

SOME OBSERVATIONS ON THE MILDEW LEAF DISEASE OF HEVEA BRASILIENSIS DUE TO OIDIUM HEVEA*

WITH two exceptions viz. *Fusicladium macrosporium*, and Abnormal Leaf-fall due to *Phytophthora* sp. mature rubber trees have until comparatively recently been singularly free from any serious leaf disease and more especially does this apply to the Eastern tropics.

The former (*Fusicladium macrosporium*)—a most destructive enemy of the rubber tree—is fortunately still confined to the Amazon Valleys, Trinidad, British Guiana and Surinam, while the latter—Abnormal Leaf-fall due to *Phytophthora*—has so far not proved serious in Malaya if it has appeared at all. This leaf disease is however a source of considerable trouble in South India and also perhaps to a lesser extent in Ceylon and Burmah.

The appearance of the Oidium Mildew dates from 1918 and was first noted by Arens in the Malang district of West Java. As the following quotation will show, Arens realised the possible capabilities of this fungus and warned the industry to keep a sharp lookout for it. In his account the following occurs: "It is not confined to the Malang country, but is present over the whole of Java. The disease is apparently a new one. Nowhere in the literature on diseases of Hevea has Mildew been recorded as growing on Hevea, neither from Java, from Sumatra, the Federated Malay States, Ceylon or other rubber-growing countries. But since the disease is easily overlooked if not attacking many trees, it seems not impossible that it may already be present in other rubber-growing countries."

The truth of the last suggestion has been fully borne out during the last ten years for now the Oidium leaf disease has been reported from Sumatra, Ceylon and Malaya.

In Java and also in Ceylon it has already assumed the character of a serious leaf disease requiring active combative measures on a large scale and at considerable cost. Its steady spread and increase in intensity must be regarded seriously, even though it has not yet caused any considerable damage in some of the rubber-growing areas. The fact should not be lost sight of that once it appears in a rubber-growing area, it is very liable to recur under suitable conditions, and that each recurrence usually means a more virulent attack as well as an increase in area affected. The appearance of the Oidium Mildew on Hevea in Ceylon was first noted in 1925, and since then the area and intensity of attack have both steadily increased. The disease was first noted in Malaya in 1925, and has appeared again in 1929, but the fact that so far no great damage has resulted in Malaya, should not lull one into a feeling of false security. The outbreak of this disease on an extensive scale is always a by no means remote possibility. The fact that the fungus is in the country and can carry on from one season to the next favourable time is, to say the least, disconcerting.

* By A. R. Sanderson in *The Quarterly Journal of the Rubber Research Institute of Malaya*, Vol. 12, No. 1, March 1930.

Reydon, in a report dealing with the Mildew Disease in East Java, 1927, states as follows:

- (1) "The Mildew disease has become considerably worse during the last few years, as compared to previous years."
- (2) "Mildew has appeared on nearly all East Java estates."
- (3) "The attacks of the disease have been severe on 48 per cent. of the total Mildew infected estates."
- (4) "Mildew has appeared on the budding beds or nurseries of 17 per cent. of the estates."
- (5) "Decrease of production was accounted to Mildew attacks on 6.4 per cent. of the Mildew estates."
- (6) "The rainfall on Mildew estates during the East Monsoon was less than on healthy estates."
- (7) "Mildew is considerably worse on low-lying than on high-lying estates, and again more severe on the south than on the eastern slopes of the fields."

Schweizer writing of the Erysiphaceae from Java, mentions that the largest number of the said Mildew (Erysiphaceae) host plants are especially virulently attacked in the dry season (the wintering season of the rubber tree) and further states that on some plants the Oidium is found through the whole year. He considers that the variation of the water supply is more especially to be considered and that the better the water supply the less the various plants suffer from Mildew attack. This explanation is in agreement with the experimental results obtained by Rivera. It is highly probable that many factors are concerned in causing infection and also in determining its intensity and spread, but although the great variability of these combinations is generally admitted, two conditions must be satisfied viz., the young leaf formation and weather conditions favourable for attack. It is clear then that the time of wintering is all important.

Variability of combination of factors for successful inoculation by another species of Oidium is well shown by the investigations of Miss Schwarz who found the same species of Oidium in West Java on *Physalis minima* and on tobacco, but infection experiments in East Java with *Physalis* which is infected the whole year through with the Mildew gave no results with tobacco. The explanation is probably that the necessary combination of factors is not present.

Gadd writing of the conditions obtaining in Ceylon when the first outbreak was noticed in 1925, states: "Normally at the time when Hevea is putting forth its new leaf, weather conditions in Ceylon are dry and not favourable for fungus growth. In 1925 there was more rain and the number of wet days was greater than usual during February and March in the rubber districts, and it is probable that these wetter conditions favoured the fungus and helped the process of adaptation to its new host. If so, given normal climatic conditions at the time new leaves are next produced it is unlikely that the trees will be severely attacked as what infectious material has persisted on the old leaves will be shed with them in wintering."

Sharples comments on this as follows:

"This year—1926—wintering was even and normal. Up to date (4-4-26) not a single case of leaf-fall has been reported this year. Thus Gadd's conclusion can be emphasised. ("Consequently given dry climatic conditions at the times of production of new leaves, it is not expected that the disease will recur to any extent.")"

Murray writing on the occurrence and significance of Oidium leaf disease in Ceylon remarks on the differing characteristics of the disease in the different districts. A dry district like Matale and a wet one like Kalutara are contrasted. Of the former district (Matale) the abundant superficial growth of mycelium and spores on the surface is a notable feature, whereas in the latter (Kalutara) district it is comparatively rare to find an affected leaf on which the fungus is visible to the naked eye. In the Matale district the leaves are sometimes so white as to appear to have been splashed with white wash. He suggests that this difference is probably related to difference in atmospheric conditions and more specially the difference in average humidity which is lower in Matale than in Kalutara.

Occurrence.—In general once the Oidium leaf disease has appeared, the spread has been certain and fairly rapid throughout the area where the host plant has been well distributed. The severity of attack has not necessarily been coincident with, or proportional to, rate of spread, because this depends so much on conditions which may not be continuous throughout any particular district. There is at present however a general consensus of opinion amongst the various investigators, that dry conditions even to drought are favourable to a maximum intensity of attack, if such conditions obtain during or immediately after the wintering season, *i.e.*, before the new leaves have reached maturity. Murray states the Oidium is not so severe in the low-country as in certain districts at higher elevations, while Reydon writing of conditions in East Java states that Mildew is worse on low-lying than on high-lying estates. It would appear then that the necessary favourable conditions may occur at different altitudes in the different rubber-growing countries.

In connection with this Rivera states:—“Everything which tends to decrease the turgency of a leaf, *e.g.*, drought, sudden differences of temperature etc. makes the leaf more sensitive to Mildew attack.”

A diminished cell vitality also increases its susceptibility to attack by the Mildew fungus.

Effect of Mildew attack on Yield of Hevea.—At present no reliable figures appear to be available as to the effect of Mildew attack on yield of Hevea, but there can be little doubt that repeated defoliations must be harmful. The effect on yield of Abnormal Leaf-fall due to Phytophthora has already been noted, and that due to Mildew disease can scarcely be expected to be less harmful. Ashplant quotes yield figures in the case of Phytophthora leaf-fall for Southern India, showing that the sprayed blocks in some cases yielded 18 lb. per acre more than unsprayed blocks and in other cases 9 to 18 lb. more per acre. A second effect on the tree is a general reduction in vitality following the depletion of food reserves. This may in some cases occur to such a degree that comparatively weak parasites can gain entry which would be impossible with a tree in full vigour. Stoughton Harris writing on the spraying of rubber as a means of control for abnormal leaf-fall mentions that there is definite evidence that the sprayed trees have a greater girth increment, hold their leaf longer at the normal wintering period, and give a yield estimated conservatively at 10 lb. per acre greater each year than unsprayed rubber, and further remarks, “the control of a leaf disease should be looked on not from the point of view of possible immediate yield response but as a prevention of the future general debilitation caused by the disease.”

Murray writing of the attacks in Ceylon, states, that “in consequence of a continual depletion a physiological die-back of twigs is a characteristic feature of badly attacked areas.”

So far as the writer knows this has not been noticed in Malaya perhaps because the attacks up to the present have not been sufficiently severe.

Recurrence.—The Hevea Mildew is known only in the Oidium stage, *i.e.*, the conidial stage. In this it agrees with most tropical Mildews, the ascospore stage of which is not known. Spread must therefore be by the conidia or by the mycelium or by movement of infected material. This cannot always account for recurrence in the same areas year after year, and since no ascus stage is known, there is no spore stage known, capable of carrying over from one wintering period to another. The inactive period in the life history of the fungus has been discussed by Bally and Bobiloff. The latter states that the fungus hibernates on the few young shoots which are always produced by some trees throughout the year, or on infected spots of mature leaves. In an affected field there are always at any given time a few trees whose young shoots are infected and these are the sources of infection when the conditions are suitable for an outbreak of the disease.

Murray commenting on this states, "In the main, observation on the life history of the fungus in Ceylon confirm Bobiloff's statement, except that in badly affected areas in certain districts the fungus never becomes wholly inactive, so that the disease is present at all times of the year." This agrees with Schweizer's account of the Erysiphaceae of Java.

It would be of considerable interest to have particulars of the distribution and amount of rainfall in these districts.

Although the various investigators are more or less in accord that diseases due to powdery mildew Oidium attain their maximum severity under dry weather conditions, and that attacks in general whether severe or mild, are coincident with dry weather even to drought conditions, this is probably not the whole truth.

Reydon states that "to conclude herefrom that more rain means less mildew is in our opinion rash, because we do not know exactly the nature of the influence of the rains on mildew attacks, and we must first find out when the young leaf period falls. The mildew attack is indeed in the first place dependent on this last factor." With the last sentence all investigators will agree but it would seem that periods of heavy rain may do much to check the spread by spores (conidia) since these would be washed off and fall to the ground; the fungus being an obligate parasite, and the conidia not capable of retaining vitality long under adverse conditions, *i.e.*, unless on a suitable living host, thus germinating power is soon lost.

It would appear however that, in conformity with Reydon's statement, any tree producing new foliage, when the spores are active, will be liable to infection. The period of activity of the spores may to a considerable extent be limited by the weather conditions, since spore production is usually much more rapid and continuous during dry weather.

Another factor of importance is that this condition according to Rivera is an optimum one for infection so that the condition favouring spore formation is also the condition favourable for attack. The rapid spread noted on many occasions may thus be accounted for.

Mites and Mildew.—Whilst it is true that mites have been found on some occasions in association with the Oidium it by no means follows that the attack by the fungus must be preceded by mite attack. The Oidium fungus is an obligate parasite and requires only the presence of the host plant and the necessary favourable conditions as regards the cell turgidity to make a successful attack. One reason for finding the two together is the fact that both show their greatest development under the same climatic conditions. It is fortunate perhaps that the most effective treatment for mildew is also the chief means of combating mite attack.

The Causal Fungus.—*Oidium Hevea* belongs to the "Powdery Mildews" (Erysiphaceae) many of which cause destructive disease of plants. The delicate, hyaline cobweb-like mycelium usually develops on the surface of leaves forming a more or less complete superficial covering. In the case of *Oidium Hevea* in Malaya a complete covering is not common. This agrees with Murray's observations in the Kalutara district of Ceylon. From this mycelium special haustoria or sucking organs are formed which penetrate the cell walls and draw their food supplies from the cell contents. Although these fungi are mainly leaf parasites they may occur on flowers, fruits and stems.

Spores (conidia) are usually produced in abundance on short erect conidiophores, and are chiefly responsible for the powdery appearance which is characteristic. The spores are distributed by wind, insect or other agency, but are usually short lived, so that if conditions are unfavourable the spread of the disease is soon checked. By destruction of the cell tissues of the leaves this type of fungus may prepare the way for the entry of other and weaker parasites which may quickly complete the destruction started by the *Oidium*. It is probably because of this that such fungi as *Gloeosporium* and *Fusarium* are so frequently found associated with *Oidium* attack.

Symptoms.—The attack of mildew in mature rubber is always most pronounced on young leaves, during and immediately after the wintering season. The young leaves in the bronze, greeny bronze, and later, pale green state, are particularly liable to attack. It may, however, attack leaves of all ages.

In the case of young foliage the leaves usually become more or less dull in appearance, as contrasted with the shining appearance of healthy leaves, crinkled from the tip and later a portion commencing at the tip becomes bluish or purplish black in colour. These changes apply to the leaves both in the bronze stage and early green stage. The leaflets soon fall to the ground and become shrivelled in appearance. The mycelium and spores can be seen best near the midrib on the under sides of the leaves. In cases of severe attack the ground may be covered with a carpet of decaying leaves and the retention of the more or less bare leaf stalks on the trees almost denuded of leaflets is a striking characteristic. The next flush of leaves may be attacked in the same way and fall to the ground long before they mature. It seems fairly obvious that several repetitions of such a leaf-fall during any one season may have serious consequences. Recurrence in successive years must have a cumulative effect. The attack on mature leaves is usually not nearly so severe as on the younger leaves, and frequently the mature leaves remain attached to the leaf stalks. The attack on the flowers if at all severe is followed naturally by a poor seed season. This has been very marked in some cases both in Malaya and in Java.

Control Measures.—Control measures fall naturally under three heads:

- (a) Measures applied to the plant direct to enable it better to withstand, to recover from, or to ward off attack, *e.g.*, application of manures, general improvement of soil conditions.
 - (b) Breeding of more or less immune strains.
 - (c) Direct attack on the parasitic fungus.
- (a) These measures should be used, if used at all, in conjunction with (c). Any attempt, *e.g.*, manuring etc. alone, to keep the plant vigorous which still leaves the fungus free play can scarcely be considered the most efficient. Further, unless some form of manuring could be applied which

would render the plant completely resistant either by increasing the thickness of the cuticle—the outer covering of the leaf—or affecting the constitution of the cell would be of doubtful efficacy. The fact that in any case the young leaves are the most susceptible complicates matters considerably. The combination of manuring and spraying, *i.e.*, (a) and (c) has had good effects in the case of abnormal leaf-fall due to *Phytophthora*.

Vollema describes manuring experiments as a possible means of combating mildew attack of *Hevea*.

Three aspects are considered :

1. "Influence of manuring on the power of resistance of the young leaf to mildew.
2. "Influence of manuring and other cultivation measures on the time and existence (duration ?) of wintering.
3. "Influence of manuring and other cultivation measures on the recuperative powers of affected trees."

"As regards (1) the conclusion arrived at was that the manures in use applied shortly before wintering cannot in any important degree increase the powers of resistance of the young leaf against mildew."

(2) The conclusion arrived at is :

"Appropriate manuring and other cultural measures by their delaying influence on wintering make the chance of attack by mildew greater."

And as regards (3) "the last year's deductions were confirmed that recuperation of manured trees is better."

Vollema finally states, "making up the profit and loss account, we must conclude that little is to be expected of an indirect attack on mildew by manuring. As apart from conclusions with the effective and cheap sulphur dusting, manuring as a rule merely keeps the attacks in hand by postponing wintering. Although recovery is certainly better, prevention is better than cure" counts in this case to the utmost."

(b) Breeding of immune or highly resistant strains offers obvious advantages but at present must go hand in hand with control measures as (c). Little is known at present regarding immunity of *Hevea* to disease either generally or specifically, and the raising of immune strains would be a long and tedious process. In any case it would not help present plantations. Direct attack on the fungus must at any rate for the present be regarded as the best line of control and sulphur or sulphur compounds are at once indicated.

The use of sulphur in the control of *Oidium* of the vine dates back to 1846 and it is estimated that at present, France alone consumes 80,000 to 100,000 tons of sulphur per annum for the work. The fungus is still present and active but the damage is negligible.

Use of Sulphur.—It may be said that the value of sulphur in spraying mixtures or dusting powders is proportional to the percentage of "free" sulphur and to the fineness of the particles. The adherence of the sulphur depends largely upon the size of the particle; sulphur with particles 5 microns to 15 microns can now be obtained. A considerable amount of experimental work with the use of sulphur and sulphur mixtures and compounds against the *Oidium* fungus has already been carried out chiefly in Java, in those districts where the disease has appeared annually with increasing virulence.

Gandrup and S' Jacob describe the results of the experiments in the control of Mildew using Bordeaux mixture, Burgundy mixture, Sulfinette—a lime sulphur preparation—and sulphur. They demonstrated experimentally the effectiveness of Sulfinette and of sulphur in a vaporous form, *i.e.*, without the fungicide actually coming into contact with either the fungus or the infected material.

They also discovered that the resin-soda adhesive medium often causes fungicides of standard strength to burn the young leaves and suggest that Sulfinette must be used at 0.25 per cent mixture to prevent burning. The final conclusion of these investigators is that the expenditure necessitated for control work would only be justified by the loss of production being proportionately large, or if capital loss caused by depreciation of the estate through Mildew permits such expense.

Bobilioff carried out observations on Oidium attack during 1929, and concludes as follows:

“Sulphur and sulphur preparations have a fungicidal effect on Oidium. When experimenting with different preparations it is not possible to differentiate conclusively between the effectiveness of these preparations. However when dusting gardens it appears that the sulphur from the sulphur works Kawah Poetih gives promising results in comparison with other preparations. On the fungicidal action of sulphur several experiments were carried out, with the following results.”

- (a) “The sulphur is effective ten days after dusting.”
- (b) “Sulphur destroys Oidium when applied to the leaf even when there is no immediate contact with the leaf spot. Dusting one side of the leaf is sufficient to destroy the fungus situated on the other side.”
- (c) “An influence of sulphur at a distance was not observed, but this point still wants confirmation.”
- (d) “A prolonged residual effect of sulphur does not exist. When dusted trees after a certain time produce new leaves, these are attacked by Oidium.”
- (e) “The effectiveness of sulphur on Oidium spots is not absolute. From the boundary of the destroyed fungus spots the fungus may develop again. On once treated leaf new Oidium spots may occur. The effect of sulphur is however not imperfect to such an extent that this is of practical influence on the Oidium control by dusting with sulphur.”

“When combating Oidium in rubber gardens we made the following observations.”

- (a) “The Oidium attack is checked by sulphur. The treated gardens have practically speaking a normal appearance and have nice foliage.”
- (b) “An extraordinary blossoming was observed in the treated gardens more than 90 per cent. of the trees were in bloom.”
- (c) “Oidium first decreased between ten applications of sulphur (after 10 days) to increase again later on (after 17 days).”
- (d) “The influence of rain on the effectiveness of sulphur is of little importance and Oidium decreased in the ordinary manner.”
- (e) “The chance of infection of treated gardens by neighbouring non-treated plots is relatively small. Thus it is possible to dust badly attacked parts without it being necessary to dust the whole plantation or division.”

CONTROL

For control purposes some form of spraying or dusting is a necessity. The material to be used is as previously indicated sulphur or sulphur compounds or preparations which will act like sulphur and become effective in a vaporous form. There are advocates of both spraying and of dusting and each method may have its advantages or disadvantages.

Spraying.—For this purpose the choice has to be made of a hand-spraying outfit or of some form of power sprayer. In either case to be really effective the apparatus must be capable of delivering a spray to a height of 50-70 feet, *i.e.*, if the tops of mature trees are to be reached without climbing.

Ashplant discussing the spraying of rubber in connection with the *Phytophthora* Leaf-fall in South India and comparing power and hand sprayers states as follows :

“The maximum height that can be reached with a fine spray operated from the ground is from 30 to 40 feet and is not much greater with a power than with a hand sprayer. With both, climbing has to be resorted to in order to reach the tops of the trees. It is this necessity for climbing that limits the possible task and takes so much time and labour. Could means be devised whereby the tops of 70 to 100 feet Hevea trees could be reached by a ground operated spray, or rather by a battery of sprays the full resources of power driven sprays would be capable of utilization. The greater speed and labour saving then made possible would alter the position entirely to the advantage of power sprayers.”

If some form of petrol motor is employed one at least of the attendants would need to possess the necessary skill and training to manage the apparatus.

Sundquist discusses the use and advantages of stationary plants with spray guns for the spraying of orchards. Amongst the advantages are saving of time and labour, more efficient work and avoidance of damage to trees by hauling. This system—a permanent one—is now established in the apple-growing districts of the Pacific North-West.

Tengwall describes experiments with sulphur dusting from aeroplanes and states as follows :

“Technically the dusting was a complete success ; on each leaf sulphur could be recognised even on the trees at the utmost limit of the estate. On the old leaves sulphur occurred principally on the top side ; on the young leaves, still hanging, sulphur was observed on both sides.”

“An evident smell of sulphur remained in the gardens many days after dusting was finished.”

“On September 12th it was observed that all the young leaves which had grown out during or after the first dusting (in August) were perfectly healthy. Even young leaves, on the trees which had been badly infected and lost most of their foliage, were healthy.”

As a result of the 1928 experiments Tengwall observes that the following conclusions can be drawn :

1. “Dusting sulphur powder from an aeroplane on Hevea plantations is possible.”
2. “Sulphur powder is able to kill *Oidium* or at least its conidia.”
3. “A dose of 50 kg. of sulphur per hectare . . . 45 lb. per acre . . . is sufficient to keep the young leaves healthy for at least 14 days.”
“The dusting experiments were reported in 1929 on a larger scale in order to get figures concerning the cost of dusting by means

of aeroplanes. This was found to be approximately 6 florins per hectare equivalent to about 1.7 dollars per acre, an amount which could probably be appreciably reduced."

Altogether the operation of power spraying on a large scale, under present conditions must of necessity be expensive and the *pros* and *cons* for its installation require careful consideration. The urgent necessity, should it arise, would however, be the deciding factor.

The following account of spraying apparatus and equipment is taken from the R. G. A. Bulletin Vol. 8, No. 7, 1926, and is a report by R. H. Stoughton-Harris, Mycologist, Rubber Research Scheme, Ceylon.

"In Ceylon and S. India the apparatus is used for control of abnormal leaf-fall due to *Phytophthora*. There are at present in use in South India several makes of spraying machines, but of these two have proved most successful and one in particular. Attention will be confined to this one only as it is understood that some 50 or more of these outfits have already been sent to estates in Ceylon. The machine referred to is the D. S. P. "Headland" Pump."

"This is a double-barrelled force pump, with a large inlet hose with strainer, and steel pressure-chamber, and two $\frac{1}{2}$ -in. outlets with stop-cocks. The machine is sent out unmounted, but should be fixed to a small wooden platform, with four projecting handles for carrying. Spares for the pump are supplied but may usefully be augmented. A list of the more useful spares may be obtained from the Research Scheme. Two lengths of hose are required, each 75-120 feet long. If more than this length is used, undue wear and many bursts and other troubles are probable. The only hose that has so far proved capable of standing up to the rough usage is the "Armada" Hose. To the end of each length of hose is attached either a bamboo "lance" (a long bamboo with a screwed metal pipe within it), or a light 15 feet steel pipe. To the end of this is attached the nozzle. Many types of nozzle have been tried, but the most successful are the "Mistifier Junior," and the "Jumbo" nozzle. A new type of combined lance and adjustable nozzle has been put on the market at the instigation of Mr. Ashplant. This is called the Drake & Fletcher "Armada" Spray Gun, and seems likely to prove very successful. With this instrument the type of spray produced is varied by turning the stop-cock at the handle end."

"Besides the actual spraying apparatus there will be required for each machine :

- Four 40-50 gallon wooden barrels.
- Two half barrels.
- Two wooden buckets.
- Two galvanised iron buckets.
- Two fine mesh latex strainers.
- Two old coagulating dishes.
- Six empty kerosene tins for carrying water.
- One spring balance, weighing to about 30 lb. or
- One household scales."

Labour.—"The number of coolies required for each machine will vary according to the distance of the point of operation from a water supply. The labour is best apportioned as follows :

- Two coolies working the pump.
- One cooly stirring Bordeaux mixture and relieving pumpers in rotation.

Four coolies spraying, two on each line.

Two to six coolies carrying water, and mixing the Bordeaux.”

Dusting.—The operation of dusting, *i.e.*, the use of a fungicide or insecticide in the form of a very finely divided dry powder possesses certain advantages as compared with spraying, and more especially in the case of tall trees like mature rubber trees.

The operation is in no way dependent on the proximity of a water supply. The material used is easily transported. A fine dust may remain suspended in the air for an appreciable time and this is an important factor in distribution.

With certain materials the operators have to exercise the greatest care if eye, nose and lung troubles are to be avoided, but precautions involving the use of masks etc., can be taken.

In the case of mixed plantation, *e.g.*, rubber and tea, the deposition of sulphur on the tea leaves might reasonably be objected to as possibly leaving an objectionable taint. Recent experiments described in the Mycologist's Report for January, 1930, Rubber Research Scheme, Ceylon, suggest that even the maximum amount of sulphur per acre which may be expected to fall on tea adjacent to dusted rubber will not taint the tea.

A further experiment showed that although there was a recognisable smell of sulphur on the green leaf and during manufacture the finished tea showed no taint.

Dusting with sulphur by use of a power duster requires considerable care. With some types of apparatus there is always the possibility of the finely divided sulphur becoming ignited and the danger with a petrol engine is obvious. It was at first considered essential that in order to be effective the leaves should be more or less covered with the spray fluid or dusting powder, and that the fungicide must remain attached for a considerable time. Recent work should appear to show that this is not so necessary since in the case of both Sulfinette and of sulphur the vapours have proved successful. A new form of power duster named the Bjorklund Duster has recently been tested against the Oidium leaf disease in Java.

The apparatus consists of a special type of 6 H.P. motor combined with a specially designed “dusting” apparatus to form a single unit. The complete duster weighs about 180 lb. ready for use and can be carried by four coolies. An automatic feeding device allows the quantity of sulphur used to be regulated. A capacity of about 260 acres per day is claimed for this apparatus.

For application to nursery plants or young plants in the field which do not exceed say 8 to 10 feet in height some form of hand sprayer or duster would probably fulfil all requirements. It would appear that the time is approaching when each large estate or group of estates will have to consider the question of installing efficient spraying and dusting equipment with the necessary chemicals as part of the ordinary estate requirement so as to be prepared for emergencies. In doing this the rubber industry would only be following the example of other large crop industries.

SUMMARY

1. It has now been definitely established that Oidium leaf disease is present throughout the rubber-growing areas of the Eastern tropics excepting South India and Burmah.

2. There is a general tendency, in all the areas affected for the disease to increase in intensity in successive years.

3. The fungus can continue in an inactive state from one favourable season to another.

4. The repeated defoliations in a single season which is a marked characteristic of Oidium attack must have an appreciable adverse effect on latex yield, as well as affecting the general vigour of the tree.

5. Original infection and rapid spread of the disease favoured by dry weather conditions during the wintering season.

6. Control can be established by the use of sulphur or sulphur compounds sprayed or dusted over affected areas.

7. Repeated sprayings or dusting are necessary at somewhat short intervals during the wintering season.

8. The use of power sprayers or dusters or possibly the use of aeroplanes is indicated for the more or less immediate future.

9. The Oidium has been found to be capable of attacking rubber of all ages from nursery plants upwards.

10. The spread of the fungus is by spores (conidia) probably wind borne.

11. The conidia are produced most abundantly during dry weather, *i.e.*, under weather conditions such as are experienced during a normal wintering season, and when the leaves are presumably most susceptible to attack.