# STUDIES IN BLISTER BLIGHT CONTROL

## II Preliminary results of tests with fungicides

C. A. LOOS

In October 1946, when blister blight made its first appearance in Ceylon tea plantations, the immediate problem that confronted the Tea Research Institute was the devising of such control measures, whereby the severity of outbreaks could be minimised and held in check. At the onset it was realised that, due to the wide differences in climatic conditions between North India and Ceylon, control measures adopted in that country might not be completely effective

out here. Until more was known of the course of the disease recommended control measures had to be based on purely agricultural practices, the chief of which was the careful regulation of pruning seasons and pruning methods. Pruning had to be timed so that pre-tipping growth was established during the periods of dry weather, under conditions unfavourable to the growth of the fungus. This recommendation, though it upset the normal routine on many estates, was sound in principle, for it allowed the bushes to form maintenance foliage which would become resistant to infection before conditions favoured the growth of the fungus. Unfortunately, in some cases, that advice was not followed.

Four years ago we should have considered a test for starch reserves, on roots of tea bushes on estates above 2,000 feet elevation, a waste of time. Today starch deficiency is the direct cause of thousands of bushes failing to recover from pruning even at elevations above 5,000 feet. Admittedly, manurial deficiencies, such as the shortage of potash, are a contributory cause but in many cases the loss of pre-tipping leaf, following on blister attacks, is the main reason. Continued plucking of bushes of maintenance leaf must inevitably lead to their destruction through starvation.

Before protection against blister blight, by the use of fungicides, became possible. More had to be known of the causative fungus as, without that basic knowledge, any experimental programme was doomed to failure. The necessary investigation was, under the direction of Dr. C. H. Gadd, completed by the end of 1948. It was, therefore, possible to conduct small scale spraying experiments in 1949 when four problems called for careful consideration —

(1). The choice of suitable fungicides.

(2). Protection of tea recovering from pruning under monsoonal conditions.

(3). Protection of tea in plucking during blister blight attacks.

(4). The most efficient means of applying fungicides.

## I. The Choice of Suitable Fungicides.

Dr. Tubbs' preliminary experiments showed that *Exobasidium vexans* is susceptible to control by copper based fungicides. Fungicidal preparations depending, for their activity, on elementary sulphur have little effect.

A number of proprietary copper based fungicides are now available in Ceylon amongst which are —

**Perenox** — A cuprous oxide formulation manufactured by Messrs. The Imperial Chemical Industries.

**Blitox** — A copper oxychloride formulation made by Messrs. Pest Control Limited.

**Shell Copper Oxychloride**.—A formulation made by the Shell Company.

**Coppesan** — Messrs. Boots (U. K.).

**Yellow cuprocide** — Messrs. Rohm & Haas, U.S.A.

**Copper Sandoz** — Messrs. Sandoz Limited, Switzerland.

To these preparations may be added the following which will be on the market in the near future.

**Kuprokyit** — A Dutch product.

**Concentrated Copper Lime** — A German product.

We are not aware of any marked differences between the efficiency of these proprietary copper fungicides but our experience of all but Perenox is limited. In testing organic fungicides we have therefore taken Perenox as a standard for comparison. The copper oxychloride fungicides are green in colour making it difficult to judge the volume of spray fluid against the dark green of the leaves,

Unless carefully supervised the spray gang finds it difficult to judge the amount of cover being put on till the spray fluid runs off the leaf. Fungicides intended for field application incorporate in the formulation a sticker and spreader. The sticker has adhesive qualities which cement the small particles of the fungicide on the leaf while the spreader tends to give an even distribution over the sprayed surface. Different manufacturers claim distinctive merits for their various formulations. There is a definite limit to the amount of work the Institute can undertake to test these claims. We have, however, tested a copper oxychloride formulation (Blitox) against a cuprous oxide formulation (Perenox).

**Cuprous oxide vs. copper oxychloride.**—An area of tea pruned at the beginning of October was divided into three approximately equal plots, their location being such that almost similar conditions prevailed. The site selected was above a marsh where blister blight had previously been known to flourish.

Two plots were sprayed at 10 day intervals with Blitox and Perenox, each at a concentration of 4 ozs. fungicide in 10 gallons of water, the spray output being approximately 12 gallons to an acre. The third plot was left unprotected to serve as a comparison for the intensity of blister infections, during the course of the trials. Spraying commenced at the first sign of bud-break on 28th October, 1949.

For the purpose of the experiment weather conditions were ideal. Each spraying operation being conducted in fine weather, the fungicide application drying on the leaves before the advent of rain. Table I shows the weather conditions which prevailed between bud-break and tipping, at which time the experiment ceased.

## TABLE I.

### Weather Conditions

| Week ending | Rainfall in inches | No. of rainy days | Average rainfall per day Inches | Sunshine per week | | Average Sunshine per day | |
|---|---|---|---|---|---|---|---|
| | | | | Hrs. | Mins. | Hrs. | Mins. |
| 3-11-49 | 0.82 | 3 | 0.12 | 49 | 28 | 7 | 07 |
| 10-11-49 | 2.14 | 5 | 0.31 | 33 | 28 | 4 | 47 |
| 17-11-49 | 3.17 | 4 | 0.45 | 45 | 27 | 6 | 20 |
| 24-11-49 | 1.73 | 4 | 0.25 | 37 | 33 | 5 | 22 |
| 1-12-49 | 0.75 | 4 | 0.11 | 29 | 17 | 4 | 11 |
| 8-12-49 | 3.74 | 3 | 0.53 | 9 | 54 | 1 | 25 |
| 15-12-49 | 0 | 0 | 0 | 4 | 16 | 5 | 45 |
| 22-12-49 | 0.43 | 6 | 0.06 | * | 0 | * | 0 |
| 29-12-49 | 4.86 | 5 | 0.69 | 11 | 19 | 1 | 37 |
| Total 28-10-49 to 29-12-49 | 17.64 | 34 | 0.28 | 220 | 42 | 4 | 38 |

* Sunshine Recorder out of order.

For the 9 weeks during which spraying was continued there were 34 rainy days with an average of 0.28 inches rain a day.

At the termination of the experiment a row of tea in each plot was pruned and counts made of stem infection, leaf infection and dead shoots. The results are tabulated in Table II.

TABLE II.

Infections on pre-tipping growth.

| Treatment | Average infections per bush on stems | leaves | Average dead shoots per Bush |
|---|---|---|---|
| Blitox | 1.1 | 3.0 | 0.3 |
| Perenox | 0.6 | 2.5 | 0.1 |
| Unprotected | 12.6 | 168.5 | 2.0 |

Both fungicides gave excellent control of blister blight but there was no evidence of extra retention, and therefore better control, with either of the two preparations. To all practical intents and purposes they were equally good so far as may be ascertained on preliminary trials.

**Concentrated preparations.**

A preparation called Yellow Cuprocide said to contain 80 per cent of copper as against the more usual 50 per cent was compared with Perenox on tea in bearing. The Yellow Cuprocide was used at a concentration of 2½ ozs. per 10 gallons and Perenox at the normal rate of 4 ozs. to 10 gallons water.

TABLE III.

Percentage infection of flush and banji

| Pluck | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
|---|---|---|---|---|---|---|---|
| Yellow cuprocide | 18 | 5 | 21 | 16 | 11 | 15 | 4 |
| Perenox | 15 | 8 | 16 | 11 | 2 | 9 | 7 |
| Unprotected | 73 | 75 | 89 | 78 | 66 | 59 | 34 |

The degree of control between Perenox and Yellow Cuprocide is not significantly different but compared with the unprotected plot they both have very marked effects as shewn in Table III.

It is unlikely that the Institute will undertake further work on testing of copper fungicides unless a new preparation has some very desirable feature, such as a low price.

## II. Protection of Tea Recovering from Pruning.

The planning of any pruning programme should depend on a number of factors. Obviously, the chief criterion has to be crop returns and pruning for recovery during periods of short crops. Climatic conditions on Ceylon tea estates, vary so considerably that no hard and fast rule can be laid down for pruning in any one month. In the Dimbula area where both the North East and South West monsoons prevail, conditions are very different to those in the Uva district, where the South West monsoon does not occur. A careful study of crop returns is essential if the full benefits of spraying during recovery are to be obtained. As a guide, crop returns for the last ten years on St. Coombs are given in Table IV.

## TABLE IV.

### Crop Records

| Month | 1940 | 1941 | 1942 | 1943 | 1944 | 1945 | 1946 | 1947 | 1948 | 1949 | Average 1940/49 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 14507 | 16639 | 17002 | 18317 | 20310 | 14948 | 20907 | 30848 | 14625 | 15043 | 18315 |
| February | 9131 | 14965 | 17161 | 12189 | 16923 | 9172 | 18793 | 17868 | 16510 | 9559 | 14227 |
| March | 11998 | 10251 | 16715 | 7518 | 24646 | 6730 | 16379 | 28245 | 11807 | 9952 | 14424 |
| April | 8548 | 24222 | 23797 | 9681 | 19056 | 15752 | 31723 | 28014 | 19594 | 9424 | 18981 |
| May | 20422 | 23197 | 24511 | 23429 | 22818 | 35736 | 29876 | 29313 | 29192 | 29681 | 26818 |
| June | 16882 | 17241 | 15849 | 9848 | 17714 | 11742 | 14729 | 22194 | 19666 | 10706 | 15657 |
| July | 12730 | 12070 | 11608 | 10150 | 15992 | 19364 | 11989 | 16626 | 6087 | 13844 | 13046 |
| August | 13090 | 13309 | 10744 | 9713 | 11889 | 11469 | 15754 | 10280 | 16076 | 10356 | 12268 |
| September | 13243 | 11514 | 17580 | 13474 | 13513 | 17372 | 12556 | 14048 | 16690 | 18220 | 14846 |
| October | 18953 | 20432 | 16638 | 15568 | 15380 | 14991 | 22930 | 18080 | 21970 | 10394 | 17535 |
| November | 15988 | 22301 | 19917 | 17908 | 17101 | 23391 | 21880 | 23924 | 21184 | 21523 | 20562 |
| December | 19868 | 17432 | 21279 | 18592 | 19470 | 20646 | 17946 | 22692 | 14243 | 15951 | 18812 |
| Total | 175270 | 203573 | 212801 | 166187 | 214817 | 201813 | 235706 | 262132 | 207644 | 174653 | 205460 |

Obviously the best time to prune will be at the end of June as the lowest cropping season is from July to September, while November and December again are heavy cropping months.

Bud-break will, of course, depend on the type of pruning adopted, a clean prune taking about 6 weeks, while with a lighter prune bud-break will commence in about four week's time.

Another important factor is rainfall. Spraying during spells of heavy rain will give little protection, as the fungicide will be washed off before it has time to stick on the leaf surface. On St. Coombs, as the rainfall figures in Table V show, the months of May, June and July are periods of heavy rainfall during which time spraying may serve a very limited purpose. As bud-break, on bushes pruned at the end of June, will not commence till early August, heavy rainfall in July can cause no inconvenience as spraying would start only after bud-break.*

## TABLE V.

### Rainfall—St. Coombs Estate

| Month | 1940 | 1941 | 1942 | 1943 | 1944 | 1945 | 1946 | 1947 | 1948 | 1949 | Average 1940/49 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 0.04 | 1.97 | 3.15 | 1.09 | 1.98 | 0.14 | 2.35 | 3.72 | 4.27 | 3.37 | 2.20 |
| February | 3.65 | 2.13 | 1.82 | 0.96 | 4.86 | 0.45 | 1.78 | 1.32 | 0.06 | 0.49 | 1.75 |
| March | 1.35 | 5.70 | 5.97 | 1.75 | 8.93 | 3.43 | 6.96 | 6.41 | 5.36 | 1.74 | 4.76 |
| April | 5.41 | 10.16 | 5.27 | 4.11 | 4.54 | 7.58 | 7.96 | 3.99 | 10.13 | 8.29 | 7.04 |
| May | 27.39 | 27.52 | 7.03 | 28.08 | 12.15 | 2.35 | 2.57 | 7.36 | 10.01 | 6.95 | 13.14 |
| June | 14.34 | 10.51 | 15.97 | 20.96 | 7.48 | 11.52 | 8.73 | 6.65 | 16.79 | 11.07 | 12.40 |
| July | 8.14 | 8.87 | 23.14 | 18.33 | 6.89 | 8.80 | 7.97 | 4.86 | 14.21 | 10.80 | 11.20 |
| August | 7.62 | 13.80 | 10.47 | 8.10 | 2.24 | 10.27 | 16.05 | 26.25 | 4.81 | 9.41 | 10.90 |
| September | 5.26 | 8.20 | 8.92 | 12.70 | 5.69 | 4.27 | 11.42 | 8.60 | 2.62 | 8.07 | 7.57 |
| October | 6.74 | 11.64 | 8.54 | 9.16 | 16.93 | 10.48 | 7.56 | 13.22 | 7.44 | 10.73 | 10.24 |
| November | 10.35 | 10.20 | 3.51 | 9.21 | 10.95 | 10.92 | 7.48 | 3.12 | 6.50 | 8.40 | 8.06 |
| December | 3.34 | 3.28 | 8.00 | 10.23 | 4.52 | 3.60 | 10.52 | 5.58 | 6.82 | 7.34 | 6.32 |
| Total | 93.63 | 113.96 | 104.82 | 124.68 | 87.16 | 73.79 | 91.35 | 91.08 | 89.02 | 86.66 | 95.61 |

* These views have been modified by more recent experiments.—Ed.

During 1949 a small-scale experiment was carried out on St. Coombs on an area pruned on the 21st June. The plots, each of which contained six bushes, were randomised for four replications. Four plots were left unsprayed the other four being sprayed weekly with a copper fungicide at a concentration of 4 ozs. in 10 gallons of water. Spraying of the treated blocks commenced on 19th July, at the first sign of bud break, and continued till the bushes were ready for tipping at the end of September. The sprayed bushes recovered normally with almost a complete absence of stem infections while pre-tipping growth matured with only an occasional blister occurring on a few leaves. The unprotected bushes were a sorry contrast, as the shoots were repeatedly killed back by blister infections till about November, when brighter weather allowed new recovery. These unprotected plots were not ready for tipping till the end of January, 1950.

It has to be emphasised that this small scale experiment, though it indicated that spraying was very effective in controlling blister blight, must be repeated on a large scale to obtain fully reliable information. The rainfall on St. Coombs averages about 90 inches for the year. There are districts, badly infected with blister blight, in which the rainfall is over 150 inches. Treatments which are effective on St. Coombs may well be ineffective somewhere else. Large scale spraying operations involve many difficulties which can only be overcome by experience. That experience will be gained in the large scale programme arranged for this year, when selected estates in the Kotmale, Dimbula, Nanu Oya, Ramboda and Nuwara Eliya districts will conduct spraying trials during the south west monsoon.

In the Kotmale area, with an annual average rainfall of approximately 175 inches, the trials will be under the control of the Institute. An area of 200 acres will be pruned from the end of June onwards, while spraying with a copper fungicide will commence from bud-break and end at tipping. In the other areas, 30-50 acres will be pruned at the end of June. Though these trials will be under the supervision of the Superintendents of the Estates concerned, the Institute will remain in close touch with the work in progress.

Protection under north east monsoonal conditions has proved very successful. The area selected for an experiment was on an estate subject to heavy mists and low cloud, conditions ideally suited to blister blight attacks. A nine acre block was divided into three approximately equal plots one of which was left unprotected while the other two were sprayed at weekly and fortnightly intervals respectively. The fungicide used was Perenox at a concentration of 4 ozs. fungicide in 10 gallons of water. The area was pruned on 1st September and spraying operations commenced with bud-break on 10th October, continuing at the stated intervals until the plots were due for tipping at the end of December. This entailed 13 weekly spraying operations and 7 fortnightly applications, at a rate which ranged from 12-13 gallons per acre. The average cost per application was Rs. 2/- per acre, inclusive of the cost of labour and fungicide. This figure, however, does not include supervision and is averaged for a six hour working day. Under the conditions of the experiment the total cost of protection was Rs. 26/- per acre for the weekly application and Rs. 14/- per acre for fortnightly sprayings.

To facilitate transport and other arrangements spraying operations were scheduled for Monday in each week. Though no attempt was made to choose favourable weather conditions, it must be emphasised that every spraying date coincided with fine weather though rain and mist often persisted on other days in the week.

At the end of the experiment a count of bushes in the plots revealed that bush stand was irregular so the tipping weights have been corrected to give an average of 3,200 bushes to an acre. Table VI shows the harvested tippings at the end of the spraying trials. We are greatly indebted to Mr. Halliday, Superintendent of Uda Radella Estate, for the figures and to Messrs. Whittall & Company for granting permission to carry out the experiment.

TABLE VI.

| Tipping | Fresh weight of tippings in pounds | | | |
|---|---|---|---|---|
| | 1st | 2nd | 3rd | Total 3 tippings |
| Weekly sprayed area | 423 | 230 | 470 | 1123 |
| Fortnightly sprayed area | 284 | 288 | 497 | 1069 |
| Unprotected area | 148 | 256 | 376 | 780 |

Taking the total tippings of the unprotected plots as a basis for calculation, the weekly sprayed area gave 44 per cent more tippings while the fortnightly sprayed area showed a gain of 37 per cent. These figures though they give a very striking picture of the effect of spraying are not the complete story. There are fewer branches on the unsprayed bushes and those that remain appear to have a gormandizing effect. It is safe to assume that loss of crop will continue throughout the cycle, the beneficial effect of spraying being felt in crop returns for a very considerable time.

A spell of dry weather in November turned what would have been catastrophe, as far as the unsprayed plots were concerned, to a period when recovery was made possible. The Superintendent expressed the fear that the three acres of unsprayed tea in the control plot might be a total loss; the difference in recovery was then so obviously apparent.

While mist and rain persisted through October and early November, the weekly sprayed plots showed no evidence of stem infections while leaf blisters were very few and hard to find. On the fortnightly sprayed bushes, stem infections were fairly extensive while leaf blisters were numerous. On the unprotected bushes both stem and leaf infections were heavy. Defoliation was fairly heavy from petiole infections on the unsprayed bushes.

At the end of the experiment a count was made on 100 bushes in each plot to ascertain the number of dead shoots per bush.

| | Average number of dead branches per bush. |
|---|---|
| Unprotected ... | 11.83 |
| Weekly Sprayed area ... | 1.46 |
| Fortnightly Sprayed area ... | 5.83 |

## III. Protection of Tea in Plucking.

Very efficient protection of tea in plucking is possible with copper fungicides. If it were not for the undesirable feature of excessive copper residues in the manufactured tea, our problem of fungicidal protection would have been solved a considerable time ago. Our main efforts to find a suitable fungicide have, therefore, been directed to trial experiments with different organic preparations, which do not incorporate heavy metals as the main fungicidal agent. Many of these organic fungicides are specific against certain diseases and we hope that, in the not too distant future, a preparation will be formulated for efficient control of *Exobasidium vexans*. The preparations already tried out have been kindly supplied by manufacturers in the U.K. and U.S.A. where research on organic fungicides is being actively pursued.

The trials were of necessity on a small scale as many of the fungicides being in an experimental stage, were available only in very small quantities. The selected plots were all in one block and each treatment had 4-8 replications on a randomised basis. The total treatment in all cases covered 24 bushes. Perenox, a cuprous oxide fungicide, was selected as a standard against which the untried formulations were evaluated, while unprotected plots showed the infection level under the conditions in which the trials were conducted.

The rate of application was governed by the small hand spraying apparatus available, the actual volume being approximately 30 gallons to an acre. This application is about three times greater than that required for efficient protection with Perenox.

Before the trials were commenced the bushes were stripped of all blister susceptible material while spraying began immediately afterwards. The first pluck, in all cases, was discarded to avoid complications arising from infections on small buds prior to spraying operations. Normal plucking to a bud and two leaves was carried out on 10 day rounds.

For convenience in presentation, the results for the different materials tested are grouped together under the names of respective manufacturers —

### (a) Messrs. E. I. du Pont de Nemours & Co.'s Dithiocarbamate fungicides (U.S.A.)

TABLE VII.

Percentage infected flush and banji.

| Pluck | | | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|---|
| Unprotected | | | 64 | 34 | 35 | 37 |
| Fermate | 1 | lb/100 gallons water | 63 | 33 | 25 | 27 |
| ,, | 2 | ,, ,, | 60 | 37 | 19 | 34 |
| ,, | 4 | ,, ,, | 57 | 32 | 21 | 22 |
| Zerlate | 1 | lb/100 gallons water | 60 | 28 | 20 | 19 |
| ,, | 2 | ,, ,, | 51 | 24 | 20 | 20 |
| ,, | 4 | ,, ,, | 53 | 24 | 10 | 9 |
| Parzate | 1 | lb/100 gallons water | 42 | 23 | 13 | 20 |
| ,, | 2 | ,, ,, | 54 | 29 | 8 | 15 |
| ,, | 4 | ,, ,, | 53 | 31 | 3 | 3 |
| **Control** | | | | | | |
| Perenox | 2½ | lbs/100 gallons water | 7 | 2 | 3 | 0 |

TABLE VIII.

Average number of blisters on third leaf.

| Pluck | | | 2nd | 3rd | 4th |
|---|---|---|---|---|---|
| Unprotected | | | 2.13 | 0.76 | 1.03 |
| Fermate | 1 | lb/100 gallons water | 2.10 | 0.87 | 0.76 |
| ,, | 2 | ,, ,, | 3.10 | 0.69 | 1.00 |
| ,, | 4 | ,, ,, | 1.09 | 0.79 | 0.28 |
| Zerlate | 1 | lb/100 gallons water | 1.76 | 1.20 | 0.73 |
| ,, | 2 | ,, ,, | 1.07 | 0.81 | 1.10 |
| ,, | 4 | ,, ,, | 1.17 | 0.44 | 0.92 |
| Parzate | 1 | lb/100 gallons water | 1.23 | 0.85 | 0.18 |
| ,, | 2 | ,, ,, | 1.77 | 0.64 | 0.12 |
| ,, | 4 | ,, ,, | 0.89 | 0.29 | 0.11 |
| **Control** | | | | | |
| Perenox | 2½ | lb/100 gallons water | 0.05 | 0 | 0 |

**Fermate** — (Ferric dimethyldithiocarbomate). No control even at application rates of 4 lbs. to 100 gallons of water.

**Zerlate** — (Zinc dimethyldithiocarbomate). Control ineffective though on the 4th and 5th plucks 4 lbs./100 gallons of water application showed a lighter degree of infection, when compared with the unprotected plots. In comparison with Perenox, however, control is relatively poor.

**Parzate** — (Zinc ethylene bis dithiocarbomate). Obviously the best of the three as far as blister blight is concerned. The high concentration of fungicide necessary for light control in comparison with Perenox makes it too expensive and uneconomic.

Rainfall previous to 2nd and 3rd plucks approximated to conditions under which protection is normally required. Results in inclement weather show that protection during those periods is extremely poor.

## (b) Messrs. Rohm & Haas' Fungicides (U.S.A.)

### TABLE IX.

**Percentage infected flush and banji.**

| Pluck | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
|---|---|---|---|---|---|---|---|
| Unprotected | 73 | 75 | 89 | 78 | 66 | 59 | 34 |
| Arathane 1½ lbs/100 gals. water | 72 | 60 | 59 | 78 | 54 | 53 | 29 |
| Dithane ,, ,, | 73 | 69 | 64 | 73 | 42 | 50 | 27 |
| **Control** | | | | | | | |
| Perenox 2¼ lbs/100 gals. water | 13 | 8 | 16 | 11 | 2 | 9 | 7 |

### TABLE X.

**Average number of Blisters on third leaf.**

| Pluck | 3rd | 4th | 5th | 6th | 7th |
|---|---|---|---|---|---|
| Unprotected | 2.82 | 2.57 | 3.60 | 3. 4 | 2. 4 |
| Arathane 1½ lbs/100 gals. water | 2.78 | 1.72 | 1.85 | 3. 0 | 1. 3 |
| Dithane ,, ,, | 2.01 | 2.17 | 2.42 | 0.79 | 1. 2 |
| **Control** | | | | | |
| Perenox 2½ lbs/100 gals. water | 0.06 | 0.04 | 0.12 | 0.15 | 0.25 |

**Arathane** (Dinitrocapryl phenyl crotonate-CR1639) No Control.

**Dithane** (Zinc ethylene bis dithiocarbomate). The preparation is similar to Messrs. Du Pont de Nemours Parzate (See tables 7 & 8). At the concentration recommended by the manufacturers control is ineffective.

### (c) Messrs. Bayer Products Limited (U.K.)

Proprietary fungicidal dust — Botrilex. A preparation containing a chloronitrobenzene. Application rate about 18 lbs. per acre. The dust caused an extensive yellowing effect on the leaves which, however, passed off with the advent of rain.

TABLE XI.

Percentage of infected flush and banji.

| Pluck | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
|---|---|---|---|---|---|---|---|
| Unprotected | 56 | 53 | 83 | 85 | 47 | 56 | 24 |
| Botrilex | 23 | 37 | 64 | 69 | 29 | 22 | 22 |
| **Control** | | | | | | | |
| Perenox 2½ lbs/100 gals. water | 5 | 3 | 4 | 6 | 1 | 6 | 2 |

TABLE XII.

Average number of blisters on third leaf.

| Pluck | 3rd | 4th | 5th | 6th | 7th |
|---|---|---|---|---|---|
| Unprotected | 1.60 | 1.27 | 1.48 | 0. 9 | 1. 5 |
| Botrilex | 0.69 | 0.75 | 1.36 | 1. 2 | 0.79 |
| **Control** | | | | | |
| Perenox 2½ lbs/100 gals. water | 0,03 | 0.11 | 0 | 0 | 0 |

The degree of control is far too light for efficiency. The rate of application, as a dust, makes economic dusting improbable.

### (d) Messrs. Plant Protection Limited (U.K.) Organic fungicides.

TABLE XIII.

Percentage infection flush and banji.

| Pluck | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
|---|---|---|---|---|---|---|---|
| Unprotected | 33 | 55 | 35 | 76 | 45 | 17 | 37 |
| Shirlan AG ½ per cent | 26 | 39 | 38 | 61 | 38 | 18 | 27 |
| 1 ,, | 48 | 38 | 20 | 62 | 26 | 7 | 31 |
| 2 ,, | 38 | 38 | 24 | 45 | 23 | 15 | 26 |
| 4 ,, | — | — | — | 33 | 18 | 4 | 8 |
| **Control** | | | | | | | |
| Perenox 2½ lbs/100 gals. water | 5 | 7 | 8 | 14 | 6 | 0 | 3 |

## TABLE XIV.

Average number of blisters on the third leaf.

| Pluck | 3rd | 4th | 5th | 6th | 7th |
|---|---|---|---|---|---|
| Unprotected | 1.91 | 2.00 | 2.00 | 0.57 | 0.38 |
| Shirlan AG ½ per cent | 1.39 | 0.54 | 1.48 | 1.0 | 0.23 |
| 1 ,, | 1.39 | 0.81 | 1.55 | 0.49 | 0.19 |
| 2 ,, | 1.34 | 0.59 | 1.21 | 0.76 | 0.63 |
| 4 ,, | — | — | 0.63 | 0.93 | 0.09 |
| **Control** | | | | | |
| Perenox 2½ lbs/100 gals. water | 0.13 | 0.03 | 0.10 | 0.10 | 0 |

Shirlan (50% salicylanilide strength). Very light control at 4% concentration, but even then far inferior to Perenox. Can never be of economic value.

## TABLE XV.

Percentage infection of flush and banji.

| Pluck | 2nd | 3rd | 4th | 5th | 6th | 7th |
|---|---|---|---|---|---|---|
| Unprotected | 55 | 35 | 76 | 45 | 17 | 37 |
| T.M.T.D. ½ per cent | 48 | 22 | 51 | 16 | 22 | 22 |
| 1 ,, | 34 | 12 | 35 | 9 | 3 | 12 |
| 2 ,, | 28 | 11 | 23 | 7 | 2 | 4 |
| 4 ,, | 20 | 7 | 18 | 7 | 1 | 2 |
| **Control** | | | | | | |
| Perenox 2½ lbs/100 gals. water | 7 | 8 | 14 | 6 | 0 | 3 |

## TABLE XVI.

Average number of blisters on third leaf.

| Pluck | 2nd | 3rd | 4th | 5th | 6th |
|---|---|---|---|---|---|
| Unprotected | 1.91 | 2.00 | 2.00 | 0.57 | 0.38 |
| T.M.T.D. ½ per cent | 1.11 | 0.82 | 0.82 | 0.74 | 0.14 |
| 1 ,, ,, | 0.66 | 0.33 | 0.38 | 0.25 | 0.11 |
| 2 ,, ,, | 0.43 | 0.42 | 0.91 | 0.14 | 0.04 |
| 4 ,, ,, | 0.43 | 0.13 | 0.43 | 0.05 | 0.17 |
| **Control** | | | | | |
| Perenox 2½ lbs/100 gals. water | 0.13 | 0.03 | 0.10 | 0.10 | 0 |

TMTD (Tetra methyl thiuram disulphide), showed a decided control above 1% concentration. At 4% concentration it appears as efficient as Perenox. The amount of TMTD required per acre at that strength is, however, extremely heavy — nearly 15 lbs. per acre is used compared with about ½ lb. of Perenox.

### (e) Messrs. Vitax Fertilisers Limited (U.K.) — Vitospor fungicide dust.

This preparation contains the following —

10 per cent copper oxychloride
1—5 per cent copper 8-quinolinolate
60 „ „ green sulphur
05-1 „ „ tricresyl phosphate, which it is stated gives the formulation greatly enhanced activity.

TABLE XVII.

Percentage of infected flush and banji.

| Pluck | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
|---|---|---|---|---|---|---|---|
| Unprotected | 81 | 73 | 67 | 60 | 25 | 68 | 39 |
| Vitospor Dust | 11 | 2 | 3 | 4 | 0 | 10 | 4 |
| **Control** | | | | | | | |
| Perenox 2½ lbs/100 gals. water | 16 | 3 | 3 | 4 | 0 | 4 | 0 |

TABLE XVIII.

Average number of blisters on third leaf.

| Pluck | 3rd | 4th | 5th | 6th |
|---|---|---|---|---|
| Unprotected | 2.3 | 2.6 | 1.20 | 1.10 |
| Vitospor Dust | 0.08 | 0.12 | 0.01 | 0.01 |
| **Control** | | | | |
| Perenox 2½ lbs/100 gallons water | 0.06 | 0.03 | 0.02 | 0.07 |

Vitospor, as already stated, incorporates 10 per cent of copper oxycloride in its formulation. At the rate of application of 18 lbs. dust to an acre approximately 1.8 lbs. of copper oxychloride is deposited on the leaves. We know that ½ lb. of Perenox will give effective control so the possibility remains that the copper oxychloride may be the controlling agent. We have now received a copper 8-quinolinolate formulation which does not incorporate the copper oxychloride and tests in the coming south west monsoon will give an answer as to whether the quinolinolate by itself will give the desired result. Vitospor in the United Kingdom costs approximately 60 cents a pound. Even at that price the fungicide used per acre will cost over Rs. 10/-, — without application costs — a figure too high for economic dusting.

### (f) Messrs. Robinson Bros (U.K.) — Calcium thioglycollate formulation (wet spray).

## TABLE XIX.

**Percentage infected flush and banji.**

| Pluck | 2nd | 3rd | 4th |
|---|---|---|---|
| Unprotected | 18 | 54 | 30 |
| Calcium thioglycollate ½ per cent | 8 | 24 | 15 |
| Do 1 ,, ,, | 17 | 36 | 26 |
| Do 2 ,, ,, | 12 | 42 | 24 |
| Do 4 ,, ,, | 14 | 54 | 20 |
| **Control** | | | |
| Perenox 2½ lbs/100 gallons water | 2 | 1 | 1 |

To summarise, we have so far been unsuccessful in our attempts to find a suitable organic fungicide which will give adequate protection at an economic rate. Third leaf infections are a very important criterion of fungicide efficiency as a blister average of even 0.5, per third leaf, would increase the spore population in the air to such an enormous extent, that resulting infections could be very considerable. With normal plucking, the third leaf remains on the bush so that infections mature and so constitute a potential spore reservoir. A fungicide to be effective should be capable of keeping the blister average per third leaf, below 0.1.

**Copper spraying of tea in plucking.**—In experiments on St. Coombs we have seen the decided advantage in the control of blister blight if tea in plucking is sprayed with a copper fungicide (Perenox). The experimental area which was pruned in December 1948 is divided into four blocks, each of which consists of three plots with the following treatments:— (a) Weekly sprayings, (b) fortnightly sprayings, (c) unprotected. A plot consists of two rows, each of 50 bushes. Two guard rows were allowed to grow up untouched as protection against spray drift between treatments.

The 4 replications of each treatment, therefore, gives an area of approximately one eighth of an acre. Plucking conformed to the normal estate practice of removing a bud and two leaves at nine day intervals. Spraying of the treated plots is done with a very fine nozzle which gives an approximate application range of 8-10 gallons to an acre, of a suspension of 4 ozs. Perenox in 10 gallons of water. Applications of the fungicide is made irrespective of weather conditions, spraying often being done during rain. When the experiment started on 23rd May, blister infection was nil following the long drought experienced in the early months of 1949. The advent of the monsoon on May 9th showed its effect on 24th June when flush infections were as follows—

Weekly sprayed plots — 7 per cent infected.

Fortnightly sprayed plots — 16 per cent infected.

Unprotected plots — 85 per cent infected.

There was, however, no appreciable loss in crop till the plucking on 23rd July from which time till the end of December the unsprayed plots showed diminished crop returns when compared with the sprayed areas.

## TABLE XX.

| Treatment | Crop harvested (expressed in pounds, dry weight per acre). | Percentage increase in crop. |
|---|---|---|
| Unprotected | 82.20 | — |
| Weekly sprayed | 103.58 | 26 |
| Fortnightly sprayed | 102.50 | 25 |

The very slight difference in crop returns between the weekly and fortnightly applications suggest that under normal estate procedure fortnightly applications are sufficient.

A study of the following table of flush infections and blister incidence on the 3rd leaf (normally left on the bush) clearly demonstrates differences between the treatments.

## TABLE XXI.

### Percentage flush infections and blister incidence on third leaf of bushes in plucking

| Plucking No. | Flush infections percentage of total flush | | | Average number of blisters on the third leaf | | |
|---|---|---|---|---|---|---|
| | Weekly spray | Fortnightly spray | Unprotected | Weekly spray | Fortnightly spray | Unprotected |
| 1 | 0 | 0 | 0 | — | — | — |
| 2 | 0 | 0.25 | 8.5 | — | — | — |
| 3 | 0.25 | 0.8 | 6.7 | — | — | — |
| 4 | 7.25 | 16.0 | 85.0 | — | — | — |
| 5 | 4.75 | 38.80 | 83.3 | 0.23 | 1.07 | 4.90 |
| 6 | 6.5 | 9.6 | 45.2 | 0.05 | 1.0 | 4.60 |
| 7 | 10.3 | 21.0 | 68.3 | 0.07 | 1.10 | 5.20 |
| 8 | 0.3 | 1.5 | 17.6 | — | — | — |
| 9 | 3.0 | 22.5 | 61.2 | — | — | — |
| 10 | 0.5 | 17.5 | 47.3 | — | — | — |
| 11 | 0.5 | 1.5 | 13.8 | 0 | 0.11 | 0.54 |
| 12 | 6.8 | 36.5 | 71.5 | 0.02 | 0.10 | 0.81 |
| 13 | 5.3 | 17.3 | 49.0 | 0.06 | 0.42 | 1.88 |
| 14 | 10.0 | 43.0 | 80.5 | 0.08 | 0.57 | 3.43 |
| 15 | 3.3 | 15.0 | 66.8 | 0.08 | 0.43 | 2.09 |
| 16 | 0.8 | 6.5 | 18.0 | 0.05 | 0.17 | 0.59 |
| 17 | 4.8 | 29.0 | 61.5 | 0.06 | 0.56 | 1.40 |
| 18 | 4.8 | 17.0 | 39.5 | 0.06 | 0.29 | 1.10 |
| 19 | 5.5 | 13.0 | 32.8 | 0.10 | 0.18 | 0.53 |
| 20 | 1.0 | 9.3 | 17.0 | 0.03 | 0.16 | 0.46 |
| 21 | 2.0 | 7.3 | 22.0 | 0.02 | 0.12 | 0.37 |
| 22 | 0.8 | 8.3 | 17.3 | 0.02 | 0.12 | 0.28 |
| 23 | 2.3 | 2.0 | 9.8 | 0 | 0.15 | 0.33 |
| 24 | 0 | 0.2 | 0.8 | 0.02 | 0.18 | 0.76 |

The blister incidence on the 3rd leaf gives a good indication of the number of blisters per bush and the potential spore production. Since one blister can produce millions of spores, spore formation can assume gigantic proportions if the incidence is over 0,5 per third leaf. When the blister incidence is between 3 and 5 per leaf unfavourable weather will cause heavy infections on flush and young stems.

This experiment will continue for a complete cycle at the end of which reliable data on the correlation between infections and epidemic attacks should become available and should indicate when spraying is desirable.

## Spray Residues.

The amount of residue left by spraying with copper fungicides is being investigated by the Biochemistry Department.

Until more data are available estates should not under any circumstances spray tea in bearing.