Spray and Seed Tuber Treatments for Late Blight Control in Potatoes

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ABSTRACT

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Potato late blight was controlled by applications of metalaxyl, milfuram, and 2-methoxy-*N*-(2,6-dimethylphenyl)-N-(tetrahydro-2-oxo-3-furanyl) acetamide. These acylalanine analogs were applied as scheduled sprays, as sprays only when conditions favorable to disease spread had prevailed, or as seed tuber treatments before planting, with fungicides suspended in 2% methyl cellulose. Curative sprays of a mixture of mancozeb or of mancozeb plus Curzate were less effective than metalaxyl in controlling late blight but were equally effective when used as preventive sprays. Yields of salable potatoes were similar from plants treated with these three fungicides in preventive or curative spray programs or by seed tuber dressing.

The incidence of potato late blight (caused by *Phytophthora infestans* (Mont.) de Bary) varies considerably in different areas of New Zealand. At locations such as Pukekohe, the disease can cause total crop loss, and total costs of the late blight control programs can exceed $300/ha. This cost could be reduced if sprays were applied when conditions favoring late blight development (blight periods) were forecast (4), but weather forecasts in New Zealand are not accurate enough to be used for predicting blight periods. Late blight could be controlled by applying sprays of an eradicant fungicide immediately after blight periods have occurred. This paper reports results of field trials using fungicides that are reported to have curative properties against phycomycetes.

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MATERIALS AND METHODS

The fungicides used were metalaxyl (Ridomil) 50% WP, 25% WP, and 2% granular formulations; milfuram (RE 20615) 50% WP; 2-methoxy-*N*-(2,6-dimethylphenyl)-N-(tetrahydro-2-oxo-3-furanyl) acetamide (RE 26745) 50% WP; mancozeb 80% WP; and 2-cyano-N-(ethylaminocarbonyl)-2-(methoxyamino) acetamide (Curzate) 8% WP, in a formulated mixture with mancozeb 64% WP.

Potato cultivar Ilam Hardy was used except in a phytotoxicity trial involving cv. Rua. Unless otherwise stated, the planting layout consisted of plots receiving fungicide treatment arranged in pairs with control (untreated) plots on either side of each pair and separated from it by two unplanted rows to allow tractor access. This layout was adopted to ensure a similar inoculum pressure on all plots. Each plot consisted of three 10-m rows; disease and yield were assessed on the center row only. All treatment plots were randomized and replicated and the results subjected to analysis of variance. Control plots were arranged regularly and not randomized among the treatment plots; the results from the control plots were analyzed separately.

Fungicide sprays were applied either at fixed intervals or after blight periods (1), starting when 60% of the plants had emerged. Blight periods occurring in the 5 days after spray application were ignored. Sprays were applied at 1,100 L/ha at 1,000 kPa, with a standard boom sprayer.

For seed tuber treatments, the tubers were sprayed to runoff with a suspension of the fungicide in 2% methyl cellulose (low substitution grade); predetermined calibration curves were used to estimate the dilution rate required to give the desired dosage. The tubers were air-dried before planting.

Disease assessments were made at weekly intervals using standard keys (3), with interpolation of intermediate values. Yields were determined on 10 plants per plot, and the weight of salable tubers was determined as those not passing through a 5 × 5 cm grid.

RESULTS

Weekly vs. postinfection spray applications, spring 1977. Metalaxyl (250 g/ha) was compared with mancozeb (2.5 kg/ha) and a 64% mancozeb/8% Curzate mixture (2.5 kg/ha). Fungicides were used for preventive applications on a weekly schedule and for eradicant treatments applied immediately after blight periods. All weekly treatments effectively controlled blight, but only the metalaxyl treatment was effective when sprays were applied after blight periods (Table 1).

Metalaxyl spray applications, autumn 1978. Three rates of metalaxyl were applied at four intervals (every 1, 2, or 4 wk or following blight periods) and their efficacy compared. The first spray was applied at approximately 60% shoot emergence. The weather was highly favorable to blight infection and only two fewer applications were made to the postblight period treatment plots than to those sprayed every week.

All weekly applications and the fortnightly and postblight period applications at 140 and 280 g/ha gave a high level of protection (Table 2). Yields increased four- to fivefold in plots where blight was effectively controlled.

Seed tuber treatments, autumn 1978. In preliminary trials, appearance of late blight could be delayed for several weeks if the fungicide was applied to the seed tubers before planting (2). A test was therefore done to compare two rates of metalaxyl. The need for a "top-up" spray at late flowering was also evaluated.

In this experiment, all treatments including controls were arranged in a randomized block of five replications. The top-up sprays were applied with a pressure knapsack sprayer.

All treatments were effective, and the treated plant showed a fourfold increase in yield compared with untreated plants (Table 3). Top-up sprays were unnecessary.

Comparison of spray and tuber applications, spring 1978. Milfuram was compared with the chemically similar metalaxyl in a range of treatments, including routine sprays and a seed tuber plus top-up spray treatment. A granular form of metalaxyl was also tested. All the treatments effectively controlled late blight infection (Table 4).

Comparison of fungicides for seed tuber treatments, autumn 1979. Seed tubers were treated with metalaxyl, milfuram, or RE 26745 in methyl cellulose before planting. Metalaxyl and RE 26745 (2 ml) were also applied by spraying, and metalaxyl by pouring granules, over each planted tuber before the furrow was closed. A standard application rate of 0.8 kg a.i./ha was used. At the late flowering stage, all plots received one spray (250 g a.i./ha) of fungicide.

A severe late blight epidemic developed approximately 4 wk after the plants emerged. Unsprayed plants collapsed in the following 4 wk and produced a negligible yield of salable potatoes (Table 5). The milfuram treatment initially gave some control of the disease, but the treated plants collapsed completely before harvest. Metalaxyl and RE 26745 treatments provided a good level of disease control for most of the growing period.

Phytotoxicity, summer 1978. In a small trial, cv. Rua plants sprayed with metalaxyl (three applications at 0.5 kg/ha) gave similar yields to unsprayed plants in the absence of late blight.

DISCUSSION

Foliar applications. The initial aim of this work was to find fungicides that would

Table 1. Late blight incidence and yield of potatoes following preventative and eradicant treatments with mancozeb, a mancozeb/Curzate mixture, and metalaxyl (spring 1977)

Fungicide	Application schedule	Sprays applied	Infection (% foliage destroyed)[y]	Yield (kg/plant)	
				Total	Salable[y]
Mancozeb (2.5 kg/ha)	Weekly	9	2.1 a	1.14	1.00 ab
	After blight periods	6	11.2 b	1.02	0.84 b
Mancozeb/Curzate (2.5 kg/ha)	Weekly	9	4.0 a	1.07	0.93 ab
	After blight periods	6	18.0 b	0.99	0.86 ab
Metalaxyl (250 g/ha)	Weekly	9	0.4 a	1.19	1.06 a
	After blight periods	6	1.1 a	1.01	0.85 b
Controls[z]			69 (± 9)	0.85 (± 0.07)	0.69 (± 0.08)

[y] In each column, treatment values with no letter in common differ significantly at $P < 0.05$.
[z] Analyzed separately (95% confidence intervals).

Table 2. Late blight incidence and yields of potatoes after metalaxyl treatments (autumn 1978)

Metalaxyl (g/ha)	Application schedule	Sprays applied	Infection (% foliage destroyed)[y]	Total yield (g/plant)[y]
70	Weekly	9	4 abc	363 ab
	Every 2 wk	5	28 de	310 bc
	Every 4 wk	3	52 g	217 c
	After blight periods	7	12 bc	283 bc
140	Weekly	9	0.4 a	356 ab
	Every 2 wk	5	4 ab	353 ab
	Every 4 wk	3	42 ef	280 bc
	After blight periods	7	3 abc	383 ab
280	Weekly	9	0.1 a	363 ab
	Every 2 wk	5	3 ab	327 abc
	Every 4 wk	3	14 cd	343 ab
	After blight periods	7	0.1 a	447 a
Controls[z]		...	97 (± 2)	87 (± 10)

[y] Values with no letter in common differ significantly at $P < 0.05$.
[z] Analyzed separately (95% confidence).

Table 3. Late blight incidence and yield of potatoes after metalaxyl as a seed tuber treatment (autumn 1978)

Metalaxyl (kg/ha)		Infection (% foliage destroyed)	Total yield (g/plant)[z]
On tubers	As a spray[y]		
1	0	4	277 b
1	0.5	4	283 b
2	0	1	285 b
2	0.5	0	291 b
0	0	76	78 a

[y] One application at flowering.
[z] Values with no letter in common differ significantly at $P < 0.05$.

eradicate foliar infections before the pathogen became sufficiently established to produce symptoms. The acylalanine analogs (metalaxyl and milfuram) appear to be very suitable for this use. Metalaxyl was effective when applied either on a routine schedule or only after blight periods. Milfuram was effective when applied on a routine schedule but was not tested in after blight period applications. However, milfuram would probably also be effective as an eradicant. RE 26745 was not tested as a spray.

Seed tuber treatments. The reductions in disease incidence and increases in yield obtained after seed tuber treatments were generally similar to those obtained from the more effective spray treatments. Plants grown from seed tubers that had been pretreated with the acylalanine analogs usually did not develop symptoms of late blight until the plants had flowered; subsequent disease spread was slow. However, milfuram was less effective than the other analogs when applied at a low rate (0.8 kg a.i./ha) under severe epidemic conditions. On farms where untreated plants are unlikely to be present, such severe conditions would probably not occur.

In several of these experiments the different fungicide treatments resulted in similar increases in yield despite large differences in the final disease levels (Tables 1 and 2). In all trials the various treatments delayed the onset of disease, compared with that in the unsprayed controls, and these results indicate the critical importance of delaying the onset of the disease to prevent loss in yield.

As far as is known, seed tuber treatments have not been attempted elsewhere, and residue studies would be required before the method could be adopted commercially. At present there are no suitable commercial preparations of these fungicides formulated for tuber treatment. Use of this treatment could save much of the direct (e.g., machinery and labor) and indirect (wheel damage to the crop and soil) costs associated with present control methods. Growers would also become less dependent on weather in maintaining crop protection. A granule in-furrow treatment appears to be a suitable alternative.

Table 4. Comparison of metalaxyl and milfuram treatments for control of late blight (spring 1978)

Fungicide seed tuber dressing (kg/ha)	Sprays applied			Infection (% foliage destroyed)	Yield (g/plant)	
	No.	Rate	Timing		Total	Salable[y]
Metalaxyl						
1	...	...	...	1.2	883	780 ab
1	1	280	At late flowering	0.2	947	757 abc
1	1	140	At late flowering	0.2	797	613 c
0	k10	84	Weekly from emergence	0.2	887	860 a
0	5	140	Biweekly from emergence	1.6	813	767 abc
0 (1 as granules in furrow)	1	280	At late flowering	1.1	817	690 bc
Milfuram						
1	1	280	At late flowering	1.1	870	747 abc
0	10	84	Weekly from emergence	0.4	880	670 bc
0	5	140	Biweekly from emergence	3.5	853	674 bc
Controls[z]				92.5	668 (± 57)	493 (± 67)

[y] Values with no letter in common differ significantly at $P < 0.05$.
[z] Analyzed separately (95% confidence intervals).

Table 5. Comparison of seed tuber fungicide treatments (0.8 kg a.i./ha) for control of late blight (autumn 1979)

Fungicide	Method of application[y]	Infection (% foliage destroyed)[z]	Yield (g/plant)[z]	
			Total	Salable
Metalaxyl	in 2% methyl cellulose	6 bc	560 a	438 a
	in water	14 a	473 ab	417 a
	as 2% granules	14 a	478 ab	387 a
Milfuram	in 2% methyl cellulose	83 d	313 c	192 b
RE 26745	in 2% methyl cellulose	5 c	507 ab	385 a
	in water	8 abc	527 ab	443 a
Unsprayed controls	(analyzed separately)	99.7	99(± 10)	4

[y] All treatments included one "top-up" spray (250 g a.i./ha) at late flowering.
[z] Values with no letter in common differ significantly at $P < 0.05$.

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