

NUTRITION IN RELATION TO DISEASE

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At our First Conference held at Peradeniya 20 years ago I spoke on the relationship between food reserves and disease in the tea bush. Today, probably the last occasion on which I shall have the honour of addressing you, I want to revert to the same subject and to show its bearing on present-day problems.

First, I must remind you what the food of a tea plant is. It is not the stuff you get out of manure bags, but something quite different. You can see it best as the kernel of a tea seed. It consists of carbohydrates, protein and oil. All seeds contain similar foods to give the young plants a start in life; later they are able to make the food for themselves from materials obtained from the air and soil.

Although green plants only can make these foods from simple materials they are required by all living things, both animal and plant. All animals and non-green plants are dependent, either directly or indirectly, on green plants for their food and consequently for their existence. The struggle for existence is largely a food hunt, and much of what we call disease is merely a result of that food hunt.

The struggle amongst green plants is not for the elaborated food but for conditions which will permit them to make it. Their requirements are (1) the raw materials and (2) the power or energy for the processes. The necessary energy is obtained from the sun as light — so green plants must have a place in the sun. The

raw materials are obtained from the air and the soil. Some of them are supplied to crops as manures which are often mistakenly thought to be the kind of food plants require. Of the crop harvested, 40 per cent. of it comes directly from the air, 50 per cent. is derived from water, leaving only 10 per cent. as nutrients derived from the soil and the manure bag.

But neither the energy nor the mineral nutrients are of any use unless the plant has well-equipped factories in which to carry out the complicated processes. These factories are leaves. Without leaves, a tea bush can no more manufacture food than an animal can, no matter how much raw material and power are available. Leafless, it still requires food to maintain life, and considerable quantities of it to build new factories in which to resume manufacture. Unless the leafless bush has food in reserve for such an emergency it has no chance of survival. When a bush has a full canopy of foliage the presence or absence of a food reserve is of no immediate importance.

The food when made is either used immediately for further growth, i.e., for the development of more leaves, or it is stored for later use. Some bushes are inherently more thrifty than others and so put more food into reserve. Climate also has a marked effect on the amount of food stored in a tea bush. Up-country bushes store more than those grown in the low-country, and for that reason, deaths after pruning occur most frequently at low elevations. Such deaths can be avoided if the bushes are pruned in such a way that they are not denuded of leaves. That is the 20-year-old story, but it is sometimes forgotten.

The tea industry is fortunate that few animals, other than men, and few non-

green plants have any great liking for tea leaves. That is not because our tea bushes are superbly healthy; it is just that tea apparently is not a popular item in the food hunt. But there is one non-green plant which has an extraordinary liking for it. So great is its liking that so far as we can ascertain it will feed on nothing else. I refer to the fungus *Exobasidium vexans*, the cause of Blister Blight. That fungus lives on tea leaves, but I see no reason to believe that it will feed only on leaves of undernourished bushes, nor can I believe that the majority of bushes in Ceylon suddenly became debilitated in 1946. The simpler and truer explanation of the virulence of the disease is that the tea bush is the natural food plant of *Exobasidium*. Consequently it cannot be controlled by more manure or different manure or any other such-like simple way.

The most destructive form of plant disease, as Ceylon knows to her cost, is one which attacks and destroys leaves. So it was not surprising that the advent of Blister Blight created considerable alarm.

Experience during the last two years has allayed many fears, and has shown that the extent of the damage caused by Blister Blight depends largely upon the manner in which the bushes are treated agriculturally.

The usual method of protecting plants against fungus leaf diseases is by coating them with a thin layer of poison to kill the invading parasites before they can do any harm. That treatment is protective, not curative, and must be carried out just as soon as weather conditions begin to favour the parasite. The poison is applied either as a watery spray or as a dust. Dusts are as a rule less efficient than

sprays against fungi. Sprays are used in nurseries with good results but their general use in tea fields is debarred for well-known reasons. Even if those difficulties and objections could be overcome, it is doubtful that spraying would ever be an economic form of control of Blister Blight because of the frequency at which spraying would have to be done. Control measures must, therefore, be based on principles derived from a knowledge of the fungus and the bush.

One of the most important characters of *Exobasidium vexans*, the Blister Blight fungus, is its inability to invade and feed upon fully grown leaves. For this reason the fungus, by itself, is unlikely ever to kill a tea bush, unless climatic conditions favour the fungus all the year round. If tea bushes were grown for their fruits and not their young leaves, Blister Blight would probably not be regarded as a disease of major importance. It is because the bushes have to be plucked and stimulated to produce abnormal amounts of young leaf, that Blister Blight finds our tea fields such a fine place for its food hunt. Logically the best way to control Blister Blight is to stop plucking. Although that is not practicable it should direct attention to the importance of plucking in the control of the disease.

The importance of the leaf in the tea bush's economy was certainly recognised by the planters who devised the formula "Two leaves and a bud for the market and one full leaf and the fish leaf for the bush." That formula proved to be an excellent working rule before the advent of Blister Blight and it still forms the standard for Ceylon plucking. If bushes are plucked to a lower standard, it is usually on somebody else's estate. Now that Blister Blight is in the field as a raider we

may ask "Whose share of the spoils does it take? The market's or the bush's?" As the fungus attacks young leaf only it may appear the market's share is the one to be raided. But before that answer is accepted it would be well to look further into the question and see how the fungus operates.

When white blisters are very numerous in the fields, the air contains a gigantic number of spores as microscopic dust which is slowly deposited on everything. Each blister liberates about a million spores per day, but fortunately they do not all fall on tea bushes. Where the spores lodge they stick. It is also fortunate that the spores which fall on a tea bush do not all germinate as they are relatively short lived and a few hours' direct sunshine kills them. They survive best in cold sunless weather and they begin to grow when wetted by dew, mist and rain. At one time it was thought that the young fungus entered the leaves through the breathing pores (stomata), but it is now known that it makes a forcible entry through the cuticle and cell walls. The fungus, however, is unable to force its way into all leaves, even of the tea bush. Our experiments show that, normally, the leaf enveloping the bud and the first from the bud can be infected quite easily, but as the leaf ages, it becomes increasingly difficult to infect. As a rule, the third leaf from the bud cannot be infected. Of course blisters are often seen on third and even older leaves but it must be remembered that a white blister takes about three weeks to develop.

Now let us assume that conditions are favourable for heavy blister attack and that all leaves are being infected as they unfold from the bud. For about a week the unfolding leaf shows no visible sign that it has been infected. During that time the shoot has elongated and another leaf

is unfolding. Our first infected leaf has now become the second from the bud and is perhaps showing some translucent spots but no sign of blister proper. About three weeks after the start of the attack our first infected leaf is carrying white blisters, but by that time it has probably become the third leaf from the bud. At this stage the plucker arrives, and takes two leaves and a bud leaving the third well-blistered leaf as the bush's share. That leaf is probably of no more use to the bush than it is to the tea maker.

If you have followed me this far you may well ask "Why should the shoot be allowed to grow until the infested leaves develop blisters"? It seems more reasonable to take the leaves to the factory before they become unsuitable for manufacture and to leave nothing for the bush. This is the basis of the Institute's recommendation to pluck at short intervals and to pluck close during periods of severe infection. Only the young growth above the plucking table should be harvested. The plucker's hands should not enter the bush nor should young growth be taken from the sides of the bush below the plucking table. This apparently severe form of plucking can do no harm so long as it is confined solely to the times when weather conditions favour the disease and when all young leaf is consequently being infected.

When weather conditions improve and the severity of blight dies down, it must not be forgotten that the bush received no share of the leaf produced during the attack. That should be made good. A period of close plucking should be followed by a period of light plucking with the definite object of increasing the bushes' permanent foliage. This perhaps is the most difficult to carry out, because the improvement in the weather conditions stimulates

the bush to more rapid growth and young leaf appears abundantly on the bush. That is a god-sent opportunity to make good any shortfall of crop. That temptation should be resisted until the bushes carry a good canopy of leaves.

What I am advocating can be summed up in the words "Bush Management" and that means rather more than the adherence to certain rules formulated by some one else. It requires personal judgment and a knowledge of certain fundamental principles.

The importance of permanent foliage to a bush cannot be exaggerated. Without sufficient foliage the bush is starving, no matter how much manure is applied or how much crop harvested. During the war, crop production was of paramount importance for patriotic motives. Large crops were obtained, though manures obtainable were at a minimum. Unfortunately those high yields are now accepted as standards, to be achieved regularly. A bush can produce only a certain amount of young leaf and if too much is sent to market and too little left for the bush, the bush must deteriorate. It is not an uncommon sight to see bushes regularly plucked although the foliage can only be described as scanty. Such bushes are often the most severely plucked and have little opportunity of forming a good cover of leaves or of building up a reserve of food. Successive prunings result in complete exhaustion of what reserves the bushes may have. For this reason deaths after pruning are becoming far more common amongst up-country bushes than formerly.

The remedy for poor foliage is rest. Pruning will not help nor will extra manure until the bushes carry enough leaves to use it. If the bushes still fail to carry their leaf, a cause other than Blister Blight must be sought.

In conclusion, I would like to say a few words about the premature blackening of blisters. It is due to the activities of other fungi, the most prevalent of which is one known as *Collectotrichum camelliae* the Brown Blight fungus. *Collectotrichum*, fortunately is a very weak parasite. It is quite incapable of invading a healthy leaf. But when the leaf cells are damaged, as by the sun causing a scorch, the fungus immediately gains entry and kills the damaged cells. Most of what is called Brown Blight results from sun scorch or similar injury.

Exobasidium, the Blister Blight fungus, has very different characters. It is able to invade a healthy leaf but it cannot feed on dead cells. Its own life, therefore, depends upon the host cells remaining alive. Although it gets its food from leaf cells it does not kill them until its life cycle is almost completed. Then in order to produce millions of spores each containing a small amount of food, it takes everything it can from the invaded cells. This exhausts them and causes their death. The dying and dead cells can be recognised by their dark colour and these normally are to be seen after a blister has been white and sporing for some days.

When a leaf is invaded by Blister Blight the invaded cells are weakened and they lose their ability to resist entry by several other fungi, including *Collectotrichum* the Brown Blight fungus. So if these spores fall on the part of a leaf weakened by Blister Blight they are able to enter after germination. These secondary fungi cause the death of the invaded leaf cells almost immediately and they then live on the dead issue. This proves fatal to Blister Blight as it cannot get its food from dead cells.

The effect of this secondary invasion is to be seen on most bushes. The blisters blacken before they become white which means that the Blister Blight fungus is killed before producing spores. The secondary invasion may occur at any stage in the development of the blister and its value is greatest when it occurs early before *Exobasidium* has begun to spore. Its effect is to reduce spore production and thereby reduce the incidence of Blister Blight.

These secondary fungi will not eradicate Blister Blight; at best they reduce its incidence. Also they may not prove an unmixed blessing for the following reason.

You will note the *Collectotrichum* and the other secondary fungi are not parasitic on the Blister Blight fungus. They follow that fungus into a leaf and then rob it of its food. They are, therefore, parasitic on the leaves and there is a risk that they may invade a greater area than Blister Blight does. So far we have not found that to occur on leaves, but there is ground for suspicion that it sometimes occurs on young stems.

On the whole I think these secondary invaders must be regarded as beneficial at present, but it is very improbable that they will materially reduce the importance of Blister Blight as a pest of tea.

Blister Blight gets its food one way and Brown Blight another. But they both get it from the tea bush. We cannot stop that food hunt but we can by proper bush management ensure that the bushes are not placed at a great disadvantage.

DISCUSSION

THE CHAIRMAN on inviting discussion intimated that questions on any pathological subject not touched upon in the paper could be raised.

MR. KENNETH MORFORD said that Dr. Gadd's address was one of the best lectures on plucking they had listened to, and they would be in complete agreement with what had been said. He asked if any advice could be given on the subject of stem infections. Should infected shoots be broken back, and was there any prospect of damaged shoots, putting out new leaves?

DR. GADD said that he had made little or no reference to stem infections in his paper. Blister Blight attacked young stem tissue in exactly the same way that it damaged young leaves. The Blight normally killed the stem in the region of the attack and so caused the death of the entire shoot above it, but it caused no injury to the buds below the damaged part of the stem. Those buds normally would break later and give rise to new shoots. The attacked shoots should, therefore, be broken off just below the damaged area.

During periods very favourable to the disease, such as occurred in Dimbula during the last South West Monsoon, another type of stem injury occurred. Young shoots below the plucking table, inside the bush, were blackened right down to the base. When he first saw them he was somewhat alarmed as such damage was likely to affect future crop. Later, he was agreeably surprised to hear that the bushes were flushing well. Those blackened young shoots were of no interest to the pluckers as they carried no flush. He was of the opinion that such blackened shoots should be left alone to avoid injury to any surviving buds at the base of the shoots.

DR. GADD also commented on the difficulty of making generalisations regarding the treatment of bushes under such varying conditions. The more he saw of the disease the more he realised the effect of local con-

ditions on its severity. He illustrated his point by referring to pruning. He said that on St. Coombs a few bushes had been pruned each month to ascertain the effect of Blister Blight during recovery. The bushes pruned in February last year were almost leafless in August owing to severe attacks. The conclusion to be drawn was that February was a really bad month to prune in. Yet in August he saw fields in Dolosbage with an excellent cover of foliage and being plucked though they also had been pruned in February. He considered local knowledge to be of the utmost importance, not merely a knowledge of a district but of individual fields. Some fields appeared to suffer more than others under what appeared to be very similar conditions, and no satisfactory reason could be given for it. He thought that superintendents with their experience of individual fields and knowledge of local climate would have little difficulty in applying the principles given by the Institute. In cases of difficulty the Institute would always be willing to help.

MR. H. C. COSENS said that on some estates up-country there had been a wholesale cutting out of high shade to meet the Blister Blight menace. He asked whether Dr. Gadd agreed with the soundness of that action.

DR. GADD replied that there appeared to be some misunderstanding regarding the importance of shade in the control of Blister Blight. It was perfectly true that the disease became prominent earlier and persisted longer in well shaded places. But when climatic conditions were favourable to the disease, i.e., when there was little or no sun and the bushes were continuously wet, unshaded areas were as severely attacked as shaded areas. The effect of shade was seen best when the disease was

relatively of minor importance. Blisters could then be found in the shaded areas when the rest of the tea was free. That was because direct sunshine killed the spores and helped to dry the dew off quickly. The Institute had advocated the control of shade but not the complete removal of it. By control was meant the removal of excess shade by lopping to allow sunshine, when there was sunshine, to reach the bushes. He felt sure that the removal of all shade from tea would not reduce the incidence of the disease materially. So, regarding the cutting out of shade purely as a means of disease control he was dead against it.

MR. ALBAN WIJESKERA asked whether the Institute advocated ring-barking of trees before felling. He had seen Grevilleas felled on many estates without being ring-barked, and wondered which was the correct method.

DR. GADD said that the question of right or wrong did not arise. If one wanted to get rid of a tree it had to be felled. There was nothing fundamentally wrong in felling living trees. But it was well known that when trees, particularly Grevilleas, were felled in tea, some bushes in their immediate vicinity were likely to die of *Ustilina* or Brown Root diseases. These diseases were almost invariably associated with the presence of tree stumps. He had written an article in the Tea Quarterly a few years ago, advancing the idea that ring-barking might be a means of diminishing the risk of root disease following felling.

When a living tree was felled its roots remained alive for some time and could not be invaded by saprophytic fungi in the soil. Spores of certain parasitic fungi that happened to fall on the cut surface germinated and rapidly invaded the stump

and roots without opposition. The fungi later passed to living tea roots in contact with the stump's roots. But when a tree was ring-barked the roots died first and the branches later. As soon as the roots were dead numerous saprophytic soil-inhabiting fungi invaded them and established themselves there. Then when the tree was felled and spores of parasitic fungi germinated on the cut surface, the parasites encountered strong resistance from the saprophytes already established there. In that competition for food the parasites were usually defeated and could not establish themselves in the roots. The risk of their passing to tea was thereby diminished.

The object of ring-barking was to kill the roots by starvation before felling, in order to diminish the risk of later occurrence of root disease in the surrounding tea. Where root disease normally occurred after felling, ring-barking was well worth trial.

MR. F. A. BOURKE said that a lot of poor and debilitated tea was to be seen as individual bushes and as small areas. He asked whether Dr. Gadd considered that to be due to Blister Blight as it seemed to him that such symptoms were more common than they had been twelve months ago.

DR. GADD replied that Blister Blight was accused of being the cause of more ills than it was really responsible for. There had been weak bushes in Ceylon before Blister Blight arrived. Blister Blight tended to show up such bushes, and as more attention was paid to the condition of foliage more weak bushes were being noticed.

The usual symptom of the debilitated tea bushes was an inability to retain their leaves. The bushes had poor foliage and thin wood. Those symptoms could be

caused by a number of different agencies. For instance, anything which destroyed the feeding roots or prevented their free formation would cause the symptoms. The amount of water a bush could absorb depended upon the number of its feeding roots; and there was a balance between the number of leaves it could carry and the amount of water it received. One of the worst destroyers of feeding roots was the meadow eelworm, *Pratylenchus (Anguiculina) pratensis*. That parasite was known before the advent of Blister Blight. It was the cause of the poor condition of many bushes, but not of all of them.

The history of many poor bushes sent to the laboratories could be read from their frames. They had a few whippy shoots and very few leaves. But away back in the past they had been pruned with a saw; the large saw cuts were very obvious. The wood formed since then had progressively become worse after each pruning. He suspected that deterioration had begun when the bushes were hard pruned. The saw had been used on the 'kill or cure' principle. The bushes were neither killed nor cured. Blister Blight could hardly be held responsible for their condition now.

(DR. GADD has added the following statement to his reply. Blister Blight is doing the greatest damage in areas frequently subjected to mist. There is evidence from such areas that the bushes have hardly added a single leaf to their permanent foliage since the arrival of Blister Blight because of the great frequency of mists. Blister Blight may not be the sole cause of the damage but it is the primary agent. Leaves which were fully developed when the disease arrived are now falling off as a result of their age. The bushes appear thin because there have been no leaf replacements. This type of

debility is restricted to those fields covered by mist on most days of the year).

THE CHAIRMAN then asked if any one present was in a position to answer the question put by the Director as to the loss of crop produced by Blister Blight.

MR. WACEY referred to the difficulty on separating the Blister Blight effect from other factors such as weather conditions and cultivation.

DR. NORRIS said he had stressed this difficulty in his paper and had referred to it because one heard various estimates of loss of crop put forward which he felt had very little real foundation.

MR. G. K. NEWTON thought information on the question could be gained by a study, not perhaps of single year records, but of pruning cycle records. These should give some indication of a decline in yield. He had studied a number of such records himself and could now and again discover indications, not only on individual estates but on individual fields, where it appeared that Blister Blight was responsible for the falling off in yield.

MR. MORFORD said he would like to support Mr. Newton very strongly on that point. One of the best guides in this connection was the records superintendents were asked to keep by the Tea Research Institute. A comparison of the falling off in crop where there was a bad attack in a field against the field records where there was no attack should give some indication of the effect of the disease. In spite of record yields in Dimbula in the past year, there were clear indications of the loss in attacked fields.

MR. SYDNEY SMITH said he thought there would be considerable unanimity in regard to loss of crop but it would take a considerable time to obtain a direct answer

to Dr. Norris's question. There were other factors which compensated for Blister Blight losses. Such losses varied from field to field and district to district down to practically nothing in the low-country. Changes in cultivation programmes and differences in plucking also complicated the picture. Dr. Gadd's lecture on nutrition had been most valuable. He would, however, ask if the time had not come for a

general survey into the causes of the deterioration of certain tea areas. Very little had been said about the meadow eelworm but his impression was that this was on the increase, particularly up-country. Other factors also were concerned and he thought a general survey such as he suggested would be helpful.

THE CHAIRMAN then called on Dr. Eden to give his paper.
