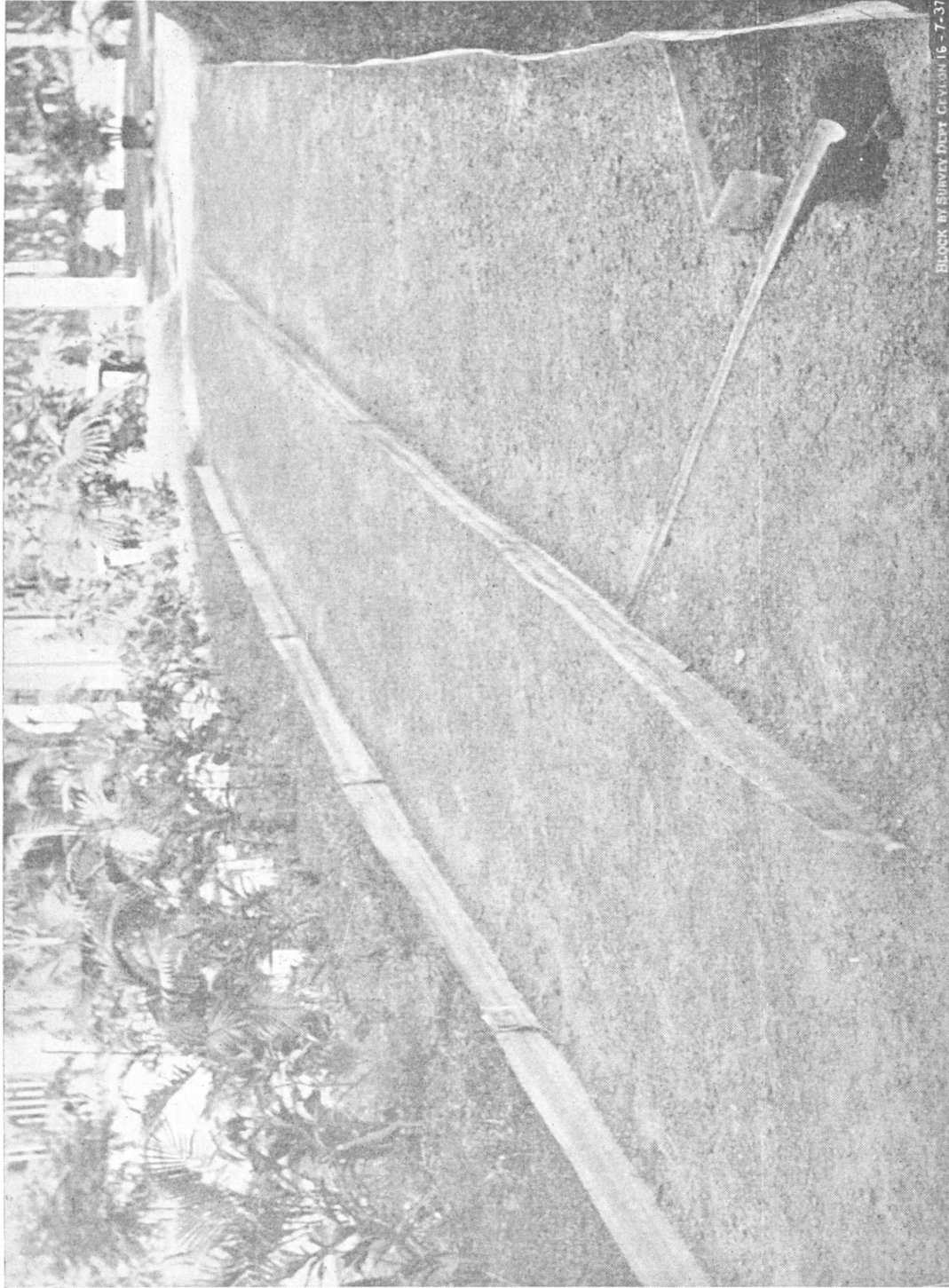


Plate I. Run-off Experiment No. I—Plots on hard cabook

On one strip, sulphate of ammonia was broadcast at the rate of 4 cwt. per acre, the other strip being left untreated as a control. The ground was dry and hard, for although there had been a heavy shower four days previously the weather before and since then had been hot, dry and windy. It should be noted that conditions were very severe. The ground was exceedingly hard, the path having been cut to a depth of about 6 inches in hard laterite from which cabook bricks had recently been cut for building purposes, and the exposed surface had not been top-dressed or treated in any way. It was really a very hard cabook sub-soil.

About an hour and a half after the application a light drizzle of rain fell, lasting only a few minutes, and this was repeated once or twice in the course of the next 6 hours. The ground was hardly wetted and there was no run-off. About 6 hours after the application a sharp shower fell, in the course of which run-off began and the first collection (1 litre) was made. It took 5 minutes to collect this litre.

Rain ceased for half an hour, after which a heavy shower fell. A second collection was made, 1 litre taking 5 minutes as in the first case. A third collection was made 5 minutes after the completion of the second, and this time only 2 minutes were required to collect 1 litre.

The various samples were filtered and the ammonia in them determined by distillation and Nesslerising in the usual way. The results are given in table I.

TABLE I

LOSSES FROM AN APPLICATION OF 4 CWT. PER ACRE SULPHATE OF AMMONIA

S/Ammonia found in surface water from control plot	S/Ammonia found in surface water from manured plot	S/Ammonia lost from manured plot	Percen- tage lost	Total loss from 1 acre
1st Collection—5 minutes				
0·00008 oz.	0·00421 oz.	0·00413 oz.	0·020	1·4 oz.
2nd Collection—5 minutes				
0·00008 oz.	0·00498 oz.	0·00490 oz.	0·023	1·6 oz.
3rd Collection—2 minutes				
0·00004 oz.	0·02342 oz.	0·02338 oz.	0·111	7·9 oz.

These figures are not altogether in favour of the contention that there is no loss. When the run-off was such that it took 5 minutes to collect 1 litre the loss was very small, and was practically the same after cessation of rain for half an hour, but when the rate of flow increased so that 1 litre was collected in 2 minutes the loss increased five-fold and reached the considerable total of half a pound of sulphate of ammonia per acre.

The explanation appears to be that on such a very hard soil the penetration of rain water has not gone beyond an inch or two when run-off begins and that it proceeds extremely slowly after that. All the sulphate of ammonia is, therefore, concentrated in the first one or two inches of surface soil, and if the run-off is rapid it carries a good deal down the slope before fixation takes place. Under estate conditions, even if the soil were as hard as in this experiment, it is likely that the run-off would have a longer distance to travel before reaching a drain, while at the same time its flow will be checked here and there by stones, leaves, roots, etc., giving time for more soaking in to take place, and the chances are that the loss would not be so great as under the very severe conditions of this experiment.

The experiment was continued as follows : after an interval of 13 days without rain and with a very hot sun and a strong wind, a heavy shower fell lasting half an hour and measuring 0.56 inches. No further application of sulphate of ammonia had been made and the run-off was collected in three lots as before. The first collection started with the beginning of the flow, the second was taken 5 minutes after the finish of the first, and the third 10 minutes after the finish of the second. The flow was rapid, only from 1 to 2 minutes being required for the collection of 1 litre. The results are shown in table II.

TABLE II
FURTHER LOSSES IN THE SAME EXPERIMENT AFTER A DRY SPELL OF 13 DAYS

S/Ammonia found in surface water from control plot	S/Ammonia found in surface water from manured plot	S/Ammonia lost from manured plot	Percen- tage lost	Total loss from 1 acre
1st Collection—2 minutes				
0.00013 oz.	0.00424 oz.	0.00411 oz.	0.020	1.4 oz.
2nd Collection—1 minute				
0.00012 oz.	0.00543 oz.	0.00531 oz.	0.025	1.8 oz.
3rd Collection—1 minute				
0.00011 oz.	0.00310 oz.	0.00299 oz.	0.014	1.0 oz.

These figures make an interesting comparison with table I. Although the rate of flow in the first collection was equal to that which caused a loss of nearly 8 oz. of sulphate of ammonia from an acre at the start of the experiment, it only caused the negligible loss of 1.4 oz. in this case, while though the rate was doubled in the second and third collections the loss per acre reached its maximum at 1.8 oz. and dropped thereafter to just over 1 oz.

This shows how small the loss is, even under these severe conditions, when rain is intermittent.

Another dry spell of 12 days followed, the weather being hot. Rain fell during the night following this interval, measuring 1.39 inches. This was not collected.

Five days later, heavy rain fell in the afternoon and three collections from both plots were made. Run-off started at 4.25 p.m. and 1 litre was collected from the control in 6 minutes and from the treated plot in 2 minutes. The second collection was made 5 minutes after the finish of the first and took 4 minutes on the control and 3 minutes on the treated plot. The third collection was made after a further interval of 5 minutes and both litres took 2 minutes to collect. The rainfall between 4.10 and 4.47 p.m. was 0.95 inches. The results in this series are shown in table III.

TABLE III

FURTHER LOSSES IN THE SAME EXPERIMENT AFTER AN INTERVAL OF 16 DAYS

S/Ammonia found in surface water from control plot	S/Ammonia found in surface water from manured plot	S/Ammonia lost from manured plot	Percen- tage lost	Total loss from 1 acre
1st Collection—2 minutes				
0.00019 oz.	0.00252 oz.	0.00233 oz.	0.011	0.79 oz.
2nd Collection—3 minutes				
0.00013 oz.	0.00212 oz.	0.00199 oz.	0.009	0.64 oz.
3rd Collection—2 minutes				
0.00004 oz.	0.00087 oz.	0.00083 oz.	0.004	0.28 oz.

The rate of flow during the first collection was the same as that recorded for the first in table II, but the loss was only just over half as much. In the second collection it was even less, and in the third, with a rate of flow again as fast as in the first, the loss dropped to the very low figure of $\frac{1}{4}$ oz. from 1 acre.

The experiment was concluded with a final series of collections 4 days later. Rain fell after an interval of 3 days, but this occurred at night and no collection was made; the total fall amounted to 0.61 inches. The following evening there was more rain, just before dark, and three collections were made from each plot, as before. The first collection took 3 minutes to produce 1 litre, after which rain ceased for 15 minutes. At the second collection the rain was heavy and 1 litre was obtained in 1 minute. At the third collection, 2 minutes were required to produce 1 litre. The results of these collections are shown in table IV.

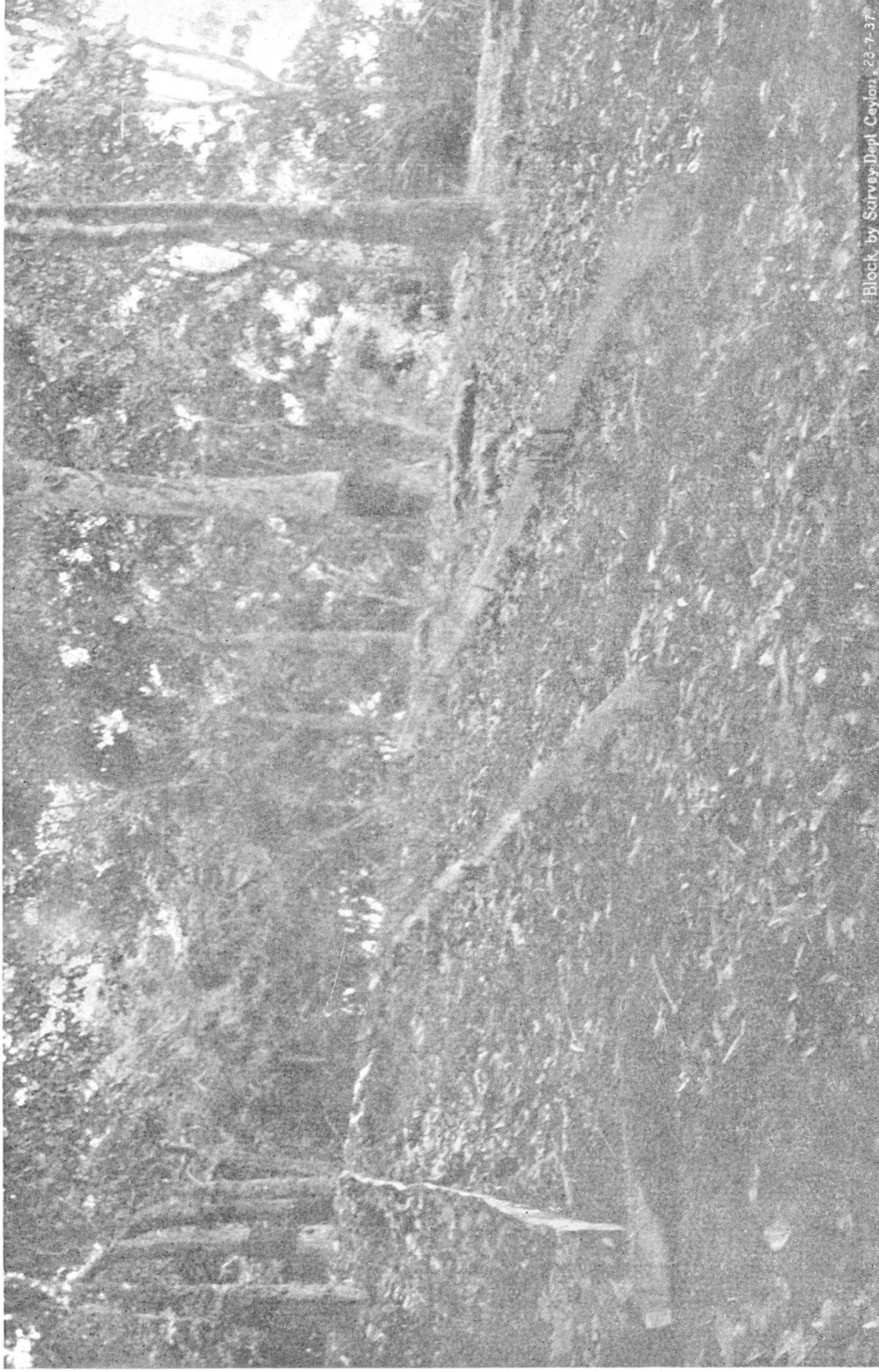
TABLE IV
FURTHER LOSSES IN THE SAME EXPERIMENT AFTER AN INTERVAL OF 4 DAYS

S/Ammonia found in surface water from control plot	S/Ammonia found in surface water from manured plot	S/Ammonia lost from manured plot	Percentage lost	Total loss from 1 acre
1st Collection—3 minutes				
0.00013 oz.	0.00233 oz.	0.00220 oz.	0.010	0.72 oz.
2nd Collection—1 minute				
0.00010 oz.	0.00171 oz.	0.00161 oz.	0.008	0.56 oz.
3rd Collection—2 minutes				
0.00005 oz.	0.00099 oz.	0.00094 oz.	0.004	0.28 oz.

This series shows practically the same losses as in the previous case.

Although tables III and IV do not show complete absence of loss it must be admitted that from one quarter to three quarters of an ounce out of 448 lb. is quite negligible. Even the first two tables, if we accept the rather inexplicably high figure of 7.9 oz. in the third collection of the first series, do not show any loss as great as 2 oz., and this from an acre on which 448 lb. has been applied is very insignificant.

These figures do not enable us to estimate what the total loss has been as a result of all the rain which fell while the experiment was being carried out. This would have involved the collection and analysis of the whole of the run-off, and this was not attempted. They do show, however, that even in heavy rain (in the 3rd series nearly an inch fell in half an hour) lasting for 5 minutes the total loss is usually of the order of from 1 to



Block by Survey Dept. Ceylon, 23-7-37.

Plate II. Run-off Experiment No. 2—Plots on forked rubber land



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Plate III. Run-off Experiment No. 3—Plots on forked rubber land

2 oz. from an acre. Remarks have sometimes been made regarding the supposed losses on an estate to the effect that the manure "has practically all gone" or "at least half of it has been washed away." If even half were washed away that would mean a loss of 224 pounds per acre, whereas the loss of a few ounces is really what happened—and that under conditions which are much more severe than those on the average estate.

SECOND EXPERIMENT

The experiment just described was looked upon as a preliminary one, and it was felt that further trials under estate conditions would be of greater practical interest. Two similar lay-outs with the same size of plots were therefore arranged on sloping ground in reasonably well-forked rubber land. They are shown in Plates II & III.

In the second experiment, sulphate of ammonia was broadcast, at the rate of 4 cwt. per acre, about 12 hours before rain fell. This rain only amounted to a slight shower of 0.09 inches and there was no run-off. There was no rain the following day, but on the evening of the second day rain started at about 10 p.m. and collection went on from that time until 2.15 a.m. by which time about 2½ litres had been collected. The total rainfall was 1.34 inches.

Except for one heavy shower and a few light drizzles, no rain had fallen for 14 days before the application, and the ground was dry, though nothing like so hard as in the previous trial. The soil was typical "cabooky" rubber land—a red, gravelly laterite. It had been forked once a year and was last forked six months before the application.

The results from this experiment are shown in table V.

TABLE V
LOSS FROM AN APPLICATION ON RUBBER LAND FORKED ONCE A YEAR

S/Ammonia found in surface water from control plot	S/Ammonia found in surface water from manured plot	S/Ammonia lost from manured plot	Percentage lost	Total loss from 1 acre
0.00014 oz.	0.00040 oz.	0.00026 oz.	0.0012	0.09 oz.

*This sample was accidentally contaminated and the result from the control in table VI was used.

THIRD EXPERIMENT

In this case the conditions as regards the soil and its previous treatment were the same as in the second experiment, the areas

being only some 15 yards apart. The application was, however, made 10 days before sufficient rain fell to enable collection to be made. The application was made on the 4th of March, and slight showers fell on the 8th, 11th and 12th, but not sufficient to cause run-off. There was no rain on the 13th, but on the 14th evening rain occurred as already noted in the previous experiment. Collection took place between 10·15 p.m. and 2·15 a.m. and about 2½ litres were collected. Total rainfall 1·34 inches. The results are shown in table VI.

TABLE VI
LOSS FROM AN APPLICATION MADE ON RUBBER LAND FORKED ONCE A YEAR

S/Ammonia found in surface water from control plot	S/Ammonia found in surface water from manured plot	S/Ammonia lost from manured plot	Percen- tage lost	Total loss from 1 acre
0·00014 oz.	0·00023 oz.	0·00009 oz.	0·0004	0·029 oz.

In both these experiments the losses are quite negligible. Traces of ammonia are always found in surface water, and the amount found in the run-off from the treated plots in the second and third experiments is not much more than may occur in shallow well waters, being only from 0·2–0·3 parts per 100,000. The figures have been calculated to ounces sulphate of ammonia per litre collected, and the resulting quantities can be disregarded from the practical point of view. Only traces of sulphate of ammonia are washed off the surface by even heavy rain when the soil is in a reasonably well-forked condition.

The conclusion from these three experiments is that little loss of sulphate of ammonia takes place by surface wash even from unforked and very hard soil unless the run-off is very rapid, and quite negligible amounts from land which has been forked 6 months before the application. If rubber land has not been forked for a year or more and is very hard it is probably advisable to fork in a sulphate of ammonia application, but this is unnecessary if the soil is loose from previous forking.

It should be noted that light forking on hard and previously unforked land may do more harm than good, for by loosening only the first inch or so it increases the amount of soil washed away and this may take a large proportion of the sulphate of ammonia with it. Such cases should be considered individually, with due regard to all the circumstances, and it is inadvisable to attempt to lay down a general rule. Possibly the best plan may be to deep-fork the land during the rains and to apply the sulphate of ammonia, without further forking, towards the end of the rainy season and when the weather is showery.