MANURIAL RESPONSES OF TEA AND WEEDS

T. EDEN

The fact that for four years we have been subject to rationing of fertilizers, has accentuated the interest that has always been shown in the question of fertilizer responses. Consequently, it has seemed to me that on this occasion it would be profitable to speak mainly of the additional information that has been accumulated since these conferences were suspended.

We now have a firmer knowledge of this subject because of our longer experience. Our oldest experiment is now in its sixteenth year and the consistent results it has given are obviously no mere flash in the pan. I may therefore usefully start by refreshing your memories of the broad results of our manurial experiments at the time of our last gathering.

At that time, nitrogenous manures showed the greatest response. Furthermore, they showed that within the range of doses used, the response was strictly proportional to the dose. That finding has been consistently confirmed and the range of dose has been extended up to a higher limit of 80 lb. of nitrogen per acre. Even at this relatively high figure the law of diminishing returns has shown no signs of operating. I have frequently been asked during the rationing period, when quotas were substantially lowered, whether it was worth while to apply these reduced quantities. The experiments have given a clear cut answer in the affirmative.

Further evidence is now available on the subject of the relative efficiency of doses given at different periods in the pruning cycle. I have been studying old records, and it is clear that when the Tea Research Institute was founded, any sort of system about the size of applications was conspicuous by its absence. For one thing, very many people were obsessed by the idea that 600 lb. of manure was better than 500 lb. without any regard to its composition. As you are now well aware, during rationing we have had many changes in the bulk relationships of manure supplies without a corresponding change in nutrient quantity. Mere bulk signifies nothing. Speaking broadly, twenty years ago fairly uniform applications were used at the annual periods in the pruning cycle.

Now in ordinary estate practice it is never possible to assess the efficiency of fertilizers by a mere inspection of crop records, because there is no adequate control. The effect of a manure can never be assessed by dividing the total crop by the pounds of nutrient supplied. Systematic experiments allow us to measure the real response with accuracy, and the results of the past few years have been instructive. The efficiency of nitrogen increases as the pruning cycle proceeds, provided that the last dose is applied sufficiently long before pruning for the manure to exert its full effect. The averages for the past 15 years show that under our conditions we can expect one pound of tea per lb. of nitrogen applied near to the time of pruning, four pounds from the second year dose, and five from the third application in a 3-year cycle These figures if plotted in a graph show a distinct bend in the curve. On other

experiments that bend is not so pronounced and may not appear at all. What is common to all our experiments is that the efficiency mounts continuously, though not necessarily uniformly, as the cycle progresses. This is the factual basis for incremental doses of manuring. It is also the explanation of why, when manure was at its scarcest, I recommended that first-year fields could advantageously be sacrificed.

These results raise the question of how far this increase in efficiency can go. Steady manuring of our experiments with invariable quantities from year to year has raised our maximum efficiency from about 4 to 6 lb. of crop per lb. of nitrogen. There are indications that the latter figure is somewhere near the maximum. It corresponds very closely to the related figure obtained in Assam.

There are two qualifications to be added to this exposition. I have been referring to mature tea with a somewhat sparse shade. We have an experiment on young tea with an excellent cover of Grevillea which, so far, has not shown any response to more than 30 lb. of nitrogen per acre. Whether it is age or shade that is the operative factor I cannot say, but, be that as it may, this experiment confirms my opinion that young tea is frequently wastefully manured.

The second reservation is concerned with the climate in Uva and similar districts. On our parallel experiments there, the efficiency of nitrogen has never exceeded a figure of 3. In fact it is only on the longer pruning cycles that this value is reached. We now know that shot-hole borer damage is in part responsible for this but the picture is not entirely clear and we must seek information about the effect of the annually recurrent drought with its effect of restricting both growth periods and suitable times of manurial application.

Turning to phosphatic manuring, the picture is different. The law of diminishing returns operates there very thoroughly. High phosphatic doses of 60 lb. phosphoric acid were once the vogue. They pay no dividends, and in our experience are not superior to doses half that size. The optimal dose may be even smaller, and we are now exploring the lower range, below 30 lb. per acre.

The importance of regulating the phosphatic dose has been forcibly demonstrated by experiments showing what a prodigious effect phosphates have on the weed flora. When plots were left unweeded for 3½ months the weight of weeds removed from the phosphatic plots was 2½ times as great as it was from those which for two cycles had been devoid of phosphate. Here again the increase from 30 lb. to 60 lb. per acre of the nutrient was ineffective so the figures act as useful confirmatory evidence of the tea results. Such rank weed growth is not only a nuisance in itself but, in the prevalent system of clean weeding, or would-be clean weeding, involves an appreciable loss of nutrient. Removal of those weeds involved a loss of valuable nutrient to the following extent :—

	lb. per acre
Nitrogen ...	11
Phosphoric Acid ...	5
Potash ...	21

It is of special interest to note that the amount of phosphates wasted is not severe. That is because the phosphate content of weeds is small. I will not go so far as to say that by multiplying these figures by 3 we can get an accurate figure for the removal of nutrients by weeds over

a year's space of time, but the position as regards nitrogen and potash is disturbing. At a conservative estimate, weeds are removing half as much nitrogen as that taken off by the tea crop at its most productive period ; an equal amount of phosphate ; and twice as much potash. I must leave the broader question of weeds as a whole for another occasion, but this is a new and important aspect of the problem.

I have just related the toll on potash supplies that weeds can make. Until quite recently potash showed no signs of giving a response on mature tea. All that happened with increased doses of potash was that the plant tissues were enriched, but no yield increments were visible. Tea was in fact a mere luxury consumer of added potash. This state of affairs held good over the first twelve years of the experiment, but in the last cycle deterioration set in on the no-potash plots. During this cycle we have lost 60 lb. per acre by reason of potash deficiency. The type of response is similar to that for phosphate. Doses of 20 lb. give an increase of crop, or if you like, maintain a normal yield : doses of 40 lb. bring no added benefit.

I have always borne in mind the fact that we were removing about 2½ lb. of potash for every 100 pounds of crop. Now there is the weed effect to contend with as well. When manurial supplies are freely available, it will be well to reconsider the adequacy of potash manuring in the light of these results.

There is one further aspect of the potash question. Some years ago the Tocklai Station published an experiment showing the beneficial results on the growth of young tea obtained by very generous potash manuring before it was brought into bearing. Like ourselves they had had no such effects on old tea. Such an effect is surprising, and my only contribution to the problem so far is that in a similar experiment on our young tea we have not confirmed their beneficial results.

DISCUSSION

The discussion that followed revolved round three main points ; (1) the competition for nutrients between weeds or cover crops and tea ; (2) the general question of weed control ; (3) the efficiency of tea as a user of nutrients at different stages of growth.

Weed Competition.—Questions were asked about the competitive effect of *Vigna* in comparison with weeds, and on the demerits of individual species of weeds in exploiting manurial applications. Dr. Eden indicated that the chief disadvantage of *Vigna* was its climbing habit, and not its competitive absorption of nutrient. Being a leguminous plant, with nitrogen-fixing nodules it made a positive contribution to the crop environment and its demands were accordingly less severe than those of weeds. No clear distinction could be made between the various individual species of weeds. Such distinction would require much detailed analytical work. As a class, grasses were more avid for nitrogen than broad-leaved weeds, and left little available nitrogen in the soil for their competitors. Whilst this characteristic was beneficial in crop rotations in which grass leys stored nitrogen for release to arable annual crops later, it was an unfavourable factor in a perennial such as tea. The storage of nutrients by weeds was particularly noticeable in the instances of phosphate and potash. Even when not contributing to increased growth, manures were capable of increasing the concentration of the nutrient concerned.

in the tissues of the weed thereby increasing the loss occasioned by clean-weeding manured tea.

This explanation raised the further enquiry of how best to dispose of weeds so as to avoid these losses; in particular whether composting involved appreciable loss. To this the reply was given that when weeds decomposed in the soil there was no appreciable loss. Composting was always accompanied by some loss. The Institute was experimenting with a system of weed-control based on leaving weeds for 3-6 months and then removing and burying them in pits. The experiment had not yet proceeded far enough to give results.

To an enquiry whether depth of cultivation had any effect on absorption of fertilizers by weeds. Dr. Eden answered that since weed root-systems were shallower than those of tea it was advantageous to fork deeply when incorporating manures.

Weed Control.—Questions about general control of weeds centred round artificial methods of killing them. It was pointed out that chemical weed killers such as had been successful with cereal crops in temperate lands worked at a disadvantage in local circumstances. Weeds and cereals grew at approximately the same pace, and when the broad-leaved weeds were scotched by chemical weed-killers early in the season, the main crop was enabled to grow rapidly and smother any attempts at renewed growth. With tea, the rate of growth was much slower than that of weeds. Annual weeds were much more vulnerable than perennial ones. Further, rotation of crops helped farmers in temperate climates to check weed growth. With a perennial crop we had not this advantage.

The use of chemical weed-killers raised the question whether inorganic manures were less favourable to weed growth than organic. Our experiments had shown no difference between the two though, under suitable weather conditions, sulphate of ammonia might have a scorching effect on weeds which would give a very temporary check. On the subject of destruction of weeds *in situ* by flame-throwing apparatus Dr. Eden had no information relevant to Ceylon. Such work was not done in the presence of a standing crop, and the only implement he had seen that might be used in tea rows was in his opinion dangerous to the tea.

Shade and consequent competition for light and root space was a good deterrent and that explained the observation that weeds were less troublesome under Albizzias.

Nutrition of Tea.—The section of the lecture dealing with efficiency of the tea bush as a user of nitrogen led to a discussion on the effect of maturity of the foliage on nutrient synthesis. The phrase immature leaf was used in connection with plucking standards, and had no special physiological meaning. Fine distinctions were not possible, but on the whole the older leaves were less efficient elaborators of food than the young. When asked to reconcile this with the previous declaration that the efficiency of a bush increased with age from pruning Dr. Eden said that age of leaf was only one factor. The over-riding factors in bush efficiency were the number of leaves and the vigour and extent of the root system. Though plucking removed the young synthetically active leaf, there was more leaf left to carry on the process at the end of a cycle than at the beginning.

To the question whether young tea required more phosphate than nitrogen, the reply was that our experiments did not suggest that young tea had different requirements from old tea. They did suggest that much young tea was over-manured.

In reply to a question concerning the effect of inorganic manures such as sulphate of ammonia on the natural balance of soil organisms, particularly parasitic eelworms like the meadow eelworms, Dr. Gadd said that the soil population was very complex consisting of many different kinds of organisms such as bacteria, fungi, insects, eelworms and others, and that any soil treatment was likely to upset the natural balance temporarily. Sulphate of ammonia tended to make soils more acid and its repeated use would favour these organisms prefering more acid conditions. It was very unlikely however that the small change in soil acidity resulting from the use of sulphate of ammonia would have any material effect on the eelworm population. The meadow eelworm lived mainly within roots and in that position would be even less affected by any small change in soil acidity than other organisms living free in the soil.