Mineral Oil Application Experiments: Reducing Current Season PVY

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Abstract. In recent years, *Potato Virus Y* has reemerged as a serious disease problem in many potato production areas in the northern United States and eastern Canada. Asymptomatic cultivars which express mild or no symptoms when infected with PVY combined with an increase in recombinant strains of this virus prevent accurate field identification and rouging of infected plants. There is a lack of effective strategies to reduce the incidence of PVY infected plants and tubers, and there is a need to improve cost-effective methods of determining PVY levels in seed lots and further understanding the impact of current season virus infection on tuber storage and quality attributes. Limited information currently exists to document the optimal oil application conditions to limit infection of PVY during the current season. In the first year of preliminary research, we have documented significant reductions in PVY incidence using different foliar oil protectants at varying concentrations and application frequencies. This area of investigation seems extremely important towards limiting continued losses associated with asymptomatic potato cultivars in which PVY remains a challenge.

Foliar Mineral Oil Treatments
Antigo, Wisconsin 2008. Langlade County Airport.

I. Oil Applications(s).

Foliar Treatments (N=12): 12 treatments X 4 reps = **48 plots**

Treat No.	Product	Application Frequency (days)	Rate [conc]	Nozzle Tip	Plot Number	Flag Color
1)	UTC	--	--	--	(101, 201, 301, 401)	red
2)	Aphoil	7	0.02	D3-DC25	(102, 202, 302, 402)	white
3)		7	0.04	D3-DC25	(103, 203, 303, 403)	blue
4)		7	0.04	XR-11003	(104, 204, 304, 404)	yellow
5)		4	0.02	D3-DC25	(105, 205, 305, 405)	orange
6)		4	0.04	D3-DC25	(106, 206, 306, 406)	pink
7)	JMS	7	0.0075	D3-DC25	(107, 207, 307, 407)	green
8)	Stylet Oil	7	0.015	D3-DC25	(108, 208, 308, 408)	brown
9)		7	0.015	XR-11003	(109, 209, 309, 409)	silver
10)		4	0.0075	D3-DC25	(110, 210, 310, 410)	lime
11)		4	0.015	D3-DC25	(111, 211, 311, 411)	violet
12)	QRD 416 (OMRI-Approved Formulation)	4	0.01	D3-DC25	(112, 212, 312, 412)	2 red

II. Plot Size.

Dimensions:
- 24 ft rows X 36" row (4 rows/ plot) = 540 ft^2 / plot
- 540 ft^2 / plot X 48 plots
- experimental replicates separated by 3, 20' alleys
- total experiment size = 0.6 acres

Cultivars:
- treatment rows will consist of 4, 20 plant rows of virus-free *S. tuberosum*, cv. 'Silverton' (▬) flanked on all sides by guard rows of the PVY-resistant cv. 'Villetta Rose' (▪▪▪▪) (Figure 1). Drive rows for foliar applications (▪▪▪▪) will be arranged to cover Villetta rose border rows and provide access for foliar applications to 4 row experimental plots.

III. PVY Inoculum.

Inoculum of Potato virus Y will be established by sap-inoculating 2, plants centrally in the 2nd and 3rd rows of each experimental plot. Infected sap was generated from *Nicotiana tabacum* plants mechanically, sap-inoculated with PVY^{O} and $PVY^{N:O}$ from isolates collected in Wisconsin 2004-06. Plants were inoculated 26 June 2008.

IV. Treatment Evaluations:

Foliar oil applications will be applied beginning 1 July 2008 using a CO_2 pressurized, tractor-mounted sprayer with a 12' boom operating at either 80 and 40 psi delivering total volumes of 21.1 and 37.5 gpa through 13 nozzles bodies equipped with either 1) a D3-DC25 Disc-Core type cone spray tip, or 2) a XR 110 03VS Flat Fan spray tip spaced 12" apart, respectively. Incidence of PVY will be surveyed monthly by counting all symptomatic plants, and their relative position in each experimental plot. Total plot yield will be determined at the conclusion of the experiment from each plot.

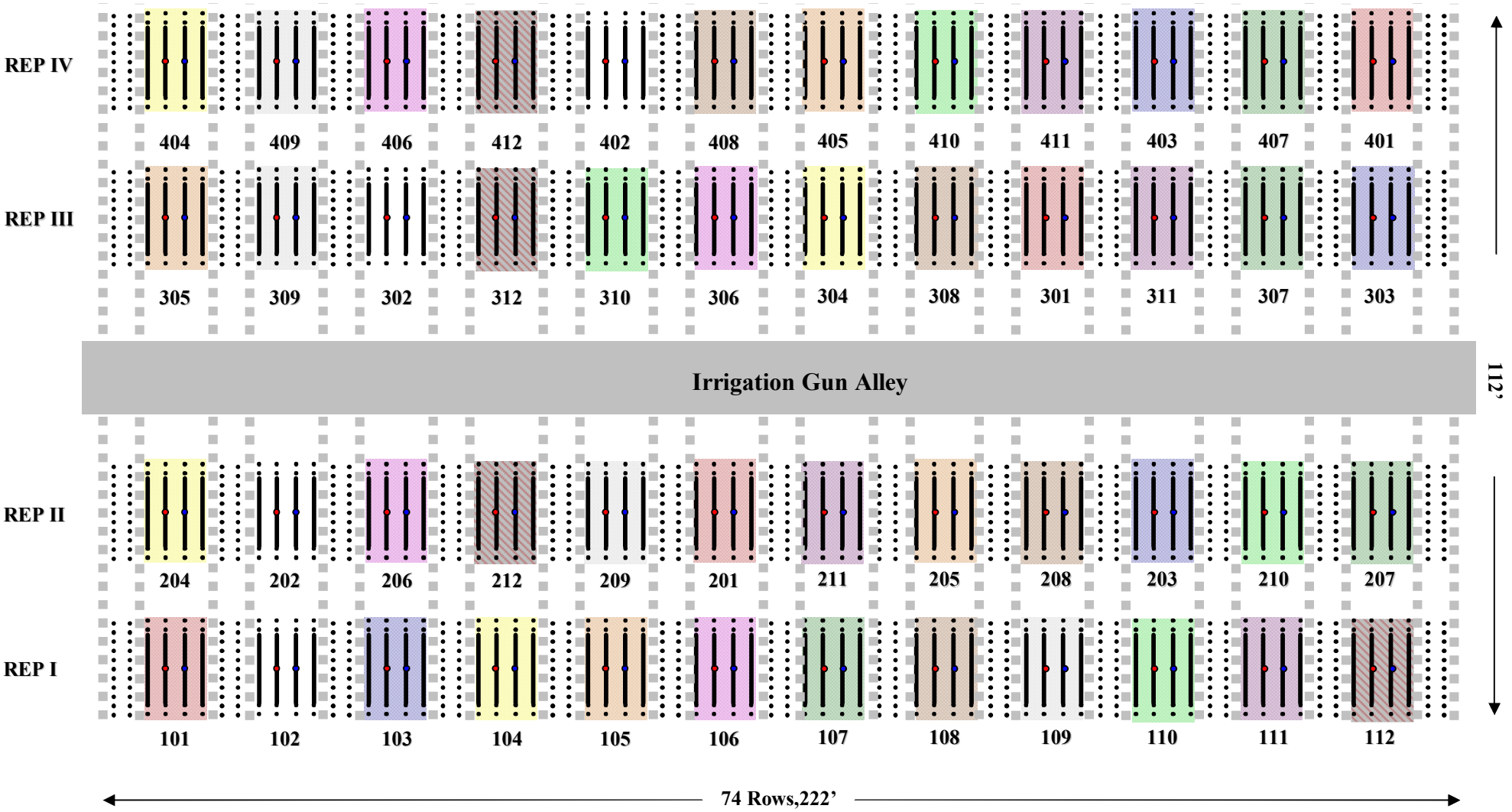

Figure 1. Experimental plot layout for evaluation of foliar-applied, mineral oil treatments at the Langlade County Airport, Antigo, Wisconsin 2008. Experimental plot size 4, row (36" bed) X 24' with 4 replicates resulting in an experiment size (222' X 112'), (0.6 acres). Two, PVY-infected plants, PVY^{O} (●) and $PVY^{N:O}$ (●) were inoculated 26 June 2008 in the center 2 rows of each plot to serve as an inoculum source for spread.

University of Wisconsin-Madison

Protocol ID: Study Director:
Location: Investigator: Dr. Russ Groves

Reps: 4 Plots: 12 by 20 feet
Spray vol: 21.1 gal/ac (37.5 gal/ac for treatments 4 and 9) Mix size: 16 liters

Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Other Rate	Other Rate Unit	Growth Stage	Appl Code	Amt Product to Measure
1	CHK	UTC										
2	ADJ	Aphoil	100	%	SL	2	% v/v					320.0 ml/mx
3	ADJ	Aphoil	100	%	SL	4	% v/v					639.9 ml/mx
4	ADJ	Aphoil	100	%	SL	4	% v/v					639.9 ml/mx
5	ADJ	Aphoil	100	%	SL	2	% v/v					320.0 ml/mx
6	ADJ	Aphoil	100	%	SL	4	% v/v					639.9 ml/mx
7	ADJ	JMS Stylet Oil	100	%	SL	0.75	% v/v					120.0 ml/mx
8	ADJ	JMS Stylet Oil	100	%	SL	1.5	% v/v					240.0 ml/mx
9	ADJ	JMS Stylet Oil	100	%	SL	1.5	% v/v					240.0 ml/mx
10	ADJ	JMS Stylet Oil	100	%	SL	0.75	% v/v					120.0 ml/mx
11	ADJ	JMS Stylet Oil	100	%	SL	1.5	% v/v					240.0 ml/mx
12	INSE	QRD 416	100	%	SL	1	% v/v					160.0 ml/mx

Material Applied	Application Date	Rate	Treatment (flag colors)	Amount Product	Amount Water
Aphoil	Monday	2%	(2=white, 5=orange)	640 ml	32 L (= 4.0 gal)
		4%	(3=blue, 4=yellow, 6=pink)	1.9L	32 L (= 8.4 gal)
	Thursday	2%	(5=orange)	320 ml	16 L
		4%	(6=pink)	640 ml	16 L
				3.5 L (0.92 gal)	
JMS Stylet Oil	Monday	0.75%	(7=green, 10=lime)	240 ml	16 L
		1.5%	(8=brown, 9=silver, 11=violet)	480 ml	16 L
	Thursday	0.75%	(10=lime)	120 ml	16 L
		1.5%	(11=violet)	240 ml	16 L
				1.3 L (0.34 gal)	
QRD 416	Monday	1.0%	(12=2 red)	160 ml	16 L
	Thursday	1.0%	(12=2 red)	160 ml	16 L
				320 ml	

Product quantities required for listed treatments and applications over 12 successive weeks of treatment:

Amount*	**Unit**	**Treatment Name**	**12 week total**
3.5	L	Aphoil 100 SL	42 L (11.1 gal)
1.3	L	JMS Stylet Oil 100 SL	15.6 L (4.1 gal)
320	ml	QRD 416 100 SL	3.8 L (1.0 gal)

* 'Per area' calculations based on spray volume= 40 gal/ac, mix size= 5 liters (mix size basis).
* Product amount calculations increased 25 % for overage adjustment.
* 'Per volume' calculations use spray volume= 40 gal/ac, mix size= 5 liters.

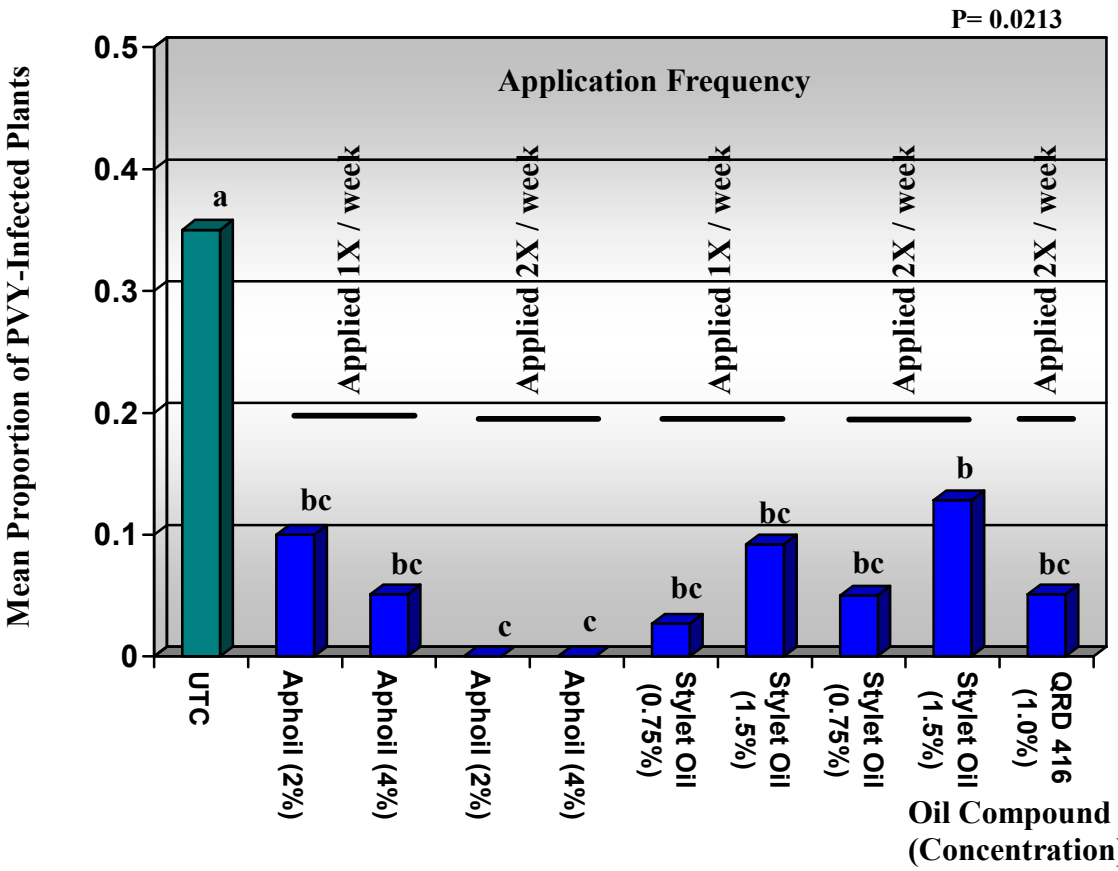

Figure 1. Mean proportion of PVY-infected plants collected from the experimental plots receiving different mineral oil compounds, application frequencies, and application rates. Probability of a difference in mean cumulative proportion of PVY-infected plants is provided (α=0.05) with a Least Squared Difference, means separation procedure. Means not followed by the same letter among columns are significantly different.

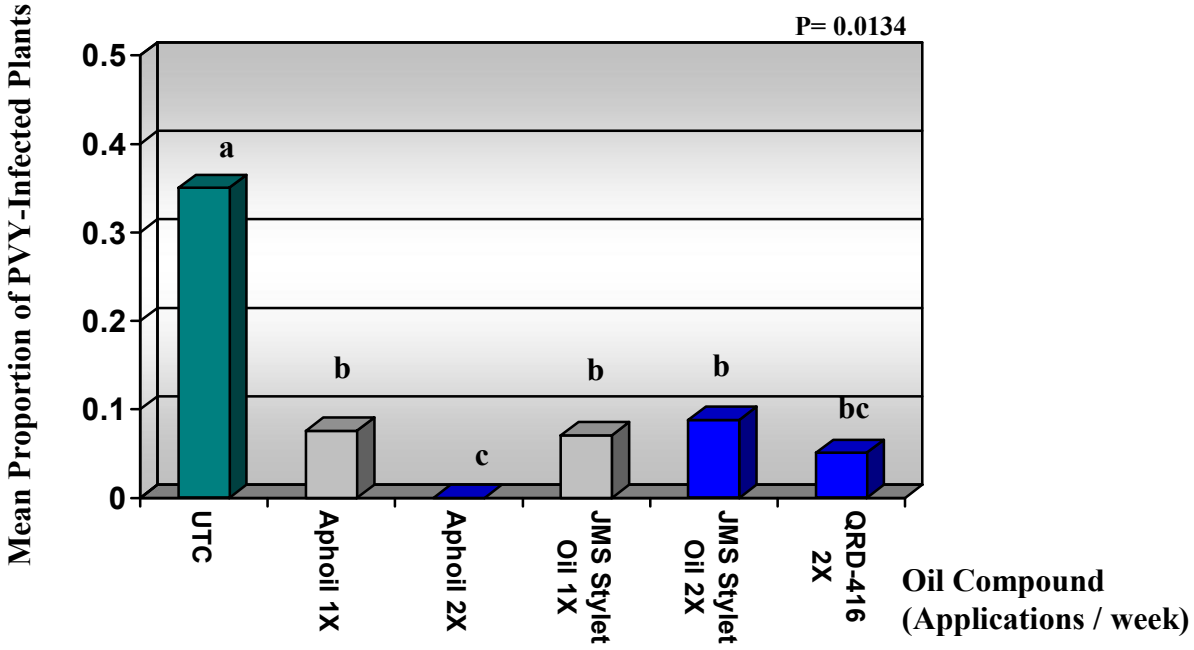

Figure 2. Mean proportion of PVY-infected plants among oil compounds applied. Probability of a difference in mean cumulative proportion of PVY-infected plants is provided (α=0.05).

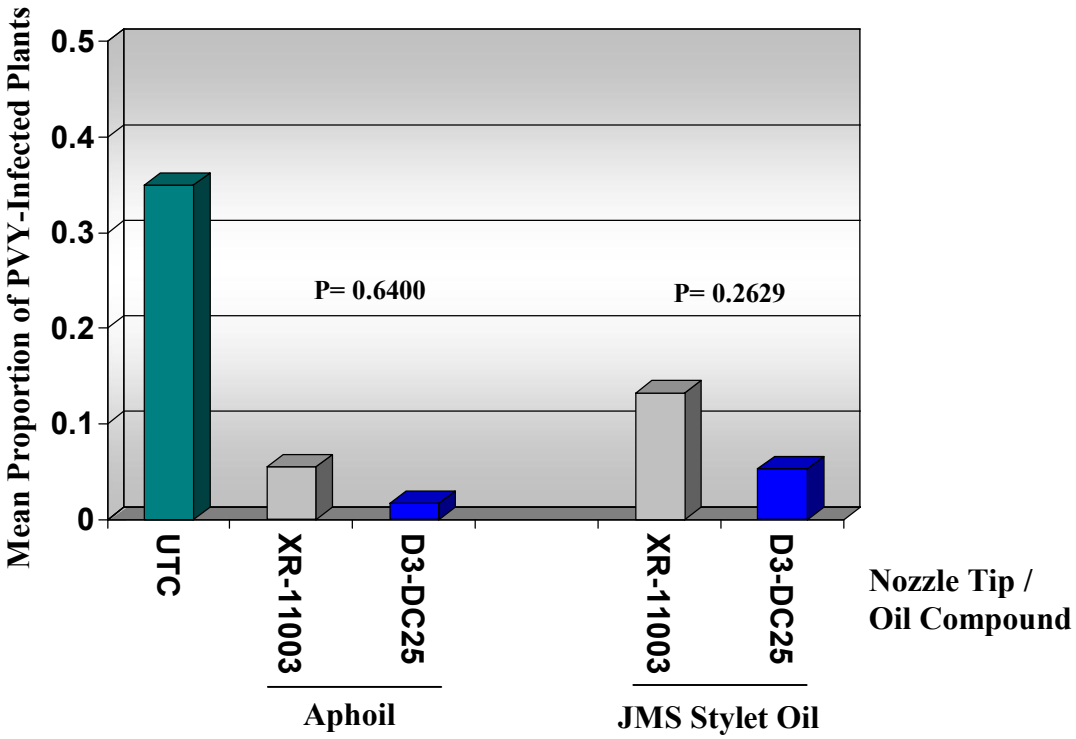

Figure 3. Mean proportion of PVY-infected plants comparing the extender range, flat fan nozzle tips (XR-11003) with the disc-core, hollow cone nozzle tips (D3-DC25). Probability of a difference in mean cumulative proportion of PVY-infected plants between tips is provided (α=0.05) for each oil compound evaluated, Aphoil and JMS Stylet Oil, respectively.

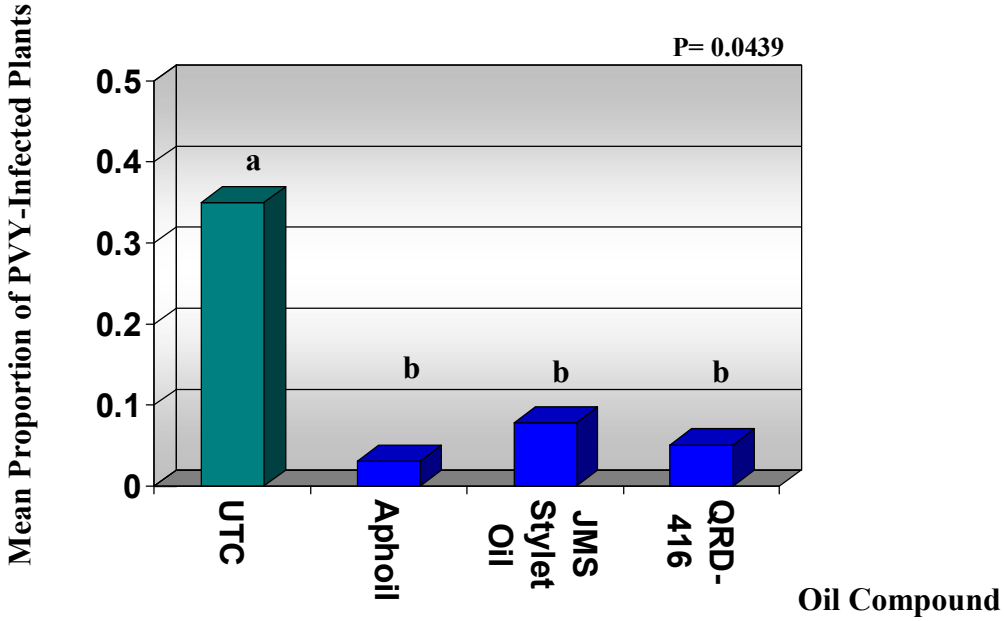

Figure 4. Mean proportion of PVY-infected plants comparing the mineral oil compounds Aphoil, JMS Stylet Oil, and QRD-416. Probability of a difference in mean cumulative proportion of PVY-infected plants among compounds is provided (α=0.05).

Table 1. Mean (± SE) yield and quality parameters collected from experimental treatments located at the Langlade County Regional Airport, Experimental Research Facility, Antigo, WI.

					Mean Yield and Quality Parameters / Treatment[1]		
Compound Applied	Trt No.	Appl Freq[2]	Concentration (%)	Nozzle Tip[3]	Mean Proportion. US #1, Grade A	Mean Proportion. US #1, Grade B	Mean Total Yield (cwt. / ac)
Untreated	1	--	--	--	96.5 ± 0.6 a	3.5 ± 0.6 a	358.4 ± 20.0 a
Aphoil	2	7	2.0	D3-DC25	96.2 ± 0.7 a	3.8 ± 0.7 a	366.2 ± 40.9 a
	3	7	4.0	D3-DC25	96.6 ± 0.3 a	3.4 ± 0.3 a	343.7 ± 15.8 a
	4	7	4.0	XR-11003	96.0 ± 0.5 a	4.0 ± 0.5 a	344.8 ± 10.6 a
	5	4	2.0	D3-DC25	96.1 ± 0.3 a	3.9 ± 0.3 a	341.0 ± 12.2 a
	6	4	4.0	D3-DC25	96.4 ± 0.4 a	3.6 ± 0.4 a	325.0 ± 29.4 a
JMS Stylet Oil	7	7	0.75	D3-DC25	96.1 ± 0.6 a	3.9 ± 0.6 a	320.5 ± 30.5 a
	8	7	1.5	D3-DC25	96.0 ± 0.8 a	4.0 ± 0.8 a	335.5 ± 19.9 a
	9	7	1.5	XR-11003	95.9 ± 0.9 a	4.1 ± 0.9 a	318.8 ± 24.8 a
	10	4	0.75	D3-DC25	97.2 ± 0.1 a	2.8 ± 0.1 a	367.0 ± 46.1 a
	11	4	1.5	D3-DC25	95.7 ± 0.1 a	4.3 ± 0.1 a	313.3 ± 14.7 a
QRD-416	12	4	1.0	D3-DC25	97.1 ± 0.3 a	2.9 ± 0.3 a	397.2 ± 27.4 a

[1] Means followed by the same letter are not significantly different ($P > 0.05$; Fisher's Protected LSD; n = 4).

[2] Application frequency of mineral oil compounds occurred on either a weekly (once / 7 days) or bi-weekly (once / 4 days) basis.

[3] Mineral oils were applied through a CO_2 pressurized, tractor-mounted sprayer with a 12' boom operating at either 80 and 40 psi delivering total volumes of 21.1 and 37.5 gpa through 13 nozzles bodies equipped with either 1) a D3-DC25 Disc-Core type cone spray tip, or 2) a XR 110 03VS Flat Fan spray tip spaced 12" apart, respectively.

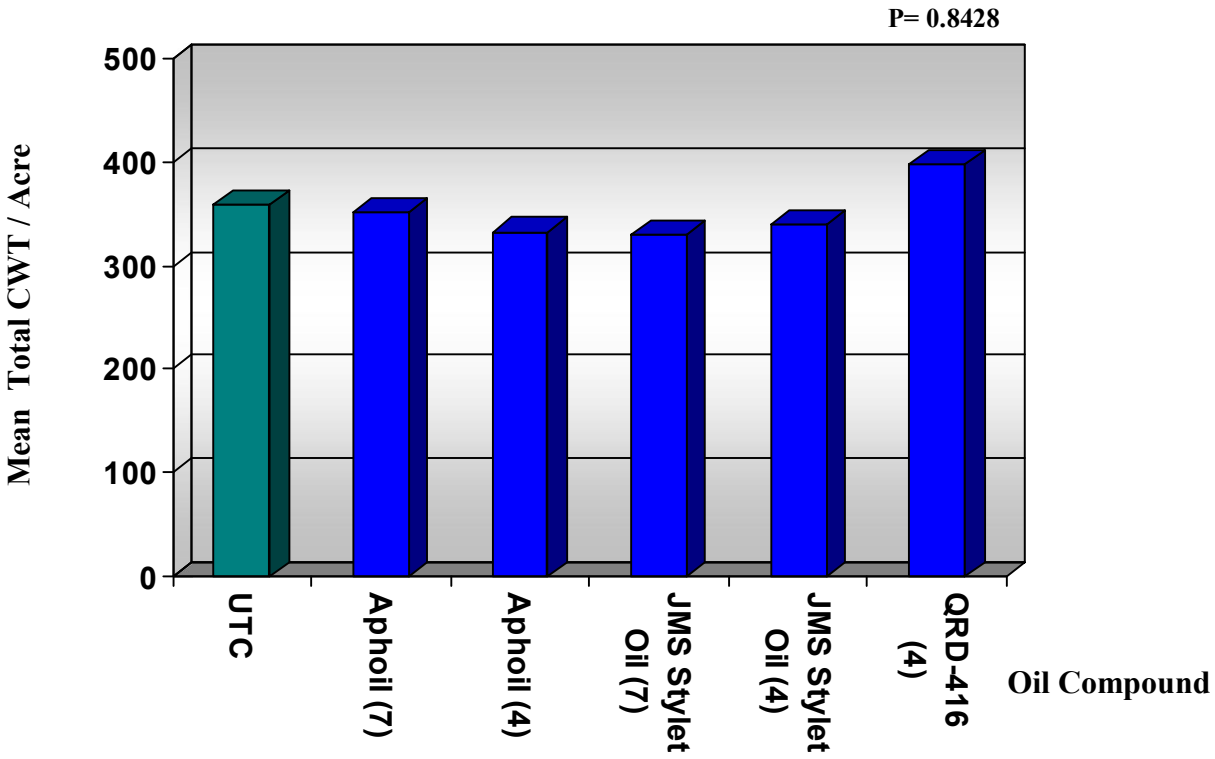

Figure 5. Mean estimated total hundred weight (CWT) / acre comparing the mineral oil compounds Aphoil, JMS Stylet Oil, and QRD-416 applied at weekly (every 7 days) and bi-weekly (every 4 days). Probability of a difference in mean estimated total hundred weight among compounds and application intervals are provided (α=0.05).

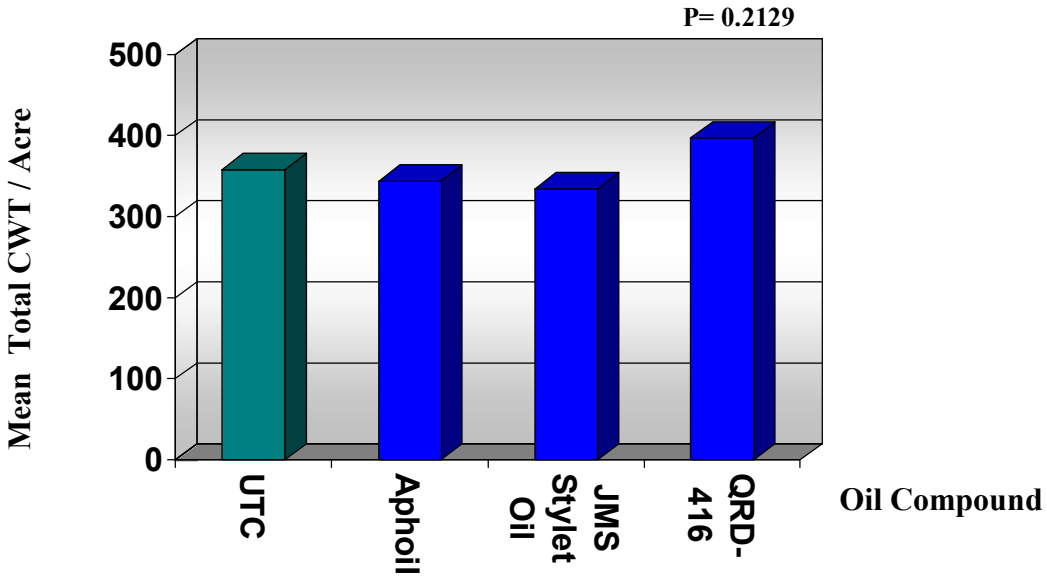

Figure 6. Mean estimated total hundred weight (CWT) / acre comparing the mineral oil compounds Aphoil, JMS Stylet Oil, and QRD-416. Probability of a difference in mean estimated total hundred weight among compounds are provided (α=0.05).

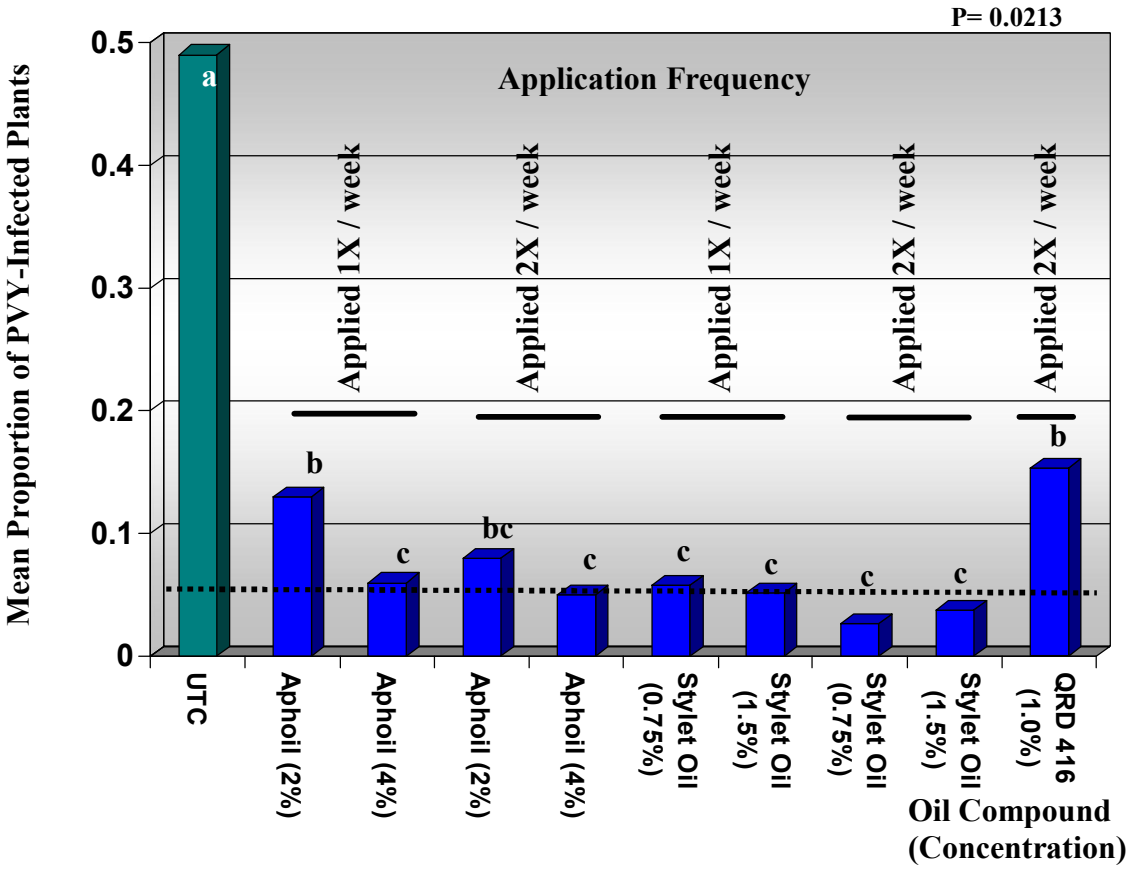

Figure 7. Mean proportion of PVY-infected plants resulting from winter grow-out tests conducted in Homestead, FL 2008-09. Symptoms recorded from plants grown from tubers receiving different mineral oil compounds, application frequencies, and application rates. Probability of a difference in mean cumulative proportion of PVY-infected plants is provided (α=0.05) with a Least Squared Difference, means separation procedure. Means not followed by the same letter

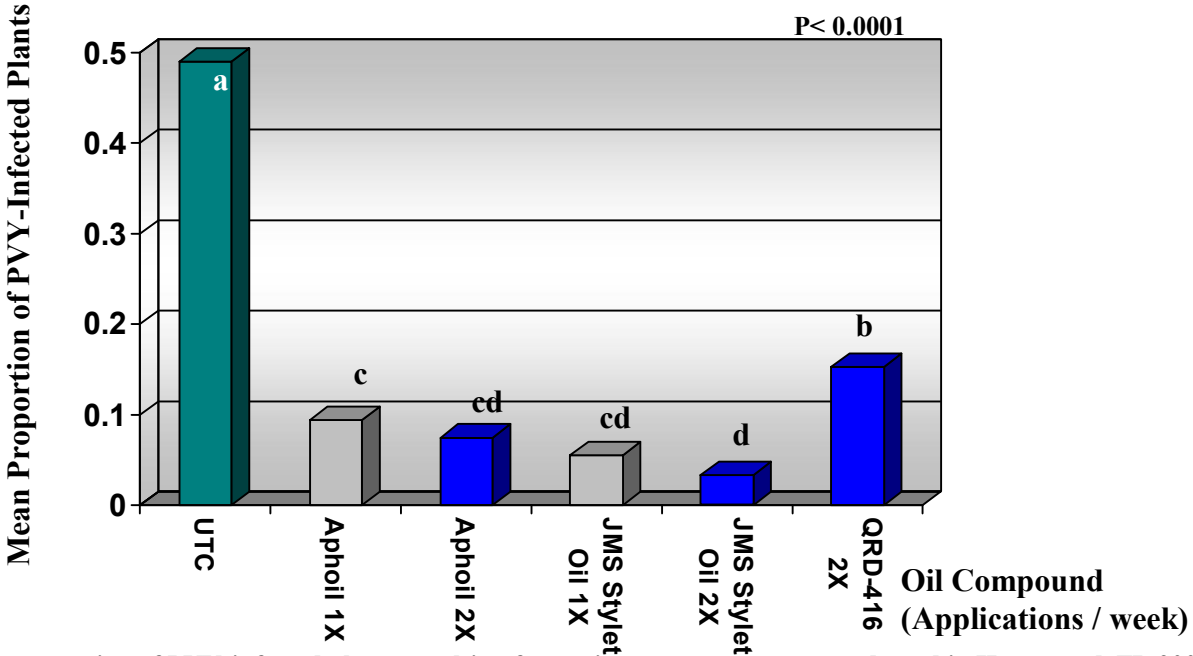

Figure 8. Mean proportion of PVY-infected plants resulting from winter grow-out tests conducted in Homestead, FL 2008-09. Symptoms recorded from plants grown from tubers receiving different oil compounds applied. Probability of a difference in mean cumulative proportion of PVY-infected plants is provided (α=0.05).

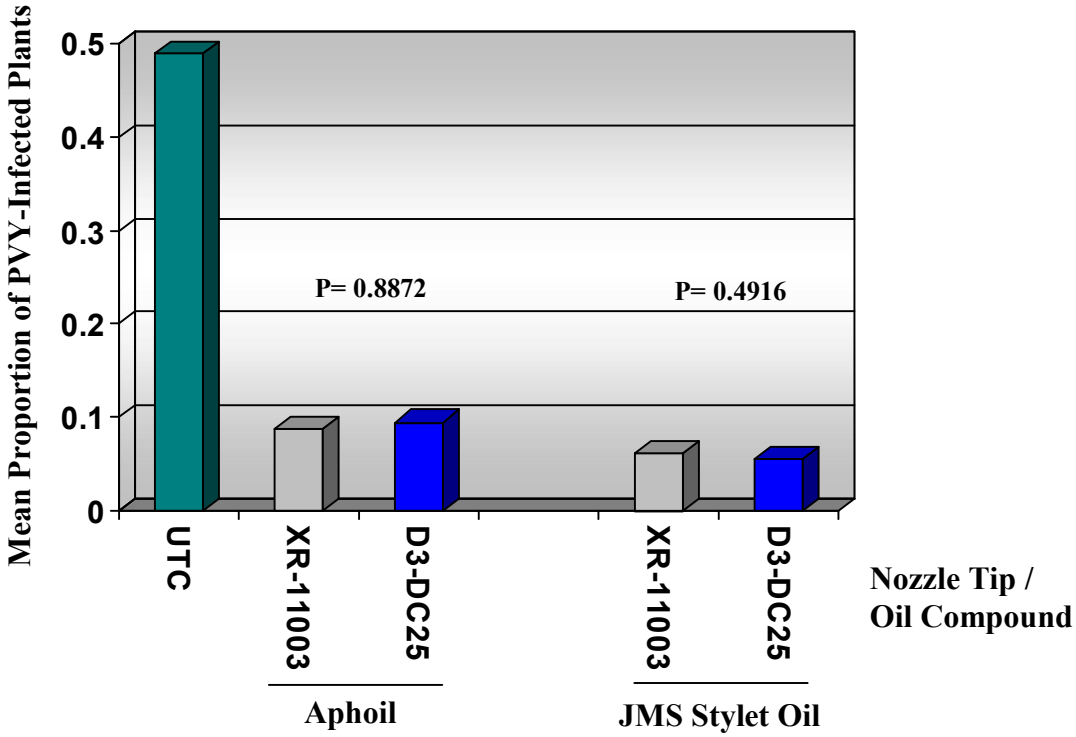

Figure 9. Mean proportion of PVY-infected plants resulting from winter grow-out tests conducted in Homestead, FL 2008-09. Symptoms recorded from plants grown from tubers comparing the extender range, flat fan nozzle tips (XR-11003) with the disc-core, hollow cone nozzle tips (D3-DC25). Probability of a difference in mean cumulative proportion of PVY-infected plants between tips is provided (α=0.05) for each oil compound evaluated, Aphoil and JMS Stylet Oil, respectively.

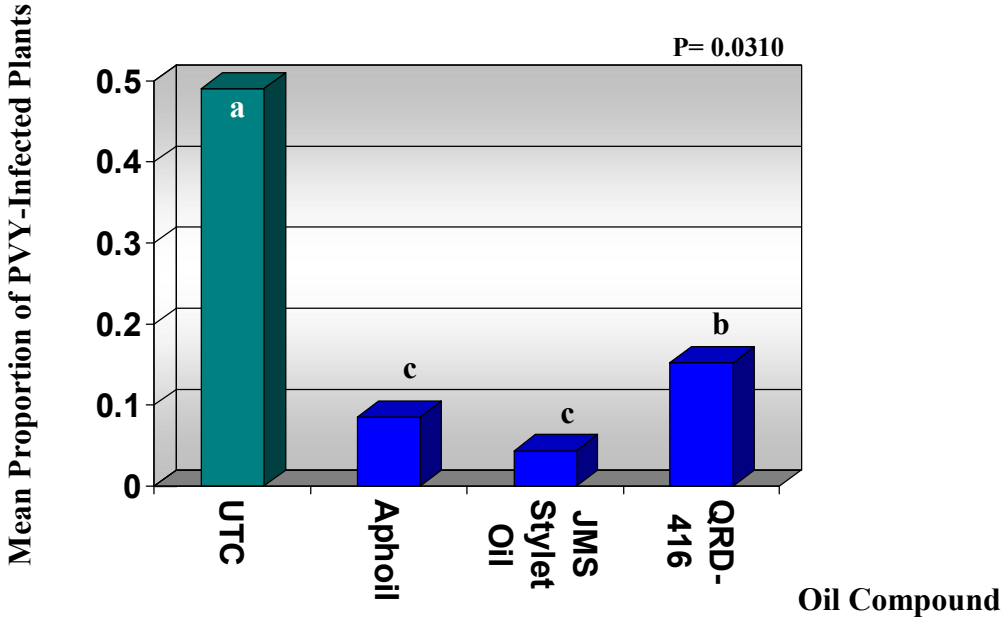

Figure 10. Mean proportion of PVY-infected plants resulting from winter grow-out tests conducted in Homestead, FL 2008-09. Symptoms recorded from plants grown from tubers comparing the mineral oil compounds Aphoil, JMS Stylet Oil, and QRD-416. Probability of a difference in mean cumulative proportion of PVY-infected plants among compounds is provided (α=0.05).

Research Summary:

2008 Field Season Results:

1) A significant difference in PVY (foliar) detection was observed among the different mineral oil compounds examined, the application frequencies, and rate (or concentration). This resulted from a significant Compound X Application X Rate interaction ($F=7.12$, $df=3,9$, $P=0.0213$). All oil applications reduced PVY foliar detection when compared with the untreated control. Among application frequencies and product concentrations, Aphoil applied twice weekly, at both the 2 and 4% concentrations, resulted in the lowest overall foliar detection of PVY. The remaining treatment combinations were not significantly different (**Figure 1**).

2) Averaging over mineral oil concentrations, Aphoil applied twice weekly again provided the greatest amount of protection from infection by PVY when compared to other treatment combinations (**Figure 2**). Here again, the remaining treatment combinations were not significantly different to each other, however all were significant improvements over untreated control plots where as much as 35% PVY infection was detected.

3) Comparing nozzle types for mineral oil application, no significant differences were detected between nozzle tips with either the Aphoil or the JMS Stylet Oil products under the conditions of our test (**Figure 3**). Recall, we conducted this comparison with only Aphoil and JMS Stylet Oil applied weekly at the higher, prescribed concentrations (4 and 1.5%) for each compound, respectively.

4) Averaging over application frequency, concentration, and nozzle type, no significant differences were observed among the 3 mineral oil compounds tested in this experiment with respect to foliar detection of PVY infection (**Figure 4**). Numerically, Aphoil had the least infection (3.1%) followed by QRD-416 (5.1%), and then JMS Stylet Oil (7.8%). Again, all compounds performed better than untreated control plots which reached 35% infection by the end of the experiment.

5) No significant impacts on tuber yield and quality were observed among any of the treatment combinations in the experiment (**Table 1**). Specifically, the mean proportion of US #1 'A' and 'B' grade potatoes, as well as total hundred weight / acre, did not differ among the interaction or main effect treatments in the experiment.

6) Closer examination of treatment effects with respect to total hundred weight per acre, did not reveal any significant differences among application frequency and the mineral oil treatment applied (**Figure 5**). Averaging over all application frequencies and concentrations, no differences in tuber yield and quality were noted among the mineral oil compounds examined (**Figure 6**). Numerically, applications of QRD-416 (2X week at 1%) resulted in the highest total yields (397.3 cwt/ac), followed by the untreated control plots (358.4 cwt/ac), Aphoil (applied once and twice weekly at 2 and 4%) (343.9 cwt/ac), and JMS Stylet Oil (applied once and twice weekly at 0.75 and 1.5%).

2008-09 Winter Grow-Out Test Results:

1) The most important set of observations for this experiment must be interpreted from the Wisconsin Seed Certification, Winter Grow-Out Test located in Homestead, FL. As is often the case with asymptomatic varieties (e.g. 'Silverton Russet'), the infection frequencies in the above-ground portion of plants do not often accurately reflect the incidence of infection among daughter tubers. Similar to the field-based assays at the end of the growing season, some significant differences in PVY were observed among the different mineral oil treatments examined. Here again, all oil applications reduced PVY detection when compared with the untreated control (49.5%). Following the untreated control, the QRD-416 compound averaged 15.3% PVY incidence. Among remaining application frequencies and product concentrations, Aphoil applied at the 2% concentrations, both once and twice a week, resulted in the next highest overall PVY infection. Finally, all remaining treatment combinations were not significantly different (**Figure 7**).

2) Averaging over mineral oil concentrations, JMS Stylet Oil and Aphoil applied twice weekly provided the greatest amount of protection from infection by PVY when compared to other treatment combinations (**Figure 8**). Here again, treatment combinations other than QRD-416, were significant improvements over untreated control plots where as much as 49.5% PVY infection was detected.

3) Comparing nozzle types for mineral oil application, no significant differences were again detected between nozzle tips with either the Aphoil or the JMS Stylet Oil products during the Winter Grow-Out Test (**Figure 9**).

4) Averaging over application frequency, concentration, and nozzle type, no significant differences were observed between the JMS Stylet Oil and the Aphoil tested in this experiment (**Figure 10**). Numerically, JMS Stylet Oil had the least infection (4.4%) followed by Aphoil (8.5%), and then QRD 316 (15.3%). Again, all compounds performed better than untreated control plots which reached 49.5% infection during the Winter Grow-Out Test.