MAINTENANCE-LEAF FALL IN LOW-GROWN TEA

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The results of experiments to determine whether maintenance-leaf fall in low-country tea was caused by a pathogen and whether leaf fall is correlated with a reduction in yield are reported. No pathogens were consistently isolated from leaves which had been shed, but it was found that Red Rust Disease (*Cephaleuros parasiticus* Karst) caused some defoliation if the attack was sited on leaf petioles. Red Rust was not, however, entirely responsible for maintenance-leaf fall, and was not its primary cause. It was found that control of saprophytic fungi did not reduce maintenance-leaf fall, neither did the deliberate removal of maintenance foliage result in significant depressions in yield. It is concluded, therefore, that maintenance-leaf fall during the latter part of the pruning cycle in low-country tea is not detrimental to the tea plant in terms of recoverable crop, and it is suggested that the high rate of growth of low-country tea is responsible for the leaves being shed quicker than in up-country tea. Other aspects of maintenance-leaf fall are discussed.

Time and again our attention has been drawn to what has been called 'the problem of maintenance-leaf fall in low-country tea' (Gadd 1949 ; Loos 1953 ; Webster 1953; Joachim 1958 ; Mulder 1960; 61). In one or more of these reports the following assumptions have been made :

a — that maintenance-leaf fall is a problem — implying a detrimental effect on the tea bush,

b — that the 'problem' occurs in the low-country, or alternatively, even if it does occur in the up-country, it does not constitute a 'problem',

c — that it is a disease, in which case it is implied that it must be caused by an organism which needs to be controlled.

On the other hand, Shanmuganathan and Redlich (1964) found no evidence that parasitic fungi were connected with maintenance-leaf fall. They also found that a reduction in the fungal colonization of dead leaves and a reduction in the maintenance-leaf fall did not result in increased yields.

This paper summarizes our observations on maintenance-leaf fall in the low-country and presents the results of experiments which attempted to determine whether it is caused by parasitic fungi, and whether it is detrimental in terms of yield.

Symptoms

The condition becomes noticeable in the latter half of the pruning cycle, and is especially pronounced on estates in the low-country where the pruning cycle is longer than two years. The older leaves which are shed often do not drop to the ground unlike in up-country tea. Instead, they are held in the form of a 'nest' in the centre of the bush, by strands of fungus, notably Horse-hair Blight (*Marasmius equicrinus*).

Where the cover of tea is continuous (*ie* with no spaces in between adjacent bushes), the 'nest' is hardly visible from above the plucking table, but in areas with poor stands of tea, it is clearly visible. The centre of the bush appears unsightly and is no doubt a cause of concern to Superintendents. The rate of leaf fall increases as the cycle nears completion, at which time it may appear that a relatively

large quantity of foliage is held in the nest. Ferns (*eg Drymoglossum heterophyllum*) often complicate matters and make their appearance in the centre of the bush. Figure 1 shows a portion of the ' nest ' with the strands of Horse-hair Blight as well as dead leaves. The general appearance of these bushes is quite untidy.

Occurrence

The condition is recorded from estates in the Galle, Kalutara, Kegalle, Kelani Valley, Matara, Morawak Korale and Ratnapura districts. It seems to be more prevalent on estates in areas with high rainfall.

The cause

There is no evidence that maintenance-leaf fall is caused by a pathogen, although, from time to time various causes, pathogenic or otherwise, have been ascribed to it. Among these are *Rhizoctonia solani* (Gadd 1949), Shot-hole Borer (Visser 1960), Thread Blight, Grey Blight, Brown Blight and Red Rust (Webster 1955), *Cercosporella* (Visser 1960), potash deficiency, and/or excess nitrogen, and *Botryodiplodia theobromae* (Mulder 1960 ; 1961). None of these claims have been supported by experimental evidence, neither have any of them been subsequently substantiated, with the possible exception of Red Rust, for which there is only circumstantial evidence (see below).

Experimental work

Laboratory experiments

Specimens of leaves from the ' nest ' of tea bushes due for pruning were obtained from the following estates :

Ellakande Estate, Baddegama ; Gikiyanakande Group, Neboda ; Hapugastenne Group, Ratnapura ; Hemingford Group, Parakaduwa ; Millakande Estate, Bulathsinhala ; Mohamedi Estate, Latpandura ; Neuchatel Group, Kalutara ; Palmgarden Group, Ratnapura ; The Pelawatte State Plantation, Migahatenne ; St Joachim Estate, Ratnapura ; Talgaswela Estate, Talgaswela, and Vogan Group, Matugama.

Isolations of fungi were made from these, but with the single exception of *M. equicrinus* no fungus was consistently isolated from all the specimens. The commonest fungi obtained were Grey Blight (*Pestalozzia theae*), Brown Blight (*Colletotrichum theae*) and *Botryodiplodia theobromae*. Inoculation experiments with these fungi in a hot room at St Coombs failed to cause defoliation.

In some leaves, there was evidence of petiolar infection by Red Rust (*Cephaleuros parasiticus* K.), but this symptom was by no means common, neither was it present at all in some of the leaves examined. It is possible that Red Rust is a contributory agent to maintenance-leaf fall, but it cannot be concluded that it is the primary cause because it is not present in *all* detached leaf petioles.

Field experiments

Experiment **LP1**

A field experiment was conducted at the Institute's Low-country Station at St Joachim Estate, Ratnapura, in order to determine the effect of various sanitary treatments, and the deliberate removal of maintenance leaf, on tea yields. The

FIGURE 1 — *A portion of the 'nest' from a tea bush at St Joachim Estate, Ratnapura (elevation about 200 ft) showing maintenance leaves and debris held in position by the Horse-hair Blight fungus*

FIGURE 2 — *Half-pruned bush in the 3rd year of its 6-year cycle at Pedro Estate, Nuwara Eliya (elevation 6400 ft), showing the absence of maintenance foliage upto a height of 3 ft from the ground*

experiment was conducted on seedling tea which had been infilled with VP, each plot having 60 bushes. The treatments were replicated five times in randomized blocks giving a total of 25 plots covering c. ½ acre. No shade trees were present in any of the plots.

The treatments were as follows :

1 – Perenox, a fungicide containing 50% W/W copper was sprayed on the maintenance foliage with knapsack sprayers at the rate of 6 oz in 15 gallons of water per acre, once every fortnight.

2 – The debris from the bushes were cleaned out manually using coir bushes, and the bushes were maintained in this condition during the second year of the pruning cycle.

3 – Treatments 1 and 2 were combined.

4 – The maintenance foliage was stripped leaving four to five, but not more than five leaves on each shoot. The layer-of leaves retained on the bush was 5-6 inches deep. (Approximately 500-900 g fresh weight of leaf was removed from each bush.)

5 – Untreated controls.

The treatments were applied at the beginning of the second year of the pruning cycle. Pre-treatment yield records were kept for the whole of the first year of the cycle. The yields from seedling bushes and VP bushes were kept separately. The number of VP bushes in each plot was recorded and the yields (both pre- and post-treatment) corrected for abberations caused by the presence of VP tea in the plots. All shade was removed. Shot-hole Borer infestation was assessed by the ' standard unit ' method and was found to be more or less uniform in all plots. No dieldrin sprays were applied. All plots received equal fertilizer application. (75 lb N ; 40 lb P_2O_5 ; 60 lb K_2O ; 24 lb MgO ; 10 lb $ZnSO_4.7H_2O$ per year).

Experiment **LP2**

In this experiment, maintenance-leaf fall was assessed from bushes grown under three levels of shade *viz* no shade, *Gliricidia maculata* spaced 14 ft apart, and *G. maculata* spaced 7 ft apart. Leaf fall was estimated by dry weight determinations of all leaves which were shed. The leaves were collected in iron wire baskets of 1/3 inch mesh. This was done once every month for the second year of the pruning cycle, from tea bushes under each treatment. Dry weights were recorded.

Results

Table 1 shows the results obtained in experiment **LP1** where the effect of various sanitary treatments on yield were investigated.

TABLE 1—*Effect of various sanitary treatments on tea yields and maintenance-leaf fall*

Treatments	Total yield (lb made tea per plot for the second year of the cycle— corrected for variations caused by VP plants)	Total Maintenance-leaf fall (Dry wt in g for the last 9 months of the cycle) from 10 bushes in each plot
1 – Sprayed with Perenox	159.72	5528.2
2 – Debris cleand out	167.7	5988.7
3 – Sprayed with Perenox and debris cleaned out	171.06	5165.8
4 – Maintenance foliage deliberately stripped	166.46	—
5 – Untreated controls	164.82	5481.8
LSD at P = 0.05	26.5	941.2

None of the treatments brought about significant ($P<0.05$) changes in yield or in maintenance-leaf fall. There is an indication that the plots which were sprayed with fungicide as well as those freed from debris (Treatment 3) had less maintenance-leaf fall.

Table 2 shows the effect of shade on maintenance-leaf fall (Experiment **LP2**)

TABLE 2—*Effect of shade on maintenance-leaf fall*

Treatment	Total Maintenance-leaf fall for 10 bushes in each plot in g dry wt
1 – No shade	3138.7
2 – *G. maculata* planted 14′ × 14′	3351.1
3 – *G. maculata* planted 7′ × 7′	3074.5
LSD at P = 0.05	294.2

None of the treatments showed significant differences in maintenance-leaf fall from each other. There is an indication that both the no-shade and heavy-shade plots showed less maintenance-leaf fall than the medium shade plot. These results are inconclusive and need further investigation.

Discussion

The present results show that maintenance-leaf fall is not a serious problem because is does not have a depressing effect on crop. The fact that yield was not depressed by the stripping treatment shows that the so-called 'maintenance foliage' does not contribute much to the ' maintenance ' of the bush. It appears that the observed maintenance-leaf fall is a normal phenomenon, where the leaves are shed when they become senile. On the other hand, these results are in conflict with the views expressed by Gadd (1949), Webster (1955) and Visser (1960) who claimed that maintenance-leaf fall was caused by fungi or insects. No such agent has so far been identified apart from Red Rust, as having any direct connexion with maintenance-leaf fall.

Another question that arises is, why does maintenance-leaf fall appear to be more marked in low-country tea ? Figure 2 shows a half-pruned tea bush in the 3rd year of its 6-year pruning cycle at Pedro Estate, Nuwara Eliya (elevation 6400 ft). It is clear that there is no maintenance foliage on this bush. It would seem that maintenance-leaf fall takes place at all elevations, and contrary to popular belief, it is not confined to the low-country. Of course, in the low-country the preponderance of particular species of fungi like *M. equicrinus* traps the leaves in the ' nest ' and prevents them falling to the ground. The bush, therefore, looks rather unsightly (Figure 1) and undoubtedly contributes to the state of anxiety among Superintendents.

It must also be remembered that low-country tea grows faster than tea at higher elevations. This would mean that in a given period of time a tea plant in the low-country produces more foliage than a bush (say of the same clone) in the higher elevations. It must follow, therefore, that more leaves will be shed by bushes in the low-country in the same period of time than by bushes at high elevations because more leaves are produced. This is clearly the reason why pruning cycles are longer at higher elevations.

The role of the parasitic alga Red Rust (*C. parasiticus*) does not seem too difficult to assess. Its distribution over the low-country tea growing areas is rather uneven. Some estates are affected more than others. On the same estate some fields are more severely affected than others. The alga can attack leaves, stems and leaf petioles. It seems that if leaf petioles are attacked, the parasite would contribute to increased maintenance-leaf fall. It cannot be assumed that *C. parasiticus* is the primary cause of maintenance-leaf fall, although it does contribute to defoliation if the leaf petioles happen to be attacked. The extent of damage of leaf petioles, however, is in no way commensurate with the extent to which leaf-fall occurs. It can, therefore, be assumed, that it is a subsidiary and not the primary cause of maintenance-leaf fall.

It is probable that some mechanism exists in the tea bush to ensure the shedding of old leaves when their photosynthetic ability is insufficient to meet the normal nutritional requirement of such leaves. Limited light received by such leaves lying deep within the canopy may thus result in their being shed.

The experiment on the effect of shade on maintenance-leaf fall would seem to need repetition.

Control measures

It is recommended that the debris and 'nest' of bushes showing much maintenance-leaf fall be cleaned out manually during, or immediately after, pruning. No further measures need be taken.

Summary

1 – Experiments on the effect on yield, of various sanitary treatments designed to reduce maintenance-leaf fall are described.

2 – The various sanitary treatments designed to control saprophytic and/or parasitic fungi did not have any significance on maintenance-leaf fall or yield.

3 – The deliberate removal of maintenance foliage did not result in decreased yields.

4 – It was confirmed that petiolar infections of Red Rust Disease caused maintenance-leaf fall in certain instances, but that Red Rust was not the primary cause of maintenance-leaf fall.

5 – Possible causes of maintenance-leaf fall are discussed.

6 – The removal of debris present in the centre of affected bushes at or immediately after pruning, is recommended.

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