Dec. 31, 2005 Final Report
ODA-OAN Nursery Research Project Proposal 05-19

Fungicide efficacy against *Phytophthora ramorum*

by

Jennifer L. Parke[1] and Richard Regan[2]
[1]Dept. of Crop and Soil Science, Agriculture and Life Sciences Bldg. 3017
Oregon State University, Corvallis, OR 97331
phone: (541) 737-8170; fax: (541) 737-5725; e-mail: Jennifer.Parke@oregonstate.edu
[2]North Willamette Research & Extension Center, 15210 NE Miley Rd., Aurora, OR 97002
phone: (503) 678-1264; e-mail: rich.regan@oregonstate.edu

For this study on fungicide efficacy against *Phytophthora ramorum,* rhododendron 'Nova Zembla' plants in 1-gal pots were established at the North Willamette Experiment Station. There were 8 treatments with 20 plants per treatment = 160 plants total. Due to the cool, rainy weather this spring, the first fungicide application was delayed until May 23, 2005 with subsequent applications on June 8 and June 28. Fungicide treatments consisted of the following materials, rates, and application intervals:

Treatment	Fungicide
1	Subdue (foliar)
2	Subdue (foliar) followed by Subdue (foliar) 4 wks later
3	Subdue (foliar)/Mancozeb tankmix
4	Trt 3 followed by Stature 4 wks later
5	Trt 3 followed by Aliette 4 wks later
6	Ranman – 3 applications at 2 wk intervals
7	Fenamidone – 3 applications at 2 wk intervals
8	No fungicide control

Fungicide	Rates per 100 gal water
Subdue (foliar)	2 fl. oz.
Mancozeb	1.5 lbs.
Aliette	5 lbs.
Ranman	6 oz.
Fenamidone	28 oz.

On May 31 and June 28, 2005, 50 leaves were collected from each treatment, bagged, labeled and transported to campus where they were wounded and inoculated with mycelial plugs of *Phytophthora ramorum*. An A1 isolate (N11A) and an A2 isolate (4143) were used to each inoculate the mid-blades of 20 leaves. Ten leaves were not inoculated to serve as controls. Leaves were incubated in moist chambers for one week before they were digitally photographed and scanned. Image analysis software was used to determine disease severity. Results were expressed both as percent of total leaf area which was necrotic, as well as the absolute area (cm^2) which was necrotic. We used the PROC GLM model in SAS for 2-way analysis of variance of our data. Percentage data were transformed (arc sin square root) prior to analysis. In all cases the non-inoculated wounded controls produced essentially zero levels of necrosis due to phytotoxicity or wound response and were left out of the analysis. Data in the tables are presented as the % necrotic lesion area.

For leaves inoculated on June 1 (Table 1), average percent necrosis for the inoculated non-fungicide control treatment was 19% and 15% for the A1 and A2 isolates, respectively. There was a significant ($P<.0001$) effect of fungicide treatment and isolate ($P<.0119$), but no significant fungicide x isolate interaction. The A1 isolate was consistently more virulent than the A2 isolate. Fenamidone, Subdue, and Subdue/Mancozeb followed by Aliette were the most effective fungicide treatments.

On the June 28 inoculation, the disease level in the untreated control was only 4% for both isolates. Because disease levels were so low, it was not possible to detect differences between treatments and data are not shown. It is not clear why inoculation did not result in greater disease during this trial, but this could provide important clues about the physiology of disease caused by *P. ramorum* in relation to host phenology. We decided to delay the third sampling to the fall after a flush of new growth, since immature leaves are more susceptible to infection. Fungicides were applied October 3, with leaf collection and inoculation on October 10 and October 11, respectively. Treatments for this final fungicide trial were as follows:

Treatment	**Fungicide**
1	Subdue (foliar)
2	Mancozeb
3	Subdue (foliar)/Mancozeb tankmix
4	Stature DM
5	Aliette
6	Ranman
7	Fenamidone
8	No fungicide control

The October 11 trial resulted in a very successful test: there was a high level of disease in the no fungicide control treatment (28% necrotic area for the A1 isolate and 6.7% necrotic area for the A2 isolate) and non-inoculated leaves had no necrosis. Results for this trial (Table 2) indicated that there was a highly significant interaction between fungicide treatment and the isolate used to inoculate the leaves ($P<.0001$), as well as significant main effects for fungicide ($P<.0001$), and isolate ($P<.0001$).

Again, the A1 isolate (N11A) was significantly more virulent than the A2 isolate (4143). A1 isolates are more typical of the European population of *P. ramorum*, whereas the N. American isolates from forests and most nurseries are the A2 mating type. The most effective fungicide treatments were Subdue, Subdue/Mancozeb, and Fenamidone. Aliette and Ranman provided some control, but neither Stature nor Mancozeb, when applied alone, provided significant control of *P. ramorum* in this test.

Discussion and Conclusions

Subdue is currently labeled for foliar application to prevent disease caused by *P. ramorum.* However, repeated applications of Subdue can result in the rapid development of resistance to this fungicide (active ingredient = mefanoxem) by *Phytophthora* species. European plant pathologists have already detected an increased tolerance of *P. ramorum* in Europe to the very similar active ingredient metalaxyl, whereas the N. American population is still responsive to this fungicide. This likely reflects the increased time that European nurseries have been utilizing metalaxyl to control *P. ramorum*, resulting in greater exposure of the *Phytophthora* population, and rapid development of resistance. A similar phenomenon could occur in the United States if Subdue is applied alone to control *P. ramorum.* A more responsible choice, and one that would preserve the efficacy of this fungicide for the long-term, would be to tankmix Subdue with a more general contact fungicide such as mancozeb. Our data suggest that additional fungicides such as Fenamidone are effective and should be registered for use on woody ornamentals to provide more options for nursery growers. The use of Fenamidone or other effective fungicide treatments in alternation with Subdue or Subdue/Mancozeb would help delay the development of resistance to mefanoxem (Subdue). It is also imperative that all fungicides should be applied **as preventative treatments only** to certified disease-free plants, and never applied to infected plants in an attempt to reduce disease severity.

Summary for N. Willamette *Phytophthora ramorum* Fungicide Study 2005 - Parke and Regan

Table 1. June 1, 2005 Inoculation

Fungicide Treatment	**Isolate**	**Average necrotic area (%)**	*****
1. Subdue	A1	7.91	cd
	A2	4.95	
2. Subdue & Subdue	A1	8.11	bc
	A2	9.17	
3. Subdue/Mancozeb	A1	13.23	b
	A2	9.80	
4. Subdue/Mancozeb & Stature	A1	7.21	c
	A2	6.78	
5. Subdue/Mancozeb & Aliette	A1	7.74	cd
	A2	5.87	
6. Ranman	A1	10.76	bc
	A2	8.17	
7. Fenamidone	A1	7.33	d
	A2	4.88	
8. No fungicide	A1	19.02	a
	A2	14.80	

*Fungicide treatments followed by the same letter are not statistically significantly different (P<.05)

Table 2. Oct 11, 2005 Inoculation

Fungicide Treatment	**Isolate**	**Average necrotic area (%)**	*****
1. Subdue	A1	0.00	d
	A2	0.36	
2. Mancozeb	A1	33.08	a
	A2	8.86	
3. Subdue/Mancozeb	A1	1.32	d
	A2	1.18	
4. Stature DM	A1	25.17	b
	A2	3.37	
5. Aliette	A1	11.44	c
	A2	5.10	
6. Ranman	A1	15.85	c
	A2	0.44	
7. Fenamidone	A1	4.61	c
	A2	0.00	
8. No fungicide	A1	28.03	ab
	A2	6.68	

*Fungicide treatments followed by the same letter are not statistically significantly different (P<.05)