THE INFLUENCE OF SHALLOW TOPSOIL ON THE INCIDENCE OF COLLAR AND BRANCH CANKER DISEASE OF TEA (*PHOMOPSIS THEAE*)

R. L. de Silva & S. R. A. Fernando

Previous work on Collar and Branch Canker Disease is reviewed and the effect of topsoil depth on root penetration has been studied. It was found that the difference between the number of roots penetrating soil at various depths in healthy and infected plants was highly significant ($P < 0.001$) for each of the depths investigated, *viz*, four, seven and ten inches below the ground. The total fresh weights of the root systems of healthy and infected bushes were also compared, but were not significantly different at $P = 0.05$. In view of these results various suggestions for improving topsoil are given. The significance of these results is discussed.

In 1965 it was shown that Collar and Branch Canker Disease was caused by the fungus *Phomopsis theae* Petch (Shanmuganathan 1965), and not by *Leptothyrium theae* as was reported earlier (Webster 1957; Mulder 1962). Shanmuganathan (1965) also reported that he had not obtained either *L.theae* or *Macrophoma theicola,* a fungus present in the low country (Petch 1925), from any of the diseased specimens from the high country. The confusion regarding the identity of the casual organism was then dispelled. In inoculation experiments, Shanmuganathan (1965) was able to obtain cankers similar to those found in nature, but he stated that the conditions in his experiments might have varied from those present under natural conditions. He also stated that cankers can arise only through wounds which can be caused by standard cultural operations on tea estates, as well as by some natural agencies.

Shanmuganathan & Rodrigo (1966) reported that in addition to infections through wounds, uninjured green shoots also became infected and died back. They showed that the damage was caused by *P.theae* and also reported that several tea clones were affected, and that plants which had been in the field for less than a year were also attacked. They suggested that prophylactic fungicide sprays be applied, and that cankered or dead branches be removed in an attempt to reduce the inoculum potential. They found that there was marked variation in clonal susceptibility to the disease.

Shanmuganathan & Rodrigo (1967a) reported that young tea plants show a seasonal variation in their susceptibility to *P.theae,* and that during the wet months, canker development was retarded. They established that there was a clear relationship between canker development and soil moisture, low soil moisture favouring the development of cankers. They demonstrated a distinct correlation between soil moisture and bark moisture, the latter being dependant on the former, and suggested that at times when soil moisture and, therefore, bark moisture is low, certain physiological changes which enhance canker development may occur in the bark tissues.

Several experiments on testing clones for resistance to *P.theae* are in progress (Kerr 1966; Shanmuganathan 1967; de Silva 1968). Shanmuganathan & Rodrigo (1967b) have pointed out that there are several different strains of the fungus *P. theae,* and that clones which show a marked degree of resistance to one strain may be susceptible to another. Overcoming the disease by selecting clones which appear to be resistant, may not, therefore, be the most satisfactory answer to the problem. Shanmuganathan & de Silva (1968) have categorized certain tea clones tentatively into three groups on the basis of their resistance to various strains of *P.theae*. They emphasize, however, that their classification is only a guide and may require amendments as more information becomes available. The foregoing summarizes the published work on Collar and Branch Canker Disease of tea. Recent observations on the disease are discussed in the present article.

Experimental

An experiment was carried out at No. 3 Field on St Coombs Estate (elevation 4500 ft. amsl) on plants of a susceptible clone, Kenilworth 16/3, three years old. The plants were put out in the field in 1966. From January to March 1967 a severe drought was experienced, during which, natural infections of plants occurred. These infections, however, were confined to individual bushes interspersed between healthy ones. The infected bushes had extensive cankers, some bushes became chlorotic and a few died. It was interesting to note the erratic distribution of the chlorotic and necrotic plants. Adjacent to such plants were often found healthy uncankered plants.

In order to investigate the reason why infections were erratic, each chlorotic or necrotic plant was uprooted at the end of the drought period, together with the adjacent plants on either side of the diseased ones. The uprooting was done carefully so as to avoid breaking the roots as far as possible. For each diseased plant, therefore, two healthy plants were uprooted. All plants were examined for the presence of cankers and, for each plant the number of roots of minimum diameter pencil thickness (0.25 in.) extending below each of three depths from the ground, *viz* four, seven and ten in., were counted. The results are summarized in Table 1.

TABLE 1—*Differences between numbers of roots of pencil thickness or greater, present at various depths below the ground in healthy and infected plants of clone Kenilworth* 16/3 *at St Coombs for* 55 *pairs of adjacent healthy and diseased plants*

	Depths below ground		
	4 *inches*	7 *inches*	10 *inches*
t values (n=55)	8.694	9.011	9.806
Significance	$P<0.001$	$P<0.001$	$P<0.001$

Differences between the number of roots penetrating soil at various depths in healthy and infected plants were highly significant ($P<0.001$) for each of the depths investigated, *viz* four, seven and ten inches below the ground.

The total fresh weights of the root systems of health and infected bushes were also compared. It was found that there was no significant difference between the total fresh weights of the root systems of healthy and infected bushes at $P = 0.05$.

Discussion

The following significant facts have been established with respect to descase incidence and infections of young plants by *P.theae*:

1 — Young tea plants are generally more susceptible than older ones.

2 — The soil moisture content is of great importance because when it is low, infections occur. This fact is confirmed by the widespread distribution of the disease in the Uva Province, whereas its distribution in the comparatively wetter districts of Dimbula and Dickoya is far less widespread.

3 — Soil moisture affects bark moisture and when bark moisture is low, infections occur, indicating that *P.theae* is a weak parasite which does not normally attack healthy vigourously-growing plants.

4 — Some clones are known to be very susceptible (Shanmuganathan & de Silva 1968) but it is significant that not all plants of a susceptible clone die or even become diseased in one and the same clearing. It cannot be assumed that there is any shortage of inoculum because spores are produced by the fungus and it would seem that spores could easily spread from one diseased bush to the next; but as often happens, a healthy bush may stand right next to a diseased or even a dead bush.

5 — The differences between the depths of root penetration in healthy and infected plants is highly significant ($P<0.001$). This could mean that during a drought when the water table in the soil recedes, those plants which have been able to send down roots to greater depths, are able to resist infections far better than those which have shallow root systems. This observation can be easily reconciled with the fact that infections take place during periods when bark moisture is low.

Some factors resulting in poor tea root penetration have been fully discussed in two previous articles (de Silva 1967; de Silva & Seevaratnam 1968). It was pointed out earlier (de Silva & Seevaratnam 1968) that there was some evidence to indicate that plants growing in poor soils may be more susceptible to *P.theae* than those growing in good soils. These authors have given detailed suggestions on how to improve soil conditions and also on how areas in which plants have died during drought periods should be supplied with new plants. These suggestions are also applicable when supplying new plants, after deaths from attacks by *P.theae.* These suggestions are summarized below, together with the Institute's latest suggsetions on counteracting attacks of *P.theae* in young tea.

The fact that young plants are more susceptible than mature tea is also in accordance with the finding that roots of mature tea may have, in course of time, penetrated the soil deeper than those of young tea. During a drought, therefore, the mature tea is able to withstand attacks, whereas young tea succumbs.

Disease distribution is clearly more widespread in the Uva Province than in wetter districts. In 1967, however, when the normally wetter Dimbula and Dickoya Districts experienced an unusually long drought period, canker incidence and deaths caused by *P.theae* in young tea were widespread and serious. This fact would seem to indicate that there is no shortage of inoculum, but that conditions for infection vary from year to year, and when conditions are favourable, widespread damage occurs.

On the subject of clonal resistance, the Institute has given a tentative classification of clones on the basis of various experiments and field observations (Shanmuganathan & de Silva 1968). It is interesting, however, that none of the clones tested so far seem to be immune. It has also happened that a clone which showed good resistance in one experiment fared rather badly in others (Rodrigo 1968). This could be because the strains of *P.theae* may have been different, but it could also be because conditions for infection varied in different experiments, possibly because the soil moisture content varied in the different experiments.

Finally, it would seem that prevention of infection depends on the success of measures to conserve soil moisture during drought periods, which are the critical times at which infection occurs, and also in making root penetration as deep as possible.

Suggestions on minimizing damage caused by *P.theae*

1 — *Identifying areas where damage is likely to occur*
It is common knowledge that the damage caused by *P.theae* is often concentrated in certain areas, whereas other areas growing the same clone do not show extensive damage. It would be advantageous to know before hand, where these areas are located, so that prompt action can be taken *before* the plants get infected. Areas with poor soil or shallow soil can often be easily identified during the drier months of the rehabilitation period because the Guatemala Grass will be chlorotic and will not grow as well as it does on the rest of a clearing. These areas can be demarcated during the drought by lopping the Guatemala Grass in the patches. They can then be given special attention according to the suggestions given below. As the growth of the Guatemala Grass in these patches will always differ from that of the rest of the Guatemala Grass because of the different times of lopping, these patches can be identified up to the time of the eradication of the grass.

2 — *Inducing deeper root penetration*
In order to induce deeper root penetration, forking bad areas to the maximum possible depth is desirable. The incorporation of mulch and compost in generous quantities will also be advantageous. Trenching may be resorted to if funds permit.

3 — *Minimizing evaporation of water from the soil*
It is essential that the soil, particularly in weak patches in new clearings be covered with thatch during dry periods in order to minimize evaporation of water from the soil. Care must, however, be taken to see that the thatch is not placed too close to the collars of the young plants.

4 — *Encouraging faster growth*
By inducing the young plants in bad patches in a clearing to grow faster, it may be possible that with the onset of the drought, they will be in a better position to withstand attacks of *P.theae* than they would otherwise be. The growth of the young plants can be accelerated by using larger planting holes in bad areas, and by incorporating more compost into them. Using larger polythene sleeves to achieve better growth of plants in the nursery may also be considered. Trenching and the incorporation of compost into the trenches can be considered if funds permit.

5 — *Preventing erosion*
In steep areas the erosion of good topsoil can be minimized by the construction of terraces and by strategically positioned drains.

6 — *Improving the soil conditions*
Soil conditions can be further improved by the addition of extra quantities of guatemala or mana loppings to bad areas, than would be used on the better areas.

Summary

This article reviews the important findings so far on Collar and Branch Canker Disease of tea caused by the fungus *Phomopsis theae* Petch. It reports the new finding that disease incidence and the penetration of roots into the soil are correlated and that diseased plants had a significantly smaller number of roots penetrating the soil at various depths, than healthy plants, but there was no significant relationship at the 5% level of probability between total root weights and disease incidence. Various methods of minimizing disease incidence in young clearings are described.