Use of Fosphite for the Control of Late Blight and Pink Rot in Potatoes

Performed for J.H. Biotech

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Study Title: Use of Fosphite for the Control of Late Blight and Pink Rot in Potatoes.

Soil Type: Silt Loam (34% sand, 56% silt, 10% clay) **Previous Crop:** Potatoes

Soil Chemical Properties (0-12"):

Soil Depth	pH	Ppm P	Ppm K	% O.M.	Ppm NO_3-N
0-12	7.8	19	143	2.8	24

Site Preparation: April 12, 50 gal/a Sectagon soil fumigant. Fertilized May 1 (190 lb/A N, 330 lb/A P_2O_5, 230 lb/A K and 90 lb/A S), disced, and packed.

Plant Variety: Ranger Russet **Planting Date:** May 17

Row Spacing: 34 inches **Plant Spacing:** 12 inches apart, 6 inches deep

Plot Size: 4 rows, 30 feet long

Seed Treatment: Machine cut and treated with Maxim

Plot Design: Randomized complete block design, 4 replications

Insecticides: Leverage foliar applied two times during season.

Herbicides: Matrix (1.5 oz/A)

Fungicide Applications: Custom built research sprayer using Teejet XR 8004VS nozzles. Fungicides applied in 40 gallons of water. Applications initiated prior at row closure and repeated weekly until the last application (two week interval).

Irrigation Type: Linear

Fertilization: 120 lb/A N injected with irrigation during growing season.
Liquid Micro mix applied by ground June 25.

Vine Kill: Vines were flailed prior to harvest.

Harvest: Middle two rows of each plot on October 6 using a single row harvester. Potatoes were laid on ground and 20 ft of row gathered for sample.

Grade: Tuber weights determined by hand grading December 15 (Tuber weight and grade classes: <4 oz, malformed, 4-6 oz US1, 4-6 US2, 6-10 US1, 6-10 US2, >10 US1, and >10 US2). Percentage of tubers with late blight symptoms also recorded.

Materials and Methods

Plots were established at Kootenai Valley Farm and Research in cooperation with Mike Hubbard on May 17. Details of plot establishment, maintenance, and harvest are listed on the preceding page. Foliar fungicide applications were initiated just prior to row closure on July 29. At the same time, "spreader rows" were inoculated with *Phytophthora infestans* (US-8) from laboratory cultures and from infected leaves obtained from the Columbia Basin of Washington.

Foliar severity of late blight and early blight was assessed on September 15. The percentage of each plot affected by late blight was estimated, and five plant stems from different plants were evaluated for the number of late blight stem lesions. For early blight severity, 10 leaves were chosen in each plot, and the number of early blight lesions was counted on 6 leaflets per leaf. Small, upper leaves and older, senescing lower leaves were not used for this measurement. The average number of lesions per leaf was determined. Each plot was also given a "health" measurement. The health measurement was a subjective score on a 0-10 scale where 0 = completely dead plants and 10 = perfectly healthy plants.

Tubers from the middle two rows of each plot were lifted from the soil on October 6 using a single row lifter. Potatoes were laid on ground and 20 ft of row per plot was collected for yield, grade, and tuber blight evaluation. Tubers were washed and graded by hand on October 31. After grading, tubers were placed back in storage, and then evaluated for late blight incidence on December 15. For pink rot challenge tests, 15 healthy US#1 tubers were retained.

Tubers were inoculated with a mefenoxam-sensitive isolate (PR01-21) and a mefenoxam-resistant isolate (PR01-1b) of *Phytophthora erythroseptica* on December 22. A suspension of zoospores (20,000 zoospores/ml) was used for inoculation. A circular filter paper was dipped into the zoospore suspension and then placed on the bud end of each tuber. Each filter paper absorbed approximately 30 µl of suspension, placing approximately 600 zoospores in contact with the bud end of each tuber. Tubers were then wrapped with saturated paper towels and placed in a large plastic bag and stored at 59°F. Tubers were evaluated 14 days after inoculation by slicing each tuber longitudinally. After slicing, tubers were allowed to sit for 30 minutes, and then the percentage of tuber tissue affected by *P. erythroseptica* was estimated. These data were used to calculate pink rot incidence and severity.

All data were summarized using Microsoft Excel and statistics were performed on raw data using the SAS software package. Analysis of variance (ANOVA) was performed for all variables using both $P<0.05$ and $P<0.10$ for determination of statistical difference. When the treatment factor was statistically significant, Fisher's protected LSD was employed to separate treatment means.

Results and Discussion

Late blight pressure was relatively low this season due to high summer temperatures. As a result, the control did not reach complete defoliation by then end of the season. All fungicide treatments resulted in significant reduction in late blight as measured by foliar blight, stem blight, and tuber blight (Table 1). Very high levels of tuber blight were present in the untreated control (22%). Late blight was not visible in treatment 5 (Dithane), but some tuber blight was found in storage. This is not surprising. In previous years, tuber blight has been found with less than 1% blight severity in plots. Lesions down inside the canopy can sometimes escape visual detection, but still lead to tuber infection.

Plots showed severe early blight pressure. Surprisingly, the treatment with Quadris did not result in a significant reduction of disease. Both treatments containing Fosphite resulted in a significant reduction in early blight severity compared to the untreated control. While Fosphite may not have any direct fungicidal activity on Alternaria, phosphorous acid is known to activate systemic acquired resistance in plants. Additionally, the Fosphite could have provided some added fertility that could have indirectly resulted in reduced early blight severity.

The pink rot challenge tests were not as effective as expected. Tubers from the untreated control typically have over 75% of the tubers infected (incidence) following inoculation. However, incidence values of 25 and 24% were observed with mefenoxam-sensitive (MS) and mefenoxam-resistant (MR) isolates, respectively. For the MS isolate, fungicide treatments did not significantly influence incidence. Disease severity was higher for treatments 3 and 4. The reasons for this are unknown. Applications of Fosphite did result in a significant reduction in pink rot incidence for the MR isolate. Severity was not influenced. Results from the MR isolate

ANOVA did not indicate a significant treatment effect for most of the yield categories, but differences were observed for US#2 6-10 oz. tubers (Table 2). The straight Fosphite treatment resulted in more tubers in that category. The average total and marketable yields for this trial were 422 and 378 cwt/A, respectively. The average percentage of US#1 tubers was 86% and the average percentage of culls was 5%.

No apparent phytotoxicity was observed with any of the treatments.

Table 1. Selected evaluations from the J. H. Biotech trial; Bonners Ferry, ID, 2003.

	Treatment	Rate/acre	Timing[1]	Late Blight Foliar[2]	Late Blight Stem[3]	Late Blight Tuber[4]	Early Blight[5]	General Health[6]	Pink Rot – MS Incidence[7]	Pink Rot – MS Severity[8]	Pink Rot – MR Incidence	Pink Rot – MR Severity
1	UTC	N/A	N/A	14.3 a	3.4 a	22.3 a	18.0 ab	5.8	25	30 a	24 a	48
2	Fosphite	10 pt	A-G	0.3 b	0.0 b	0.0 b	8.1 c	5.8	25	30 a	7 b	29
3	Fosphite	10 pt	ACE	0.8 b	0.3 b	0.3 b	7.4 c	7.5	20	65 b	4 b	12
	Quadris	6.2 fl oz	B									
	Dithane	2.0 lb	DF									
4	Dithane	2.0 lb	ACDEFG	0.5 b	0.1 b	0.8 b	19.1 a	7.5	38	70 b	27 a	53
	Quadris	6.2 fl oz	B									
5	Dithane	2.0 lb	A-F	0.0 b	0.0 b	0.3 b	11.9 bc	7.5	NT	NT	NT	NT
	LSD (0.05)			9.1	1.9	15.2	6.8	NS	NS	**	NS	NS
	LSD(0.10)			7.4	1.6	12.4	5.6	NS	NS	**	**	NS

[1] Sequential application number. Dates and weather data are as follows:

	A	B	C	D	E	F	G
Date	July 29	August 5	August 12	August 20	August 28	September 3	September 19
Time	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.
Air Temp (°C)	21	16	19	21	14	20	14
RH (%)	44	66	51	48	67	47	71
Dew presence	no	no	no	no	no	no	no

[2] Average percentage of plot affected by late blight.
[3] Average number of late blight stem lesions.
[4] Percentage of harvested tubers with late blight symptoms.
[5] Average number of early blight lesions per leaf (6 leaflets evaluated from 10 leaves).
[6] Rated subjectively on a 0-10 scale where 0 = completely dead and 10 = perfect plant health.
[7] Percentage of tubers (out of 15) developing symptoms after inoculation with *P. erythroseptica.*
[8] Average of internal flesh discolored by apparent *P. erythroseptica* infection. Average does not include tubers that did not become infected.
**Due to missing values, LSD values could not be calculated. Means were separated based on linear contrasts.

Table 2. Tuber grade data from the J.H. Biotech trial: Bonners Ferry, ID, 2003.

			US#1			US#2			Total	Market		
Trt	< 4	Culls	4-6 oz	6-10 oz	>10 oz	4-6 oz	6-10 oz	>10 oz	yield	yield	% US#1	% Culls
1	3.6	3.0	5.0	9.7	33.7	0.4	1.9 b	1.9	429	381	91.2	5.0
2	2.0	2.2	4.2	9.3	33.6	0.6	3.5 a	4.2	431	401	84.2	3.9
3	2.3	4.1	4.0	11.9	24.7	0.4	1.7 b	9.0	421	375	78.8	5.9
4	2.6	1.0	3.1	14.6	40.2	0.5	1.1 b	3.9	485	459	91.0	1.6
5	2.7	3.3	5.4	13.7	33.3	0.9	1.4 b	3.7	466	423	90.1	5.3
LSD(0.05)	NS	NS	NS	NS	NS	NS	1.4	NS	NS	NS	NS	NS
LSD(0.10)	NS	NS	NS	NS	NS	NS	1.1	NS	NS	NS	NS	NS

Appendix 1. Raw data from J.H. Biotech trial.

		Foliar	Stem			Tuber			US#1 Tubers			US#2 Tubers			Total	Market	%	%
Trt	Rep	LB	LB	Health	EB	blight	<4	Culls	4_6	6_10	>10	4_6	6_10	>10	Yield	Yield	US1	Culls
1	1	5	2.4	8	16.5	8.2	1.7	8.2	4.1	7.2	37.7	1	2.5	0	453.0	381.2	93.3	13.1
2	1	1	0	5	5.7	0.0	1.6	0.4	2.6	5.5	33.8	1	3.2	3.8	376.8	362.3	84.0	0.8
3	1	1	0.4	7	13.6	0.0	2.1	2.2	1.3	6.9	21.6	1	2.8	11.5	358.6	327.4	66.1	4.5
4	1	0	0	7	17.8	1.1	1.9	0.6	1.2	10.8	51.6	0.3	1	5.3	527.8	509.7	90.6	0.8
5	1	0	0	7	19.6	0.0	3.3	2	4.4	10.9	24.1	0	1	0	331.8	293.3	97.5	4.4
1	2	20	6.8	4	11.0	47.9	3.8	1.5	3.4	8	55.9	0	1.5	0	538.0	499.5	97.8	2.0
2	2	0	0	5	5.9	0.0	2.6	4.6	6.7	8.9	15.9	1.2	4.4	4.8	356.5	304.2	75.2	9.4
3	2	1	0.2	5	7.1	0.0	3.3	0	10	22.3	10.1	0.2	1.1	0.8	347.0	323.1	95.3	0.0
4	2	1	0	7	18.0	0.0	3	1.7	4.9	21.4	35.5	0.9	0.6	1.2	502.4	468.3	95.8	2.5
5	2	0	0	8	6.0	0.0	3.7	5.4	5	19	22	2.7	2.4	6.2	482.1	416.0	80.3	8.1
1	3	30	4	4	22.3	32.9	4.3	0.8	7.6	10.5	15.6	0.4	1.7	4.2	327.4	290.4	84.3	1.8
2	3	0	0	7	11.0	0.0	2.9	3	5.5	15.3	35.8	0.3	2.8	1.2	485.0	442.1	92.94	4.49
3	3	1	0.4	9	3.2	1.0	2.1	0.2	3.3	12.8	27.9	0.5	2.5	12.7	450.1	433.4	73.70	0.32
4	3	0	0	7	15.3	1.9	1.9	1.2	1.9	12.2	27.7	0	2.6	7.5	399.3	376.8	80.54	2.18
5	3	0	0	7	11.5	1.2	1.9	4.4	5.5	13.4	34.7	0.6	0.9	5.3	484.2	438.5	88.74	6.60
1	4	2	0.2	7	22.1	0.0	4.6	1.6	4.8	13	25.6	0	1.8	3.4	397.8	352.8	89.30	2.92
2	4	0	0	6	9.9	0.0	1	0.6	1.8	7.4	48.7	0	3.6	6.8	507.5	495.9	84.77	0.86
3	4	0	0	9	5.5	0.0	1.5	13.8	1.3	5.5	39.2	0	0.4	11	527.8	416.7	80.14	18.98
4	4	1	0.2	8	25.3	0.0	3.4	0.6	4.5	13.8	46.1	0.6	0	1.4	511.1	482.1	96.99	0.85
5	4	0	0	8	10.7	0.0	1.7	1.5	6.6	11.4	52.2	0.3	1.2	3.1	566.3	543.0	93.85	1.92