

# DISEASES :

## THE ENEMIES OF TEA

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Tea, like any other crop, is subject to a number of pests and diseases which reduce yields by attacking the crop itself directly or by weakening, or killing the entire bush. For a crop that is grown so extensively under monocultural conditions, tea is fortunate in that it suffers relatively little from diseases. Two diseases are of major economic importance to the industry in Ceylon, Blister Blight (*Exobasidium vexans*) and Red Root Disease (*Poria hypolateritia*), and these are serious enough to raise appreciably the cost of tea production. A third disease, Collar and Branch Canker (*Phomopsis theae*), may also be of some sporadic, local interest to the industry through its effects on young clonal tea in certain districts. There are also certain diseases or disorders like Phloem Necrosis Virus Disease and maintenance-leaf fall which are prevalent in certain tea districts. Oilspot Disease is a very interesting one, confined mainly to seedling tea at high elevations. Various root rots like Charcoal Stump Rot (*Ustilina deusta*), Brown Root Disease (*Fomes noxius*) and Black Root Disease (*Rosellinia arcuata*) are recorded occasionally, but seldom are more than a few bushes killed.

In the past when costs of production were low and highly effective pesticides were not available, chemical treatment of the diseases of tea was almost unknown. For example, Red Root Disease was controlled for a long time by hand by grubbing and destroying all infected bushes and then removing all infected material from the soil by forking. Today this is not feasible, even if the method proved effective, because of the high cost of labour. In recent years because of rising labour costs and other factors, the cost of production has been following suit and greatly increased yields per acre are required to run estates profitably. This has led to a growing awareness of the losses caused by pests and diseases. Furthermore, a wide range of synthetic organic and inorganic chemicals are now available which can control effectively a large number of pests and diseases at relatively low dosages. All these have resulted in the use of more sophisticated methods for pest and disease control in tea in recent times. *Poria* is now eradicated not by hand, but by treating the soil in affected areas with chemicals like methyl bromide.

This review summarizes our current knowledge of the most important diseases of the tea plant in Ceylon, with special reference to the progress that has been achieved in their control during the last decade or so. Some of the problems encountered in their control are also referred to very briefly.

### **Blister Blight** (*Exobasidium vexans*)

The tea plant's worst enemy in Ceylon is generally considered to be Blister Blight, a leaf disease which threatened to wipe out the industry in the late 1940's. Today, thanks to copper, the disease is easily checked by spraying with 4-6 oz of fungicide per acre about once a week during the wet monsoon months. Nevertheless, the disease is of major economic importance because its control costs the country well over Rs 10 million per annum. Since the early discovery that copper compounds controlled the disease adequately, considerable research has been carried out during the last 15 to 20 years with the objective of effecting refinements in the method of control in order to cut down costs.



FIGURE 1 — Control of *Blister Blight* on tea using mistblowers

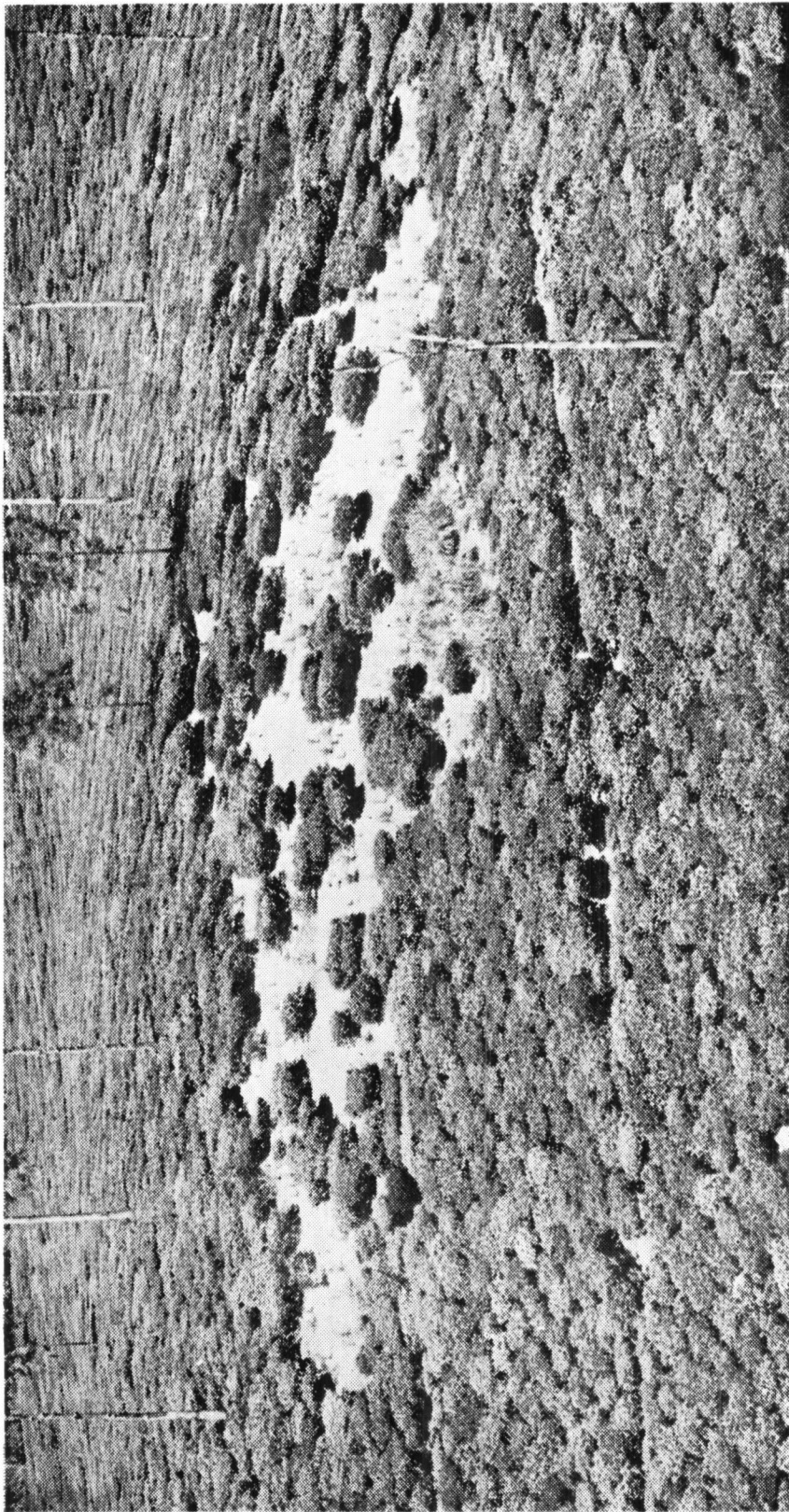


FIGURE 2 — *Tea* destroyed by *Poria hypolateritia*

An important factor influencing the onset and severity of the disease has been shown to be the pattern of rainfall distribution during the monsoon months, May to December, each year. The amount of sunshine recorded during this period is also of great significance in determining the severity of the disease, because infection increases markedly with decreasing mean daily sunshine. In the high-country where the disease is economically important, temperature is relatively uniform throughout the year and is, therefore, not regarded as a vital factor.

The traditional fungicide for the control of Blister Blight is copper. Although in the early days Bordeaux Mixture was found to be satisfactory, the present practice is to use 'fixed' coppers, generally based on copper oxychloride or cuprous oxide and containing approximately 50% metallic copper by weight. The fixed coppers are more easily prepared than Bordeaux Mixture and are also suitable for low-volume spraying. They are generally less tenacious, however, than Bordeaux Mixture but since tea has to be sprayed almost weekly to protect the young shoots that are being constantly unfurled, this is not a very important factor. The relative efficacy of the oxide and the oxychloride has been compared in a number of experiments over the years, but to date no significant differences have been observed. There is, however, a tendency among the growers to prefer the oxide because its reddish-brown colour renders checking the evenness of the spraying easy.

During the last decade, a large number of the more modern organic fungicides like Captan and Zineb has been tested from time to time but none of these have proved as effective as copper at comparable dosages. It is interesting to note that organic fungicides are on the whole not much favoured in tropical agriculture presumably because of the high cost and comparative lack of tenacity.

Following the great success of oil-based copper formulations in the control of banana disease in the West Indies, these were also tested against Blister Blight and were found to be just as efficient as the standard copper fungicides of equivalent copper content, but, some of them tainted the made product. Currently certain 'colloidal' formulations of the oxychloride are also used to control Blister Blight in a number of estates. These formulations contain only about 25% metallic copper, but give satisfactory protection during mild to moderate monsoonal conditions when applied at the recommended dosages. However, during severe monsoon weather, control is not always satisfactory, presumably because of their low copper content and necessitating an increase in the dosage during this period.

The addition of spray adjuvants like stickers has also been tested on a number of occasions but they do not seem to result in significant improvement in control.

Following the discovery in South India that nickel chloride is suitable for blister blight control, this compound was tested in Ceylon recently and was found to be reasonably satisfactory. An aqueous solution of nickel chloride at concentrations of 4 oz. in 2-15 gallons of water per acre will afford economic control of the disease during moderate monsoon conditions. An increase in the dosage as in the case of 'colloidal' copper seems necessary, however, during severe monsoon weather. As dosages of 8 oz or more can lead to scorching of the leaves because of over-spraying, this is not recommended by the Institute. It should be mentioned here that unlike copper which is a protectant, nickel chloride acts as an eradicant fungicide. It prevents the appearance of the blisters after infection or arrests the development of blisters and inhibits sporulation.

Recently some manufacturers marketed formulations containing both copper and zinc in the form of their oxides. The advantage of these formulations is that a certain amount of the routine zinc applications can be effected without any extra effort. The zinc in these mixtures has, of course, little or no fungicidal properties.

All pesticidal applications in tea are made with shoulder-strung or knapsack equipment because the use of other types is clearly impossible as almost all tea land is sloping, much of it very steep, and there are deep drains, shade trees and other obstructions at frequent intervals. Further, because of this sloping terrain, the spraying operator can move only very slowly and for this reason lighter machines with low liquid outputs are preferred. For over ten years all blister spraying was, therefore, carried out with portable knapsack sprayers either charged during the operation or charged previously at some central point with a charge pump. The volume of liquid initially employed was 15 gallons but later this was reduced to ten gallons by using finer nozzles.

A notable improvement in recent times in spray-application techniques has been the introduction of motorized mistblowers in preference to conventional knapsack sprayers. It is now possible to use the same amount of fungicide in much lower volumes of water (2-4 gallons) per acre. Moreover, because treatment is rapid, the saving in labour costs is considerable, and spray coverage and blister blight control have so far proved very good. Labour reaction to these machines is also satisfactory as complaints about noise, vibration or excessive weight are rare. On the whole, mistblowing has now established itself as the accepted method of blister blight control for tea in bearing. For young tea, tea recovering from pruning and for nursery plants, where the full foliage needs protection, high-volume spraying with knapsack sprayers generally gives better results.

Recently, ultra-low volume spraying using a motorized sprayer fitted with a rotary atomizer was tested but results were not encouraging. The machine is very similar to the mistblower except that because of the rotary nozzle, spray deposits are likely to be lighter with consequent improvement in protection. Since the spray is very fine, drift is a serious problem and good coverage can be obtained only when there is little or no wind. Further, because the nozzle outlet in this machine is positioned behind the operator's back and has to be pre-set before spraying, it is not easy to direct the spray beam on undulating tea.

With regard to spray-timing, the sunshine scheme developed earlier is being followed by a number of estates with satisfactory results. According to this scheme, the decision to spray or not is based on the amount of sunshine recorded during the previous four - to five-day period immediately preceding the day on which a spraying round is due. If plucking rounds are every eight days, and if the average sunshine per day for the previous four-day period is above four hours, then the spraying can be postponed by four days. The average sunshine for the next four-day period (fifth to eighth day) is then calculated and spraying is carried out only if this is below four hours. After a round of spraying, the sunshine during the next four days is ignored and the next spray is applied only when the average falls below four hours for the second four-day period or a subsequent one. In the case of ten-day plucking rounds, the average is worked out for five-day periods instead of four.

This scheme serves to achieve appreciable savings in spraying costs by reducing the number of spray applications, especially at the beginning and end of the monsoon while keeping Blister Blight at an economically low level. This scheme is, of course, not universally applicable to all estates in the high-country without suitable modifications. Clearly it will not be suitable for fields which are heavily shaded, or in well-known 'mist-pockets'. Further, if only one sunshine recorder is used for the whole estate certain modifications will be necessary to correct for variations in the sunshine received on different fields. For example for fields that show a consistently high level of infection, more than four hours of sunshine may be necessary to keep infection below danger level. Similarly for fields with low natural infection, fewer than four hours may be sufficient. It is possible that for certain fields, or even

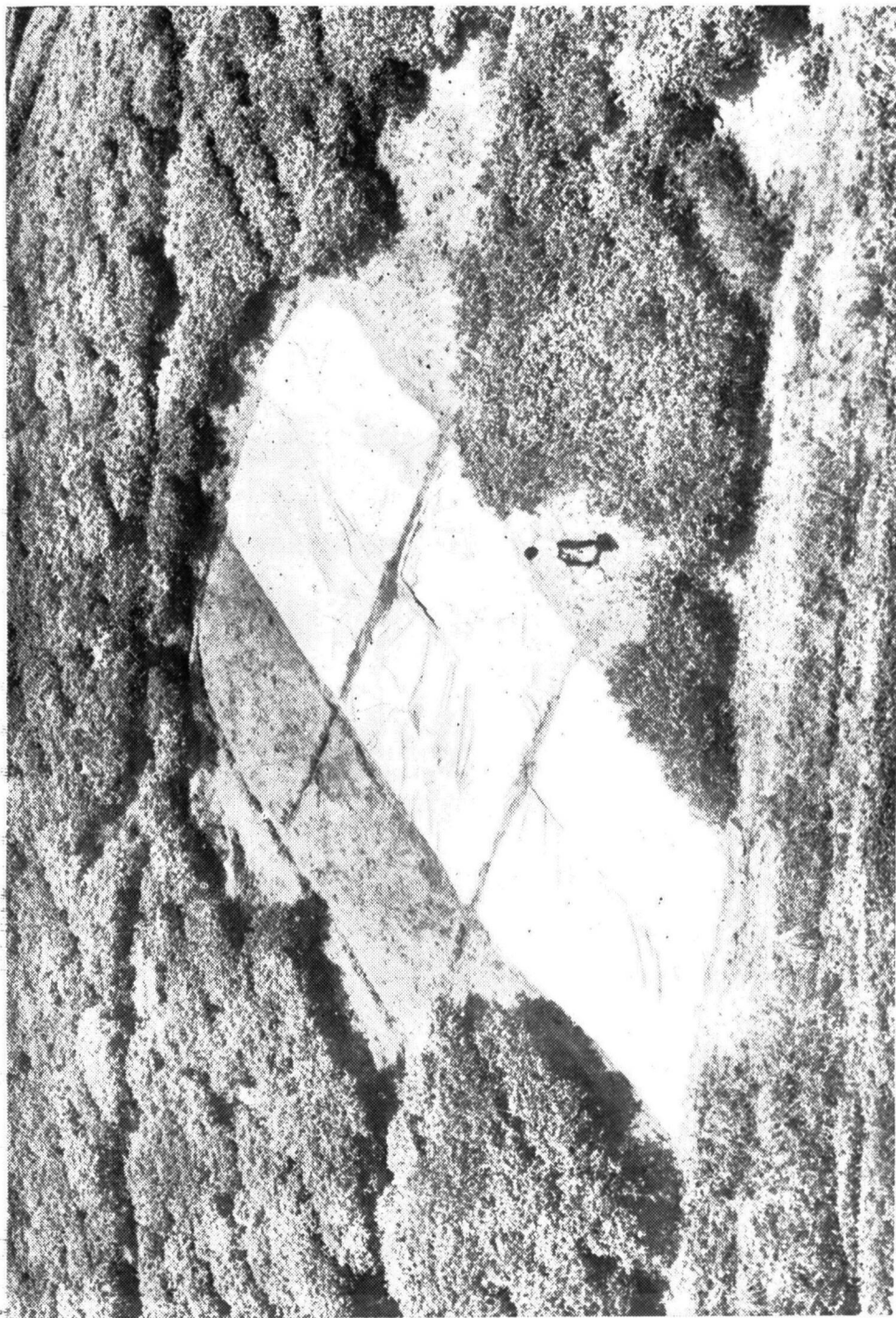


FIGURE 3 — Control of Poria Root Disease with methyl bromide

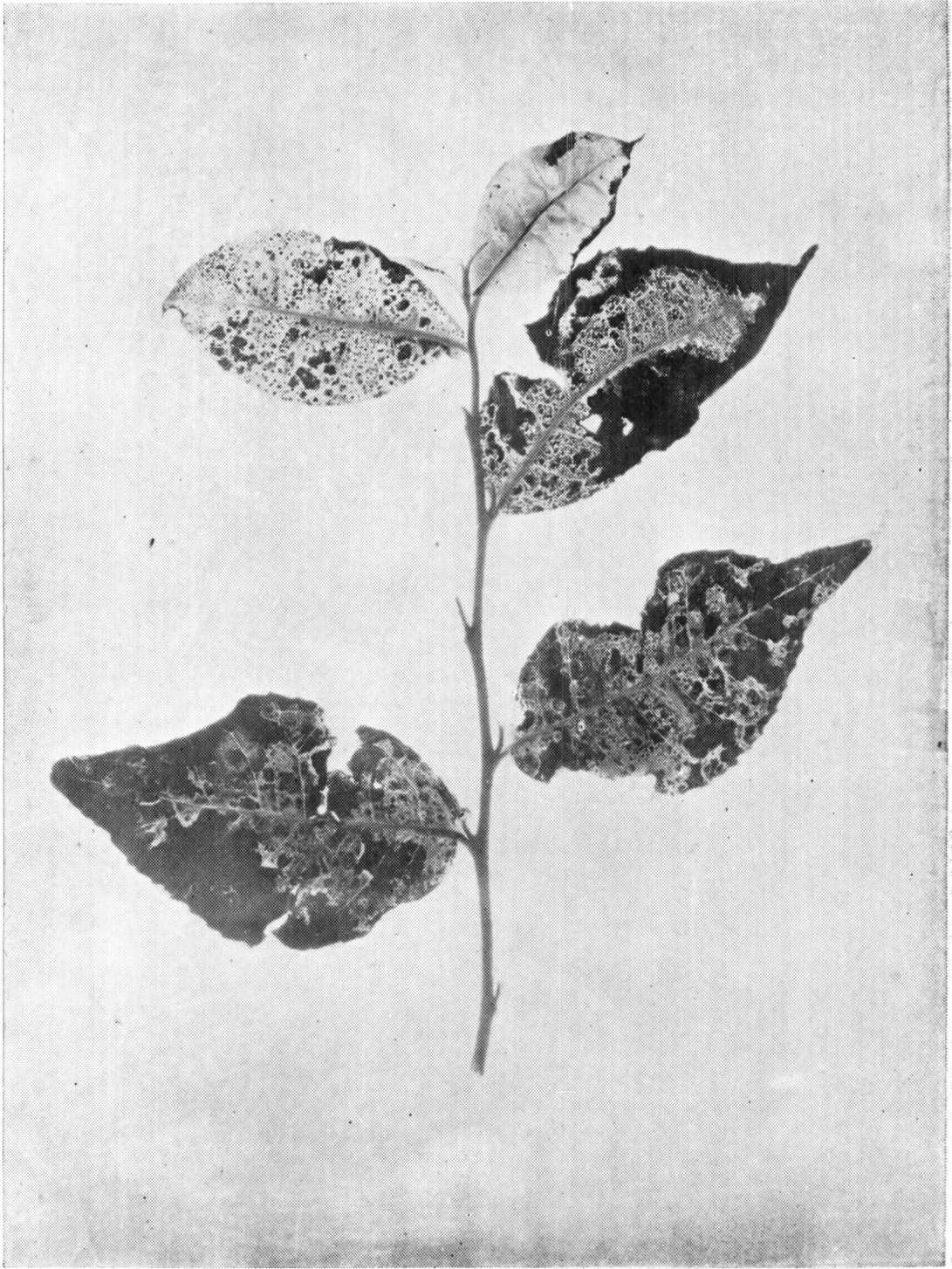


FIGURE 4 — *A tea shoot showing necrotic areas on the leaves, caused by Oilspot Disease*

certain estates, the adoption of this scheme may not result in significant reduction in spraying rounds, if natural infestation is high. In such cases, there is no alternative to routine weekly spraying rounds.

During the last five years considerable fundamental studies on the epidemiology of Blister Blight have been carried out with the objective of forecasting disease incidence accurately. Based on these studies, a new spray-timing scheme has been developed recently but the effectiveness of this scheme has still not been determined and it is our intention to conduct a number of experiments in the next few years to find out whether this scheme will be suitable for use on estates.

The control of Blister Blight presents special problems because of the unique nature of the tea crop. First, tea is an evergreen perennial kept in an active vegetative state throughout most of its life and susceptible material is, therefore, available throughout the year. Secondly, as almost all the tea in Ceylon is grown on hill slopes, mechanization of cultural operations is extremely difficult. For example, the introduction of aerial spraying is clearly impossible. Thirdly, as the crop consists of young shoots that are harvested at seven-to ten-day intervals, spraying has to be carefully integrated with plucking rounds to minimize the risk of over-contamination of the manufactured leaf. Finally, because the disease affects the very crop itself, the use of more potent curative or eradicant fungicides like certain mercuric compounds is precluded. Any improvements in the existing method of control should, therefore, take into account all these factors, and that does not leave much room for refinements.

#### **Red Root Disease (*Poria hypolateritia*)**

Although Blister Blight is economically the most important disease affecting tea, its control is relatively simple and it seldom presents serious problems to the grower. On the other hand, the root diseases though less serious are more difficult to deal with for obvious reasons and have, therefore, been very much neglected over the years. At present on a few estates, *Poria* has destroyed over a hundred acres of tea and in many others the area affected could be well over 25 acres if all the infected patches are added together. Root diseases are without doubt of great economic importance, because infection of a plant means not only gradual loss of yield and income during the period of infection, but also a loss of capital by the death of the plant. This is often not realized because transmission of disease is slow and deaths extend over long periods.

For a long time the root diseases of tea were controlled by removing all infected root material by hand and then replanting the affected area, a method which is not only expensive but rather erratic in effectiveness. Because success was invariably poor, many estates in despair gave up cleaning disease-infected patches altogether. Meanwhile, the affected patches gradually extended in area and a survey carried out in 1960 showed that in the high-country alone there were over thousand acres of tea affected by *Poria*. The Institute, therefore, began investigations on other methods of control which were more effective and cheaper, and in 1963 DD was recommended as a soil fumigant for eradicating *Poria* in infected patches. A great advantage of chemical control is that it saves a lot of tedious root extraction inherent in the earlier method.

DD which is essentially a nematocide has appreciable fungicidal properties as well, especially when used at large dosages. When injected at the rate of about 200 gallons per acre, it controls *Poria* effectively only in the top 18 in of soil. But to achieve complete control of the disease, it is necessary to obtain good penetration of the fumigant down to about 30 in. Further, as the dosage used is high, treatment

with DD is quite considerable. A search was, therefore, made for fumigants, with greater powers of penetration than DD, and methyl bromide proved highly effective in this respect.

Methyl bromide has very high penetrative powers and in tropical soils its performance as a pesticide and a herbicide (principally against weed seeds) is indeed remarkable. Since methyl bromide is very volatile it is necessary to cover the soil for at least 24 hours after treatment, but this has the added advantages of more effective and uniform fumigation and the amount of material used can be reduced significantly. In view of the great promise shown by methyl bromide, the complete eradication of *Poria* at moderate costs now seems possible.

Methyl bromide has also been found to be effective against Black Root Disease (*Rosellinia arcuata*), another disease which can occur in patches frequently and kill a number of bushes. The effectiveness of this material against the other root rots of tea (*Fomes noxius*, *Fomes lignosus* and *Ustulina deusta*) is now being investigated, though seldom do these diseases appear in large patches to warrant chemical treatment.

In addition to killing *Poria*, methyl bromide also controls the Root-Lesion (*Pratylenchus loosi*), and Root Knot Nematodes of tea and at the same time suppresses the growth of weeds in treated areas for over three months. It also stimulates certain soil fungi which are antagonistic to *P.hypolateritia*, and causes a temporary nitrification lag that seems to stimulate the growth of tea planted on treated land. So far it has not shown any undesirable effects like stimulation of other pathogens of tea.

There is little doubt that the initial outbreaks of root diseases in young tea plantations were the result of leaving behind infected roots in the soil after clearing the jungle. Apart from this, outbreaks may have also occurred by stumps becoming infected by airborne spores or by further development of dormant inocula lying in contact with the roots before felling. On the other hand, fresh outbreaks in old plantations can only arise by accidental introduction of infected material within the plantation or by stump infection of shade trees after felling, similar to forest tree stumps. Field observations indicate clearly that the incidence of root diseases can be greatly enhanced, if shade trees are felled without taking adequate precautions to prevent infection of the stumps and roots by parasitic fungi. Such infection can be minimized a good deal by ring-barking the trees before felling. Although ring-barking was recommended on purely theoretical considerations, it has shown good results and work is now in progress to check it experimentally and if necessary to effect suitable modifications. Experiments are also in progress to find out whether arboricides can be used instead of ring-barking to achieve the same objective.

The dispersal of infected plant material within plantations can be prevented only by rigorous supervision of labour during cleaning operations for root disease eradication, or during uprooting for replanting.

At present there is no satisfactory alternative to ring-barking except winching, but this is not practicable always, especially with large *Grevillea* and *Albizia* trees. Where ring-barking is absolutely impossible for want of time, trees may be cut below ground level and then covered with soil, though this method has proved useless for the control of stump infection of pines by *Fomes annosus*. Infection of stumps by airborne spores can also be prevented by painting the exposed stump surface, when trees are felled above ground level, but it will be necessary sometimes to renew the paint at frequent intervals. These measures will prevent infection by a fungus like *Ustulina deusta*, which spreads mainly by air-borne spores, but not by *P.hypolateritia*, which spreads by root contact with infected plants. *P.hypolateritia* occasionally develops fructifications on old tea stumps, though mercifully enough, no viable spores are produced.

Current research on root diseases includes in addition to refinements in the existing methods of control, testing of new fumigants in the laboratory and field, basic studies on the behaviour of the causal fungi in the soil, inoculum potential, rate of spread of disease, *etc.* Selection of clones resistant to *P.hypolateritia* is also being pursued vigorously in pot and field experiments.

### **Collar and Branch Canker (*Phomopsis.theae*)**

With the increase in acreage of young tea, Collar and Branch Canker Disease is assuming greater importance every year. The disease is now fairly widespread in the planting districts of Badulla, Haputale, Madulsima, Nuwara Eliya, Passara, Udapussellawa and in the drier parts of Dimbula. There is now much evidence which suggests that the disease is mainly associated with dry weather and this is why it is particularly bad in the north east monsoon zone. Both field observations and experimental results indicate that fungal activity is high when soil moisture is low. Most of the fatal infections in the north east monsoon area seem to take place, during the period June to August, and in Dimbula during January to March. Low soil moisture imposes a severe water-stress on the young plants and predisposes them to infection and disease development. Two weeks of low soil moisture immediately before and immediately after infection increase significantly the size of the resulting cankers. In this regard, a post-inoculation dry period seems more important than a similar pre-inoculation dry period.

Canker attacks are generally sporadic in occurrence and vary in intensity from year to year and between localities. The worst attacks are observed soon after a prolonged drought and invariably on poor soils. The disease is unknown below 3500 ft in elevation, the fungus thus preferring cool, dry conditions for its activity. The disease has not been observed so far in tea older than eight years and the most serious out-breaks occur usually in the second, third and fourth year from planting, though exceptions are not uncommon. The extent of damage varies depending on the clone, type of soil, location, *etc* ; during severe outbreaks about 65% or more of the plants may be affected but the number killed seldom exceeds 25% in one single season. Repeated outbreaks can cause serious losses sometimes warranting complete replanting of at least portions of new clearings.

Recent observations show that in addition to causing cankers on the older stems, *P.theae* can also infect apparently uninjured, succulent green shoots. Infection of green shoots generally causes small local lesions, although in some instances the whole shoot can be killed. Shoot infections rarely cause serious damage to the bush but their significance lies in their ability to provide inoculum for infection of the older stem. Infection of the latter takes place mainly through wounds or injuries caused by mechanical damage, wind or sun scorch.

The origin of collar cankers that completely girdle the stem is not fully understood as inoculations on the collar invariably produce cankers which girdle the stem only partially. There is a strong tendency for cankers to run length wise on the stem rather than laterally and the present indications are that complete cankers can be induced only if sufficiently large wounds are inflicted on the collar. This point, no doubt, merits further investigation and a number of experiments are now in progress to elucidate it.

Certain cultural practices also have a marked influence on the disease. Bending young plants in the early stages to induce rapid bush formation renders them more susceptible to the disease. There is evidence from field observations that the incidence of cankers is greater in young tea that is heavily shaded. From purely

theoretical considerations, heavy thatching during the dry season should benefit young clearings by conserving soil moisture but precise information on this point is lacking at present.

With regard to control of the disease, some modifications in cultural practices and spraying during the dry season have been tentatively suggested as control measures based on current information on the disease. A number of experiments on control are planned for the future and only when these are completed can firm recommendations be made. On the whole the planting of resistant clones seems most desirable at least in areas where the disease is serious in view of the marked variation in clonal susceptibility that is evident. About 35 clones are now being tested in three experiments to assess their resistance or susceptibility to the disease and the present indications are that at least a few of these would prove highly resistant. Two clones that appear promising are DT 95 and TRI 2023, while TRI 2024, KEN 16/3, N3 and NL 3/1 seem highly susceptible.

### **Phloem Necrosis Virus Disease**

Phloem Necrosis Virus Disease of tea which was shown to be caused by a virus in 1939 is only of potential importance to the industry. The disease did not prove as dangerous as was anticipated then and today it is of some economic importance only in a few estates above 5000 ft in elevation.

Phloem Necrosis occurs mainly in old seedling tea of low jat, most of which is now being replanted with more vigorous, vegetatively propagated high jat clones. With one possible exception, none of these clones has yet shown any symptoms of infection by this virus and the general belief is that they are either resistant or tolerant to the disease.

### **Oilspot Disease**

Oilspot Disease like Phloem Necrosis occurs mainly in seedling tea at high elevations (over 6000 ft). The disease is caused by a fungus which remains for the most part in the basal portions of the bush, being confined chiefly to the woody frame. Here it attacks the wood causing a kind of soft rot and produces a toxin which is responsible for the characteristic oily spots seen on the leaves. As the disease progresses, affected leaves fall off resulting in the death of branches and eventually of the entire bush.

The fungus appears to be a weak parasite which gains entry into the frame through large pruning cuts that are unprotected. After gaining a foothold in the not been possible to identify the fungus yet because no fructifications have been found on affected bushes and the fungus remains sterile in laboratory cultures. Fructifications are probably produced on stumps and logs in nearby jungle and the spores released from these may form the inoculum for infection of tea stumps.

In many instances affected bushes can be saved by collar pruning well below into healthy wood. In such cases it is obvious that the prune cuts should be protected by tar or other paint to prevent re-infection by the fungus, but it seems doubtful whether any of the wound covers now available can provide an effective barrier until the wound calluses over completely.