

**POTATO** (*Solanum tuberosum*)

**Early Blight;** *Alternaria solani*

**Late Blight;** *Phytophthora infestans*

**Black Scurf;** *Rhizoctonia solani*

**Silver Scurf;** *Helminthosporium solani*

**Pink Rot;** *Phytophthora erythroseptica*

R. V. James and W. R. Stevenson

Department of Plant Pathology

University of Wisconsin-Madison

Madison, WI 53706

#### **EVALUATION OF THE EFFECT OF FOLIAR FUNGICIDES ON POTATO STORAGE**

**QUALITY, 2001:** A field trial was conducted at the Hancock Agricultural Research Station in central Wisconsin during the summer of 2001 to evaluate the efficacy of 63 foliar fungicide treatments to control early and late blight on Russet Burbank potatoes. Fungicide treatments were applied at weekly intervals from 20 Jun to 22 Aug, according to treatment protocol, for a total of 9 weeks. Tubers were harvested and graded 17-20 Sep 2001 and, for selected treatments, a 30-40 pound sample was stored from each replicate plot. Any diseased tubers observed were discarded during the grading process and recorded as culls. Stored tubers included a mix of sizes from the four middle size grades, ranging from 4-16 oz. Tubers were placed in the potato storage area at the Hancock Agricultural Research Station, maintained at approximately 50° F and 90% RH until evaluation on 13 Mar 2002. All tubers were rated for presence or absence of symptoms of late blight, soft rot, pink rot, silver scurf, black scurf and early blight.

**Table 1. Hancock Fungicide Trial, 2001 - Effect of treatment on relative AUDPC, yield and quality after storage.**

Treatment, rate/acre formulated product (and active ingredient in [ ]) and schedule summary <sup>1</sup>	Relative AUDPC <sup>2</sup>			Yield (cwt/A)		% of tubers with:							Silver scurf index <sup>3</sup>	Rhizoc-tonia index <sup>4</sup>
	Early blight	Late blight	Com-bined	Total	US#1	No symp-toms	Late blight	Soft rot	Pink rot	Silver scurf ONLY	Rhizoc-tonia ONLY	Early blight		
1 Untreated .....	0.243	0.0121	0.311	437.9	203.4	66.8	0.0	8.7	0.0	23.2	3.5	0.0	16.0	2.2
BAS 510F 70 WG 0.21 lb [0.15 lb] A,C,E,G,I														
4 + Acrobat 50 WP 0.4 lb [0.2 lb] C,E,G,I .....	0.045	0.0064	0.110	518.0	241.7	76.6	0.0	9.3	0.0	13.6	0.7	0.0	7.3	1.6
Bravo WS 0.75 pt [0.56 lb] A-C; Reason 0.34 pt [0.18 lb] +														
6 Bond 0.25 pt + Scala 0.64 pt [0.27 lb] D-J .....	0.090	0.0000	0.141	476.8	213.5	60.5	0.0	22.3	0.0	15.9	0.4	1.2	16.0	0.9
Bravo WS 1.5 pt [1.13 lb] A,C,E,J; Quadris 2.08 SC 0.38 pt [0.1														
7 lb] B; 0.76 pt [0.2 lb] D,F; Bravo WS 1.5 pt [1.13 lb] +														
Previcur 1.0 pt [0.75 lb] G-I .....	0.031	0.0000	0.051	505.9	205.7	72.7	0.0	1.5	0.0	24.8	3.5	0.6	16.5	1.9
Bravo Zn 4.17 F 2.13 pt [1.11 lb] A,C,E,G,I,J; Quadris 2.08 F														
8 0.38 pt [0.1 lb] B,D,F,H .....	0.055	0.0000	0.087	503.3	200.9	64.0	0.0	0.8	0.0	34.5	0.0	0.7	22.5	0.0
Bravo Zn 4.17 F 2.13 pt [1.11 lb] A,C,E,G-J; Quadris 2.08 F														
9 0.38 pt [0.1 lb] B,D,F .....	0.047	0.0000	0.077	509.8	216.7	72.9	0.0	8.5	0.0	16.1	2.3	0.6	9.8	1.9
Confidential P-1 0.18 lb [0.027 lb] + Confidential P-2 0.38 pt														
17 [0.1 lb] + Induce 0.13% (v/v) A-J .....	0.088	0.0000	0.146	488.2	199.4	59.8	0.0	5.9	0.0	34.1	13.6	0.0	17.3	12.5
Dithane Rainshield 1.5 lb [1.13 lb] A,C,E; Quadris 2.08 SC														
25 0.38 pt [0.1 lb] B; 0.76 pt [0.2 lb] D,F; Dithane Rainshield														
1.5 lb [1.13 lb] + Previcur 1.0 pt [0.75 lb] G-I; Dithane														
Rainshield 2.0 lb [1.5 lb] J .....	0.074	0.0000	0.124	486.3	195.4	59.2	0.0	5.2	0.0	34.9	0.8	0.7	24.5	2.5
Dithane Rainshield 2.0 lb [1.5 lb] A,C; Quadris 2.08 SC 0.38 pt														
26 [0.1 lb] B,D,F; Gavel 75 WG 2.0 lb [1.5 lb] E, G-J .....	0.045	0.0000	0.073	493.4	195.2	73.5	0.0	5.7	0.0	20.1	0.6	0.6	16.5	0.6
Echo Zn 4.17F 2.13 pt [1.11 lb] A,B; Echo Zn 4.17F 2.13 pt														
29 [1.11 lb] + Curzate 60DF 0.35 lb [0.21 lb] C-J .....	0.155	0.0000	0.220	469.5	220.9	66.5	0.0	1.9	0.0	31.6	2.3	0.0	19.0	2.2
Echo Zn 4.17F 2.13 pt [1.11 lb] A-J .....	0.132	0.0000	0.193	479.8	202.1	61.1	0.0	21.1	0.0	17.4	1.6	0.0	16.0	1.9
Equus 82.5 DF 1.4 lb [1.16 lb] A,C,E,G-J; Quadris 2.08 SC														
31 0.38 pt [0.1 lb] B,D,F .....	0.057	0.0004	0.093	503.3	229.8	73.6	0.0	4.8	0.0	19.8	2.8	1.0	12.0	1.9
Headline (BAS 500 00F) 0.38 pt [0.1 lb] A,C,E,G,I .....	0.070	0.0028	0.139	495.9	204.1	67.0	0.0	4.3	0.0	26.0	7.9	1.6	15.3	7.2
Headline (BAS 500 00F) 0.38 pt [0.1 lb] A-J .....	0.080	0.0000	0.116	491.2	172.3	63.3	0.0	7.8	0.0	28.5	1.4	0.4	19.8	1.3
Headline 0.76 pt [0.2 lb] A,D,G,J; BAS 550F 50 WP 0.4 lb [0.2														
42 lb] B,E,H; Ranman 400SC 0.17 pt [0.07 lb] + Silwet L-77														
0.23 pt C,F,I .....	0.117	0.0000	0.174	467.5	186.7	81.2	0.0	1.2	0.0	16.0	2.0	1.4	5.8	0.9
KP481 50WG 0.38 lb [0.19 lb] + Manzate 75DF 1.25 lb [0.94														
43 lb] A-J .....	0.125	0.0000	0.175	494.2	191.5	80.4	0.0	1.2	0.0	16.6	2.1	0.5	10.3	4.1
KP481 50WG 0.5 lb [0.25 lb] + Manzate 75DF 1.25 lb [0.94 lb]														
44 A-J .....	0.044	0.0004	0.070	496.5	222.9	71.1	0.0	4.7	0.0	23.4	0.5	0.3	14.8	0.0
KP481 50WG 0.5 lb [0.25 lb] A,C,E,G,I; Manzate 75DF 2.0 lb														
45 [1.5 lb] B,D,F,H,J .....	0.044	0.0001	0.069	503.8	167.9	64.0	0.0	19.5	0.0	16.1	2.1	0.0	14.0	2.8
KP481 50WG 0.75 [0.38 lb] A,C,E,G,I; Manzate 75DF 2.0 lb														
46 [1.5 lb] B,D,F,H,J .....	0.079	0.0000	0.111	518.6	210.0	67.9	0.0	5.8	0.0	25.1	2.5	0.0	16.0	1.9
KQ667 68.75WG 0.75 lb [0.52 lb] A-E; 1.0 lb [0.69 lb] F-J;														
47 + Curzate 60DF 0.21 lb [0.13 lb] C-J .....	0.082	0.0003	0.122	498.3	185.2	80.3	0.0	1.1	0.0	17.6	0.3	1.1	12.0	0.9
KQ667 68.75WG 1.0 lb [0.69 lb] A-E; 1.5 lb [1.03 lb] F-J;														
48 + Curzate 60DF 0.21 lb [0.13 lb] C-J .....	0.091	0.0003	0.132	489.6	231.0	70.2	0.0	5.4	0.0	24.4	0.6	0.0	18.3	1.9
KQ667 68.75WG 1.5 lb [1.03 lb] A-J .....	0.083	0.0000	0.134	500.5	206.5	57.0	0.0	13.9	0.0	29.1	0.3	0.0	20.3	0.3
KQ667 68.75WG 2.0 lb [1.38 lb] A-J .....	0.067	0.0000	0.106	514.9	200.1	70.5	0.0	4.6	0.0	24.9	1.4	0.0	14.0	0.9
Manzate 75DF 1.5 lb [1.13 lb] A-C; Quadris 2.08 SC 0.38 pt														
54 [0.1 lb] D; Curzate 60DF 0.21 lb [0.13 lb] + Equus ZN 6F														
1.5 pt [1.13 lb] E-J .....	0.053	0.0000	0.090	504.7	170.7	58.3	0.0	21.5	0.0	17.1	5.7	0.0	12.0	7.5
Manzate 75DF 1.5 lb [1.13 lb] A-C; Quadris 2.08 SC 0.38 pt														
55 [0.1 lb] D; Curzate 60DF 0.21 lb [0.13 lb] + Super Tin 80														
WP 0.19 lb [0.15 lb] E-J .....	0.047	0.0003	0.075	520.4	214.7	59.1	0.0	10.4	0.0	28.8	6.3	0.3	14.3	9.1
Penncozeb 75 DF 1.25 lb [0.94 lb] + Bravo WS 0.75 pt [0.56 lb]														
56 A-J .....	0.126	0.0000	0.185	477.5	171.5	64.2	0.0	7.0	0.0	28.5	2.6	0.2	20.8	2.2

Treatment, rate/acre formulated product (and active ingredient in [ ]) and schedule summary <sup>1</sup>	Relative AUDPC <sup>2</sup>			Yield (cwt/A)		% of tubers with:							Silver scurf index <sup>3</sup>	Rhizoc-tonia index <sup>4</sup>
	Early blight	Late blight	Com-bined	Total	US#1	No symp-toms	Late blight	Soft rot	Pink rot	Silver scurf ONLY	Rhizoc-tonia ONLY	Early blight		
57 Penncozeb 75 DF 1.25 lb [0.94 lb] + Bravo WS 0.75 pt [0.56 lb] A,C,D,F,G,I,J; Quadris 2.08 SC 0.38 pt [0.1 lb] B,E,H.....	0.058	0.0000	0.086	509.6	201.2	71.8	0.0	6.2	0.0	19.7	4.4	0.0	7.0	5.0
58 Penncozeb 75 DF 2.0 lb [1.5 lb] A,C,D,F,G,I,J; Quadris 2.08 SC 0.38 pt [0.1 lb] B,E,H.....	0.055	0.0005	0.090	502.6	200.1	60.8	0.0	6.7	0.0	29.7	6.8	0.3	10.8	4.4
59 Phostrol 4 pt [3.35 lb] A-F; 6 pt [5.02 lb] G-J.....	0.203	0.0000	0.260	396.2	136.0	61.2	0.0	10.5	0.0	28.3	1.8	0.0	15.0	1.6
64 Ranman 400SC 0.17 pt [0.07 lb] + Headline 0.38 pt [0.1 lb] + Silwet L-77 0.23 pt A-J.....	0.059	0.0000	0.103	495.6	192.2	68.9	0.0	11.6	0.0	17.9	0.6	1.0	13.3	0.0
Pr > F <sup>4</sup> .....	<0.01	<0.01	<0.01	<0.01	0.21	0.95	---	0.88	---	0.43	0.41	0.32	0.86	0.59
LSD (P = 0.05) <sup>4</sup> .....	0.050	0.0038	0.063	48.4	NS	NS	---	NS	---	NS	NS	NS	NS	NS

- Application dates: A = 20 Jun, B = 27Jun, C = 3 Jul, D = 11 Jul, E = 18 Jul, F = 25Jul, G = 1 Aug, H = 8 Aug, I = 15 Aug, J = 22 Aug.
- Relative area under the disease progress curve. Data for each observation date were plotted on a graph and the area under the line was calculated for each treatment providing a measure of the relative severity of disease throughout the season. A disease rating of 100% foliage infection for the entire season would produce a value of 1.0. All relative AUDPC values are expressed as the proportion of this value. Either decreased disease severity or later disease development will contribute to lower relative AUDPC. Early blight AUDPC was calculated from 19 Jun-28 Aug; late blight from 26 Jun-28 Aug. Disease had progressed sufficiently that it was difficult to evaluate early blight and late blight separately for a number of plots on 4 Sep. The combined AUDPC was calculated from "combined" blight rating data (total defoliation of the plot, combining both early and late blight) from 19 Jun-4 Sep (if only early blight was seen in a plot, the rating for early blight was used in the calculation of the combined AUDPC since the total disease was equal to early blight).
- Silver scurf index: Tubers were spread out and the % of the top surface area with silver scurf symptoms was rated on a 5 point scale with 0 = none; 1 = 1-10% of the surface area of the tuber affected; 2 = 10-25% affected; 3 = 25-50% affected; 4 = 50-75% affected; 5 = > 75% affected. The lesion area index was calculated by summing the number in each class times the class number / 5 times the total number of tubers rated. The index represents a percentage of the worst possible case (if all tubers were rated 5, the index would = 100).
- Rhizoctonia index: Tubers were spread out and the severity of Rhizoctonia symptoms on the top surface was rated on a 5 point scale with 0 = none; 1 = 1-5 sclerotia; 2 = 5-10 sclerotia; 3 = 10-20 sclerotia; 4 = > 20 sclerotia. The Rhizoctonia index was calculated by summing the number in each class times the class number / 4 times the total number of tubers rated. The index represents a percentage of the worst possible case (if all tubers were rated 4, the index would = 100).
- Analysis of variance was performed on data, and Fisher's protected least significant difference (LSD) was calculated. NS = not significant at the P = 0.05 level.

**Table 2. Hancock Fungicide Trial, 2000 – Effect of treatment on internal quality of stored tubers (treatment numbers as listed in table 1).**

trt	% with no internal defects	% with any kind of internal defect	Com-bined Defect Rating <sup>1</sup>	Hollow Heart <sup>2</sup>				Internal Browning <sup>2</sup>				Black Spot/Bruising				
				% with ANY HH	% with SLIGHT HH	% MODER-ATE HH	% SEVERE HH	% with ANY IB	% with SLIGHT IB	% MODER-ATE IB	% SEVERE IB	% Bruise Free	% with 1 spot (< 1cm)	% with 1 spot (> 1cm)	% with 2-3 spots	% with > 3 spots
1	57.5	42.5	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.5	32.5	2.5	7.5	0.0
4	37.5	62.5	1.3	5.0	5.0	0.0	0.0	12.5	12.5	0.0	0.0	40.0	30.0	10.0	20.0	0.0
6	53.7	46.3	1.0	5.9	3.1	2.8	0.0	5.9	0.0	5.9	0.0	56.8	21.7	2.8	18.8	0.0
7	65.0	35.0	0.6	0.0	0.0	0.0	0.0	2.5	0.0	2.5	0.0	67.5	17.5	5.0	10.0	0.0
8	45.0	55.0	0.8	2.5	2.5	0.0	0.0	5.0	2.5	2.5	0.0	50.0	42.5	0.0	7.5	0.0
9	45.0	55.0	1.1	2.5	2.5	0.0	0.0	10.0	7.5	2.5	0.0	50.0	27.5	2.5	17.5	2.5
17	42.5	57.5	1.0	5.0	2.5	2.5	0.0	7.5	2.5	2.5	2.5	47.5	35.0	7.5	10.0	0.0
25	53.0	47.0	0.9	2.5	2.5	0.0	0.0	2.5	2.5	0.0	0.0	53.0	27.7	2.3	17.1	0.0
26	42.5	57.5	1.2	7.5	5.0	2.5	0.0	15.0	7.5	5.0	2.5	52.5	27.5	5.0	15.0	0.0
29	67.5	32.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	67.5	22.5	7.5	2.5	0.0
30	55.8	44.2	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.1	36.7	5.0	5.3	0.0
31	40.5	59.5	0.9	0.0	0.0	0.0	0.0	4.5	4.5	0.0	0.0	42.7	43.2	0.0	14.1	0.0
35	47.5	52.5	0.9	5.0	2.5	2.5	0.0	2.5	2.5	0.0	0.0	50.0	32.5	2.5	15.0	0.0
37	45.6	54.4	1.3	5.0	2.5	0.0	2.5	7.8	2.5	0.0	5.3	45.3	30.8	2.8	15.6	5.6
42	40.0	60.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0	35.0	12.5	10.0	2.5

trt	% with no internal defects	% with any kind of internal defect	Com-bined Defect Rating <sup>1</sup>	Hollow Heart <sup>2</sup>				Internal Browning <sup>2</sup>				Black Spot/Bruising				
				% with ANY HH	% with SLIGHT HH	% MODER-ATE HH	% SEVERE HH	% with ANY IB	% with SLIGHT IB	% MODER-ATE IB	% SEVERE IB	% Bruise Free	% with 1 spot (< 1cm)	% with 1 spot (> 1cm)	% with 2-3 spots	% with > 3 spots
43	50.0	50.0	0.9	0.0	0.0	0.0	0.0	5.0	5.0	0.0	0.0	52.5	30.0	2.5	15.0	0.0
44	52.5	47.5	0.8	0.0	0.0	0.0	0.0	2.5	2.5	0.0	0.0	55.0	27.5	5.0	12.5	0.0
45	31.9	68.1	1.2	0.0	0.0	0.0	0.0	3.1	0.0	3.1	0.0	35.0	36.9	10.0	18.1	0.0
46	63.2	36.8	0.5	0.0	0.0	0.0	0.0	12.5	7.5	5.0	0.0	73.2	24.3	2.5	0.0	0.0
47	60.0	40.0	0.5	2.5	2.5	0.0	0.0	2.5	2.5	0.0	0.0	60.0	37.5	0.0	2.5	0.0
48	52.5	47.5	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.5	20.0	12.5	12.5	2.5
49	57.5	42.5	0.7	0.0	0.0	0.0	0.0	5.0	2.5	2.5	0.0	60.0	25.0	7.5	5.0	2.5
50	55.0	45.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.0	37.5	5.0	2.5	0.0
54	37.5	62.5	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.5	37.5	7.5	12.5	5.0
55	48.6	51.4	0.7	2.5	0.0	2.5	0.0	7.8	0.0	7.8	0.0	53.9	40.8	2.8	2.5	0.0
56	43.3	56.7	0.9	0.0	0.0	0.0	0.0	2.5	2.5	0.0	0.0	45.8	30.8	13.1	10.3	0.0
57	62.5	37.5	0.6	2.5	2.5	0.0	0.0	2.5	2.5	0.0	0.0	65.0	22.5	2.5	10.0	0.0
58	56.1	43.9	0.6	0.0	0.0	0.0	0.0	2.5	2.5	0.0	0.0	58.6	31.6	0.0	9.8	0.0
59	37.5	62.5	1.0	2.5	2.5	0.0	0.0	5.0	5.0	0.0	0.0	42.5	32.5	12.5	12.5	0.0
64	60.0	40.0	0.8	2.5	2.5	0.0	0.0	12.5	7.5	5.0	0.0	72.5	10.0	5.0	12.5	0.0
Pr>F <sup>3</sup>	0.34	0.34	0.07	0.25	0.60	0.65	0.48	< 0.01	0.04	0.03	0.03	0.30	0.41	0.18	0.21	0.71
LSD	NS	NS	0.6*	NS	NS	NS	NS	8.5	6.8	4.8	2.4	NS	NS	NS	NS	NS

1. The worst possible rating would be 10. Hollow heart and internal browning categories given values of 1(slight), 2 (moderate), 3 (severe); bruising categories given values of 1 (1 spot<1cm) to 4 (> 3 spots). Combined defect rating = sum of Hollow heart, int. browning and bruising values//10 (the worst defect value a tuber could have if hh=3, ib=3 and bruise=4).
2. Hollow heart and internal browning evaluation: slight – longest dimension < 1 cm; moderate 1-2 cm; severe > 2cm.
3. Analysis of variance was performed on data, and Fisher’s protected least significant difference (LSD) was calculated. NS = not significant at the P = 0.05 level.