
EXPERIMENTS ON THE FUNGICIDAL CONTROL OF LATE BLIGHT OF POTATO

II. Some aspects on improvement of the field control of epiphytotics

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IN the first paper of this series the results of evaluations of fungicides on the control of late blight epiphytotics of potato have been discussed. The present paper deals with experiments on improvement of the efficiency of controlling natural epiphytotics of late blight ; the experiments were planned with the following objectives in view :

1. Reduction in the concentration of the fungicide and decreasing the frequency of spray application.
2. Addition of stickers to the spray to improve the tenacity of the fungicide under conditions of heavy rainfall.
3. Reduction in the quantity of the spray by application to the minimum of plant surface required to obtain economic control of the disease.
4. Search for more economical and effective carbamate fungicides

Experiment I: Effect of varying dosage of the fungicide and frequency of spray application on the control of late blight

The trial was conducted at the Livestock Farm, Bopatalawa in the 1957 Yala season. The rainfall was unusually heavy in the test area during the latter stages of the crop, a critical period for the development and spread of *Phytophthora infestans* ; The rainfall recorded during the last 45 days of crop growth was as heavy as 21.25 inches.

The variety Duke of York which is reputed for its extreme susceptibility to late blight infection was planted in furrows to which the following pre-planting manurial and fertilizer mixture had been

added; sulphate of ammonia, Conc. superphosphate, and muriate of potash in the proportion of 4, 2½ and 1 cwt. per acre and farmyard manure applied at 10 tons to an acre.

The experiment took the form of a randomized block with a plot size of 20' × 20'; the treatments were replicated three times. A commercial fungicide based on zinc ethylene bisdithiocarbamate was applied at dosages of 0.5, 1.0, 1.5 and 2.0 lb. in 100 gallons of water and at frequencies of 3, 6, 9, 12 and 15 days. The method of spray application and disease assessment reported earlier (Abeygunawardena, D. V. W., and Peiris, J. W. L., 1958), were adopted in the present investigation.

The tuber yield and the fungicidal efficacy ratings, meaning the per cent of foliar disease, are shown in table 1.

TABLE I

Effect of dosage of fungicide and frequency of spraying on the extent of foliar disease and tuber yield

Frequency of Spraying in days	Dosage of fungicides							
	0.5lb/100 gals.		1lb/100 gals.		1.5lb/100 gals.		2lb/100 gals.	
	Mean% disease	Yield in tons/ acre	Mean% disease	Yield in tons/ acre	Mean% disease	Yield in tons/ acre	Mean% disease	Yield in tons/ acre
3	26.6	1.86	10.3	2.14	2.3	2.69	2.3	3.06
6	88.3	1.67	88.3	1.34	50.0	1.70	50.0	2.12
9	88.3	1.65	95.0	1.33	81.6	1.59	66.6	2.96
12	96.6	1.68	96.6	1.49	95.0	1.63	90.0	1.61
15	96.6	1.36	98.3	1.49	95.0	1.65	96.6	1.66

Unsprayed control—1.36 tons per acre.

The tuber yield is largely dependent upon disease control. The trends for foliar disease and tuber yield are remarkably striking. Maximum disease control and as a consequence maximum yield was obtained with a dosage of 2 lb. of the fungicide in 100 gallons of water giving an increase of about 54 per cent of tuber weight over the unsprayed check plot; the extents of disease control and tuber yield decreased progressively with the decrease in concentration of the fungicide. The difference between dosages of 1.0 and 0.5 lb. was non significant whereas the dosage of 1.5 lb. was significantly more effective than 1.0 and 0.5 lb. In regard to the frequency of spraying, a three day interval of spraying was distinctly superior to any other longer interval in the case of all dosages except the lowest dosage. With

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a 3 day interval of spraying the efficacy of disease control increased with the increase of dosage of the fungicide. Thus, under conditions of the experiment, maximum yield and disease control was obtained with a 3 day frequency of spray application at a dosage of 2 lb. in 100 gallons of water.

Experiment II: *Effect of varying dosage of fungicide and sticker on the extent of Late Blight Control*

Tenacity of the spray deposit is an important factor which determine the field performance of any protective fungicide. In heavy rainfall the fungicide applied to the leaf surface is rapidly leached thereby necessitating the increase in dosage and frequency of spray application. In the present investigation the efficiency of stickers in the fungicidal spray was evaluated to ascertain the suitable quantities of fungicide and sticker which would give maximum disease control.

The fungicide zinc ethylene bisdithiocarbamate and the commercial sticker "Tenac" and "Albolinium" were mixed in varying proportions and sprayed at weekly intervals. The experiment was set down at Rahangala. The design of the trial was of the usual randomized block type replicated 4 times and with a plot size of 15' X 14'. The variety Great Scot was used and planting was delayed in order to subject the trial to the heavy rains in April. The results are given in Table 2.

TABLE II
Effect of varying dosage of fungicide and sticker on disease control

<i>Dosage of fungicide lbs/100 gals.</i>	<i>Concentration of sticker</i>	<i>Yield in tons per acre Tenac</i>	<i>Yield in tons per acre Albolinium</i>			
0	..	0.2	..	3.00	..	2.9
0.5	..	0.15	..	4.23	..	3.94
1.0	..	0.1	..	4.70	..	4.37
1.5	..	0.05	..	5.58	..	4.81
2.0	..	0.0	..	5.51	..	5.80
Unsprayed Control—3.61 tons per acre.						

The analysis shows a highly significant linear response. The efficacy of treatment increased progressively with the increase in concentration of the fungicide, the two stickers showing similar trends. The sticker "Tenac" has given a yield of about 10 per cent more than Albolinium.

Experiment III: Extent and Control of Infection by *Phytophthora infestans* on Upper and Lower leaf surface of Potato

Bjorkling K and Sellgren K. A. (1955) reported that in mild attacks of *Phytophthora infestans* there were about 7 or 8 times as many infections on the upper surface as on the lower surface of leaves. The possible control of late blight by coating the upper surface only with the fungicide, thereby reducing the quantity of spray used, was ascertained in a field investigation carried out at Rahangala. The results of the trial are summarised in Table 3.

TABLE III
Effect of leaf surface sprayed on the extent of disease control

<i>Treatment</i>	<i>%Disease</i>	<i>Yield tons/acre</i>
Upper leaf surface sprayed ..	96	4.68
Both leaf surfaces sprayed ..	72	6.67
Unsprayed check ..	100	4.12

The treatments gave a yield significantly superior to the unsprayed check. Spraying of both leaf surfaces was significantly superior to spraying the upper leaf surface only, giving an increase in yield of about 25 per cent. Thus, under the conditions of infection by *Phytophthora infestans* obtained in the test area spraying both upper and lower leaf surfaces is an important requirement in late blight control.

Experiment IV: Relative Efficiency of Dithiocarbamate Fungicides in Controlling Disease

Preparations approved for the control of *P. infestans* include a group of organic fungicides based on the salts of dithiocarbamic acid which in recent years have become increasingly popular among potato growers. Several workers have reported the efficiency of dithiocarbamate fungicides to control late blight of potato and tomato.—(Chathopadyay S. B. 1952; Callbeck L. C. 1956; Thiede H. 1956). In Ceylon, Abeygunawardena, D. V. W., and Peiris, J. W. L. (1958), demonstrated that under the climatic conditions prevailing at Bopatalawa, the dithiocarbamates were significantly superior to all other organic and inorganic preparations tested; the fungicide based on zinc ethylene bisdithiocarbamate being most effective against late blight. In an attempt to improve disease control by "white sprays" the present investigation was undertaken at Rahangala.

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A variety of dithiocarbamate fungicides were screened. Their active ingredients are given below :—

- A. 70% manganese ethylene bisdithiocarbamate.
- B. 70% manganese ethylene bisdithiocarbamate.
- C. 65% zinc ethylene bisdithiocarbamate.
- D. 65% zinc ethylene bisdithiocarbamate.
- E. 70% zinc ethylene bisdithiocarbamate.
- F. 76% zinc ethylene bisdithiocarbamate.
- G. zinc ethylene bisdithiocarbamate and copper oxychloride.
- H. 76% Ferric dimethyl dithiocarbamate.
- I. 76% Ferric dimethyl dithiocarbamate.
- J. 19% Disodium ethylene bisdithithiocarbamate.

The method of spray application, disease assessment and cultural operations were similar to those reported earlier. The experiment was statistically set down, all treatments were randomized and replicated 4 times. The individual spray plot was 15' × 20'. The yield results and spray efficiency data for the different preparations are presented in Table 4.

TABLE IV
Relative efficiency of dithiocarbamate fungicides in controlling late blight

<i>Fungicide</i>	..	..	<i>Yield tons/acre</i>
A. 70% manganese ethylene bisdithiocarbamate	..	..	7.42
B. 70% manganese ethylene bisdithiocarbamate	..	..	6.65
C. 65% zinc ethylene bisdithiocarbamate	..	..	6.19
D. 65% zinc ethylene bisdithiocarbamate	..	..	5.38
E. 70% zinc ethylene bisdithiocarbamate	..	..	5.00
F. 76% zinc ethylene bisdithiocarbamate	..	..	6.00
G. zinc ethylene bisdithiocarbamate and copper oxychloride	..	..	6.64
H. 76% Ferric dimethyl dithiocarbamate	..	..	5.24
I. 76% Ferric dimethyl dithiocarbamate	..	..	4.90
J. 19% Disodium ethylene bisdithiocarbamate	..	..	4.52
Control	..	..	3.30

Significant difference—0.33 tons per acre.

A study of the data on tuber yield reveal that the preparation A with manganese ethylene bisdithiocarbamate as its active principle out yielded all other treatments and gave an increase in yield of about 2½ times that of the unsprayed check. The preparation B having the same active principle gave significantly superior yields to most preparations having zinc ethylene bisdithiocarbamate with the exception of the formulation G which is a combination of the zinc ethylene bisdithiocarbamate and copper oxychloride. The formulations having

Ferric dimethyl dithiocarbamate and Disodium ethylene bisdithiocarbamate, although giving comparatively better control than the unsprayed check are of little importance to justify their commercial use against late blight of potato.

DISCUSSION

With an extremely susceptible variety of potato, namely Duke of York, epiphytotics of late blight have been shown to be effectively controlled by the application of increased concentrations of the fungicide at frequent intervals. In corporation of stickers to the fungicidal spray did not reduce the concentration of the fungicide required to give effective control of the disease. The difference in the efficiency of stickers used is demonstrated. The sticker Tenac giving a yield of about 10 per cent more than Albolinium.

Protective spraying of both upper and lower leaf surfaces is a necessary requisite in controlling late blight epiphytotics; spraying of both leaf surfaces was significantly superior to spraying the upper leaf surface only, giving an increase in yield of about 25 per cent.

The dithiocarbamates differed in their effectiveness on controlling the disease. The manganese ethylene bisdithiocarbamates outyielded all other dithiocarbamates. The formulations containing zinc dithiocarbamates were superior to those with Ferric dimethyl dithiocarbamate and Disodium ethylene bisdithiocarbamate.

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