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Influence of Fungicides and Biological Products on Potato Diseases and Yukon Gold Yield and Quality

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Introduction: Effective disease management is critical to maximizing potato yield, fresh market quality, and grower profitability. This study investigated the effectiveness of fungicides and biological products for controlling *Rhizoctonia solani* (black scurf), *Colletotrichum coccodes* (black dot), and *Verticillium dahlia (*Verticillium wilt). The study was conducted at the Intermountain Research and Extension Center (IREC) in 2012. All treatments were applied to a potato crop grown in soil that was not fumigated prior to planting. A sub-set of treatments were applied to soil fumigated with metam sodium (Vapam) in the fall of 2011. Disease evaluations included incidence and severity of *Rhizoctonia* lesions on belowground stems and stolons at tuber initiation, foliar Verticillium wilt symptoms in mid-August, black dot sclerotia coverage on lower stems at vine maturity, and black scurf and black dot on tubers post-harvest. Potato stand, yield, tuber size, and tuber defects were also evaluated for all treatments. No fungicides besides those listed in the treatment list were applied to the study site.

Trial Information

Location:	IREC, Tulelake, CA
Soil Type:	Tulebasin mucky silty clay loam with 4.5% organic matter
Planting Date:	May 18, 2012
Vine Kill Date:	September 14, 2012
Days to Vine Kill:	116 days
Harvest Date:	September 28, 2012
Irrigation:	Solid-set sprinklers
Plot Size:	2 rows (6 ft) wide by 30ft long; (10 ft of plot length was used for destructive in-season sampling) (20 ft of plot length was harvested for yield)
In-Row Spacing:	9.1 inches
Row Spacing:	36 inches
Number of Reps:	6 replications
Fertilizer per acre:	232lbs N - 73lbs P_2O_5 - 16lbs K_2O - 31lbs S
Herbicides:	Matrix and metribuzin
Insecticides:	Admire Pro

Treatments and Application Timings are detailed in Table 1.

Results

Potato Stand, Yield, and Tuber Quality

Yukon Gold seed used for this trial appeared healthy at planting, but stand emergence was below normal for all treatments. Stand emergence did not exceed 86% whereas 95% is typical (Table 2). *Rhizoctonia* and a sprout inhibitor applied during seed storage appear to be the reason for poor stand emergence. Potato stand in the untreated control and biological treatments was less than 65%. In comparison, potato stand in plots treated with Maxim seed treatment and fungicides in-furrow was 86%. Maxim is known to provide good early-season *Rhizoctonia* suppression, and *Rhizoctonia* was the only pathogen recovered from seed pieces that did not emerge.

Potato yield was heavily influenced by differences in potato stand (Table 2). Fungicide treatments had a higher potato stand and higher total potato yield compared to the untreated control. Biological treatments did not increase total yield compared to the untreated control. In unfumigated plots, compost tea and fish emulsion treatments (trts 7-9) and Actinovate (trt 5) had lower potato stand and total yield compared to the untreated control. In Vapam-fumigated plots, Compost at 10 ton/A pre-plant (trt 23) and pelleted chicken manure (trt 24) had lower potato stand and total yield compared to the untreated control.

Multiple biological treatments increased the percentage of tubers with external defects (Table 3). Compost at 10 ton/A applied pre-plant and pelleted chicken manure applied pre-plant had a higher percentage of tubers with knobs in the Vapam-fumigated plots. Compost applied pre-plant in combination with compost tea + fish emulsion (trt 9) and Serenade/Optiva + Bio-Tam (trt 15) had a higher percentage of knobs in the unfumigated plots.

In-Season Disease Suppression

Compost tea + fish emulsion starting 5 weeks after planting (trt 8) and pelleted chicken manure applied pre-plant (trt 10) lowered Verticillum wilt symptoms compared the untreated control in unfumigated plots (Table 3). Compost applied at 10 tons/acre (trts 20 & 23) and pelleted chicken manure (trt 24) lowered Verticillium wilt symptoms in fumigated plots (Table 4). The reason these biological treatments showed less Verticillum wilt symptoms may be related to disease suppression or the fact these treatments had low potato stands.

All fungicide treatments (trts 11-14 and trt 21) reduced the incidence and severity of *Rhizoctonia* lesions on belowground stems and stolons compared to the untreated control (Table 4). Fungicide treatments had higher stolons per plant and root weights compared to the untreated control. There were no differences between fungicides with regard to *Rhizoctonia* suppression. Serenade Soil/ Optiva (trt 3), compost tea + fish emulsion starting 5 weeks after planting (trt 8), and pelleted chicken manure (trt 10) reduced *Rhizoctonia* lesion severity on stems and stolons compared to the untreated control in unfumigated plots (Table 3). These biological treatments did not reduce *Rhizoctonia* severity as much as fungicides. Biological treatments did not significantly reduced *Rhizoctonia* in fumigated plots (Table 4).

Suppression of Tuber *Rhizoctonia* Black Scurf and Black Dot

The incidence and severity of *Rhizoctonia* black scurf on tubers was low and variable preventing statistical differences. Numerically, pelleted chicken manure and all fungicide treatments had lower incidence and severity of black scurf on tubers compared to the untreated control (Table 5).

Fungicides did not reduce the coverage and severity of *Colletotrichum coccodes* (black dot) on tubers (Table 4). In some instances, fungicides actually increased black dot on lower stems and tubers compared to the untreated control (Table 5). Some compost tea + fish emulsion treatments had less black dot coverage on stems and tubers, but black dot incidence on tubers averaged 90% or greater for all treatments (Table 4).

Summary

Tested fungicides produced the highest yields, highest potato stands, and best suppression of *Rhizoctonia*. Serenade, pelleted chicken manure, and compost tea + fish emulsion lowered the incidence and severity of *Rhizoctonia* lesions on stems and stolons in unfumigated plots, but they were not as effective as fungicides. A similar study at IREC conducted in 2011 showed compost applied pre-plant in combination with compost tea reduced the severity of *Rhizoctonia* lesions on belowground stems. This treatment also increased potato yield compared to the untreated control in 2011, but unlike 2012, 2011 potato stands were similar across treatments. Additional research will be conducted in 2013 to evaluate biological and fungicide treatments for suppression of *Rhizoctonia solani* and *Colletotrichum coccodes.*

Table 1. 2012 Biological & FungicideTreatments & Application Timings.

Non-Fumigated Treatments			Foliar Treatment Application Times					
			5 WAP	5-15 WAP	6.5 WAP	9 WAP	12 WAP	13 WAP
Trt #	Product	Product Rate	Early Vegetative Growth	Every Two Weeks	Late Vegetative Growth	Tuber Initiation	Tuber Bulking	Tuber Bulking
1	Untreated Control							
2	Serenade in furrow *(Bacillus subtillis)*	4qt/A						
2	Optiva foliar *(Bacillus subtillis)*	16 oz/A	X			X		X
2	Actinovate in furrow *(Streptomyces lydicus)*	9 oz/A						
2	Actinovate foliar *(Streptomyces lydicus)*	9 oz/A	X			X		X
2	Superzyme in furrow *(Bacillus, Pseudomonas putida, and Trichoderma spp.)*	4qt/100 gal						
2	Superzyme foliar *(Bacillus, Pseudomonas putida, and Trichoderma spp.)*	3 qt/100 gal	X			X		X
3	Serenade in furrow *(Bacillus subtillis)*	4qt/A						
3	Optiva foliar *(Bacillus subtillis)*	16 oz/A	X			X		X
4	Superzyme in furrow *(Bacillus, Pseudomonas putida, and Trichoderma spp.)*	4qt/100 gal						
4	Superzyme foliar *(Bacillus, Pseudomonas putida, and Trichoderma spp.)*	3 qt/100 gal	X			X		X
5	Actinovate in furrow *(Streptomyces lydicus)*	9 oz/A						
5	Actinovate foliar *(Streptomyces lydicus)*	9 oz/A	X			X		X
6	Compost pre-plant	10 ton/A						
7	Compost tea in furrow	10 gal/A						
7	Compost tea foliar	5 gal/A		X				
7	BioWest Fish Plus foliar (fish emulsion)	2.5 gal/A		X				
8	Compost tea foliar	5 gal/A	X			X		X
8	BioWest Fish Plus foliar (fish emulsion)	2.5 gal/A	X			X		X
9	Compost pre-plant	10 tons/A						
9	Compost tea in furrow	10 gal/A						
9	Compost tea foliar	5 gal/A		X				
9	BioWest Fish Plus foliar (fish emulsion)	2.5 gal/A		X				
10	Nutri-Rich Pelleted Chicken Manure 4-3-3 pre-plant	3 ton/A						
11	Maxim 4FS*	0.08 oz/100 lbs seed						
11	Moncut in furrow	1.1 lb/A						
12	Maxim 4FS*	0.08 oz/100 lbs seed						
12	Moncut in furrow	1.1 lb/A						
12	Compost tea foliar	5 gal/A		X				
12	BioWest Fish Plus foliar (fish emulsion)	2.5 gal/A		X				
13	Maxim 4FS*	0.08 oz/100 lbs seed						
13	Moncut in furrow	1.1 lb/A						
13	Penthiopyrad-Vertisan foliar	20 fl oz/A				X		
14	Maxim 4FS	0.08 oz/100 lbs seed						
14	Quadris in furrow	0.6 fl. oz/1000 ft						
14	Quadris foliar 1st app.	12 fl. oz/A			X			
14	Endura foliar 2nd app.	8 oz/A				X		
14	Tanos foliar 3rd app.	8 oz/A					X	
15	Serenade in furrow *(Bacillus subtillis)*	4qt/A						
15	Optiva foliar *(Bacillus subtillis)*	16 oz/A	X			X		X
15	BIO-TAM in furrow *(Trichoderma spp.)*	3 oz/1000 ft						
15	Bio-TAM foliar *(Trichoderma spp.*)	2.5 lb/A	X			X		X

Table 1. 2012 Biological & FungicideTreatments & Application Timings continued.

Fall Vapam Fumigated Treatment List (Vapam applied in fall 2011 at 47 gal/A via rototill incorporation)			Foliar Treatment Application Times					
			5 WAP	5-15 WAP	6.5 WAP	9 WAP	12 WAP	13 WAP
Trt #	Product	Product Rate	Early Vegetative Growth	Every Two Weeks	Late Vegetative Growth	Tuber Initiation	Tuber Bulking	Tuber Bulking
16	Untreated Vapam Control							
17	Serenade in furrow *(Bacillus subtillis)*	4qt/A						
17	Optiva foliar *(Bacillus subtillis)*	16 oz	X			X		X
18	Serenade in furrow *(Bacillus subtillis)*	4qt/A						
18	Optiva foliar *(Bacillus subtillis)*	16 oz/A	X			X		X
18	BIO-TAM in furrow *(Trichoderma spp.)*	3 oz/1000 ft						
18	Bio-TAM foliar *(Trichoderma spp.*)	2.5 lb/A	X			X		X
19	Serenade in furrow *(Bacillus subtillis)*	4qt/A						
19	Optiva foliar *(Bacillus subtillis)*	16 oz/A	X			X		X
19	Actinovate in furrow *(Streptomyces lydicus)*	9 oz/A						
19	Actinovate foliar *(Streptomyces lydicus)*	9 oz/A	X			X		X
19	Superzyme in furrow *(Bacillus, Pseudomonas putida, and Trichoderma spp.)*	4qt/100 gal						
19	Superzyme foliar *(Bacillus, Pseudomonas putida, and Trichoderma spp.)*	3 qt/100 gal	X			X		X
20	Compost pre-plant	10 tons/A						
20	Compost tea in furrow	10 gal/A						
20	Compost tea foliar	5 gal/A	X	X				
20	BioWest Fish Plus foliar (fish emulsion)	2.5 gal/A	X	X				
21	Maxim 4FS	0.08 oz/100 lbs seed						
21	Moncut in furrow	1.1 lb/A						
21	Penthiopyrad-Vertisan foliar	20 fl oz/A				X		
22	Compost pre-plant	3 ton/A						
23	Compost pre-plant	10 ton/A						
24	Nutri-Rich Pelleted Chicken Manure 4-3-3 pre-plant	3 ton/A						
25	Compost tea foliar	5 gal/A	X			X		X
25	BioWest Fish Plus foliar (fish emulsion)	2.5 gal/A	X			X		X

Table 2. Influence of Fungicides and Biological Products on Yukon Gold Tuber Yield, Size, Plant Stand, and Specific Gravity at IREC in 2012.

		Tuber Yield (cwt/A)											
			U.S. No. 1's (cwt)										
Trt#	Treatment Name- Non-Fumigated Treatments	Total 1's	>14oz	10-14oz	6-10oz	4-6oz	<4oz	Culls & 2's	Total	Percent Stand[1]	Tubers / Plant	Avg Tuber Size (oz)	Specific Gravity
1	Untreated Control	339	118	90	92	39	20	48	407	57	7.3	8.4	1.091
2	Serenade + Actinovate + Superzyme	304	99	86	88	31	21	60	385	56	6.8	8.9	1.090
3	Serenade	330	113	87	92	39	27	44	402	59	7.6	8.0	0.087
4	Superzyme	333	82	93	113	45	27	35	396	63	7.0	7.3	1.090
5	Actinovate	272	84	93	74	22	16	69	357	49	7.1	9.2	1.090
6	Compost	326	106	89	90	41	26	45	397	58	7.7	8.2	1.086
7	Compost Tea + Fish Emulsion at 2-week Intervals	284	101	84	71	28	14	63	361	50	6.8	9.1	1.087
8	Compost Tea + Fish Emulsion 5, 9, and 13-weeks after Planting	282	110	66	76	30	12	66	359	44	7.6	9.1	1.090
9	Compost at Planting + Compost Tea + Fish Emulsion at 2-week Intervals	229	87	64	58	20	13	72	314	36	8.8	9.7	1.089
10	Pelleted Chicken Manure	358	147	96	81	34	16	59	432	48	7.7	9.4	1.088
11	Maxim + Moncut	391	26	71	188	106	63	9	463	86	8.1	5.7	1.088
12	Maxim + Moncut + Compost Tea + Fish Emulsion	343	15	54	160	114	72	9	424	86	8.2	5.2	1.088
13	Maxim + Moncut + Vertisan	379	33	66	178	102	69	12	460	85	8.2	5.6	1.089
14	Maxim + Quadris + Endura + Tanos	370	25	53	176	115	69	13	451	86	8.4	5.3	1.086
15	Serenade + Bio-Tam	273	87	69	84	33	17	83	373	51	7.2	8.8	1.086
	95% confidence interval	47	21	17	23	10	15	21	41	6	0.9	0.7	NS
Trt#	Treatment Name- Fall Vapam Treatments (Do Not Compare with Non-Fumigated Treatment Results)												
16	Untreated Vapam Control	354	105	88	113	47	29	39	422	59	7.6	8.0	1.094
17	Fall Vapam + Serenade	285	95	81	81	28	17	56	358	44	8.2	9.2	1.092
18	Fall Vapam + Serenade + Bio-Tam	271	99	71	76	24	134	48	452	44	7.6	13.3	1.095
19	Fall Vapam + Serenade + Actinovate + Superzyme	305	103	85	88	30	19	52	376	45	7.8	9.1	1.094
20	Fall Vapam + Compost + Compost Tea + Fish Emulsion	383	117	92	128	45	23	40	446	62	7.2	8.4	1.096
21	Fall Vapam + Maxim + Moncut + Vertisan	411	44	81	184	102	68	12	491	83	8.7	6.0	1.095
22	Fall Vapam + Compost (3 ton/acre)	318	87	88	106	37	23	50	391	60	6.6	8.4	1.092
23	Fall Vapam + Compost (10 ton/acre)	257	107	66	62	22	12	57	325	44	6.5	10.3	1.095
24	Fall Vapam + Pelleted Chicken Manure	225	105	58	46	16	10	89	324	35	8.0	10.9	1.093
25	Fall Vapam + Compost Tea + Fish Emulsion	275	79	75	84	37	23	50	348	52	7.2	8.6	1.093
	95% confidence interval	64	NS	NS	24	12	NS	23	80	9	0.9	2.7	NS

[1] The seed spacing for this trial was 9.2 inches; 100% emergence = 74 plants per plot.

Table 3. Influence of Fungicides and Biological Products on Yukon Gold Tuber Internal and External Defects at IREC in 2012.

		Percent External Defects[1]					Percent Internal Defects[2]			
Trt#	Treatment Name- Non-Fumigated Treatments	Knobs	Growth Cracks	Green	Rot	Total	Hollow Heart	Black Spot Bruise	Tuber Stem End Necrosis	Tuber Vascular Discoloration
1	Untreated Control	5	1	2	0	9	8	6	4	24
2	Serenade + Actinovate + Superzyme	7	1	3	0	12	2	6	0	42
3	Serenade	4	1	3	1	8	4	4	0	40
4	Superzyme	4	0	3	1	8	4	2	4	38
5	Actinovate	7	1	4	1	14	4	3	3	42
6	Compost	4	1	3	1	9	2	8	4	48
7	Compost Tea + Fish Emulsion at 2-week Intervals	6	2	5	0	13	4	4	12	26
8	Compost Tea + Fish Emulsion 5, 9, and 13-weeks after Planting	8	2	4	1	14	4	4	2	44
9	Compost at planting + Compost Tea + Fish Emulsion at 2-week Intervals	11	1	5	1	18	8	0	8	26
10	Pelleted Chicken Manure	5	1	4	1	11	8	16	2	31
11	Maxim + Moncut	1	0	1	0	2	6	8	2	24
12	Maxim + Moncut + Compost Tea + Fish Emulsion	1	0	1	0	2	0	8	2	28
13	Maxim + Moncut + Vertisan	1	0	1	0	2	2	6	4	30
14	Maxim + Quadris + Endura + Tanos	2	0	0	0	2	0	4	0	24
15	Serenade + Bio-Tam	9	2	5	1	16	8	4	4	30
	95% confidence interval	4	1	2	NS	5	NS	NS	5	NS
Trt#	Treatment Name- Fall Vapam Treatments (Do Not Compare with Non-Fumigated Treatment Results)									
16	Untreated Vapam Control	5	0	2	0	7	12	4	0	26
17	Fall Vapam + Serenade	10	1	2	0	12	10	0	0	38
18	Fall Vapam + Serenade + Bio-Tam	7	0	3	1	11	18	0	6	26
19	Fall Vapam + Serenade + Actinovate + Superzyme	7	0	1	0	8	10	2	0	36
20	Fall Vapam + Compost + Compost Tea + Fish Emulsion	3	1	2	0	7	8	2	2	28
21	Fall Vapam + Maxim + Moncut + Vertisan	1	0	1	0	2	4	4	0	28
22	Fall Vapam + Compost (3 ton/acre)	6	0	3	0	9	7	4	2	33
23	Fall Vapam + Compost (10 ton/acre)	10	0	3	1	14	10	4	0	30
24	Fall Vapam + Pelleted Chicken Manure	15	3	6	0	23	10	8	2	26
25	Fall Vapam + Compost Tea + Fish Emulsion	8	0	2	1	11	10	2	6	22
	95% confidence interval	NS	NS	2	NS	6	NS	NS	NS	NS

[1] = Percent of total tubers per plot

[2] = Percent incidence out of 10 tubers evaluated from each plot (6-14 oz tubers)

Table 4. Influence of Fungicides and Biological Products on Yukon Gold Plant Characteristics and Disease at IREC in 2012.

Trt#	Treatment Name- Non-Fumigated Treatments	Vert. Wilt Rating 8/14/12[1]	End of Season Vine Vigor[2]	Stolons/ Plant	Root Wt./ Plant (grams)	Stolons with Rhizoc. Lesions %	Stems with Rhizoc. Lesions %	Stolon & Stem Rhizoc. Severity Rating[3]
1	Untreated Control	6.0	3.0	16.7	46.7	25	71	6.3
2	Serenade + Actinovate + Superzyme	5.8	2.8	10.7	48.7	35	68	5.8
3	Serenade	6.0	3.2	13.6	43.2	14	46	5.1
4	Superzyme	6.0	3.0	14.9	57.5	23	57	5.3
5	Actinovate	5.8	2.8	10.6	53.5	24	55	6.2
6	Compost	5.8	3.0	15.6	63.1	21	65	6.1
7	Compost Tea + Fish Emulsion at 2-week Intervals	5.8	3.4	12.2	50.2	21	68	6.4
8	Compost Tea + Fish Emulsion 5, 9, and 13-weeks after Planting	5.6	3.0	9.7	42.6	14	67	4.9
9	Compost at planting + Compost Tea + Fish Emulsion at 2-week Intervals	6.0	3.4	11.6	51.8	21	66	6.2
10	Pelleted Chicken Manure	4.8	3.6	13.6	57.7	7	61	4.0
11	Maxim + Moncut	6.4	2.8	21.9	71.2	9	13	1.9
12	Maxim + Moncut + Compost Tea + Fish Emulsion	7.0	2.4	21.7	63.9	14	25	2.6
13	Maxim + Moncut + Vertisan	6.5	3.0	21.1	62.2	12	23	2.1
14	Maxim + Quadris + Endura + Tanos	6.2	2.8	22.6	72.3	9	18	1.8
15	Serenade + Bio-Tam	6.2	3.0	12.8	53.1	18	63	6.9
	95% confidence interval	0.4	0.4	3.7	14.8	8	13	1.2
Trt#	Treatment Name- Fall Vapam Treatments (Do Not Compare with Non-Fumigated Treatment Results)							
16	Untreated Vapam Control	5.8	4.0	18	46.7	10	40	3.9
17	Fall Vapam + Serenade	5.7	4.0	15	42.4	16	55	4.7
18	Fall Vapam + Serenade + Bio-Tam	5.8	4.0	15	38.7	15	63	5.5
19	Fall Vapam + Serenade + Actinovate + Superzyme	5.5	4.0	16	42.0	7	61	4.5
20	Fall Vapam + Compost + Compost Tea + Fish Emulsion	5.2	4.0	18	50.0	10	50	3.9
21	Fall Vapam + Maxim + Moncut + Vertisan	5.4	3.8	23	58.2	4	19	1.9
22	Fall Vapam + Compost (3 ton/acre)	5.6	3.8	19	48.8	10	47	4.0
23	Fall Vapam + Compost (10 ton/acre)	5.0	4.0	12	34.7	18	59	4.4
24	Fall Vapam + Pelleted Chicken Manure	5.0	4.0	13	42.3	8	70	4.5
25	Fall Vapam + Compost Tea + Fish Emulsion	6.0	3.8	14	37.2	11	58	5.0
	95% confidence interval	0.5	NS	3	6.2	NS	14	NS

[1] = Verticillium Wilt Rating 0-9 scale, 0= 0 Symptoms, 1= Trace, 2= 1-5% of plants show symptoms of disease, 3= 5-10%, 4= 10-20%, 5= 20-40%, 6= 40-60%, 7= 60-75%, 8= 75-90%, 9= 90-100%

[2] = Vine Vigor Rating 1-5 scale, 5= highest vigor

[3] = Rhizoctonia Severity Rating for Belowground Stems and Stolons (10ft of row) 0-10 scale, 0= no infection

Table 5. Influence of Fungicides and Biological Products on Yukon Gold Tuber Disease at IREC in 2012.

Trt#	Treatment Name- Non-Fumigated Treatments	Rhizoc Tuber Incidence %	Avg Rhizoc. Coverage on Tubers %	Rhizoc. Tuber Severity Rating[1]	Avg. Black Dot Coverage on Lower Stems %	Black Dot Tuber Incidence %	Avg Black Dot Coverage on Tubers %	Black Dot Tuber Severity Rating[2]
1	Untreated Control	36	0.9	4.0	25.9	98	9.0	3.5
2	Serenade + Actinovate + Superzyme	28	0.8	4.4	22.9	100	7.0	3.8
3	Serenade	20	0.8	4.4	26.3	94	7.0	3.8
4	Superzyme	26	0.7	4.4	35.0	100	10.0	3.3
5	Actinovate	22	0.4	4.5	21.4	98	10.0	3.7
6	Compost	30	0.9	4.2	25.8	92	10.0	3.2
7	Compost Tea + Fish Emulsion at 2-week Intervals	20	0.8	4.5	23.5	98	7.0	4.0
8	Compost Tea + Fish Emulsion 5, 9, and 13-weeks after Planting	28	1.5	4.0	19.1	90	5.0	4.2
9	Compost at planting + Compost Tea + Fish Emulsion at 2-week Intervals	22	0.4	4.4	15.2	96	8.0	3.6
10	Pelleted Chicken Manure	11	0.2	4.7	19.8	100	11.0	3.1
11	Maxim + Moncut	16	0.3	4.6	37.9	100	15.0	2.4
12	Maxim + Moncut + Compost Tea + Fish Emulsion	10	0.1	4.8	39.0	100	13.0	3.1
13	Maxim + Moncut + Vertisan	14	0.2	4.8	35.1	98	11.0	3.1
14	Maxim + Quadris + Endura + Tanos	4	0.0	4.9	31.8	100	11.0	2.9
15	Serenade + Bio-Tam	18	0.7	4.5	28.5	100	7.0	3.8
	95% confidence interval	NS	NS	NS	8.6	NS	3.0	0.6
Trt#	Treatment Name- Fall Vapam Treatments (Do Not Compare with Non-Fumigated Treatment Results)							
16	Untreated Vapam Control	24	0.7	4.3	37.2	100	9.5	3.1
17	Fall Vapam + Serenade	14	0.4	4.7	28.5	100	8.9	3.2
18	Fall Vapam + Serenade + Bio-Tam	22	1.0	4.1	32.5	100	11.6	2.9
19	Fall Vapam + Serenade + Actinovate + Superzyme	8	0.2	4.8	30.1	98	6.6	4.0
20	Fall Vapam + Compost + Compost Tea + Fish Emulsion	20	0.6	4.2	33.2	100	10.5	3.4
21	Fall Vapam + Maxim + Moncut + Vertisan	6	0.1	4.9	37.0	100	14.9	2.8
22	Fall Vapam + Compost (3 ton/acre)	10	0.2	4.8	42.0	100	12.8	2.8
23	Fall Vapam + Compost (10 ton/acre)	28	1.2	3.8	34.2	100	12.2	3.0
24	Fall Vapam + Pelleted Chicken Manure	8	0.9	4.5	27.8	100	10.1	3.1
25	Fall Vapam + Compost Tea + Fish Emulsion	24	1.0	4.1	38.3	100	12.3	2.6
	95% confidence interval	NS	NS	NS	NS	NS	NS	NS

[1] = Rhizoctonia (black scurf) Severity Rating on Tuber Skin (10 tubers/ plot) 1-5 scale, 5= no infection

[2] = Black Dot Severity Rating on Tuber Skin (10 tubers/ plot) 1-5 scale, 5= no infection