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Seed Treatment Trials 2008-2009.

W. W. Kirk, R. L Schafer and P. Tumbalam
Department of Plant Pathology, Michigan State University, East Lansing, MI 48824

Seed treatments and seed plus foliar treatments for control of seed- and soil-borne Rhizoctonia, 2008.

Potatoes with *Rhizoctonia solani* (black scurf), 2- 5% tuber surface area infected, were selected for the trials. Potato seed was prepared for planting by cutting and treating with fungicidal seed treatments two days prior to planting. Seed were planted at the Michigan State University Muck Soils Experimental Station, Bath, MI on 4 Jun into two-row by 20-ft plots (ca. 10-in between plants to give a target population of 50 plants at 34-in row spacing) replicated four times in a randomized complete block design. The two-row beds were separated by a five-foot unplanted row. Dust formulations were measured and added to cut seed pieces in a Gustafson revolving drum seed treater and mixed for two minutes to ensure even spread of the fungicide. Fungicides applied as pre-planting potato seed liquid treatments were applied in water suspension at a rate of 0.2 pt/cwt onto the exposed seed tuber surfaces, with the entire seed surface being coated in the Gustafson seed treater. In-furrow at-planting applications were delivered at 8 pt H2O/A in a 7" band using a single XR11003VS nozzle at 30 p.s.i. Foliar applications were applied with a R&D spray boom delivering 25 gal/A (80 p.s.i.) and using three XR11003VS nozzles per row. Fertilizer was drilled into plots before planting, formulated according to results of soil tests. Additional nitrogen (final N 28 lb/A) was applied to the growing crop with irrigation 45 DAP (days after planting). Previcur Flex was applied at 0.7 pt/A on a seven-day interval, total of four applications, starting one day after inoculation of adjacent plots with *Phytophthora infestans*. Weeds were controlled by hilling and with Dual 8E at 2 pt/A 10 DAP, Basagran at 2 pt/A 20 and 40 DAP and Poast at 1.5 pt/A 58 DAP. Insects were controlled with Admire 2F at 1.25 pt/A at planting, Sevin 80S at 1.25 lb/A 31 and 55 DAP, Thiodan 3 EC at 2.33 pt/A 65 and 87 DAP and Pounce 3.2EC at 8 oz/A 48 DAP. Vines were killed with Reglone 2EC (1 pt/A on 20 Sep). Plots (20-ft row) were harvested on 16 Oct and individual treatments were weighed and graded. Four plants per plot were harvested 10-days after the final treatment application (13 Jul) and the percentage of stems and stolons with greater than 5% of the total surface area were counted. An index of below ground health was evaluated 35 DAP on a scale of 0 - 5 where 0 = no symptoms of stem canker, 1 = 1 – 5%, 2 = 6 – 10%, 3 = 11 – 20%, 4 = 21 – 50%, 5 = 50 – 100% of the surface of roots, stolons and stem affected by Rhizoctonia. Samples of 50 tubers per plot were harvested 14 days after desiccation and assessed for black scurf (*R. solani*) incidence (%) and severity 40 days after harvest. Severity of black scurf was measured as an index calculated by counting the number of tubers (n = 50) falling into each class 0 = 0%; 1 = 1 - 5%; 2 = 6 -10%; 3 = 11 - 15; 4 >15% surface area of tuber covered with sclerotia. The number in each class is multiplied by the class number and summed. The sum is multiplied by a constant to express as a percentage. Indices of 0 - 25 represent 0 - 5%; 26 - 50 represent 6 - 10%; 51 - 75 represent 11 - 15% and 75 - 100 >15% surface area covered with sclerotia. Meteorological variables were measured with a Campbell weather station located at the farm, latitude 42.8269 and longitude -84.365deg. Maximum, minimum and average daily air temperature (^{o}F) were 81.2, 25.3 and 53.1 and 0-d with maximum temperature >90^{o}F (May); 91.9, 39.6 and 66.7 and 1-d with maximum temperature >90^{o}F (Jun); 89.9, 38.3 and 68.5 and 0-d with maximum temperature >90^{o}F (Jul); 87.9, 35.5 and 65.6 and 0-d with maximum temperature >90^{o}F (Aug); 91.7, 33.3 and 59.3 and 1-d with maximum temperature >90^{o}F (Sep). Maximum, minimum and average daily soil temperature (^{o}F) were 78.0, 41.4 and 58.1 (May); 81.6, 52.6 and 67.7 (Jun); 82.2, 55.8 and 71.1 (Jul); 85.7, 55.2 and 71.4 (Aug); 81.8, 51.6 and 65.3 (Sep). Maximum, minimum and average soil moisture (% of field capacity) 80.2, 74.0 and 76.6 (May); 91.1, 73.5 and 81.5 (Jun); 100.8, 77.0 and 83.2 (Jul); 97.0, 76.5 and 81.0 (Aug); 123.1 (flooding), 76.6 and 84.3 (Sep). Precipitation was 1.08 in. (May), 3.59 in. (Jun), 3.69 in. (Jul), 1.56 in. (Aug) and 7.02 in. (Sep). Plots were irrigated to supplement precipitation to about 0.1 in./A/4 day period with overhead sprinkle irrigation.

No treatment affected final plant stand. Seven treatments resulted in significantly improved seed emergence rates 31 DAP (RAUEPC values greater than 14.2) compared to the untreated check (RAUEPC = 9.4). Marketable yield and total ranged from 236 to 324 cwt/A (untreated check = 255 cwt/A) and 265 to 354 cwt/A (untreated check = 288 cwt/A), respectively, but no treatments were significantly different from the untreated check or from the standard commercial seed treatment Maxim FS. No treatment affected the total number of stolons or stem number per plant. Treatments with less than 51.6% incidences of stems with >5% girdling due to Rhizoctonia stem canker were significantly different from the untreated check. No treatments had significantly less stolon canker incidence in comparison to Maxim FS or the untreated check. Treatments resulting in less than 42.5% incidence of tubers with black scurf were significantly lower than the untreated check. Treatments with less than 38.8% incidence of tubers with black scurf were not significantly different from Maxim FS. Treatments with less than 19.1% severity index of tubers with black scurf were significantly lower than the untreated check (29.4%). Treatments with less than 16.3% severity index of tubers with black scurf were not significantly different from Maxim FS (6.3%). Seed treatments and seed treatment plus fungicide applications of fungicides were not phytotoxic.

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Treatment and rate/1000 row feet and rate/cwt potato seed	Final plant stand (%)		RAUEPC[z]		Yield (cwt/A) US1		Yield (cwt/A) Total	
Maxim 4FS 0.16 fl oz/cwt (A[y])…	84.5	a[x]	11.1	bcd	278	a	310	a
LEM 17 200EC 0.67 fl oz (B)….....	89.0	a	15.1	ab	257	a	286	a
LEM 17 200EC 1.15 fl oz (B)….....	90.5	a	16.6	a	324	a	354	a
LEM 17 200EC 1.6 fl oz (B)……..	91.5	a	14.2	abc	290	a	321	a
LEM 200SC 1.6 fl oz (B)……	87.5	a	13.6	a-d	280	a	311	a
Quadris 2.08SC 0.4 fl oz (B)……..	87.0	a	14.6	ab	286	a	316	a
Evito 4FL 0.26 fl oz (B)…….....	88.0	a	16.9	a	293	a	325	a
BUPOT-1 3.4SC 0.3 fl oz/cwt (A)..	85.5	a	13.2	a-d	317	a	351	a
BUPOT-1 3.4SC 0.5 fl oz/cwt (A)..	89.5	a	12.2	bcd	305	a	337	a
BUPOT-3 3.4SC 0.3 fl oz/cwt (A)..	91.0	a	15.2	ab	264	a	296	a
BUPOT-3 3.4SC 0.5 fl oz/cwt (A)..	85.5	a	10.4	cd	286	a	319	a
BUPOT-5 3.4SC 0.3 fl oz/cwt (A)..	85.0	a	11.3	bcd	254	a	288	a
BUPOT-5 3.4SC 0.5 fl oz/cwt (A)..	89.0	a	10.3	cd	236	a	265	a
BUPOT-7 3.4SC 0.3 fl oz/cwt (A)..	87.5	a	13.0	a-d	270	a	306	a
BUPOT-7 3.4SC 0.5 fl oz/cwt (A)..	88.0	a	13.5	a-d	275	a	307	a
WE1042-1 6DS 0.75 lb/cwt (A)…..	91.0	a	14.4	abc	252	a	284	a
WE1043-1 6DS 0.75 lb/cwt (A)…..	84.5	a	13.4	a-d	270	a	309	a
WE1044-1 6DS 0.75 lb/cwt (A)…..	89.5	a	12.8	a-d	275	a	305	a
Untreated Check…….....	68.0	a	9.4	d	255	a	288	a
$HSD_{0.05}$	14.18		4.26		59.6		61.0	

Treatment and rate/1000 row feet and rate/cwt potato seed[z]	Stems (35 DAP) Number	Stems (35 DAP) Percent infected[w]	Stolons (35 DAP) Number/plant	Stolons (35 DAP) Girdling[v] > 5%	Root and lower stem canker index 35 DAP[u] (0 – 5)	Tuber black scurf Incidence (%)	Tuber black scurf Severity scale (0 - 100)
Maxim 4FS 0.16 fl oz/cwt (A)……	3.8	31.7 d-g	8.4	6.5 a	1.7 a-e	20 f	6.3 d
LEM 17 200EC 0.67 fl oz (B)….....	3.6	29.5 d-g	7.3	4.5 a	1.3 c-e	35 b-f	12.8 cd
LEM 17 200EC 1.15 fl oz (B)….....	4.1	42.0 cde	7.1	12.4 a	1.5 b-e	42.5 bcd	16.3 bcd
LEM 17 200EC 1.6 fl oz (B)…….	3.8	34.3 def	7.8	9.9 a	1.3 cde	21.3 ef	7.2 d
LEM 200SC 1.6 fl oz (B)……..	3.9	21.0 fg	8.9	7.0 a	1.0 e	37.5 b-f	15.3 bcd
Quadris 2.08SC 0.4 fl oz (B)…….	4.3	16.7 g	9.4	7.6 a	1.1 de	33.8 b-f	12.8 cd
Evito 4FL 0.26 fl oz (B)…….....	3.6	24.3 fg	7.7	7.8 a	1.0 e	26.3 def	12.2 cd
BUPOT-1 3.4SC 0.3 fl oz/cwt (A).	4.4	26.8 e-g	7.6	4.1 a	1.4 b-e	22.5 ef	8.8 cd
BUPOT-1 3.4SC 0.5 fl oz/cwt (A).	4.2	63.1 ab	7.1	19.8 a	2.1 ab	25 def	9.1 cd
BUPOT-3 3.4SC 0.3 fl oz/cwt (A).	3.9	51.6 bc	7.8	8.7 a	1.9 a-d	38.8 b-f	14.7 bcd
BUPOT-3 3.4SC 0.5 fl oz/cwt (A).	4.1	55.3 abc	6.9	7.5 a	1.7 a-e	26.3 def	10.0 cd
BUPOT-5 3.4SC 0.3 fl oz/cwt (A).	3.6	33.0 d-f	8.0	4.2 a	1.7 a-e	36.3 b-f	13.8 bcd
BUPOT-5 3.4SC 0.5 fl oz/cwt (A).	4.3	40.9 c-e	7.7	6.3 a	2.3 a	32.5 b-f	12.8 cd
BUPOT-7 3.4SC 0.3 fl oz/cwt (A).	4.2	44.0 cd	8.4	10.5 a	2.0 abc	28.8 c-f	8.8 cd
BUPOT-7 3.4SC 0.5 fl oz/cwt (A).	4.2	33.2 d-f	8.3	9.3 a	1.9 a-d	40 b-e	14.1 bcd
WE1042-1 6DS 0.75 lb/cwt (A)….	3.5	42.1 cde	8.1	8.9 a	1.9 a-d	51.3 ab	24.1 ab
WE1043-1 6DS 0.75 lb/cwt (A)….	3.8	41.4 cde	7.6	11.5 a	1.8 a-d	36.3 b-f	15.0 bcd
WE1043-1 6DS 0.75 lb/cwt (A)….	3.9	30.8 d-f	8.9	9.2 a	1.7 a-e	46.3 abc	19.1 abc
Untreated Check…….....	4.6	71.7 a	9.5	15.9 a	2.3 a	65.0 a	29.4 a
$HSD_{0.05}$	1.10	15.81	1.95	10.05	0.75	19.96	10.33

[z] RAUEPC = Relative area under the emergence progress curve measured from planting to 31 days after planting

[y] Application dates: A= 4 Jun (liquid formulations for seed piece application at 0.2 pt/cwt; B= 4 Jun (in-furrow); C= 29 Jun (banded over row).

[x] Values followed by the same letter are not significantly different at $p = 0.05$ (Honest Significant Difference; Tukey Multiple Comparison).

[w] Stems with greater than 5% of area with stem canker due to *Rhizoctonia solani*.

[v] Stolons with greater than 5% of area with stolon canker due to *Rhizoctonia solani*.

[u] An index of below ground health was evaluated 35 DAP on a scale of 0 - 5 (see text)

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Seed treatments and seed plus foliar treatments for control of seed- and soil-borne Rhizoctonia, 2009.

Potatoes with *Rhizoctonia solani* (black scurf), 2- 5% tuber surface area infected, were selected for the trials. Potato seed was prepared for planting by cutting and treating with fungicidal seed treatments two days prior to planting. Seed was planted at the Michigan State University Muck Soils Experimental Station, Bath, MI on 4 Jun into two-row by 20-ft plots (ca. 10-in between plants to give a target population of 50 plants at 34-in row spacing) replicated four times in a randomized complete block design. Due to flooding (see meteorological data below) the plots were destroyed and replanted on 8 Jul. The two-row beds were separated by a five-foot unplanted row. Dust formulations were measured and added to cut seed pieces in a Gustafson revolving drum seed treater and mixed for two minutes to ensure even spread of the fungicide. Fungicides applied as pre-planting potato seed liquid treatments were applied in water suspension at a rate of 0.2 pt/cwt onto the exposed seed tuber surfaces, with the entire seed surface being coated in the Gustafson seed treater. In- furrow at-planting applications were delivered at 8 pt H2O/A in a 7" band using a single XR11003VS nozzle at 30 p.s.i. Foliar applications of Previcur Flex 0.7 pt/A + Bravo WS 6SC 1.5 pt/A were applied for maintenance on a 7-day schedule from 10 Aug to 15 Sep with a R&D spray boom delivering 25 gal/A (80 p.s.i.) and using three XR11003VS nozzles per row. Fertilizer was drilled into plots before planting, formulated according to results of soil tests. Additional nitrogen (final N 28 lb/A) was applied to the growing crop with irrigation 45 DAP (days after planting). Weeds were controlled by hilling and with Dual 8E at 2 pt/A 10 DAP, Basagran at 2 pt/A 20 and 40 DAP and Poast at 1.5 pt/A 48 DAP. Insects were controlled with Admire 2F at 1.25 pt/A at planting (except where CruiserMaxx and Valent formulations were applied), Sevin 80S at 1.25 lb/A 31 and 55 DAP, Thiodan 3 EC at 2.33 pt/A 65 DAP and Pounce 3.2EC at 8 oz/A 48 DAP. Vines were killed with Reglone 2EC (1 pt/A on 20 Sep). Plots (20-ft row) were harvested on 16 Oct however there was insufficient tuber development to justify yield analyses. Four plants per plot were harvested 105 DAP and the percentage of stems and stolons with greater than 5% of the total surface area were counted. An index of below ground health was evaluated 35 DAP on a scale of 0 - 5 where 0 = no symptoms of stem canker, 1 = 1 – 10%, 2 = 11 – 20%, 3 = 21 – 30%, 4 = 31 – 50%, 5 = 51 – 100% of the surface of roots, stolons and stem affected by Rhizoctonia calculated by adding the % incidence and % severity and dividing by 2. Samples of 20 tubers per plot were harvested 14 days after desiccation and assessed for black scurf (*R. solani*) incidence (%) and severity 40 days after harvest. Severity of black scurf was measured as an index calculated by counting the number of tubers (n = 50) falling in class 0 = 0%; 1 = 1 - 5%; 2 = 6 -10%; 3 = 11 - 15; 4 >15% surface area of tuber covered with sclerotia. The number in each class is multiplied by the class number and summed. The sum is multiplied by a constant to express as a percentage. Indices of 0 - 25 represent 0 - 5%; 26 - 50 represent 6 - 10%; 51 - 75 represent 11 - 15% and 75 - 100 >15% surface area covered with sclerotia. Meteorological variables were measured with a Campbell weather station located at the farm, latitude 42.8269 and longitude -84.365deg. Maximum, minimum and average daily air temperature (^{o}F) were 84.2, 28.9 and 55.9 and 0-d with maximum temperature >90^{o}F (May); 95.8, 35.9 and 64.9 and 2-d with maximum temperature >90^{o}F (Jun); 82.9, 40.1 and 64.2 and 0-d with maximum temperature >90^{o}F (Jul); 91.5, 37.4 and 67.0 and 2-d with maximum temperature >90^{o}F (Aug); 83.1, 31.8 and 60.4 and 0-d with maximum temperature >90^{o}F (Sep); 62.7, 23.8 and 44.5 and 0-d with maximum temperature >90^{o}F (to 15 Oct). Maximum, minimum and average daily soil temperature (^{o}F) were 68.1, 47.4 and 57.9 (May); 78.7, 55.9 and 66.6 (Jun); 73.3, 61.4 and 67.4 (Jul); 75.6, 59.7 and 69.2 (Aug); 68.4, 55.9 and 63.6 (Sep); 56.3, 45.6 and 51.8^{o}F (to 15 Oct). Maximum, minimum and average soil moisture (% of field capacity) 77.2, 62.4 and 66.9 (May); 77.0, 60.8 and 67.2 (Jun); 76.7, 58.2 and 63.7 (Jul); 75.0, 55.1 and 61.7 (Aug); 58.7, 52.1 and 54.2 (Sep); 57.4, 52.5 and 54.5^{o}F (to 15 Oct). Precipitation was 2.98 in. (May), 5.76 in. (Jun), 5.62 in. (Jul), 5.25 in. (Aug), 1.09 in. (Sep) and 1.25 in. to 15 Oct. Plots were irrigated to supplement precipitation to about 0.1 in./A/4 day period with overhead sprinkle irrigation.

The plots were flooded in Jun due to extensive rainfall. Seed tubers were treated and plots were replanted on 8 Jul after the soil had dried sufficiently. The plots flooded again in late Jul and again in mid Aug. Emergence was reduced by these events. The final plant stand in the untreated control (63.0%) was not significantly different from any of the treatments, which ranged from 63.0 to 76.5%. No significant differences in seed emergence at 31 DAP (RAUEPC values ranged from 21.5 to 31.2 with the untreated control = 21.5), were observed. Marketable yield and total yield were not measured due to insufficient development of tubers. Only Maxim had significantly greater stems/plant in comparison to the untreated control (5.0 stems/plant) and LEM17 200EC 1.63 fl oz had significantly fewer. No differences were found among the treatments in terms of stolon number per stem, which ranged from 7.6 to 10.6; (untreated control = 7.9). All treatments had significantly lower incidence of stems with >5% girdling due to Rhizoctonia stem canker in comparison to the untreated control (71.2%). All treatments had significantly less stolon canker in comparison to the untreated control (61.5%). Treatments resulting in greater than 43.3% stems/plant girdled had significantly higher canker incidence in comparison to Maxim MZ, the standard commercial seed treatment (34.4%). The overall severity index of root and lower stem canker indicated that treatments with an index value lower than 4.3 had significantly less Rhizoctonia stem and stolon canker than the untreated control (4.9). No treatments had significantly less Rhizoctonia stem and stolon canker in comparison with Maxim MZ (3.4). Two treatments (LEM17 200EC 1.63 fl oz and YT6692.08SC 0.85 fl oz) resulted in significantly lower tuber black scurf incidence than the use of Quadris. Only one treatment (Actinovate) showed no significant reduction in tuber black scurf incidence relative to the untreated control. The severity of tuber black scurf in all treatments was significantly less than in the untreated control (37.8%). No treatments were significantly different in comparison to Maxim MZ (19.7). No phytotoxicity was observed in any treatment.

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Treatment rate/cwt potato seed (A)[z] and rate/1000 row feet (B)	Final plant stand (%)	RAUEPC[y]	Stem number/plant	Stolon number/stem
LEM17 200EC 0.72 fl oz (B[x])……	70.0 a[w]	22.8 a	5.4 bc	9.9 a
LEM17 200EC 1.63 fl oz (B)…….	72.0 a	31.2 a	3.8 d	8.1 a
LEM17 200EC 3.26 fl oz (B)…….	76.5 a	28.7 a	4.7 cd	10.0 a
YT669 2.08SC 0.85 fl oz (B)…….	72.0 a	26.7 a	4.8 bcd	10.6 a
YT669 2.08SC 1.27 fl oz (B)…….	69.0 a	24.4 a	4.6 cd	10.1 a
LEM17 200EC 1.25 fl oz (A)…….	70.0 a	26.5 a	4.9 bcd	8.9 a
Quadris 2.08SC 0.576 fl oz (B)……..	71.0 a	21.9 a	5.8 b	9.2 a
Maxim MZ 10.1DS 0.5 lb (A)……	71.0 a	27.1 a	7.2 a	9.9 a
Actinovate 0.0371WP 0.103 oz (B)…	66.5 a	27.6 a	4.6 cd	7.6 a
Untreated Control……...	63.0 a	21.5 a	5.0 bc	7.9 a
$LSD_{0.05}$	7.97	8.44	1.11	2.24

Treatment rate/cwt potato seed (A)[z]	Percent stem girdling[v] >5%	Percent stolon girdling[u] > 5%	Root and lower stem canker index 35 DAP[t] (0 – 5)	Tuber black scurf Incidence (%)	Tuber black scurf Severity scale (0 - 100)
LEM17 200EC 0.72 fl oz (B)…….	39.0 cd	47.1 bc	4.1 bc	48.8 bc	17.5 bc
LEM17 200EC 1.63 fl oz (B)…….	44.8 bc	31.6 d	3.8 cd	42.5 c	14.7 c
LEM17 200EC 3.26 fl oz (B)…….	37.7 cd	31.9 d	3.8 cd	46.3 bc	19.1 bc
YT669 2.08SC 0.85 fl oz (B)…….	50.0 b	40.5 c	4.3 b	40.0 c	15.6 c
YT669 2.08SC 1.27 fl oz (B)…….	50.5 b	47.5 bc	4.3 b	47.5 bc	19.4 bc
LEM17 200EC 1.25 fl oz (A)…….	46.7 bc	49.8 b	4.3 b	47.5 bc	20.0 bc
Quadris 2.08SC 0.041 fl oz (B)……..	43.3 bcd	39.9 c	3.8 cd	57.5 b	24.1 b
Maxim MZ 10.1DS 0.5 lb (A)……	34.4 d	25.1 d	3.4 d	47.5 bc	19.7 bc
Actinovate 0.0371WP 0.103 oz (B)…	44.7 bc	27.3 d	3.8 cd	60.0 ab	23.4 b
Untreated Control……...	71.2 a	61.5 a	4.9 a	73.8 a	37.8 a
$LSD_{0.05}$	9.12	8.03	0.39	12.91	6.51

[z] Application type; rate per 1000 row ft for in-furrow applications; rate per cwt of potato seed-piece application prior to planting; liquid formulations for seed piece application at 0.2 pt/cwt.
[y] RAUEPC = Relative area under the emergence progress curve measured from planting to 31 days after planting.
[x] Application dates: A= 8 Jul (liquid formulations for seed piece application at 0.2 pt/cwt); B= 8 Jul (in-furrow).
[w] Values followed by the same letter are not significantly different at $p = 0.05$ (Fishers LSD).
[v] Stems with greater than 5% of area with stem canker due to *Rhizoctonia solani*.
[u] Stolons with greater than 5% of area with stolon canker due to *Rhizoctonia solani*.
[t] An index of below ground health was evaluated 35 DAP on a scale of 0 - 5 where 0 = no symptoms of stem canker, 1 = 1 – 10%, 2 = 10 – 20%, 3 = 21 – 30%, 4 = 31 – 50%, 5 = 51 – 100% of the surface of roots, stolons and stem affected by Rhizoctonia.