THE MANURING OF TEA*

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In a small book on soils which I reviewed in the last number of *The Tea Quarterly* the author stressed the view that the agricultural problem of plant nutrition will only be satisfactorily solved when the physiology of the plant is completely known. This is unfortunately only too true, and though, as I pointed out in the review in question, we cannot wait till all this detailed knowledge is available before coming to grips with the problem of manuring of crops, such a declaration serves to remind us that the plant is the most important factor in the partnership of plant, manure and soil. Too often we are apt to think and speak of manuring the soil and not of feeding the plant. So today in speaking to you of tea manuring it is the plant relationship that I shall emphasize and you will hear little about manurial recipes for this or that type of soil.

MANURING IN RELATION TO GROWTH STAGE OF THE PLANT

It is common knowledge that the plant obtains its mineral foodstuffs such as potassium; its phosphorus and its nitrogen from the soil by means of its root; and that its carbonaceous tissues are built up from carbon dioxide abstracted by the leaves from the atmosphere. How these two streams of food supply are combined is still largely a mystery, but, from the combination of the two, substances are produced which repair the wastage of tissues, provide for storage, stimulate growth, and bring about all the complex changes that occur in the normal life time of a plant. Now I neither can nor intend to delve into the difficulties of the plant's mechanism for doing all these things, but in the few sentences I have already used there have occurred three words involving three important conceptions, time, storage, growth.

It is obvious that in any attempt to rationalise manuring of a crop we shall have to take into account these factors. Let me put a few questions: Does it matter when we manure the tea bush? If we supply more food than the bush can use immediately, can it store it up for use in the future? To what extent can we make a bush grow when, to speak colloquially, it does not want to? Does there

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come a time when a bush does not take up any more foodstuffs? Does a bush require a change of diet and of quantity of food at different stages in its growth? These are the kind of questions which to my mind lie at the root of successful manurial practice and not the questions relating to the alternative use of sulphate of ammonia and blood meal; mineral phosphate or superphosphate.

To some of these questions I can give no answer at all, to some I can only give a partial or a tentative answer, but the experimental work done by the Institute has to an appreciable extent brought order out of chaos and since manurial recipes are still a mystery to some, I am going to play the part of the conjurer who shows how his tricks are done.

There are some crops which only take up nitrogen during particular phases of growth. For example, the barely plant growing for fifteen weeks between seed time and harvest attains its maximum store of nitrogen by the end of the tenth week. Thereafter it merely moves the nitrogen it has garnered from one place to another; from leaf to maturing grain. Our evidence for tea is necessarily incomplete, but there is no evidence to hand that such phasal growth occurs in tea where of course the attainment of a reproductive phase giving flower and seed is sedulously avoided. That is not the same thing as saying that there are not occasions when nutrient uptake rates differ widely but such periods are more directly linked to the climatic conditions than to something intrinsic in the plant.

YIELD RESPONSE TO NITROGEN

The fact that manuring has been so widely successful under all sorts of conditions confirms us in the view that up to a certain limited capacity the bush will utilize manure during the greater part of its life. Of course one can imagine a condition when the bush is so large that other environmental factors, *e.g.*, light and water become limiting, but on the average tea estate in Ceylon that stage is not found. Nor are the quantities usually applied so great that the bush cannot deal with them. If all the nitrogenous manures that are imported into Ceylon were used exclusively on tea and were strictly rationed, no tea estate would receive more than 30 lb. of nitrogen per acre. The Tea Research Institute has so far experimented with doses as high as 80 lb. per acre and so far the response is fully proportional to the dose. The highest dose has only been given during the last two years to tea which previously had 40 lb. of nitrogen per acre, and it may be that when this 80 lb. has had its full effect over a period of years, the bushes will have developed to a stage where the limiting conditions of light and water, to which

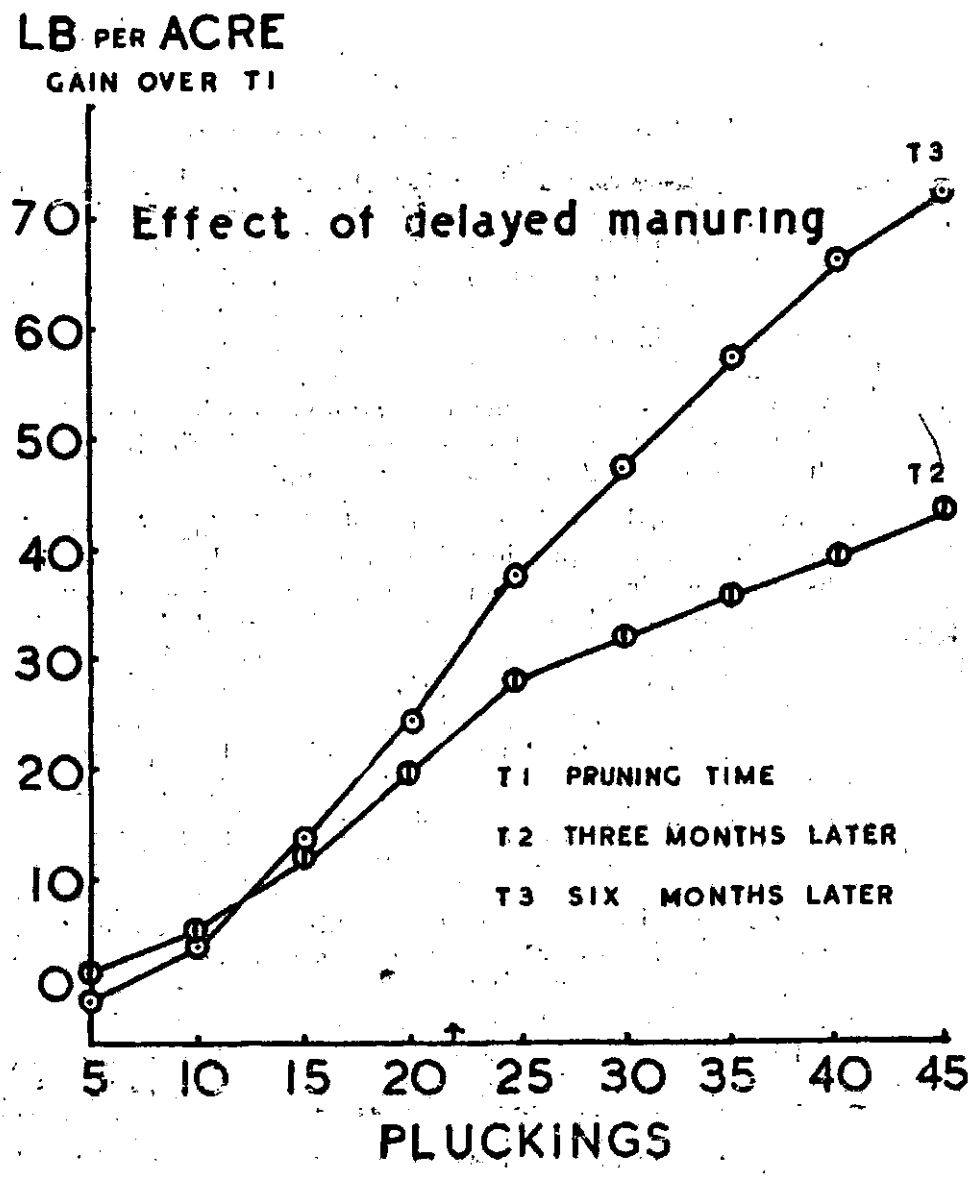
I referred, become operative; when therefore it will be possible to *maintain* the crop on reduced rations, but that time has not yet arrived. Because therefore we are using doses well beneath those which do give a continuously economic response, where the law of diminishing returns has not begun to operate, we can be fairly sure that throughout the cycle manuring will be beneficial.

LIMITING PERIODS FOR MANURING

The only reservations to this statement are at the beginning and end of the pruning cycle. To deal with the latter period first, we have not yet obtained the same decisive experimental evidence as we possess for the beginning, but in the April number of *The Tea Quarterly* I analysed field yields and showed in a number of cases that the apparent efficiency of manures used very shortly before pruning was affected by the short time they had in which to act. We have been able to find no evidence of carry-over of these late dressings (or of marked storage of nitrogen from them in the bush) that justifies their use within 2 or 3 months of pruning.

We now have further evidence about the beginning of the cycle. Having tried dressings at pruning time, three months later, and at six months from pruning, we found that a year after pruning there was a very appreciable benefit from the 3 months' delay and a slightly greater benefit from the six months' delay. At that time however the difference between 3 and 6 months' delay was not sufficiently large to speak about with confidence. At the close of the first year all plots irrespective of their time of initial treatment were again manured. One might have considered it likely that this new application would equalise the status of the plots fairly rapidly in the second year, but actually this has not been the case. If we plot the extra yield given by the two sets of plots which in the first year received delayed dressings, we find that in the case of the 3 months' delay the curve does rise less steeply after the second year manuring,* but in the case of the 6 months' delay, after a further six months the rate of increase of yield is only just showing signs of dropping. In brief, the delay in application of the first year mixture not only benefits the tea in that year, but enables the subsequent dose of manure to be used more advantageously than would otherwise have been the case. At the present moment just over half way through the pruning cycle the maximum benefit from the delayed manuring amounts to 72 lb. per acre, using of course, exactly the same amounts of manure in both cases. As I have explained in previous lectures the lack of effect of manures applied at pruning time in the very early stages of the cycle is due to the fact that nothing like full

* Marked with an arrowhead in the diagram on the time scale of pluckings.


LB PER ACRE
GAIN OVER T1
Effect of delayed manuring
T3
T2
70
60
50
40
30
20
10
0
T1 PRUNING TIME
T2 THREE MONTHS LATER
T3 SIX MONTHS LATER
5
10
15
20
25
30
35
40
45
PLUCKINGS

efficiency is achieved by the plant until it has a crown of foliage that makes it self-supporting in those nutrient constituents that come not from the soil but from the air. The present data show that once that efficiency is attained the increasing root, shoot and leaf expansion makes nutrient consumption and use extremely favourable.

So far then we have found by our experimental work that there is a period at the beginning of each pruning cycle when the bush develops solely from its stored food reserves. This is followed by a period of rapid expansion and of nutrient activity, and the question as to whether that activity becomes more sluggish as the cycle proceeds still remains to be settled. We know that in many instances the yield drops toward the end of the cycle. We have still to determine whether the capacity to use manures drops too, or whether the decline is due to entirely other causes. At present the indications are that instead of a flat rate of manuring throughout the cycle, starting with the time of pruning, we shall be better served by a gradually increasing supply up to the later manuring, *i.e.*, when the bush is not increasing its flushing points. The initial dose would be delayed till that period of the cycle when the plant becomes self-supporting in carbohydrate synthesis. For low-country conditions with fringe pruning or high cut-across that point will be much nearer pruning time than up-country. I define the correct itme as tipping time.

ADVISORY METHODS

So far I have dealt with what I consider to be the most important aspect of manuring — its relation to the growth and development of the plant. I propose to end my lecture by indicating how I tackle the business of advisory work on manuring. In a district with which I am not thoroughly familiar, I frequently visit the estate in question. This not only gives me a chance of examining the records and abstracing information likely to be helpful, and discussing matters with the superintendent; it also makes it easier to tell whether the fault (if any) is really due to inadequate or irrational manuring, or is attributable to some other cause. As regards the manure mixtures used, I alter these only when they are positively wasteful or more expensive than circumstances justify, or when they are obviously not capable of maintaining the crop in good production. Monthly yields per field arranged by pruning cycles are the most valuable data I can examine, much more so than the average annual yield per acre. From cycle yields it is possible with experience to assess the value that is being obtained from the manuring, and to choose a manuring interval that will best suit the purpose. Having settled this, a single suitable mixture is prescribed. The question as to what is a suitable mixture requires some definition.

First let us consider the nitrogenous constituent. If a sufficient yield is being steadily obtained on a given quantity of nitrogen, then that quantity can be taken as standard, unless it can be shown that some portion of it is wastefully used under the existing scheme. Using that quantity per annum as a datum line, the quantities at each application are calculated, at present quite empirically, with a gradual increase governed by age from pruning till the last or last but one according to the information revealed by the cycle yield curves: the average remains that previously decided. I admit that this method has not yet been reduced to a stage of complete experimental verification but it has a solid rational basis behind it, and experience over some years now shows that it works.

The phosphoric acid and potash are applied *pro rata* and their standard rates are determined by separate considerations. For crops of normal size, (*i.e.*, 500-900 lb. per acre) experiments show that though 30 lb. of phosphoric acid gives a measurable response, a higher dose (60 lb. per acre) does not. I have therefore taken 30 lb. as a standard dose. The truly economic figure may be below this; I hope to test that later, but it is demonstrably not higher than 30 lb.

In the case of potash we have recorded over a period of 8 years *no crop* response to potash. We have discovered small but definite differences in the chemical composition of the foliage of the plant which may or may not be precursors of something more important. Brokers have tended to prefer very slightly the teas manured with potash. We cannot therefore dismiss potash because it gives no obvious and directly tangible results. We know that a quantity of potash is continually and permanently removed from the soil in the form of crop and pruning wood. It is therefore our aim to replace this in full and to safeguard ourselves by erring on the side of generosity. Two point five pounds of potash per 100 lb. of harvested tea is the lower limit.

Such a conception as I have put before you gives a programme which I can illustrate by an actual example. An estate with a two-year cycle was receiving a mixture of the following composition once in a cycle of 2 years at pruning time:—

Groundnut cake	...	60 lb.
Crushed fish	...	170 ,,
Sulphate of ammonia	...	80 ,,
Saphos	...	50 ,,
Muriate of potash	...	40 ,,
	Total	400 lb.

thus giving approximately 27.5 lb. of nitrogen, 21.5 lb. of phosphoric acid, and 20 lb. of potash. Cost was in this case a consideration, so that it was obvious that two points needed adjustment:—

(1). The type of mitxure (the prescription being expensive in its type of nitrogen).

(2). Time of application (which was wasteful).

The following mixture was substituted:—

Castor cake	...	20 lb.
Sulphate of ammonia	...	130 ,,
Muriate of potash	...	30 ,,
Saphos or Safaga	...	70 ,,
	Total	250 lb.

giving 27.6 nitrogen, 20.7 phosphoric acid and potash 15 lb. This does not differ widely in nutrient value from the previous mixture except in being more economical in potash, a change that the low crop justified. But for the same sum of money 400 lb. of this mixture could be bought, giving 44 lb. of nitrogen, 32.5 lb. of phosphoric acid and 24 lb. of potash. This is an increase of nearly 60 per cent in nitrogen, and the other constituents are also in suitable proportions.

In place of a single application, this was divided into two portions of 165 lb. at six months from pruning time and the remaining 235 lb. at 15 months from pruning. This programme satisfies all the general requirements of which I have been speaking.

We have not said the last word about tea manuring, and further refinements in practice can be confidently expected when our experimental scheme is expanded. What can I believe be as confidently predicted is that since the whole matter is being based on experimental evidence of known credibility, the changes will be progressive and not (as has more than once in past history been the case) retrograde and contradictory in their trend.