

ONION (*Allium cepa*)

Neck rot; *Botrytis aclada* and *B. allii*

Damping-off; *Pythium ultimum* and *Rhizoctonia solani*

Black mold, green mold; *Aspergillus niger*, *Penicillium* spp.

L.J. du Toit, M.L. Derie, L.M. Brissey,

B. Holmes, M. Twomey, and E. Gatch,

Washington State University-Mount Vernon

NWREC, Mount Vernon, WA 98273

Evaluation of seed treatments for soilborne damping-off pathogens and seedborne fungi of onion, 2008.

A seed lot of a proprietary onion cultivar naturally infected with neck rot *Botrytis* spp. (*B. aclada* and *B. allii*) was used to evaluate fungicide treatments for control of seedborne *Botrytis* spp. as well as damping-off from soilborne *Pythium ultimum* and *Rhizoctonia solani*. For Coronet and Rovral 4F seed treatments, seeds were placed in a slurry of a proprietary blue liquid colorant (4.0% by seed weight mixed 1:1 with water), to which the appropriate fungicide was added. Seeds were treated with water + colorant for the control treatment. The seeds and slurry were shaken in a flask until the slurry was adsorbed completely onto the seeds. Other seed treatments were applied by the registrants, i.e., AgriCoat LLC (Soledad, CA) for Agricoat 711A and Agricoat 800A, and Syngenta Crop Protection (Stanton, MN) for the FarMore D300 treatments, Thiram 42-S, and Apron + Maxim + A14635 (an experimental fungicide). Seed germination was tested for four replications of 100 seeds/treatment using the blotter assay of the Association of Official Seed Analysts (AOSA). A seed health assay for *B. aclada* and *B. allii* was also completed for four replications of 100 seeds/treatment. The seeds were placed onto Kritzman and Netzer's semi-selective agar medium (20 seeds/Petri dish with 5 plates/replication), the dishes sealed with Parafilm, and then incubated at 22°C with near-UV and fluorescent light on a 12 h/12 h day/night cycle. Seeds were examined microscopically after 5, 9, and 14 d. Each treatment was also evaluated against soilborne inoculum of *P. ultimum* and *R. solani*. For each of four replications in a randomized complete block design, 50 seeds were planted into each of two flats (24.5 cm² x 6 cm deep) filled with Redi-Earth Peat-Lite planting mix (for a total of 100 seeds/treatment). For *P. ultimum*, the planting mix was inoculated at 1.19×10^6 cfu/flat using a soil-oatmeal culture of *P. ultimum*. For *R. solani*, the planting mix was inoculated at 2.88×10^5 to 4.32×10^5 cfu/flat using a soil-oatmeal culture of the fungus. For each pathogen, non-treated seeds were also planted into non-infested planting mix as a control treatment. The number of seedlings emerged and the number of emerged seedlings with damping-off symptoms were recorded 7, 14, 21, 28, and 35 d after planting. Total dry biomass of emerged seedlings was recorded 35 to 40 d after planting. Data were subjected to analyses of variance and means comparison using Fisher's protected least significant difference (LSD).

In the germination assay, only Coronet significantly increased seed germination at 6 d compared to non-treated seed. In contrast, Farmore D300 alone and combined with Actigard or Mertect 340F significantly reduced early germination. However, by 10 d there were no significant differences in germination among treatments. Non-treated seed averaged only 67.5% germination, reflecting the long duration of storage of this seed lot for research projects on seedborne *B. aclada* and *B. allii*. In the seed health assay, *B. aclada* and *B. allii* were observed on 65.3% of the non-treated seeds. All treatments except Apron + Maxim 4FS + A14635 and Farmore D300 significantly lowered the incidence of neck rot fungi. AgriCoat 711A, AgriCoat 800A, and Rovral 4F were the most effective (<3% infection), followed by Coronet (<6%) and Farmore D300 + Thiram 42-S (11.8%). Thiram 42-S and other Farmore D300 combinations had intermediate efficacy. *Aspergillus* spp. (primarily *A. niger*) were detected on 6.5% of the non-treated seeds vs. <0.5% of seeds with AgriCoat 711A, AgriCoat 800A, and 0% of the seeds treated with Coronet. Thiram 42-S and Farmore D300 + Actigard or Farmore D300 + Thiram 42-S were the next most effective. AgriCoat 711A, AgriCoat 800A, and Coronet were the most effective against seedborne *Penicillium* spp. (<1.0%) compared to non-treated seeds (18.3%); followed by Rovral 4F and Farmore D300 combined with Thiram 42-S, Actigard or thiamethoxam (<4%). In the damping-off greenhouse assays, Thiram 42-S and all treatments with mefenoxam (Farmore D300 and Apron + Maxim 4FS + A14635) significantly increased emergence at 35 d in flats inoculated with *P. ultimum*, from 30% in flats with non-treated seeds to >40% (44 to 61%). However, only seed treated with Farmore D300 + Mertect 340F, Farmore D300 + Thiram 42-S, or Farmore D300 + Vanguard WG significantly increased final plant dry weights in the *P. ultimum* assay (to > 7 g vs. 4.8 g for non-treated seeds). For the flats inoculated with *R. solani*, only 3% emergence was observed for the non-treated seeds. Rovral 4F resulted in the highest emergence (51%, similar to 57% observed in non-inoculated flats), followed by Coronet (42 to 43%) and Apron + Maxim 4FS + A14635 (42%). All other treatments except AgriCoat 711A and AgriCoat 800A (2 to 4% emergence) also improved emergence significantly (11 to 34%) compared to non-treated seeds in the *R. solani* assay. Seedling dry weights in flats inoculated with *R. solani* were significantly improved by all treatments except AgriCoat 711A, AgriCoat 800A, and Thiram 42-S compared to non-treated seed. Rovral 4F and Apron + Maxim 4FS + A14635 resulted in the highest dry plant weights (2.3 and 2.2 g, respectively), followed by Coronet (1.9 and 2.0 g at 200 ml and 400 ml/100 kg seed, respectively) and the various Farmore D300 combinations (1.2 to 1.8 g) compared with non-treated seed (0.2 g). Overall, the results demonstrate the need for multiple fungicides on onion seed to control the diversity of seedborne and soilborne pathogens that can infect onion seedlings. Of all the seed treatments evaluated, Coronet gave the most effective control of the seedborne fungi as well as soilborne *R. solani*, but was ineffective against soilborne inoculum of *P. ultimum*. The organic seed treatments were highly effective against the seedborne fungi but not against soilborne inoculum of *P. ultimum* or *R. solani*.

Seed treatment and rate of product/100 kg seed*	Seed germination assay:		Seed health assay: % Seed infected (14 d)							
	% Seed germinated		Other seedborne fungi							
	6 d	10 d	<i>Botrytis aclada</i> and <i>B. allii</i>		<i>Aspergillus</i> spp.		<i>Penicillium</i> spp.			
Non-treated seed	28.5	cde**	67.5	65.3	b	6.5	cde	18.3	a	
AgriCoat 711A	30.8	cd	65.3	0.0	j	0.3	h	0.3		h
AgriCoat 800A	32.8	abc	70.8	0.8	j	0.0	h	0.5		h
Apron + Maxim 4FS + A14635	23.0	ef	76.0	79.8	a	8.0	bcd	10.5	bc	
Coronet 200 ml	37.0	ab	72.5	5.0	i	0.0	h	0.0		h
Coronet 400 ml	38.0	a	75.5	5.3	i	0.0	h	0.0		h
Farmore D300 52.6 g	21.0	f	70.0	57.3	bc	10.0	ab	13.5	ab	
Farmore D300 52.6 g + Actigard 10 ug	11.8	g	65.8	34.8	fg	1.3	g	3.5		efg
Farmore D300 + Mertect 340F 40.7 g	21.3	f	75.8	50.0	cd	5.3	def	11.8	ab	
Farmore D300 + thiamethoxam	26.0	def	72.5	40.3	ef	7.0	bcd	3.5		ef
Farmore D300 + Thiram 42-S 390 ml	29.8	cde	72.5	11.8	h	1.5	g	2.5		fg
Farmore D300 + Trigard OMC 75 WP 6.7 g	29.3	cd	73.8	47.0	de	9.0	bc	7.8		d
Farmore D300 + Vangard WG 3.33 g	29.3	cd	73.0	49.0	d	4.5	ef	7.5		cd
Rovral 4F 1,040 ml	31.3	bcd	70.5	1.3	j	14.3	a	2.3		g
Thiram 42-S 390 ml	28.3	cde	73.8	30.0	g	2.8	fg	5.3		de
LSD (Pr < 0.05)	6.17		NS		Sq root		Rank			Rank

	Greenhouse assays (inoculated planting mix)							
	<i>Pythium ultimum</i>				<i>Rhizoctonia solani</i>			
	Emergence (% , 35 d)		Dry weight (g, 35 d)		Emergence (% , 35 d)		Dry weight (g, 35 d)	
Non-treated seed in non-inoculated mix	63	a	11.9	a	57	a	4.4	a
Non-treated seed in inoculated mix	30	ef	4.8	efgh	3	h	0.2	ef
AgriCoat 711A	23	f	3.3	h	2	h	0.1	f
AgriCoat 800A	26	f	4.0	gh	4	h	0.2	ef
Apron + Maxim 4FS + A14635	51	bc	6.7	cdefg	42	bcd	2.3	b
Coronet 200 ml	39	de	4.6	fgh	43	bcd	2.0	bc
Coronet 400 ml	36	de	4.7	fgh	44	bc	1.9	bc
Farmore D300 52.6 g	52	bc	7.8	bcde	34	def	1.8	bc
Farmore D300 52.6 g + Actigard 10 ug	51	bc	6.3	defgh	30	ef	1.2	cd
Farmore D300 + Mertect 340F 40.7 g	61	ab	10.3	ab	34	cdef	1.7	bc
Farmore D300 + thiamethoxam	44	cd	5.8	defgh	29	f	1.4	cd
Farmore D300 + Thiram 42-S 390 ml	56	ab	8.5	bcd	39	cde	1.8	bc
Farmore D300 + Trigard OMC 75 WP 6.7 g	51	bc	6.9	cdefg	31	ef	1.8	bc
Farmore D300 + Vangard WG 3.33 g	57	ab	9.4	abc	26	f	1.4	cd
Rovral 4F 1,040 ml	25	f	4.1	gh	51	ab	2.2	b
Thiram 42-S 390 ml	54	abc	7.3	bcdef	11	g	0.8	de
LSD (Pr < 0.05)	10.0		3.11		Arcsin		Log	

* FarMore D300 = mefenoxam (Apron) + fludioxonil (Maxim) + azoxystrobin (Dynasty) at a combined rate of 12.5 g a.i./100 kg seed, applied by Syngenta Crop Protection. Each product applied in combination with Farmore D300 was applied by Syngenta Crop Protection at the product rate shown above except for those with rates provided by Syngenta as active ingredient (a.i.): A14635 (an experimental fungicide) at 5.0 g a.i. /100 kg seed and thiamethoxam (experimental formulation of an insecticide) at 0.1 mg a.i./seed. AgriCoat 711A and AgriCoat 800A (proprietary ingredients) developed by AgriCoat LLC for certified organic production.

** Means with the same letter in a column are not significantly different. ‘-’ = non-treated seeds planted into non-inoculated planting mix (only included in the greenhouse assays for damping-off pathogens, not the germination and seed health assays). ‘NS’ = means not significantly different at $P = 0.05$. ‘Arcsin’, ‘Log’, ‘Sq root’, and ‘Rank’ indicate original means are shown but means separation is based on arcsin square root, log, and square root transformation, and Friedman’s non-parametric rank test, respectively, because of heterogeneous variances and/or non-normal variances.