BLISTER BLIGHT — A REVIEW*

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INTRODUCTION.

In October, 1946 Blister Blight was reported from an estate in the Dolosbage district of Ceylon. This incidence of the disease followed close on its observance in the tea districts of South India. In a short space of time the attack spread through the tea areas receiving the South West monsoon while at the end of 1946 areas subject to only the North East rains received their first visitation of the fungus. Since then probably every tea estate has had its attacks which may occur as light or heavy infestations dependant on climatic or environmental conditions. Much has since been written and said both of the disease and its control. When the disease first became general in our tea areas instructions on control measures had to be based on the evidence collected from other countries where it had been known for many years. Many of these recommendations, in the light of further knowledge, have been found to be impracticable under the varied conditions in which Ceylon tea is grown. The time appears opportune now to sort out the evidence we have accumulated bringing together in one publication the observations we have made and the control measures now advocated by this Institute.

We will be failing in our duty if we do not record the vast amount of time and energy spent by two former officers of this Institute, Dr. Gadd and Dr. Tubbs, on whose shoulders rested the responsibility of advisory and research work in connection with the then new disease.

In addition to addresses at the many Planters' Association meetings a number of publications on Blister Blight have been issued. A list of these publications is given at the end of this review.

THE FUNGUS AND ITS DISTRIBUTION

No adequate control measures on any fungal disease is possible without a full knowledge of the morphology and life history of the causative fungus. Such work is often arduous and long, especially with an obligate parasite, when cultural growth on synthetic media is impossible. It became evident very soon after this work was commenced that previously published data left much to be desired. In consequence the work undertaken had to be as full and comprehensive as possible. Though much of this work has been of academic interest it was essential as a basis in the adoption of control measures. In a review such as this, no useful purpose can be served by mentioning the points of scientific interest we have established. Two papers dealing fully with this matter have been accepted for publication (Gadd and Loos 1948 and 1949) in a scientific journal while a publication of more popular interest to planters appears elsewhere in this issue of the "Tea Quarterly."

Elevation plays an important part in the severity of the disease. Below about 1,000 feet Blister Blight is of no economic importance; extensive control measures on estates below that elevation are, therefore, unnecessary. At higher elevations severity of attack depends mainly on climatic conditions. Fields and valleys over which mist

* **Editor's Note.**

This article which was published as a circular in June 1949 should be read in conjunction with the addresses given by Dr. R. V. Norris and Mr. J. Lamb to the Standing Committee for Agency Affairs reported on page 48.

persists for fairly long periods suffer more severely than those areas over which these conditions do not usually prevail.

Our experimentation has revealed that a blister spore is relatively short lived. Under dry but shady conditions they remain viable for about a week. However, spores exposed for one hour to direct sunlight or to a temperature of 95°F. fail to germinate. This probably accounts for the failure of Blister Blight to establish itself in the low-country.

Previous work in other countries suggested that entry of the fungus into a tea leaf was *via* the stomata (breathing pores) which are located on the under-surface of the leaf. Research work in this laboratory has proved that entry is mainly through the leaf cuticle on either the upper or lower surfaces of the leaf and that there is no stomatal attraction. Further, 8 hours has been found sufficient for germination and entry into the leaf. During the whole of this time moist, sunless conditions must exist but once penetration has occurred the fungus is able to establish itself whatever conditions may prevail outside the leaf.

CONTROL MEASURES

As stated many times before it is unlikely that *eradication* or *cure* of Blister Blight will ever be possible. Bearing this in mind emphasis has to be laid on control. The more one sees of the disease the more evident is the effect of local conditions on its severity. For this reason control may only be achieved by a combination of several measures which may vary from estate to estate and even from field to field.

The three main forms of control applicable are :—

(1) Protection of susceptible material with fungicides.

(2) Modification of existing agricultural practices.

(3) Establishment of Blister resistant clones.

(1) PROTECTION WITH FUNGICIDES.

Three major difficulties require consideration in any plan for the widespread use of fungicides. These are firstly the difficulties arising from the hilly terrain of the tea districts in Ceylon ; secondly, the cost factor and thirdly what is probably the most important, the avoidance of the risk of contaminating the manufactured article.

It is perhaps advisable first to take into consideration the third major difficulty — contamination and risk to the manufactured article.

Copper fungicides have so far proved the most efficient as protection against Blister attack. Copper, however, above a certain limit is undesirable. For effective control against Blister tea has to be sprayed at frequent intervals. Each spraying operation deposits a copper residue on the blight susceptible flush as well as on the older non-susceptible leaves. The copper content of the manufactured product, therefore, goes up accumulatively both from the amount of copper deposited on the young flush and by absorption into the plant system *via* the older leaves. Accordingly this Institute cannot recommend indiscriminate spraying of large areas in plucking with a copper fungicide.

Fortunately the problem of copper deposits on tea recovering from pruning, i.e., bud-break to the last tipping, does not cause the same anxiety. Many estates have fields lying in mist belts where dry weather conditions are not sufficiently long to allow of a complete recovery in favourable weather. Those estates may find it both economic and safe to protect pre-tipping growth with a reliable copper fungicide. It may also be necessary to protect individual bushes which due to other reasons apart from Blister Blight need protection during resting periods. The small amount of copper which may come in contact with the surrounding tea during such an operation may be counted as negligible. Likewise there is no objection to the use of copper fungicides for the protection of nursery plants.

For continuous spraying of the tea in plucking our attention has been directed towards the more modern and less well known class of fungicides termed "organic" since they contain no metallic element. Most of the larger manufacturers, both in the United Kingdom and the United States, have now been approached and we are eagerly awaiting receipt of samples for test in the field. Several of these are now in transit.

At this point it must be noted that whether or not a particular fungicide will prove effective against Blister cannot be determined except after a field trial since, as stated earlier in this review, the fungus cannot be grown in laboratory culture. Had this been possible, as is the case with many disease fungi the whole problem would be greatly simplified, since it would have proved an easy matter to assess the possible effectiveness of many different fungicides after only a few days trial in the laboratory.

In the meantime it must be repeated that no satisfactory fungicide for use on tea *in plucking* is yet known. However, there is no reason to suppose that one will not eventually be found.

Fungicidal Applicators.—It is emphasised that the best disease control products are useless unless they can be applied by efficient machine. This problem is often overlooked or misunderstood. In the case of fungus control, as in Blister Blight, we have to deal with a static spore and for this reason both the upper and lower surfaces of the young flush has to be coated with a fine film of the fungicide. In the control of a roving pest such efficient coverage with a contact insecticide is not, for obvious reasons, necessary, or desirable.

Three main types of applicators or machines are in use for spraying operations.

(1) Helicopters and other suitable aircraft.

(2) Motor borne sprayers.
  (a) Fog applicators
  (b) Pressure sprayers.

(3) Portable knapsack sprayers.

(1) Helicopters and spraying from the air.

To be effective, spraying from the air has of necessity to be a few feet above the material to be sprayed. The hilly terrain of Ceylon tea plantations and the presence of tall shade trees make this operation both dangerous and ineffective. Helicopters have usually been used for the application of insecticidal dusts in the control of insect pests. Our attention has been drawn to the use of this method of application in the Sudan against a pest of cotton. Cotton in Sudan is grown in country which is very flat the only obstables being probably scattered buildings. Expert advice which has been obtained by this Institute indicates that the use of helicopters under the conditions prevailing up-country is not practicable.

(2) Motor-borne sprayers or dusting machines.

(a) *Fog Applicators.*—Such a machine has been under trial in Bogawantalawa. We were glad of the opportunity of watching these demonstrations which took place on April 27th, May 6th, 17th, 27th and June 7th.

The machine used was Todd's Insecticidal Fog Applicator (TIFA). The machine generates a dense fog impregnated with minute particles of fungicide emulsified in oil or water.

Two fungicides with copper compounds were used throughout these demonstrations.

(A) Copper oxychloride in an oil emulsion.

(B) Copper oxide in water.

Two plots, one for each fungicide to be tested, were marked out. The plots were bounded on one side by an estate road from

which operations were made. Immediately before each demonstration white cards were clipped on the tops of tea bushes, care being taken to keep exposed the full card surface. The cards were placed at intervals of 5 yards in depth from zero up to 40 yards. They were then subsequently tested for copper deposits, using a microchemical reagent sensitive to one part per hundred million of copper. The results are given in Table I.

consideration the high cost of the machine and the need of extensive road systems on estates we consider it doubtful that the TIFA machine will ever be an efficient proposition under Ceylon tea conditions. A TIFA instructive leaflet advises the use of a hood to concentrate the fog in the area under treatment. The cost and labour involved for such an operation under tea conditions might well be abnormally high.

(b) *Pressure Sprayers.*—The possibi-

TABLE I.

TEST FOR COPPER ON CARDS. TIFA DEMONSTRATION.

Distance from machine / Fungicide	0 yds.		5 yds.		10 yds.		15 yds.		20 yds.		25 yds.		30 yds.	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1st Demonstration	3x	—	2x	—	x	—	x	—	0	—	0	—	0	—
2nd ,,	3x	—	2x	—	x	—	0	—	0	—	0	—	0	—
3rd ,,	3x	3x	2x	2x	x	lx	0	x	0	0	0	0	0	0
4th ,,	2x	0	3x	0	2x	0	2x	0	x	0	0	0	0	0
5th ,,	2x	2x	3x	x	3x	x	3x	0	lx	0	lx	0	x	0

0 = No deposit
3x = Very heavy deposit of copper
2x = Heavy deposit of copper
lx = Fair ,, ,, ,,
x = Trace of copper

A very marked feature of the demonstration was the heavy deposits up to 2 or 3 yards from the spray nozzle. Shade tree trunks and tea bushes were coated with a thick layer of the fungicide which in some cases must have been about 1/16th of an inch thick. This type of deposit is both wasteful and injurious. The carry of the fog in still air is probably 10-15 ft., *beyond that distance the wind appears to be the governing factor.* The degree of Blister infection beyond 10 yards indicated a marked falling off in protective coverage at about this distance.

Doubtless the machine is capable of forming an efficient fog but the efficient distribution of this fog under outdoor conditions is always problematic. Taking into

lity of efficient spraying by means of small power-spraying outfits worked by a low horse-power petrol engine is receiving our attention. This problem was fully discussed with Dr. Wiltshire, the Director of the Commonwealth Mycological Institute, Kew. He agreed that the most efficient answer to our problem would be a machine of this type capable of being driven along the usual estate footpaths. Dr. Wiltshire has undertaken to explain our needs to spray machine manufacturers. We await developments with keen interest.

To be efficient a power sprayer should be capable of directing a fine mist 50-60 feet from the spraying lance. The cost of such a machine should be in the neighbourhood of Rs. 2,-3,000.

(3) **Portable Knapsack Sprayers.**

This type is well known on most estates as the pneumatic knapsack sprayer. For nurseries and for the spraying of individual bushes where portability is essential this machine has proved to be most efficient. However, for fairly large scale operations the fatigue and time involved in pumping operations is considerable. A new type of battery sprayer in which one pumping operation is sufficient for a whole day's work is now on the market. A set of these sprayers has been ordered for trial purposes. It is expected that the costs of spraying operations with this machine will be considerably reduced.

2. MODIFICATION OF EXISTING AGRICULTURAL PRACTICE.

By suitably modifying or merely altering the times at which certain agricultural practices are carried out it is possible very greatly to reduce the potential damage due to Blister Blight. Some of the more important ways in which this can be done are briefly outlined below.

Pruning.—By far the most effective method so far discovered to minimise Blister Blight damage is adjustment of the time of pruning so as to ensure that recovery takes place during the driest and most mist-free period of the year. No definite pruning dates can be laid down by the Institute since climatic conditions vary so greatly from district to district and indeed from field to field on the same estate. In this connection therefore the local knowledge of the estate Superintendent is of the greatest importance. However, as a rough guide it may be suggested that in those districts which receive both monsoons the optimum pruning time will be found to fall somewhere around November, December, while in those districts which only receive the North East Monsoon the optimum pruning time will probably occur around May.

The main point to remember about choice of pruning dates is that Blister Blight infection must be at a minimum during the whole period from budbreak to tipping. What is essential is that the bush must have been able to acquire a good canopy of healthy mature leaves before infection builds up. Then since mature leaves are relatively immune to Blister the bush will have a good healthy undercover of foliage which should keep it going throughout most of the pruning cycle.

We, of course, realise that on account of shortage of labour it may not be possible to prune all fields at the same time. Here again the local knowledge of the Superintendent is of great importance, since he can so arrange his pruning programme that those fields worst attacked are pruned at the optimum time, while those less badly attacked can be pruned either a little before or afterwards.

Although much lighter pruning, even skiffing, was originally thought to be required before we knew much about the disease, subsequent experience has produced no evidence to show that any change from the usual type of pruning now recommended is either necessary or desirable on account of Blister Blight. One word of warning is, however, advisable in this connection. Since the advent of Blister Blight we have found shortage of carbohydrate reserves to be becoming increasingly in evidence at higher and higher elevations. This must be watched out for and it may well be that the area in which rim-lung pruning is standard will have to be extended.

Many up-country estates running long cycles may also have to consider the advisability of reducing the length of cycle run. As stated earlier the bush is to a great extent dependant on a healthy undercover of foliage and when once this has been shed naturally, as a result of old age, the bushes on bad Blister Blight areas may be

unable to replace it. Should this occur then yields may be expected to fall and the bushes to deteriorate unless the cycle is brought to an early close.

Tipping.—Owing to the limited length of the comparatively free period from Blister Blight infection early tipping is obviously advisable. In so far as it is compatible with the above recommendation it may well be desirable to tip somewhat higher than normal so that the maximum amount of healthy undercover foliage may be preserved for the bush. Put in another way healthy mature leaves should not wantonly be removed at tipping as it is unlikely that they can be subsequently replaced.

Plucking Policy.—There is an interval of approximately 7 days between the unfolding of each flush leaf. It will be seen that this observation has considerable relevance in what follows. Blister Blight attack on tea in plucking may be divided into two phases in each of which a different plucking policy should be followed. These phases are (a) Leaf attack only, (b) Stem and leaf attack.

(a) *Leaf attack only.*—In the absence of any stem attack a leaf, even if blistered, is likely to remain attached to the bush and provide a certain amount of assimilating area which will help towards the bush's maintenance. Accordingly there is no reason to depart from the normal plucking procedure of taking 2 leaves and a bud and leaving the 3rd leaf and fish for the bush. What has, however, been recommended is closer plucking rounds by which is meant plucking at more frequent intervals. From what has been said earlier it is evident that the 2nd leaf from the bud may increase in age from about 14 days to 21 days before it becomes the 3rd leaf and thus no longer pluckable. 21 days is quite sufficient for a white blister to appear but 14 days is rather too short. However, by shortening the interval between plucks a larger proportion of younger flush will be taken each time with a consequent improvement in the quality of the leaf entering the factory.

(b) *Stem and leaf attack.*—This is much the more serious case since the whole shoot is liable to be destroyed if left. While the attack maintains its severity, therefore, there is little advantage in leaving any such attacked leaf for the bush since it will almost certainly be rendered useless as a consequence of the stem attack. Accordingly, in this case only, and only for the duration of the attack, it is recommended to pluck to the fish leaf. By so doing the shoot when plucked will be about 7 days younger on the average and therefore less likely to have succumbed to the stem attack. In other words it is preferable to pluck immature flush rather than let Blister Blight take it.

Drastic ills call for drastic remedies and this is unfortunately only too true in the present case. Accordingly it is imperative that when the attack has died down the bushes so plucked should be rested for a few rounds in order that they may make up for all the leaf surface which has been lost. This resting is an integral part of the plucking policy recommended and only where it is strictly adopted can the Institute endorse a policy of fish-leaf plucking.

Manuring.—Good health is largely a matter of good nutrition. This truism applies equally to plants as to men and may be best interpreted in the present case as an injunction to ensure that adequate manure is available for the bushes to make all the growth they can when such growth is possible. Furthermore it may well be that badly attacked fields require slightly more manure on a yield basis than unattacked fields since account must also be taken of the nutritional elements required to build up the tissues destroyed by Blister Blight.

Control of shade.—Heavy shade is a factor predisposing to Blister Blight infection. This is because it delays the early

morning sun reaching the bushes and dispelling dew and mist, thus permitting humid conditions suitable for infection to persist. Too much importance must not be attached to the influence of shade, however, since in most areas conditions suitable for infection only occur during the monsoons when the presence or absence of shade can have little effect. In these areas the beneficial effects of properly controlled shade far outweigh any possible losses due to increased Blister Blight attack and any policy of ruthless felling would be foolish in the extreme.

In the areas where mist tends to lie continually, even in fine weather, it cannot be doubted that heavy shade will increase the severity of Blister Blight attack. Accordingly a policy of controlled felling should be adopted for these areas with the object of letting the sun in as early in the morning as possible and thus reducing the length of time during which infection is possible.

3. ESTABLISHMENT OF BLISTER RESISTANT CLONES.

Vegetative propagation, without doubt, provides one of the most promising long term ways of reducing Blister Blight losses to a minimum. The general methods of vegetative propagation are too well known now to warrant description here but a few words concerning the right type of material for selection may not be out of place. The essential qualification required of a good mother bush is that it shall continue to yield well even during a severe Blister attack. Considered rather more fully, this means that the bush must be not only of a vigorous high yielding type but must also display a considerable amount of Blister resistance, as otherwise it would fail to yield during a severe attack. This then is the obvious time to select mother bushes for propagation. Of course, in addition any selected bush must also be a good rooter in the nursery and capable of producing good quality tea. Selection against Blister Blight is still in its infancy but such experience as we have already indicates that there should be plenty of suitable material available on most estates provided it can be discovered.

It will be noted that no recommendation is made to look for completely immune bushes. Immune bushes are comparatively rare and even when found, prove, in most cases, to be poor jat, low yielding types. However, this is not to say that high yielding, good jat, immune bushes do not exist and those estates which possess them are fortunate indeed.

SUMMARY OF PRINCIPAL CONTROL MEASURES

The following is a brief resume of the principal control measures mentioned in

(1) Spraying pre-tipping fields and nurseries with a copper fungicide.

(2) Adjustment of pruning dates.

(3) Adoption of a suitable plucking policy.

(4) Control of shade in fine weather mist pockets.

(5) Establishment of resistant clones.

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