POWDERY MILDEW CONTROL IN POTATOES [1]

by
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During the period 1973 to 1976 we evaluated the control of powdery mildew, Erysiphe cichoracearum, by aircraft-applied sulfur on rill irrigated Russet Burbank potatoes. In 1977 we also tested EL-222, an experimental systemic fungicide on Norgold and Kennebec potatoes. Mildew was quite severe in all our trials, and sulfur provided effective control. However yield increases attributed to the treatments were found in only 2 out of 5 trials. Sulfur dust or liquid both gave control whether applied weekly or biweekly. Sulfur gave no control if applied after infection was established. EL-222 was very effective in controlling powdery mildew but unfortunately is no longer available for testing in the United States.

INTRODUCTION

Powdery mildew of potato was first reported in central Washington in 1946 (8). It was observed earlier on greenhouse-grown potatoes in the eastern United States (6, 13) and has since been found in Utah (12) and the eastern United States (10). Powdery mildew has been reported from Europe (7, 11, 14), the Middle East (9), South America (2), Mexico (4) and New Zealand (5).

Powdery mildew in the initial stages is easily overlooked since only very small brownish elongated stipples occur on stems and leaf petioles. As the disease becomes more severe the stipples become very numerous on interveinal tissue of leaves as well as on petioles and stems. In epidemics the lower leaves become chlorotic and drop, a white powdery (mildew) appears over the plant surface, the leaf internodes between the terminal petioles become twisted and brittle, and the plant dies. The infected plant remains erect, not collapsing like a plant with a systemic wilt. Powdery mildew in the very susceptible Norgold Russet may appear the first week of July and kill the plant by early August. Powdery mildew of the Russet Burbank usually doesn't become severe until middle or late September and may never kill the plants.

Menzies (8) in 1946 didn't feel that powdery mildew caused commercial damage to potatoes near Prosser, Washington. Since that time, however, powdery mildew has become a yearly threat to about 20,000 acres of potatoes in eastern Washington that are grown under rill irrigation. Powdery mildew presents no problem under sprinkler irrigation since water droplets wash away spores on potato foliage before infection occurs.

In commercial fields, 3 to 5 applications of sulfur dust or liquid are applied each season by aircraft for powdery mildew control. Occasionally, however, even where sulfur has been applied, severe powdery mildew symptoms have developed. The application of lime sulfur and sulfur alone have adequately controlled powdery mildew on potato in Israel (9). Apparently aircraft application of sulfur for control had not been evaluated.

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In 1973 we started evaluating aircraft-applied sulfur dust and liquid for the control of powdery mildew. Time of first sulfur application and frequency and number of subsequent applications were studied. In 1977 the experimental systemic powdery mildew fungicide EL-222 was compared with sulfur for control.

METHODS AND MATERIALS

Sulfur dust (either 75 or 98% elemental sulfur) at 30 lb/a and sulfur liquid (6 lb ai/gal) at 3 lb sulfur/a in 8-10 gal water/a were applied by fixed wing aircraft to plots 60 ft wide by 200 ft in length. Treatments were randomized 3 to 8 times. First applications were made in July when very few powdery mildew stipples had developed. Subsequent applications were made either weekly or biweekly until September (Table 1). In 1976 applications of liquid sulfur starting in July were compared to applications starting in August after plants had been infected.

Powdery mildew symptoms were rated before and after treatment and one or two 20 ft rows were harvested from each treatment in October.

In 1977, EL-222 EC (a-(2-chlorophenyl) -a(4-chlorophenyl)-5 pyrimidine methanol), a systemic fungicide, was applied at 2- and 4-week intervals and compared with biweekly applications of sulfur liquid. These treatments were applied with a hand sprayer at 25-30 psi on plots 9 ft wide by 20 ft in length, randomly arranged and replicated 6 times. Symptom ratings and yields were taken as in previous trials.

RESULTS

Plots receiving aircraft applications of sulfur dust and liquid had significantly less powdery mildew than the control in 3 out of 4 fields during the period in 1973-75 (Table 1, Fields 1-73, 2-73, 3-74, and 4-75). In 1974 plots treated weekly with liquid sulfur had significantly less powdery mildew than plots treated biweekly. Plots treated weekly with liquid sulfur had less powdery mildew than those treated with sulfur dust in 1974 but not in 1975 (Table 1, Fields 3-74 and 4-75). When the liquid sulfur treatment was delayed until August 18 after noticeable infection had occurred, there was no control of powdery mildew (Table 1, Field 5-76). By October 5, powdery mildew was prevalent in all plots, regardless of treatment.

Sulfur applications had no affect on % U.S. No. 1 tubers during four years of testing (Table 1). Although sulfur gave good control of powdery mildew, yields were significantly increased in only two out of four years (Table 1, Fields 1-73 and 4-75). There were no consistent differences in yields between plots receiving weekly and biweekly applications of sulfur nor between plots receiving dust or liquid forms of some sulfur. In 1976, even though the nine weekly applications of liquid sulfur controlled powdery mildew up to September 16, they did not increase yield (Table 1, Field 5-76).

In the 1977 trial, EL-222 at either 30 or 60 g/a and at either 2- or 4-week spray intervals gave significantly more control of powdery mildew than liquid sulfur and showed great promise for control of this disease (Table 2). Sulfur-treated plots again had less powdery mildew than untreated plots. Neither EL-222 or sulfur had any affect on % U.S. No. 1 tubers. There was no significant difference in yield between EL-222 and sulfur treatments, but all treatments yielded significantly more than unsprayed plots. Unfortunately, EL-222 has been removed for further testing in the United States.

DISCUSSION

Powdery mildew on rill irrigated Russet Burbank potatoes in the Columbia Basin becomes noticeable with the first part of September and usually kills the plants by October. Aircraft applications of sulfur dust or liquid reduced the amount of powdery mildew early in

the fall but did not prevent it from killing the plants in the fall. Yield was increased by sulfur treatments in only 2 out of 4 years of testing. In some years powdery mildew on Russet Burbank appears only at time of natural senescence and sulfur provides little control. However, if late season severity is anticipated and the initial sulfur treatment is delayed until a uniform infection has occurred treatment is completely ineffective.

Evidently inoculum is present throughout the season since powdery mildew can infect the very susceptible Norgold Russet in early July and kill plants 3 to 4 weeks later. Plants of Russet Burbank that have physiologically aged such as those under a moisture stress become infected earlier with powdery mildew.

We question how this obligate parasite survives the winters since we have yet to find the overwintering cleistothecium (1). Possibly our race of the pathogen is not host specific on potato as thought (8), but maybe is surviving on another Solanum spp. Wild Solanum dulcamara L. survives winters on protected river banks but powdery mildew hasn't been found on this species. Night shade, Solanum nigrum L. var. villosum L., an annual weed is a host of powdery mildew (8). However, we feel it would only provide seasonal and not overwintering inoculum since we haven't observed cleistotheca on this host. Powdery mildew survives as resting mycelia in overwintering volunteer potato tubers in the field, however, no one has reported infection of tuber tissue.

LITERATURE CITED

1. Alexopoulos, C. J. 1952. Introductory Mycology. John Wiley and Sons, N. Y. 482 pp.

2. Bertossi, E. O. 1963. Fitopatologia fungosa validiviana. 4a contribucion. Rev. Univ., Santiago, 48:41-56. (In Rev. Appl. Mycol. 44:1031. 1965).

3. Chorin, M. 1946. The powdery mildews of potatoes in Palestine. Palestine J. Bot. R. Ser. 5:259-261. (In Rev. Appl. Mycol. 28:464. 1947).

4. Delgado-Sanchez, S. L. Fucikovsky and M. Cadena-Honojosa. 1969. The occurrence of some previously unreported diseases of potatoes in Mexico. Plant Dis. Rptr. 53:189-190.

5. Dingley, J. M. 1960. New records of fungus diseases in New Zealand, 1958-1959. N. Z. J. Agric. Res. 3:461-467.

6. Kunkel, L. O. 1936. Powdery mildew of potato in New Jersey. Phytopathology 26:392-393.

7. Marchal, P. and E. Foëx. 1927. Rapport phytopathologique pour les anneés 1926-1927. Ann. des Epiphyties (France) 13:383-454.

8. Menzies, J. D. 1950. Erysiphe cichoracearum DC as a parasite of potatoes. Plant Dis. Rptr. 34:140-141.

9. Palti, J. and S. Moeller. 1944. Trials for control of powdery mildew on potatoes. Palestine J. Bot., R. Ser. 4:148-156. (In Rev. Appl. Mycol. 24:203. 1945).

10. Rowe, R. C. 1975. Powdery mildew of potatoes in Ohio. Plant Dis. Reptr. 59:330-331.

11. Thomas, D. G. 1946. Powdery mildew of potato. Nature (London) 158:417-418.

12. Threshow, M. and O. S. Cannon. 1961. Powdery mildew of potato in Utah. Plant Dis. Reptr. 45:354-355.

13. Valleau, W. D. 1941. Powdery mildew of potato in Kentucky. Phytopathology 31:357-358.

14. Vanha, J. 1902-1903. Eine neue Blattkrankheit der Rübe. Zeitschrift fur Zuckevindustrie in Böhmen. 27:180-187.

Table 1. Effect of sulfur applied by fixed wing aircraft on the control of powdery mildew and production of Russet Burbank potato.

Sulfur treatment[1]	Field and year	Date of: First application	Date of: Last application	Total applications	Application interval	Powdery mildew index[2] July 26	Aug 20	Sept 16	Oct 5	% U.S. No. 1 tubers	Yield cwt/a
Control	1-73	-	-	-	none	1.6 a	4.8 a[4]	5.8 a	-	69 a	577 b
Dust	1-73	July 11	Sept 5	5	biweekly	0.6 a	2.5 b	2.9 b	-	61 a	654 a
Liquid	1-73	July 11	Sept 5	5	biweekly	0.9 a	1.8 b	3.3 b	-	67 a	662 a
Control	2-73	-	-	-	none	3.5 a	4.0 a	-	-	59 a	516 a
Dust	2-73	July 11	Sept 5	5	biweekly	3.3 a	4.0 a	-	-	62 a	539 a
Liquid	2-73	July 11	Sept 5	5	biweekly	3.1 a	3.5 a	-	-	55 a	508 a
Control	3-74	-	-	-	none	-[5]	4 b	7 c	-	40 a	562 a
Dust	3-74	July 24	Sept 4	7	weekly	-	4 b	4 b	-	33 a	554 a
Dust	3-74	July 24	Sept 4	4	biweekly	-	3 b	5 b	-	30 a	539 a
Liquid	3-74	July 24	Sept 4	7	weekly	-	2 a	2 a	-	30 a	531 a
Liquid	3-74	July 24	Sept 4	4	biweekly	-	2 a	4 b	-	31 a	562 a
Control	4-75	-	-	-	none	0	1.5 a	5.0 a	-	44 a	562 b
Dust	4-75	July 25	Sept 17	9	weekly	0	0 a	0.3 b	-	41 a	623 ab
Dust	4-75	July 25	Sept 17	5	biweekly	0	0.6 a	2.3 ab	-	43 a	662 a
Liquid	4-75	July 25	Sept 17	9	weekly	0	1.0 a	4.2 a	-	43 a	654 a
Liquid	4-75	July 25	Sept 17	5	biweekly	0	0 a	1.5 b	-	35 a	570 b
Control	5-76	-	-	-	none	0.2 a	5.0 b	8.5 b	10.0 a	62 a	569 a
Liquid	5-76	July 28[3]	Sept 23	9	weekly	0.2 a	2.0 a	4.6 a	7.0 a	65 a	653 a
Liquid	5-76	July 28	Sept 23	5	biweekly	0.2 a	1.6 a	3.3 a	7.0 a	55 a	600 a
Liquid	5-76	Aug 18[3]	Sept 23	6	weekly	0.2 a	4.3 b	7.8 b	8.6 a	63 a	607 a
Liquid	5-76	Aug 18	Sept 23	3	biweekly	0.3 a	4.6 b	8.6 b	9.3 a	63 a	553 a

TABLE CONTINUED

Table 1 (continued)

1 Sulfur dust: Fields 1-73, 2-73 and 3-74 received 30 lb/a of 75% sulfur; 4-75 received 30 lb/a of 98% sulfur. Sulfur liquid: Fields 1-73, 2-73, 3-74, 4-75 and 5-76 received 0.5 gal (6 lb ai/gal) /a in 8 to 10 gal of water/a.

2 Powdery mildew index: 0=no symptoms; 5=lesions on stems and petioles, and systemic infection of terminals; and 10=plants dead.

3 Application started on either July 28 when only a trade of mildew was evident and on August 18 after a uniform infection occurred in all plots.

4 Vertical means followed by the same letter of the alphabet are not significantly different according to Duncan's Multiple Range Test at the 5% level.

5 No data recorded.

Table 2. Effect of EL-222 and sulfur on powdery mildew control and potato production in a trial conducted in 1977.

Treatment and Active Ingredient	Rate/a	Spray interval	Total applications	Disease index[1] (0 - 10) Sept. 9	% lb U.S. No. 1 tubers	Yield cwt/a
Norgold Russet variety						
EL-222 EC-12.5% ai-1 lb ai/gal	30 g	2 wk	7[2]	1 c[4]	73 a	726 a
EL-222 EC-12.5% ai-1 lb ai/gal	60 g	2 wk	7[2]	1 c	69 a	719 a
EL-222 EC-12.5% ai-1 lb ai/gal	30 g	4 wk	4[3]	2 c	69 a	711 a
EL-222 EC-12.5% ai-1 lb ai/gal	60 g	4 wk	4[3]	2 c	71 a	682 a
Sulfur flowable - 6 lb ai/gal	3 lb	2 wk	7[2]	4 b	71 a	624 a
Unsprayed Control	--	--	-	9 a	65 a	479 b
Kennebec variety						
EL-222 EC-12.5% ai-1 lb ai/gal	30 g	2 wk	7[2]	1 c	73 a	799 a
EL-222 EC-12.5% ai-1 lb ai/gal	60 g	2 wk	7[2]	1 c	68 a	682 ab
EL-222 EC-12.5% ai-1 lb ai/gal	30 g	4 wk	4[3]	1 c	75 a	661 ab
EL-222 EC-12.5% ai-1 lb ai/gal	60 g	4 wk	4[3]	1 c	74 a	719 ab
Sulfur flowable - 6 lb ai/gal	3 lb	2 wk	7[2]	5 b	72 a	697 ab
Unsprayed Control	--	--	-	7 a	78 a	472 c

[1] Disease index: 0=no powdery mildew; 10=severe systemic infection, lower leaf drop and death.

[2] Sprayed on June 21, July 6, July 20, August 2, August 16, August 26 and September 8.

[3] Sprayed on June 21, July 20, August 16 and September 8.

[4] Vertical means of the same letter of the alphabet are not significantly different according to Duncan's Multiple Range Test at the 5% level.