

METHODS OF APPLICATION AFFECTING EFFICIENCY OF
RIDOMIL[®] IN THE CONTROL OF
PHYTOPHTHORA INFESTANS ^{1/}

by
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SUMMARY

In 1983 at Mt. Vernon, Wa., we compared root versus leaf absorption of Ridomil[®] in White Rose potato for control of *Phytophthora infestans*, the cause of late blight. Late blight was controlled in plots where Ridomil applied 18 hr. previously to foliage was washed into the soil by rain and sprinkler irrigation. However, foliage application gave less effective control in plots where a plastic tarp on the soil surface prevented entry of Ridomil into the soil where it could be absorbed by the roots. Spraying Ridomil over potato seed pieces in furrow at planting (a non-registered use) to be absorbed later by roots, gave control equal to or better than foliage applications of Ridomil. Late blight control was better and yields were significantly more in plots sprayed prior to late blight appearance compared to spraying after late blight developed on leaves. Foliage sprays or spraying over potato seed pieces at planting prevented most late blight tuber rot at harvest. For maximum control of *P. infestans*, Ridomil should, therefore, be applied to foliage prior to appearance of symptoms and washed off leaves by rain or sprinkler irrigation about 18 hours after application for root absorption.

INTRODUCTION

In eastern Washington, late blight on potato caused by *Phytophthora infestans* (Mont.) de Bary, occurred on about 2,000 acres in 1975, 25,000 acres in 1982 and 35,000 acres in 1983 (1, 2). In 1982, one foliage spray of Ridomil[®] (metalaxyl) class acylalanine, N-(2,6 dimethyl-phenyl)-N-(methyl (-) oxyacetyl) - alanine methyl ester plus other fungicide protectants stopped an epidemic. In 1983, Ridomil MZ 58[®] (metalaxyl plus mancozeb, zinc ion and manganese ethylenebisdithiocarbamate) effectively controlled late blight.

In 1979 at Mt. Vernon, Wa., a low rainfall year (approximately 60% of normal), five foliage sprays of Ridomil applied every 2 weeks for a total of .9 lb ai/A failed to effectively control late blight (G. D. Easton, unpublished). In that year very little Ridomil was washed off foliage by rainfall to the soil for absorption by roots. However, Ridomil reduced foliage blight when applied as a dust to cut seed pieces at approximately 1.2 lb ai/a (1 lb 5% dust/cwt of seed). These observations suggested that Ridomil is better absorbed by roots than leaves. Greenhouse studies showed that ¹⁴C metalaxyl applied to foliage of tomato and avocado was not translocated in sufficient amounts to protect seedlings from infection by *Phytophthora cinnamomi* Rands (6). In another study much higher levels of late blight protection occurred if Ridomil was applied to soil rather than foliage (5). Ridomil applied to diseased foliage has been reported to act as an eradicator of *P. infestans* and to control an epidemic within two days (3). This paper reports a study of methods and timing of Ridomil application to promote absorption by potato foliage or roots for the most effective control of *P. infestans*.

^{1/} Mention of a product used in these studies does not constitute a recommendation by Washington State University over other products.

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MATERIALS AND METHODS

Tests were conducted near Mt. Vernon, Wa., on a Puget silt loam soil in an area where late blight occurs annually on the very susceptible White Rose potato. Ridomil foliage sprays were applied prior to late blight occurrence in a "preventative program" and after late blight had occurred in a "curative program". Late blight control and tuber production were compared when treatments were applied to foliage over polyethylene tarped and untarped plots. Tarps prevented most Ridomil run-off from reaching the soil to be absorbed by roots. A treatment in which Ridomil was sprayed over seed at planting on May 17 and 18 was included for comparison. Plots with no Ridomil application served as control treatments. Plots were 9 ft wide by 20 ft long arranged in randomized complete block design with five replications.

N, P, and K fertilizers at 200, 200 and 500 lb/A, respectively were broadcast, and the field plowed 12 inches deep. A preplant application of Eptam^R 7E, s-ethyl dipropylthiocarbamate, 4 lb ai/A was used for weed control. In the seed piece treatment at planting, Ridomil was sprayed into the open furrow at 1.5 lb ai/A at 14.5 psi in 25 gal water/A at 1 mph over the potato seed pieces in an 8 inch band. Disc on the planter closed the treated furrow. During the planting in all plots, Difonate^R 10G, 0-ethyl S-phenyl ethylphosphonodithioate at 2 lb ai/A was banded on each side and level with the seed piece for wireworm control. The day after planting for additional weed control, Eptam 7E at 1 lb ai/A plus Treflan^R EC, a, a, a-trifluoro-2, 6 dinitro-N, N-dipropyl-p-toluidine, at .37 lb ai/A were sprayed twice over the hills and mixed into the surface 2 inches with rolling cultivators. On June 21 to 24, when plants were 4 to 6 inches high, 4 mil, clear polyethylene tarps, 28 ft wide by 30 ft long, were laid over two randomized paired plots to be sprayed later with Ridomil in either a "preventative" or "curative" program. Plants were pulled through slits cut in the tarps. Earth dams were made in the furrows at the ends of the plots under the tarps to prevent foliage run-off from going back under the tarps. On June 30, prior to late blight appearance and again on July 27, the "preventative program" plots with and without tarping were sprayed with Ridomil at .25 lb ai/A in 25 gal water/A at 24 psi at 1 mph with a hand-carried gas engine powered sprayer with boom. On July 27, shortly after the first appearance of late blight, similar treatments in "curative program" plots were sprayed. Foliage sprays of Ridomil were not repeated after July 27 because the disease appeared to be controlled until the first part of September. Approximately 18 hr after each foliage application, Ridomil was washed off foliage in plots with and without plastic tarps by a solid set sprinkler irrigation system. This system applied .5 to .8 inches of water at 45 psi through 9/64 inch dia. orifices during a 1.5 hr period. Equal amounts of water were also applied to unsprayed plots. Water applied was calculated from catch bottles, 2.75 in. dia., located in irrigated plots. Plant defoliation and death due to late blight were rated at a scale of 0 = no foliar lesions to 10 = all leaves infected and plants completely defoliated 5 times at 2 wk intervals starting July 27. June through October precipitation data were extracted from records of a weather station within one-half mile of the testing site. On September 30, foliage was killed with Dow General^R, 2-sec-butyl-4, 6-dinitrophenyl, applied at 2.5 lb ai/A with the addition of X 77^R nonionic spreader a 1 qt/A in 50 gal water/A. The foliage was dead at harvest on October 25.

Orthogonal data comparisons were used to test significance at P=.05 and .01 level (4).

RESULTS

Very wet weather favorable for late blight occurred during the experiments. Mean temperatures and rainfall were 60.7 and 3.6, 61.0 and 2.7, 63.0 and 1.1, 56.3 and 3.5, and 49.5 F and 1.7 inches for June, July, August, September and October, respectively. Late blight lesions on foliage appeared July 27, and untreated plots were completely defoliated by the last of August.

Ridomil applied either to foliage or over the potato seed pieces at planting had significantly reduced late blight foliage and tuber rot at harvest and significantly increased total

yield and % No. 1 tubers (Table 1). Two Ridomil sprays applied before foliage blight in a "preventative" program significantly reduced foliage late blight appearing by July 27 and August 10, and increased yield significantly more than one spray of Ridomil applied after the appearance of late blight in a "curative" program. Plots treated with Ridomil at planting had significantly less foliage late blight than plots receiving foliage sprays in either a "preventative" or "curative" program. The treatment at planting increased yield significantly more in the "curative" but not the "preventative" foliage spray program. Plots tarped to prevent most of the Ridomil sprayed on foliage from running off on to the soil after a 18 hr. sprinkler irrigation wash had significantly more foliage late blight and significantly less yield than plots not tarped. A control treatment of an additional 18 hr. sprinkler irrigation wash had no effect on late blight control or potato production.

DISCUSSION

Foliar sprays of Ridomil gave less control of foliage late blight in plots where a plastic tarp prevented entry of Ridomil into the soil where it could be absorbed by roots. Previously we found that foliage sprays of Ridomil gave no control during a low rainfall year when little if any Ridomil was washed off leaves into the soil (G. D. Easton, unpublished). One application of Ridomil over seed pieces at planting, although 3 to 6 times more ai/A, gave control equal or better than that obtained with foliage applications. In Ohio, single, in-furrow application of Ridomil at planting has also been reported to effectively control foliage late blight and tuber rot at harvest (5). All of these observations would indicate that Ridomil needs to be either washed off foliage by precipitation or supplemental irrigation or to be applied to soil and/or seed pieces at planting for subsequent uptake by roots to provide maximum control of P. infestans.

Foliage sprays of Ridomil in tarped plots gave some control of P. infestans under this high rainfall year. Control could have been due to absorption of Ridomil either through leaves or stems or absorption by roots of runoff down stems through slits in plastic to soil.

Applying Ridomil in a preventative program rather than a curative program gave better control of late blight early in the season and increased yield. Ridomil has been reported to act as an eradicant of P. infestans and can control an impending epidemic within two days (3). However, under severe late blight conditions Ridomil needs to be applied prior to late blight appearance to be the most effective. Therefore, some type of spore trapping and late blight forecasting system is needed to predict time of foliage infection.

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Table 1. Methods of Ridomil application (at planting versus foliage), timing of foliage application (preventative versus curative), and foliage versus root absorption (tarping versus no tarping) on control of late blight and potato production.

Orthogonal data comparison	Late blight foliage disease index (0-10) ^{1/}						Late blight tuber rot at harvest	% U.S. No. 1 tubers	cwt/A
	7-27	8-10	8-24	9-7	9-22				
Ridomil ^{2/} versus (vs) no Ridomil	.5 ^{1/} vs 1.7** ^{10/}	.6 vs 4.2**	1.1 vs 8.8**	3.9 vs 10.0**	6.2 vs 10.0**	4.3 vs 15.2**	77** vs 70	417** vs 178	
Foliage spray ^{3/} vs none	.6 vs 1.7**	.8 vs 4.2**	1.5 vs 8.8**	5.3 vs 10.0**	8.0 vs 10.0**	5.4 vs 15.2**	76** vs 70	405** vs 178	
Preventative ^{4/} vs Curative	.4 vs .9**	.6 vs 1.1**	1.4 vs 1.5	5.2 vs 5.3	7.8 vs 8.2	5.3 vs 5.4	75 vs 77	443** vs 367	
At planting ^{6/} vs none	.2 vs 1.7**	.3 vs 4.2**	.3 vs 8.8**	1.3 vs 10.0**	2.6 vs 10.0**	2.2 vs 15.2**	79** vs 70	440** vs 178	
Foliage spray vs at planting	.6** vs .2	.8** vs .3	1.5** vs .3	5.3** vs 1.3	8.0** vs 2.6	5.4 vs 2.2	76 vs 79	405 vs 440	
Preventative vs at planting	.4 vs .2	.6 vs .3	1.4** vs .3	5.2** vs 1.3	7.8** vs 2.6	5.3 vs 2.2	75 vs 79	443 vs 440	
Curative vs at planting	.9** vs .2	1.1** vs .3	1.5** vs .3	5.3** vs 1.3	8.2** vs 2.6	5.4 vs 2.2	77 vs 79	367 vs 440**	
Foliage spray tarp ^{7/} vs foliage spray, no tarp	.8 vs .5	1.2** vs .5	1.9** vs 1.1	6.7** vs 3.4	9.0** vs 7.0	6.1 vs 4.7	76 vs 76	358 vs 452**	
Preventative tarp vs preventative, no tarp	.5 vs .3	.8 vs .3	1.8** vs 1.0	6.6** vs 3.8	8.9** vs 6.7	7.1 vs 3.5	73 vs 77	390 vs 497**	

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Orthogonal data comparison	Late blight foliage disease index (0-10) ^{1/}					% U.S. No. 1 tubers	cwt/A
	7-27	8-10	8-24	9-7	9-22		
Curative, tarp vs curative, no tarp	1.0 vs .7	1.5 ^{9/} vs .7	1.9** vs 1.1	6.7** vs 3.9	9.0** vs 7.3	79 vs 75	326 vs 408*
Foliage spray, foliage wash ^{8/} vs .8 foliage spray, no foliage wash (control)	.8 vs .5	.9 vs .8	1.6 vs 1.4	5.4 vs 5.2	7.7 vs 8.3	75 vs 77	419 vs 391
Foliage wash only vs no wash (control)	1.0 vs .7	4.3 vs 4.1	8.8 vs 8.8	10.0 vs 10.0	10.0 vs 10.0	71 vs 69	172 vs 184

1/ Index 0-10, 0 = no foliar lesions and 10 = all leaves infected and plants completely defoliated.
 2/ Mean of all foliar and at planting Ridomil treatments.
 3/ Mean of all foliar Ridomil treatments.
 4/ Foliage sprayed with Ridomil on June 30 prior to late blight appearance and again on July 27 at 0.25 lb a/A in 25 gal water/A at 24 psi.
 5/ Foliage sprayed with Ridomil on July 27 after late blight appearance at the same rate and methods as 4/.
 6/ Ridomil sprayed in open furrow over potato seed pieces in an eight inch band during planting at 1.5 lb a/A in 25 gal water per acre at 14.5 psi.
 7/ Plots covered with plastic tarp with plants growing through slits to prevent foliage run-off of Ridomil from reaching roots.
 8/ Sprinkler irrigation (.5 to .8 inches) applied to plots 18 hr after every Ridomil foliage spray to wash Ridomil from leaves.
 9/ * = significantly different at P=.05.
 10/ ** = significantly different at P=.01.