

Field investigations on the control of "late blight" of potato

II. Dosage, Frequency and Timing of Fungicide Application, and Economics of Control

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ABSTRACT

Fungicide spray application against the late blight disease of potato, based on a visual judgement of "blight weather", was found to be more effective in controlling the disease than a regular seven, ten or a fourteen-day spraying schedule. The economical advantages in using this method are discussed. Under normal weather conditions prevalent in the Nuwara Eliya District the use of the standard dosage recommended by the fungicide manufacturer was found to be adequate and very satisfactory. There is no economical advantage in using an inorganic fungicide coupled with a dithiocarbamate or other organic product as the incidence of tuber blight is very negligible in the hill country potato growing areas in Sri Lanka.

INTRODUCTION

Surveys carried out recently on the incidence and control of the late blight disease of potato in the hill country districts of Sri Lanka have shown that a very large majority of the cultivators use a fungicide to control the disease. However, a majority of cultivators use control measures indiscriminately and without any understanding of the basis for their usage ; therefore such measures invariably result in heavy and unnecessary expenditure, thus increasing the cost of production.

The trials reported in this paper were undertaken with the object of finding the optimum dosage, frequency and timing of application of a few promising fungicides selected from the screening trials reported earlier (Wimalajeewa *et al.*, 1973).

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RESULTS

The trials were conducted during the period Maha 1971-72 to Maha 1972-73, at the Agricultural Research Station in Sita Eliya (1900 m), using the potato variety "Arka". Randomized complete block designs with four replicates were used for all the trials. Other experimental methods were as described in Part I of this paper.

RESULTS

Frequency and Timing of Fungicide Applications

Two trials were conducted to find out the optimum frequency of fungicide spraying and the timing of spray application in relation to weather conditions. Two fungicides were tested in the Maha 1971-72 trial with spray applications being made once every ten days, and depending on weather conditions. In the Maha 1972-73 trial four fungicides were tested with spray applications being made at seven day and fourteen day intervals, and depending on weather conditions. The first spraying was carried out in both trials about five weeks after planting. In treatments where spraying depended on a visual judgment of "blight weather" spray applications were made only if one or more of the following weather conditions prevailed continuously for two days, with the actual spraying being done on the third day; i(i) moderate to heavy rains, (ii) intermittent showers with little sunshine, (iii) mist or fog, with or without rain, and overcast skies.

In the Maha 1971-72 trial, owing to the relatively dry weather that was prevalent during the early stages of the crop, no blight infection was observed in the field till about the seventh week after planting. Infection was first observed in the control plots, and it was only after the tenth week that it was noticeable in the other treatments. Consequently the yields in the latter treatments were only little affected by the disease. No significant differences (at 5% level) were observed between the two modes of spraying with either Manzate D or Vondozeb. (Table 1).

In the Maha 1972-73 trial, blight infection was seen in the control plots seven weeks after planting, and in other treatments about a week later. With the onset of very wet weather at this time the level of infection rose very rapidly in the control and in some of the other treatments where Antracol and Dithane M-45 were used. The highest degree of control was achieved with Manzate D sprayed on the basis of a visual judgment of weather conditions. It was found that all fungicides sprayed in this manner gave significantly

better yields (at 5% level) than the control. With the exception of Dithane M-45 the other fungicides tested gave satisfactory control of the disease when sprayed at 7-day intervals (Table 2).

Fungicides Dosage

In this trial, carried out during Yala 1972, four fungicides were tested, each at three different dosages. The dosages tested were the standard recommended by the manufacturer, half, and twice that. Owing to the relatively dry weather prevalent during the first eight weeks after planting, there was a considerable delay in germination of the "seed" tubers. No late blight infection was observed in any of the treatments till about the ninth week after planting. All three dosages of the four fungicides tested gave significantly better yields (at 5% level) than the control (Table 3). The relationship between blight infection development and weather is shown in Fig. 3.

The use of Organic Fungicides followed by Inorganic Fungicides

In this trial carried out during Maha 1971-72 three dithiocarbamate fungicides and a copper based fungicide were tested as indicated in Table 4. All fungicidal treatment in this trial gave significantly higher yields (at 5% level) over the control. Except for Manzate D there was no indication that any of the other organic fungicides tested, and used alone throughout the crop period, would give better control than the treatments where these fungicides were used in combination with a copper based formulation.

Economics of Control

In view of the results obtained from the trials on fungicide dosage and the use of inorganic fungicides following organic formulations, only such factors as (a) the kind of proprietary product used, and (b) the frequency and timing of spray application are considered in working out the economics of late blight control.

Products that are now in standard use against late blight such as Antracol, Dithane M-45 and Manzate D are compared with Vondozeb and Difolatan 80 W, which have been more recently introduced and found to be promising in respect to increase in yield and profit (Table 5). The data shown are based on the fungicide trials described in Part I of this paper. Manzate D was the most promising treatment with an increase in profit of 214% over the control, when used on a ten day spraying schedule.

The economic advantage in using a spraying schedule based on visual judgment of "blight weather" as against a regular seven or fourteen day schedule are shown in Table 6. The data shown are based on the Maha 1972-73 frequency and timing of fungicide application trial. The use of a spraying schedule based on weather gave the best results with all the fungicides tested. Manzate D showed an increase in profit of 328% over the control when used in this manner.

DISCUSSION AND CONCLUSIONS

It is apparent from the data given in Tables 2 and 6 that in controlling the late blight disease of potato it is more economical to use a spraying schedule based on a visual assessment of "blight weather" than a schedule carried out at regular seven or fourteen day intervals. Biologically the "blight weather" described below provides very favourable conditions, in terms of such physical factors as relative humidity, free moisture and temperature, for infection and rapid development of the disease. In view of the practical simplicity of the method it is recommended that it be used by all potato growers in general and in all production farms. Wherever there is any difficulty in using this method the adoption of a seven to ten day spraying schedule is recommended as an alternative. Any one or more of the following weather conditions would favour blight infection in the field: (a) a rainfall of over 8-10 mm. a day. However, heavy and washing rains may not be quite favourable for infection (de Weille, 1963); (b) intermittent showers with some degree of sunshine. The relative humidity and light under these conditions are invariably found to be very favourable for germination of *P. infestans* spores and subsequent infection of the host (de Weille, 1963); (c) mist or fog with overcast skies. Under these conditions the relative humidities approach 100% and thus provide ideal conditions for heavy infection. In fact, high relative humidity rather than rainfall is a more important component of "blight weather" (Cox and Large, 1960).

In general the average daily temperature under conditions described above is about 15-18°C, with the diurnal variation of this factor being relatively small.

In regard to dosage or concentration of the fungicide in the spray fluid, there was no clear indication in the trials described in the present paper that a higher dosage than that is generally

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recommended by the fungicide manufacturer has any advantages under normal conditions. Lower dosages were found to give poorer control of the disease. Under weather conditions which are extremely favourable for blight, as found in the Nuwara-Eliya District from May to August, it would be more advisable to avoid the cultivation of potato altogether during such periods rather than to attempt to control the disease using heavier dosages of the fungicide and more frequent spray applications (Wimalajeewa, *et al.* 1973).

One of the chief objects in the trials on the use of organic fungicides in the early stages of the crop followed by inorganic fungicides in the latter stages was to control any blight that may occur in the tubers. The rationale for use of such a pattern of fungicide application is the relatively greater persistence of inorganic fungicides in the soil. However, the incidence of tuber blight has been found to be practically negligible both in the surveys and trials carried out at Sita Eliya. As such, no change in the existing pattern of spraying, where a single dithiocarbamate or other organic fungicide is used throughout the period, is recommended at present.

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Table 1. *Effect of Fungicides on the control of late blight. Timing of fungicide applications. Maha 1972-73 Trial*

Planted on 16.9.1971.

Sprayed on : 23.10, 3.11, 13.11, 23.11, 3.12, 12.12, 23.12 (normal ten day spraying schedule)

23.10, 25.10, 28.10, 3.12, 6.12, (spraying based on visual assessment of "blight weather"

<i>Fungicide</i>	<i>Rate/1000 l</i>	<i>Mean% blight at 11 weeks</i>	<i>Mean Yield metric tons/ha</i>
Manzate D 10 day sched. . .	.. 2 Kg. . .	51.3 ..	25.51
Manzate D depending on weather	.. 2 Kg. . .	42.5 ..	26.32
Vondozeb 10 day sched.	.. 2 Kg. . .	59.0 ..	23.84
Vondozeb depending on weather	.. 2 Kg. . .	51.3 ..	23.40
Control .. ..	.. — ..	95.0 ..	13.14
L. S. D. (P=0.05) ..	.. ..	.. ..	9.13

Table 2. *Effect of fungicides on the control of late blight. Timing of fungicide applications Maha 1972-73 Trial*

Planted on : 9.8.72.

Sprayed on : 12.9, 19.9, 25.9, 3.10, 10.10, 16.10, 23.10, 30.10, 7.11 (7 day spraying schedule)
12.9, 25.9, 10.10, 23.10, 7.11, (14 day spraying schedule)

12.9, 15.9, 25.9, 29.9, 3.10, 16.10, 19.10, 23.10 (spraying based on visual assessment of "blight weather")

<i>Fungicide</i>	<i>Rate/1000 l</i>	<i>Mean% blight at 10 weeks</i>	<i>Mean Yield metric tons/ha</i>
Manzate D-7 day schedule	.. 2 Kg. . .	22.0 ..	27.26
Manzate D-14 day schedule	.. 2 Kg. . .	65.0 ..	17.96
Manzate D-depending on weather	.. 2 Kg. . .	4.5 ..	30.37
Vondozeb -7 day schedule..	.. 2 Kg. . .	58.0 ..	22.85
Vondozeb -14 day schedule	.. 2 Kg. . .	73.0 ..	15.01
Vondozeb-depending on weather	.. 2 Kg. . .	34.0 ..	27.45
Dithane M-45-7 day schedule	.. 2 Kg. . .	87.2 ..	14.18
Dithane M-45 -14 day schedule	.. 2 Kg. . .	89.5 ..	13.04
Dithane M-45 -depending on weather	.. 2 Kg. . .	57.8 ..	23.43
Antracol-7 day schedule ..	.. 2 Kg. . .	61.8 ..	19.37
Antracol -14 day schedule..	.. 2 Kg. . .	77.8 ..	15.71
Antracol-depending on weather	.. 2 Kg. . .	54.0 ..	21.70
Control — ..	99.2 ..	10.12
L. S. D. (P=0.05)	6.39

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Table 3.—Effect of fungicides on the control of late blight. Fungicide dosage trial. Yala 1972

Planted on : 10.2.72.

Sprayed on : 1.4, 11.4, 21.4, 2.5, 12.5, 22.5.

Fungicide	Rate/ 1000 l	Mean% blight at 9 weeks	Mean yield metric tons/ha
Manzate D ..	1 Kg ..	33.5 ..	18.14
Manzate D ..	2 Kg ..	25.2 ..	18.24
Manzate D ..	4 Kg ..	23.3 ..	18.65
Vondozeb ..	1 Kg ..	45.8 ..	17.76
Vondozeb ..	2 Kg ..	32.2 ..	19.79
Vondozeb ..	4 Kg ..	30.8 ..	17.54
Dithane M-45 ..	1 Kg ..	65.8 ..	16.21
Dithane M-45 ..	2 Kg ..	59.2 ..	16.88
Dithane M-45 ..	4 Kg ..	49.0 ..	16.89
Antracol ..	1 Kg ..	70.0 ..	14.73
Antracol ..	2 Kg ..	65.4 ..	15.68
Antracol ..	4 Kg ..	54.6 ..	16.15
Control ..	..	82.0 ..	9.98
L. S. D. (P=0.05) ..	..	..	3.95

Table 4. Effect of fungicides on the control of late blight. Use of inorganic fungicide in combination with organic fungicides. Maha 1971-72

Planted on : 16.9.72.

Sprayed on : 23.10, 3.11, 13.11, 23.1, 3.12, 14.12, 23.12

Fungicide	Number of sprayings	Rate/ 1000 l	Mean% blight at 11 weeks	Mean yield metric tons/ha
Manzate D ..	7 ..	2 Kg ..	52.5 ..	9.49
Vondozeb ..	7 ..	2 Kg ..	60.0 ..	9.35
Antracol ..	7 ..	2 Kg ..	67.5 ..	7.41
Cupravit Ob 21 ..	7 ..	6.5 Kg ..	78.8 ..	7.23
{ Manzate D ..	first 4 ..	2 Kg ..	67.5 ..	8.15
{ Cupravit Ob 21 ..	latter 3 ..	6.5 Kg ..		
{ Vondozeb ..	first 4 ..	2 Kg ..	72.5 ..	7.10
{ Cupravit Ob 21 ..	latter 3 ..	6.5 Kg ..		
{ Antracol ..	first 4 ..	2 Kg ..	76.3 ..	7.48
{ Cupravit Ob 21 ..	latter 3 ..	6.5 Kg ..		
Control ..	..	..	95.0 ..	5.04
L. S. D. (P=0.05) ..	..	..	..	1.53

Table 5.—Cost of fungicidal control of late blight in relation to the kind of proprietary product used.

Spray applications were made on a ten day schedule at 2 Kg/ha.

Proprietary Fungicide	Average Yield metric tons/ha	Approximate cost of production per ha in Rs. *	Income per ha. in Rs. †	profit per ha in Rs.	% increase in profit over control
Control (i.e. no fungicide used)	.. 8.7	.. 4,600	.. 10,875	.. 6,275	.. —
Manzate D	.. 19.8	.. 5,050	.. 24,750	.. 19,700	.. 214
Vondozeb	.. 17.6	.. 4,950	.. 22,000	.. 17,050	.. 172
Difolatan 80 W	.. 16.8	.. 5,050	.. 21,000	.. 15,950	.. 154
Antracol	.. 13.9	.. 5,000	.. 17,375	.. 12,375	.. 97
Dithane M-45	.. 13.9	.. 5,000	.. 17,375	.. 12,375	.. 97

* Based on retail prices of fungicides quoted by the agents in January, 1973.

† Based on price of potato at Rs. 1,250 per metric ton.

Table 6.—Economics of fungicidal control of late blight in relation to frequency and timing of fungicidal application.

Fungicide	7 day schedule		14 day schedule		spraying schedule based on weather	
	Nett profit/ ha in Rs. *	% increase in profit over control	Nett profit/ ha in Rs. *	% increase in profit over control	Nett profit/ ha in Rs. *	% increase in profit over control
Manzate D	.. 29,100..	268..	17,600..	128..	33,800..	328
Vonozeb	.. 23,600..	198..	13,900..	67..	29,300..	271
Antracol	.. 19,200..	143..	14,500..	83..	22,100..	180
Dithane M-45	.. 13,100..	66..	11,400..	44..	24,300..	207
Control	Nett Profit/ha— Rs. 7,900					

* Profit calculated as for Table 5.