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STUDIES ON COLLAR AND BRANCH CANKER DISEASE OF YOUNG TEA (*PHOMOPSIS THEAE* PETCH)

4—EFFECTS OF SOME CULTURAL TREATMENTS ON DISEASE INCIDENCE AND SEVERITY

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Field experiments and observations indicated that some of the cultural treatments practised on tea plantations have a significant effect on the incidence and severity of Collar and Branch Canker Disease. In susceptible clones the incidence of the disease was higher on plants brought into bearing by bending as compared with cutting across. Pruning decreased disease incidence and severity, while shade appeared to have the opposite effect. Mulching with polythene reduced disease incidence markedly, but mulching with Mana Grass had no significant effect. Preplant fumigation with DD and Ditrapex increased host resistance during the first year after planting.

In a greenhouse experiment nitrogen and potash had a significant effect on disease severity, the size of the cankers decreasing with increasing levels of both nitrogen and potash. There was also a significant interaction between the responses to nitrogen and potash, indicating that with increasing nitrogen levels disease severity increased unless potash levels are also increased.

In recent studies (Shanmuganathan & Rodrigo 1967) a close correlation was found to exist between the development of stem cankers on young tea and rainfall. Maximum canker activity was associated with low rainfall indicating that rainfall was affecting the disease indirectly by influencing soil moisture. Further, site factors and host resistance were also shown to be important in determining the severity of the disease (Shanmuganathan 1965; 1969). In this paper the effects of certain cultural treatments on the incidence and severity of the disease are reported.

EXPERIMENTAL

1—Effect of two methods of bringing into bearing on disease incidence

Two methods usually adopted on estates to bring young tea into bearing are bending and cutting-across. In two field experiments one at Downside Estate, Welimada, and the other at Nayabedde Estate, Bandarawela, the two methods were compared with regard to the incidence of cankers, during the first four years after planting.

At Nayabedde, the experiment was conducted on two clones, NAY 3 and NAY 13, in a clearing planted in November 1962. In May 1963, four plots, each of 100 plants of each clone were marked out and the plants in two plots of each clone were brought into bearing by bending, and those in the remaining two by cutting across. The method of bringing into bearing practised at Nayabedde is to bend the main shoot and about four to six lateral branches in a circular fashion a few months after planting, then cut them across at 35-40 cm and tip at about 50 cm. The bent plants were given this treatment. In the cut-across treatment, plants were cut at 15-20 cm, then at 35-40 cm and tipped at 50 cm.

*Refer experiment numbers in the Annual Reports of the Tea Research Institute of Ceylon.

The experiment at Downside was carried out on similar lines except that the clone used was TRI 2024. Both experiments were conducted over a four-year period during which, three assessments for canker incidence were carried out at approximately yearly intervals. The last assessment was done in July 1967 after the tea was pruned. At each assessment the number of cankers present on all the 100 plants in each plot was recorded. The results are summarized in Table 1.

TABLE 1 — *Effect of two methods of bringing into bearing on the incidence of Collar and Branch Canker Disease* (Phomopsis theae) *in young tea*

		No. of cankers per 100 plants Method of bringing into bearing	
Time of assessment	Clone	Bent	Cut-across
Downside Experiment			
Jan. 1965	TRI 2024	8.0	2.8
Jan. 1966		19.3	6.0
Jul. 1967		13.6	4.1
Nayabedde Experiment			
Dec. 1964	NAY 3	11.5	8.5
Dec. 1965		1.5	1.5
Jul. 1967		5.0	1.5
Dec. 1964	NAY 13	6.3	5.5
Dec. 1965		4.9	11.1
Jul. 1967		4.4	2.5

At Downside there was a fairly high incidence of cankers throughout the course of the experiment, presumably because the clone used was highly susceptible to the disease (Shanmuganathan 1969). Further, weather and soil conditions were also more favourable there than at Nayabedde. It will be seen from the results that the number of cankers recorded on the bent plants is about three times that on plants which were cut across. This difference was evident at all three assessments. At Nayabedde the same trend is again evident in clone NAY 3, though the difference is not so large as at Downside, probably because of the low incidence of natural cankers. In 1965 it was observed that when natural incidence was low, there was no difference between the number of cankers recorded on the bent plants and those which were cut across. In the case of clone NAY 13, which is inherently more resistant to the disease than NAY 3, the difference in canker incidence between the two treatments is probably not significant. The abnormally high canker incidence on this clone in 1965 is difficult to explain. However, a possible explanation might be the erroneous inclusion of mechanical wounds caused by weeding scrapers with cankers caused by *P. theae* during the recording.

2—Effect of pruning on disease incidence and severity

The effect of pruning on disease incidence and severity was studied in a number of field experiments at St Coombs and other estates in Uva. It was thought that pruning would reduce disease by minimizing the water stress on the plant during drought. If pruning proved effective in reducing disease, this cultural practice could be exploited profitably as a control measure.

Experiment **P89*** *at Aislaby Estate, Bandarawela*

In June 1969, 50 pairs of canker-free plants were selected in a clearing of clone DG 39 in its third year from planting and one plant of each pair was cut-across at a height of 38 cm. The pruned plants had sufficient foliage to prevent sun scorch of the frames during the ensuing drought. The unpruned plants of each pair was allowed to grow unchecked. In December the 100 plants were examined for cankers and the number recorded to obtain a measure of disease incidence.

The results clearly indicated that the incidence of cankers was significantly higher on the unpruned plants as compared with the pruned plants.

No. of cankers per 50 plants

Pruned	4
Unpruned	37

Experiment **P90** *at TRI Uva Station, Passara*

In this experiment the effect of pruning on disease severity was determined by artificial inoculation. Twenty five pairs of plants were selected at random in a 3-year-old clearing of Clone TRI 2024, and one plant of each pair was cut-across at 45 cm in June 1969, at the onset of the dry season. The unpruned plant was plucked in the normal manner. A week after pruning all the 50 plants were inoculated on the collar with the culture of a virulent strain of *P. theae.* The length of the resulting leisons were recorded in September. It was observed that the cankers on the unpruned plants were significantly longer than those on the pruned clones.

Mean lesion length (cm)

Pruned	0.48
Unpruned	3.99

Experiment **P115** *at St Coombs, Talawakele*

This experiment is similar to **P90.** Again 25 pairs of plants were selected in a clearing of Clone TRI 2024 in its fourth year after planting and one plant of each pair was pruned at 45 cm in January 1970. Twenty days after pruning the 50 plants were inoculated as in **P90** and the cankers produced were recorded in the following May. The results confirmed the observation made earlier, *ie* the disease is more severe on unpruned plants than on pruned plants.

Mean lesion length (cm)

Pruned	0.27
Unpruned	1.23

Experiment **P91** *at St Coombs, Talawakele*

In this experiment two methods of pruning were compared with unpruned in regard to disease severity. The two methods of pruning investigated were clean prune and rim-lung prune; in the former, the whole bush was cut-across at about 30 cm leaving practically no foliage on the bush, while in the latter two or three peripheral branches were left unpruned. The three treatments, including an unpruned control, were applied to randomized plots consisting of 10 plants each and

replicated ten times. The pruning was done on 7 March 1970 and five plants in each plot were inoculated with *P. theae* on 15 March. The resulting cankers were measured on 21 June.

	Mean lesion length (cm)	No. of lesions per 50 plants
Clean prune	1.34	7
Rim-lung prune	0.22	4
Unpruned	1.12	34

The best treatment in this experiment was rim-lung prune which had fewer cankers than the other two treatments. Further, only four out of the 50 inoculations were successful in this treatment as compared with 34 in the unpruned control plants. On the clean-pruned plants only seven cankers developed but due to severe sun scorch of the frames it was not possible to measure them accurately. This may account for the abnormally large lesions recorded on these plants. In most instances the cankers had merged with portions of the frame which were affected by sun scorch.

3—Effect of shade on disease incidence

Observations on the effect of shade on disease incidence were carried out in Experiment **VP1** (1961) at St Coombs. In this experiment 31 clones and a seedling progeny were planted in randomized replicated plots consisting of 36 plants each. There were four blocks, two of which were shaded and two unshaded. The shade consists of dadap trees (*Erythrina lithosperma*) spaced 5.3 m apart; the tea was planted at a spacing of 1.2 m between the rows and 0.6 m in the rows. The plots were separated by a guard row of the red flush clone, TRI 2043. Canker incidence was estimated in November 1966 after the plants had received their first prune by recording the number of cankers on all the plants in the four blocks. Statistical analysis of the results showed that the incidence of cankers in the shaded blocks was significantly higher than that in the unshaded blocks (Table 2).

TABLE 2 — *Effect of shade trees on the incidence of cankers caused by* P. theae

	Mean No. of cankers (transformed data)
Shade	1.94
No shade	1.54
LSD ($P = 0.01$)	0.35

4—Effects of three levels of nitrogen and potash on disease severity

Young tea is usually fertilized with generous doses of nitrogen, potash and phosphate in order to bring the plants into bearing as early as possible. As high doses of nitrogen and potash, in particular, can have some influence on canker incidence, a pot experiment (**P85**) was done in the greenhouse to investigate the effects of three levels of nitrogen and three levels of potash on the disease.

One-year-old plants of the highly susceptible Clone KEN 16/3 were planted in 25 cm diameter plastic pots and left unfertilized for about six months. The treatments were then applied. The required quantities of nitrogen and potash were given at intervals of three to four months. There were ten plants per treatment. The treatments were as follows:

1 – 2.0g	ammonium	sulphate	+	1.0g	muriate	of	potash	(N_0K_0)
2 – 2.0g	ammonium	sulphate	+	1.5g	muriate	of	potash	(N_2K_1)
3 – 2.0g	ammonium	sulphate	+	2.0g	muriate	of	potash	(N_0K_2)
4 – 4.0g	ammonium	sulphate	+	1.0g	muriate	of	potash	(N_1K_0)
5 – 4.0g	ammonium	sulphate	+	1.5g	muriate	of	potash	(N_1K_1)
6 – 4.0g	ammonium	sulphate	+	2.0g	muriate	of	potash	(N_1K_2)
7 – 6.0g	ammonium	sulphate	+	1.0g	muriate	of	potash	(N_2K_0)
8 – 6.0g	ammonium	sulphate	+	1.5g	muriate	of	potash	(N_2K_1)
9 – 6.0g	ammonium	sulphate	+	2.0g	muriate	of	potash	(N_2K_2)

Phosphate was given to all plants at the rate of 5 g superphosphate per plant at each fertilizer application, and magnesium and zinc were given as foliar sprays. During the course of the experiment, all plants exhibited symptoms resembling calcium deficiency seen in sand culture experiments (Pethiyagoda & Krishnapillai 1970), and one application of lime was therefore made at the rate of 5 g per pot but there was only a slight improvement as a result of this treatment.

After four fertilizer applications, the plants were inoculated with *P. theae* on 15 November 1970. The resulting cankers were measured on 23 March 1971 and canker length was used to estimate the effect of the various treatments on the disease.

TABLE 3 — *Effect of three levels of nitrogen and three levels of potash on disease incidence*

	Mean canker length (cm)
Levels of nitrogen	
N_0	8.93
N_1	7.23
N_2	6.97
Levels of potash	
K_0	11.06
K_1	6.35
K_2	5.64
LSD (P=0.05)	1.31

		Levels of nitrogen		
		0	1	2
Levels of potash	0	12.57	8.31	12.30
	1	6.72	6.44	5.89
	2	7.50	6.95	1.66
		LSD ($P = 0.05$)		2.29

The results are shown in Table 3. It is evident that both nitrogen and potash have a significant effect on canker length. The effect of potassium appears to be more marked than that of nitrogen. With increasing levels of nitrogen and potash, there was a steady decrease in canker length, though the differences in canker lengths between the middle and highest levels were not statistically significant. Further, the interaction between nitrogen and potash is highly significant. The mean length of cankers decreased steadily with increasing levels of nitrogen both at the middle and highest levels of potash, but at the lowest level of potash, the length of the cankers decreased when nitrogen was increased and then increased at the highest level of nitrogen. The combination which gave the smallest cankers was N_2K_2, which received the highest levels of nitrogen and potash.

5—Effect of soil fumigation before planting tea on disease severity

Soil fumigation with methyl bromide, Ditrapex or DD to control soil-borne pathogens is now an accepted practice on tea estates. Occasionally, soil fumigation is also resorted to as an alternative to soil rehabilitation with Guatemala Grass, to control parasitic nematodes before replanting. Striking increases in the growth of tea after treatment of soil with methyl bromide have been reported recently, (Shanmuganathan & Fernando 1967; Manipura 1971). Further, compounds like chloropicrin and DD have also been shown to increase the growth and yield of other crops. It appeared, therefore, the soil fumigation could have some influence on the susceptibility of young tea to canker and a field experiment (**P87**) was carried out to investigate this possibility. In this experiment the susceptibility to *P. theae* of tea planted on soil treated with methyl bromide, chloropicrin, DD (1,3 dichloropropene and 1,2-dichloropropane), Ditrapex (80% D-D and 20% Trapex) and Trapex (methyl isothiocyanate) was compared with that of the tea planted on untreated land.

The five fumigants were applied at the rate of 0.05 Kg per sq. m to plots of 18 sq. m each on 22 September 1969 and 45 days after treatment, one-year-old plants of Clone TRI 2024 were planted on the plots. There were five plots per fumigant and five untreated plots and 30 plants were grown on each plot. On 12 March 1971, five plants were selected at random in each plot and inoculated with *P.theae,* once on the main stem. The cankers produced were measured and recorded on 20th May 1971.

Analysis of the results (Table 4) indicated that WN 12 and DD were effective in reducing canker length significantly, as compared to the control. Methyl bromide and chloropicrin appeared to cause a reduction in canker length but the difference was not significant. It is interesting to note that Trapex, which is not a chlorinated hydrocarbon like the other four compounds, was the least effective.

TABLE 4—*Effect of soil fumigation with five fumigants on the length of cankers caused by* P. theae

	Mean canker length (cm)
Ditrapex	4.70
DD	5.16
Methyl bromide	5.22
Chloropicrin	5.26
Trapex	5.83
Untreated control	6.47
LSD ($P = 0.05$)	1.31

6—Effect of mulching soil with grass and covering soil with polythene on disease incidence

Mulching young tea with Guatemala Grass (*Tripsacum laxum*) or Mana Grass (*Cymbopogon confertiflorus*) loppings is a common practice on many tea estates, the main object being to conserve soil moisture during dry weather. Recently Manipura *et al.* (1969) have produced experimental evidence which vindicates the usefulness of this practice. As one of the major predisposing factors for outbreaks of *P. theae* is low soil moisture (Shanmuganathan & Rodrigo 1967), it would appear that mulching should help minimize disease incidence. The experiment (**P66**) described below was carried out to verify this. The experiment was conducted in a clearing of Clone TRI 2024 in its third year from planting at St Leonards Estate, Halgranoya. The treatments were as follows :

1 — Mulching with Mana grass as practised on the estate—usually about 10-15 tonnes of fresh loppings are applied per hectare;

2 — Mulching with polythene—strips of black polythene film (gauge 500) 1.2 m wide were laid down between the rows of tea and kept in place by means of pegs;

3 — Untreated control.

Plots consisted of 50 bushes each planted at a spacing of 1.2 m x 0.6 m. The experiment was laid out in randomized blocks and each treatment had seven replicates. The treatments were carried out in early June, which is usually the beginning of the dry season in this area. Canker incidence was estimated by recording the number of cankers and deaths in October when the experiment was concluded. As expected, there was little rain in June, July and August and a serious outbreak of the disease occurred.

Analysis of the results showed that plots covered with polythene had significantly less cankers than those mulched with Mana grass and the untreated (Table 5). There appeared to be fewer deaths due to cankers in the polythene-covered plots as compared with the other two treatments but the difference was not statistically significant. Plots thatched with Mana Grass were, however, not significantly different from that of the control plots in regard to both number of cankers as well as deaths.

TABLE 5—*Effect of mulching with polythene and Mana Grass on disease incidence*

Treatment	Mean No. of cankers (transformed data)	No. of dead plants out of 350
Polythene	1.80	3
Mana Grass	2.61	15
Untreated	2.49	19
LSD ($P = 0.05$)	0.67	NS

DISCUSSION

The experiment and observations described in this paper demonstrate clearly the influence of cultural treatments on disease incidence. The experiments on bringing into bearing indicate that bending young plants makes them more susceptible to *P.theae* than cutting across, especially in the case of susceptible clones. In the case of a resistant clone, however, the method of bringing into bearing has little effect on disease incidence. It is well known that bending induces rapid spreading and greater top growth as compared with cutting across, as a result of which, it is possible to bring bent plants into bearing earlier (Manipura 1971). The greater susceptibility of bent plants to the disease may be due to an imbalance in the shoot/root ratio and consequent vulnerability to water stress during dry weather. Some observations carried out at Downside Estate, Welimada, revealed that the shoot/root ratio of a bent plant is significantly higher than that of a cut-across plant (see below), implying that the greater shoot development in a bent plant is not matched by a corresponding increase in root development and the higher shoot/root ratio results.

Effect of two methods of bringing into bearing young tea on bush size and shoot/root ratio

Method of bringing into bearing	Fresh weight of whole bush (Kg)	Shoot/root ratio
Bent	0.88	2.53
Cut-across	0.39***	1.46**

A possible explanation for the difference in susceptibility between a bent and a cut-across plant to *P. theae* may be that their shoot/root ratios differ.

The results from the pruning experiments provide strong evidence that a pruned bush is less susceptible to the disease than an unpruned bush. A pruned bush is likely to withstand drought better than an unpruned bush because of reduced foliage. A pruned bush is, therefore, more resistant to the disease. Pruning, therefore, appears to be an effective practical method by which the disease can be controlled. The best type of prune seems to be a 'low to medium skiff' that would remove a good portion of the foliage while retaining enough leaves to protect the frames against sun scorch. To be fully effective, pruning should be carried out at the beginning of the drought and not when the plants have begun to wilt as this might interfere with the plant's own defensive mechanism to withstand the drought. This method of control could be practised in clearings in the third or fourth year from planting when disease incidence is likely to be high.

The limited observations on the effect of shade on the disease suggest that tea growing under dense shade is likely to be more susceptible to the disease than unshaded tea. Clearly, more field experiments are necessary to obtain conclusive evidence on this point but it nevertheless appears that under conditions of drought both tea and the shade trees compete directly for moisture from the same levels of the soil and this perhaps explains the increased susceptibility of shaded tea to the disease.

The observations on the effects of different levels of nitrogen and potash suggest that nutrition is an important factor in disease susceptibility. Field trials with varying doses of nitrogen and potash and even phosphate are necessary to investigate fully the effects of nutrition on the disease, but for the present it appears that high levels of both nitrogen and potash increase disease resistance while low levels have the opposite effect. It is also evident that if nitrogen levels are increased disease resistance will decrease unless potash levels are also increased correspondingly.

The results of the experiment on soil fumigation are of great interest because in addition to stimulating growth, soil fumigation, especially with the chlorinated hydrocarbons, also increase host resistance to disease. A similar effect was observed by Devay *et al* (1962) who found that preplant soil fumigation with DD and other related compounds increased the resistance of peach seedlings to Bacterial Canker

(*Pseudomonas syringae*). The nature of the induced resistance is not known but it is probably not related to increased vigour because induced resistance and increased growth did not follow the same pattern. In our experiment, the two compounds which were most effective in stimulating growth were methyl bromide and chloropicrin, whereas DD and Ditrapex were the two most effective in inducing resistance.

Contrary to expectations, mulching with Mana Grass has not shown any beneficial effects in regard to disease incidence in our experiment whereas mulching with polythene reduced disease incidence markedly. It is likely that in the experiment described, mulching with Mana Grass was not very effective. Alternatively, it might have been sufficiently effective but counteracted by some other factor that had favoured disease incidence. The authors have subsequently observed that *P. theae*, which is a facultative parasite, can grow and sporulate readily on decomposing Mana Grass and this suggested that mulching with this material might have increased disease incidence by increasing the amount of inoculum available for infection.

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