SOME STUDIES ON TOBACCO DISEASES IN CEYLON—V

THE USE OF FUNGICIDES IN THE CONTROL OF DAMPING-OFF OF TOBACCO SEEDLINGS

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ELABORATE methods of pre-treatment of seed-bed soil are usually employed in the control of damping-off in tobacco seedlings. In an experiment recorded in the first number of this series (Park & Fernando, 1937), it was observed that one of the incidental effects of a nursery spray programme directed against frog-eye of tobacco seedlings, was the almost complete control that this spraying provided against damping-off (*Pythium* sp.). It was felt that a spray programme of this type which functioned against more than one major disease was of considerable value in nursery practice. The present communication presents the damping-off data in a second nursery experiment designed primarily for frog-eye control.

DESIGN OF EXPERIMENT

The experiment was laid out in the form of six randomized blocks of four plots each. The following four treatments were randomized within each block :—

1. Weekly spraying with colloidal copper.
2. Weekly spraying with salicylanilide.
3. Weekly dusting with copper-lime dust.
4. Untreated control.

The experiment was laid down at the Experiment Station, Ganewatta, during the 1938 *maha* season. There were six nursery beds each measuring 50 by 4 feet. Each bed functioned as a block and was partitioned crosswise into four plots measuring $12\frac{1}{2}$ by 4 ft. In the collection of data, a six inch border was

rejected on either side of the partitions and at the two ends of the beds ; the net area contributing data in each plot was hence 46 square feet. The arrangement of rectangular plots end-on in a block is admittedly not the best for experimental purposes, but this could not be avoided as wider beds would have interfered with weeding and other cultural operations.

EXPERIMENTAL MATERIAL AND METHODS

Preparation of nurseries.—A part of the rotation area of the station that had not carried nurseries in the immediate past, was selected. The soil was a light brown, sandy loam. The area was levelled and well-rotted farmyard manure was applied at the rate of seven baskets per twenty square yards on August 22, 1938. Brushwood was piled on the area which was then burnt on August 24. The area was divided up into beds measuring 50 by 4 feet with 2 feet alleys between beds which were raised about one foot above the level of the surrounding land to allow free drainage. The surface soil was again burnt with brushwood on August 28 but no tobacco trash was used in either of the burnings. Six baskets of compost were added to each bed on August 30, and to every twenty square yards of nursery bed the following fertilizer mixture was applied two days before sowing :—

	lb.
Superphosphate	1
Nitrate of soda	½
Sulphate of potash	½

The nursery technique outlined above is the routine practice in tobacco stations in Ceylon, a fuller account of which is given by Livera (1935).

Sowing of nurseries.—The seed was obtained from selected Harrison's Special plants from the *maha* crop, 1937–38. The capsules were derived from flowers that had been selfed under bags. Each nursery bed was sown with one tablespoonful of seed which was mixed with sand at the rate of one quart to every teaspoonful of seed for the purpose of uniform distribution. The dates of sowing of the experimental beds were as follows :—

Beds (Blocks)	Sowing date
1 and 2 ..	.. September 17, 1938
3 and 4 ..	.. September 24, 1938
5 and 6 ..	.. October 1, 1938

The sowing dates were separated by intervals of one week. The seedlings were protected against tobacco stem-borer (*Pthorimaea heliopa* Lower.) by a cheese-cloth cover over each bed, above which was constructed a cadjan shade. The beds

were watered twice a day, *viz.*, at 7 A.M. and at 3.30 P.M. The cheese-cloth cover was removed prior to the first watering, and was not put back till the completion of the second watering.

*Composition of the fungicides.**—

1. *Colloidal copper.*—The following spray formula was used:—

Proprietary colloidal copper	..	1 oz.
Proprietary spreader	..	1/16 oz.
Water ..	..	1 gallon

The colloidal copper and the spreader used in the above formula are identical with those adopted in the 1937 and 1938 experiments (Park and Fernando, 1937 (*a*) and (*b*) and 1938). This colloidal copper is a proprietary fungicide containing 22 per cent. copper oxychloride, 50 per cent. water and 28 per cent. of an organic complex (Jacquemain & Gravier, 1932). The spreader is a proprietary preparation having a composition allied to a sulphonate of an alkylated hydrocarbon.

2. *Salicylanilide.*—This is a proprietary product containing 25 per cent. salicylanilide, 10 per cent. of an emulsifier and wetter and 65 per cent. water (Cunningham, 1935). The product was used at a concentration of $\frac{1}{2}$ ounce per gallon at the first spraying, and at 1 ounce per gallon for all subsequent sprayings.

3. *Copper-lime dust.*—A proprietary dust consisting of powdered copper sulphate and hydrated lime, was employed.

Application of the fungicides.—Spray applications were made with a two-gallon knapsack sprayer working under a pressure of 75 lb. per square inch. The spray lance carried an angle-bend fitted to a single nozzle which delivered the spray in the form of a finely-divided mist. The dust was applied with a small hand bellows. During the spraying and dusting operations the drift of spray and dust to adjacent plots was checked by the use of jute hessian screens. As stated above, the fungicides were applied at approximately weekly intervals. The applications were made in the early morning or in the late afternoon.

RESULTS

The beds showed some degree of difference in density of stand. Conditions within beds were, however, more uniform, and it may be assumed that within any bed, the percentage emergence per unit area was approximately the same for the

* The regulations of the Department of Agriculture, Ceylon, do not permit of the names of any proprietary fungicides being mentioned in Departmental publications, but the information will be supplied to those desiring it in private communication.

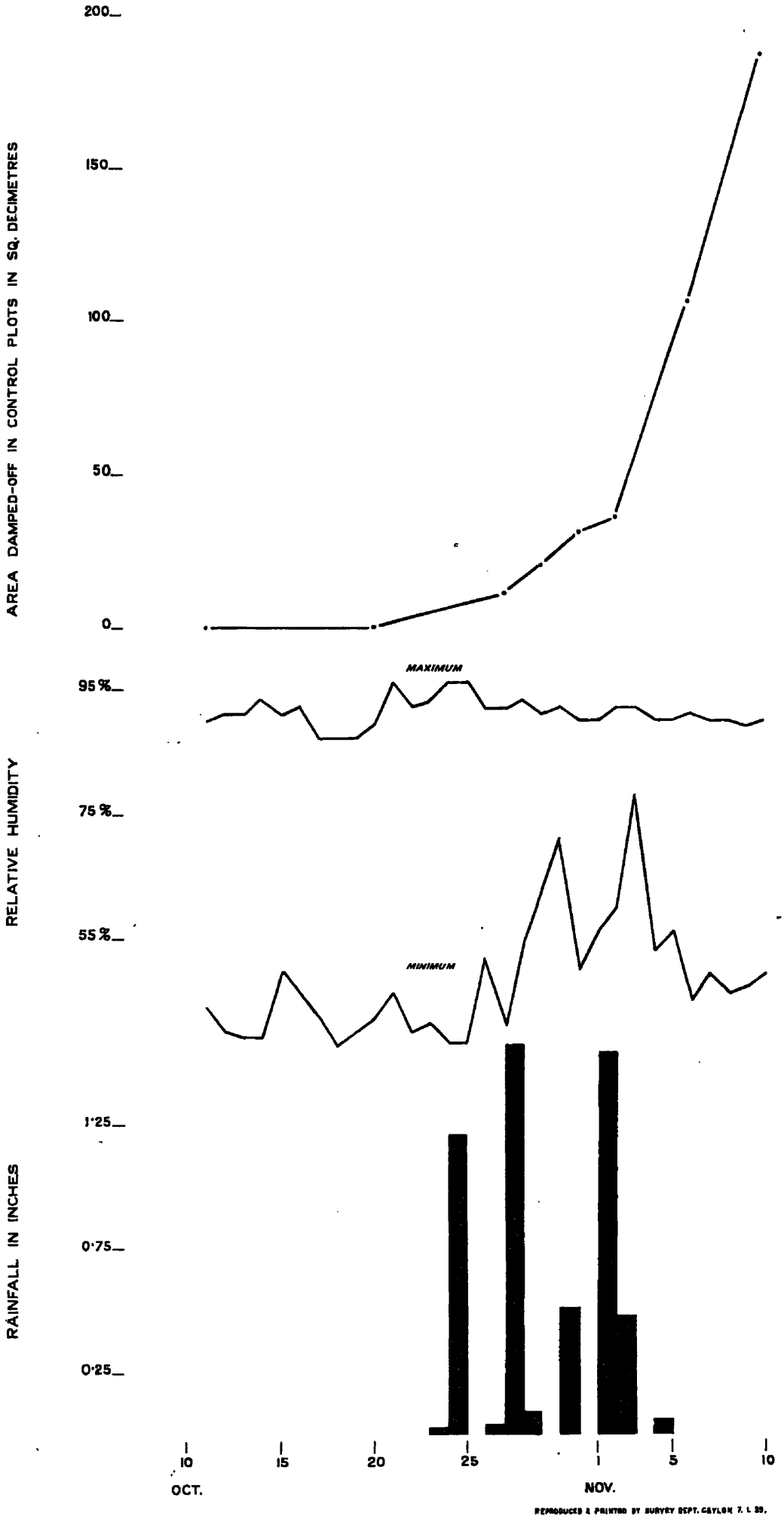

FIG. I.—COURSE OF DAMPING-OFF INFECTION WITH RELEVANT METEOROLOGICAL DATA.

various treatments. The numbers of damped-off seedlings in plots subjected to the various treatments would accordingly provide an estimate of the efficacy of the treatments. Damped-off seedlings, however, tended to disintegrate into a soft mush under conditions of excessive humidity such as prevailed after watering the beds in the evening and covering them over with cheese-cloth overnight. Only an approximate count of such seedlings is thus possible. Another disturbing factor was the occasional, inadvertent removal of damped-off seedlings by labourers. As the beds were very thickly sown, it was felt that if the assumption that within any bed the percentage emergence per unit area was approximately the same for the various treatments, was valid, the areas of soil surface exposed by the removal of damped-off seedlings would provide a more reliable and a more easily recorded estimate of the intensity of the disease than a count of damped-off seedlings. The fact that the variate in this record of damaged areas of seed-bed is distributed normally and hence lends itself to a straightforward analysis of variance, is a further incidental consideration; the counts of diseased seedlings constitute asymetric distributions of the binomial or the Poisson type and should undergo transformation into a square root, inverse sine or logarithmic scale before they can be profitably subjected to an analysis of variance (Cochran, 1938).

Table 2 presents records made on various dates of the total numbers of damped-off seedlings and the total areas of seed-bed damaged by the disease in the different treatments. The values for the control plots are plotted in Fig. 1. Table 3 gives the analysis of variance of the record of damaged areas made on November 10.

Relevant meteorological data are also presented in Fig. 1.

PHYTOCIDAL EFFECTS

All the fungicides produced a certain amount of spray injury of the leaves. The damage caused by the colloidal copper and the copper-lime dust was inappreciable. Small heaps of the dust round the collars of the seedlings did not appear to affect their growth markedly. Spraying with salicylanilide, on the other hand, resulted, in some instances, in severe leaf-scorch.

DISCUSSION

The incidence of damping-off in the experimental beds was abnormally high consequent on the dense seedling stand. In one instance the damaged area amounted to 20·3 per cent.

of the whole extent of the plot. The number of centres of infection in a plot rarely exceeded 5. Individual centres were, however, of considerable extent.

The first appearance of damping-off in the nurseries followed closely on the beginning of the rains. The summation curve of infection in control plots is given in Fig. 1, and appears to be logarithmic. If, however, the records had been continued, the final curve might, possibly, have presented a sigmoid form.

The value of F for treatments in the analysis of variance recorded in Table 2, passes the five per cent. point and the effect of the application of fungicides may therefore be considered significant. The high degree of heterogeneity of infection resulted in an extremely large experimental error, but the performance of colloidal copper was significantly better than that of salicylanilide. Salicylanilide and the copper lime dust did not produce significant control.

As previously reported by Park and Fernando (1937) weekly spraying with colloidal copper provides almost complete control of damping-off. A separate area of the nursery consisting of three beds was subjected to a weekly spraying with the colloidal copper compound. The cost of spraying tallied with the previous estimate of Park and Fernando who obtained a figure of 15 cents for spraying an area for supplying sufficient seedlings for planting one acre. Taking the cost of labour and depreciation on spraying apparatus into account, the total amount works out at less than 20 cents.

SUMMARY

A nursery experiment designed primarily for frog-eye control of tobacco seedlings at the Experiment Station, Ganewatta, provided certain data which are presented in this paper, on the control of damping-off. Three proprietary fungicides applied weekly were compared with a control, the randomized block lay out being adopted.

The results showed that weekly spraying with the colloidal copper compound gave almost complete control of damping-off, while the other two fungicides produced no significant control. The total cost of spraying with the colloidal copper fungicide, including labour and depreciation, was estimated to be less than 20 cents for an area of nursery sufficient for planting one acre.

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FIG. II.—DUSTING IN TOBACCO NURSERIES.

FIG. III.—SPRAYING IN TOBACCO NURSERIES.

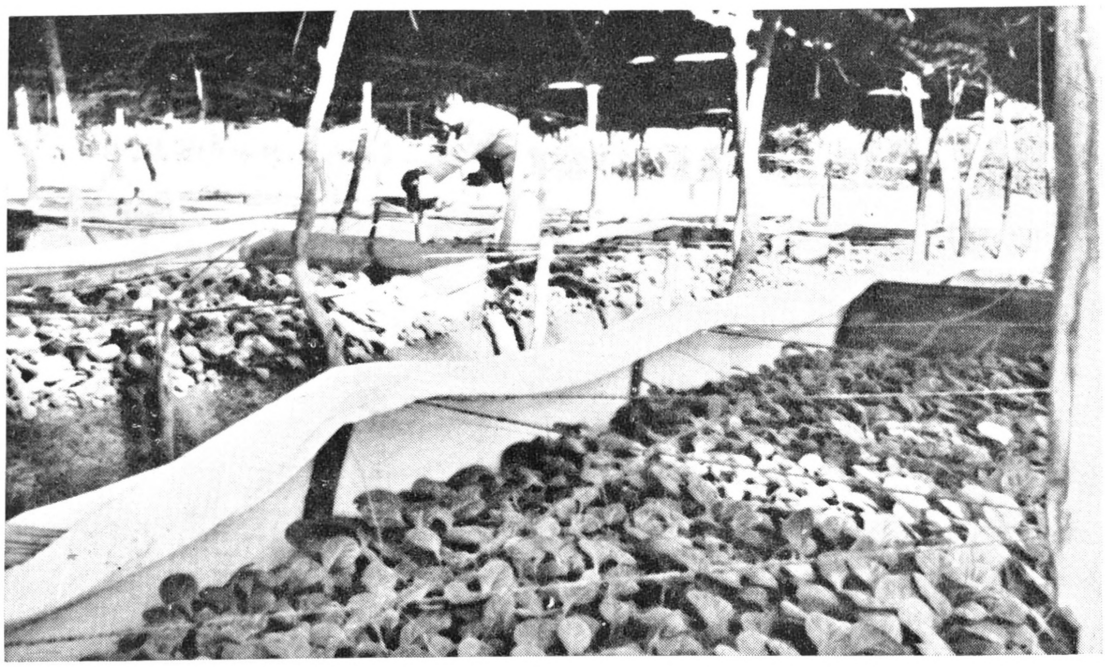

FIG. IV.—GENERAL VIEW OF TOBACCO NURSERIES.

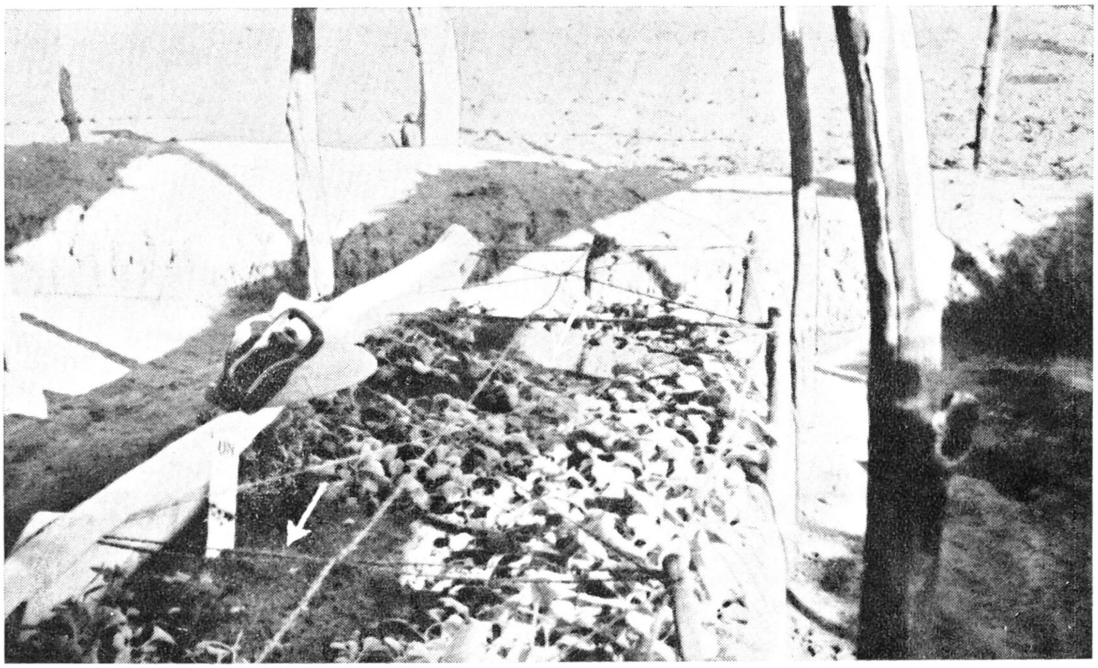

FIG. V.—ILLUSTRATING EXTENT OF DAMAGE BY DAMPING-OFF IN TOBACCO NURSERIES: ARROWS INDICATE AREAS OF SOIL SURFACE EXPOSED BY REMOVAL OF DAMPED-OFF SEEDLINGS.

TABLE 1.

Dates of application of fungicides	Time of application	Average size of leaves in nurseries	Quantities of spray fluid used per 200 sq. feet of nursery	Quantities of dust used per 200 sq. feet of nursery	Remarks
1. October 6, 1938	10 A.M.–10.45 A.M.	1 × 1 cm. (beds 1 and 2)	1½ gallons	2⅜ oz.	Only beds 1 and 2 sprayed and dusted
2. October 11	3.45 A.M.–5 P.M.	2 × 2·5 cm. (beds 1 and 2) 0·7 × 0·7 cm. (beds 3 and 4)	—	2⅜ oz. (beds 1 and 2) 1¼ oz. (beds 3 and 4)	Only beds 1–4 sprayed and dusted
3. October 20	—	2·6 × 3·4 cm. (beds 1 and 2) 1·1 × 1·1 cm. (beds 3 and 4) 0·6 × 0·7 cm. (beds 5 and 6)	2 gallons (beds 1–6)	2⅜ oz. (beds 1 and 2) 2 oz. (beds 3 and 4) 1½ oz. (beds 5 and 6)	All beds sprayed and dusted
4. October 27	—	5·2 × 8·0 cm. (beds 1 and 2) 5·2 × 5·6 cm. (beds 3 and 4) 1·5 × 1·6 cm. (beds 5 and 6)	2⅜ gallons (beds 1–6)	2⅜ oz. (beds 1–6)	All beds sprayed and dusted. Damping-off first observed
5. November 2	9 A.M.–10 A.M.	—	2⅜ gallons (beds 1–6)	1⅜ oz. (beds 1–6)	All beds sprayed and dusted

TABLE 2.

Date of record	October 27		October 29		October 31		November 2		November 6		November 10
Treatments	No. of plants damped-off	Area damped-off in sq. cm.	No. of plants damped-off	Area damped off in sq. cm.	No. of plants damped-off	Area damped off in sq. cm.	No. of plants damped-off	Area damped off in sq. cm.	No. of plants damped-off	Area damped off in sq. cm.	Area damped-off in sq. cm.
1. Colloidal copper	0	0	0	0	4	3	11	23	11	23	121
2. Salicylanilide	17	229	54	452	156	772	462	1,837	1,517	9,557	13,316
3. Copper lime dust	13	154	98	420	360	1,968	655	3,519	1,152	7,108	8,676
4. Control	65	1,168	184	2,051	479	3,142	687	3,608	1,489	10,616	18,756

TABLE 3.

Analysis of Variance of Record of Damped-off Areas made on November 10, 1938.

	D. F.	Sum of squares	Variance	F	5 per cent. point.	1 per cent. point
Blocks	5	2741·5				
Treatments	3	3102	1034·0	3·7	3·29	5·42
Error	15	4114·4	274·3			
Total	23	9958				

Standard error : 16.6

	Colloidal copper	Copper-lime dust	Salicylanilide	Control	General Mean	Significant Difference
Mean area damped-off per plot in sq. decimetres	0·17	14·5	22·17	31·17	17·0	20·38

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