



SILVER SCURF BEGINS BELOWGROUND ON POTATOES IN WESTERN WASHINGTON

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Abstract

Photographs of multiple sporulation and infection-cycle events on decaying seed potato pieces, including the roots, stolons, and progeny tubers of potato plants, indicate that silver scurf caused by *Helminthosporium solani* is a polycyclic disease, belowground, on potatoes in western Washington, warranting new approaches for disease control.

Introduction

Specialty potato growers in western Washington seek better measures for controlling silver scurf on smooth-skinned red, yellow, and white potatoes. Quality is an important issue for fresh market and seed potato sales, and smooth-skinned cultivars are thought to be more severely damaged than Russet-skinned cultivars. The lesions (Figure 1) produced by the silver scurf fungus, *Helminthosporium solani*, are very detrimental on potato tubers, diminishing economic value as well as increasing the risk of seed tuber-borne disease.

Potato seed piece fungicides have been shown to have some efficacy in reducing silver scurf infections that are transmitted from seed to progeny tubers. Seed treatments currently recommended for this purpose in the Pacific Northwest include products such as Dynasty (azoxystrobin), Maxim 4FS (fludioxonil), and Maxim MZ (fludioxonil plus mancozeb). See Hamm et al. (2007); the [Pacific Northwest Plant Diseases Management Handbook](#); Powelson and Rowe (2008); and [WSU Pesticide Information Center Online](#) to acquire information on their use. New products are being tested and becoming available all of the time.

In western Washington, which has a mild marine climate where silver scurf can be severe on susceptible smooth-skinned potato cultivars and where some of these fungicide evaluations have occurred, seed piece fungicides, although helpful, have not yet been able to eliminate the disease. Especially puzzling is that even with a low number of lesions on tubers, sporulation by the fungus can be high, as was shown in a two-year field study at WSU Mount Vernon NWREC (Table 1). Moreover, it has been established in several areas, including western Washington (Table 2), that extended periods between vine kill and harvest can lead to increasing levels of silver scurf infections and that, oftentimes, progeny tubers may already be infected before going into storage.

Many facets of the silver scurf disease cycle in western Washington are unknown. For foliar diseases on potato, like early blight and late blight, the disease cycles are considered to be “polycyclic,” meaning that many cycles of spores can be produced in one growing season to cause numerous and subsequent (or secondary) infections or disease cycles. Because the silver scurf fungus produces numerous spores (or conidia) on Christmas tree-like structures called conidiophores (see Figure 2 and Figure 7), this project investigated whether silver scurf is a polycyclic disease on belowground potato plant parts.

For more information on silver scurf and its control in the Pacific Northwest, see [PNW Extension Publication #596](#) (Hamm et al. 2013).

Table 1. Silver scurf ratings on tubers from four potato cultivars, randomly sampled from WSU Mount Vernon NWREC experimental field trial plots in 2007 and 2008.

Seed treatment (fl oz/cwt) used at planting	2007 Harvest ^a		2008 Harvest ^a	
	% Tuber surface with lesions ^b	% Tubers <i>H.</i> <i>solani</i> spores ^b	% Tuber surface with lesions ^b	% Tubers <i>H.</i> <i>solani</i> spores ^b
<i>Cascade White</i>				
Non-treated, diseased seed	28 b	100 b	25 b	98 b
Maxim (0.08)	28 b	99 b	21 b	99 b
Maxim (0.16)	25 b	99 b	22 b	97 b
Mertect (0.021)	24 b	98 b	--- ^c	---
Dynasty (0.38)	8 a	82 a	8 ab	95 b
Dynasty + Maxim (0.38 + 0.08)	4 a	68 a	5 a	59 a
Non-treated, pre-nuclear seed ^d	2 a	68 a	6 a	65 a
<i>LSD</i> ($P = 0.05$) ^e	7.4	12.9	11.9	13.3
<i>Chieftain</i>				
Non-treated, diseased seed	13	100 c	12	98
Maxim (0.08)	22	99 bc	20	100
Maxim (0.16)	13	96 ab	16	100
Mertect (0.021)	17	97 ab	---	---
Dynasty (0.38)	13	94 ab	13	100
Dynasty + Maxim (0.38 + 0.08)	10	92 a	12	98
Non-treated, pre-nuclear seed ^d	17	99 bc	16	97
<i>LSD</i> ($P = 0.05$)	<i>NSD</i> ^e	5.4	<i>NSD</i>	<i>NSD</i>
<i>Russet Norkotah</i>				
Non-treated, diseased seed	32 b	100	15 c	99 c
Maxim (0.08 fl oz/cwt)	19 a	99	19 c	93 c
Maxim (0.16 fl oz/cwt)	16 a	99	11 c	94 c
Mertect (0.021 fl oz/cwt)	34 b	99	---	---
Dynasty (0.38 fl oz/cwt)	18 a	99	9 c	93 c
Dynasty + Maxim (0.38 + 0.08)	13 a	93	3 b	50 b
Non-treated, pre-nuclear seed	14 a	97	0 a	2 a
<i>LSD</i> ($P = 0.05$)	7.6	<i>NSD</i>	5.9	18.9
<i>Yukon Gold</i>				
Non-treated, diseased seed	27 c	97 b	20 c	97 c
Maxim (0.08)	23 c	97 b	13 b	94 c
Maxim (0.16)	10 b	77 a	19 c	97 c
Mertect (0.021)	28 c	99 b	---	---
Dynasty (0.38)	6 ab	66 a	8 ab	86 bc
Dynasty + Maxim (0.38 + 0.08)	2 a	59 a	5 a	73 ab
Non-treated, pre-nuclear seed ^d	---	---	5 a	69 a
<i>LSD</i> ($P = 0.05$)	5.8	13.6	6.0	12.8

^a Vine kill dates were 85 and 84 days after planting for 2007 and 2008, respectively. Harvest dates were 42 and 33 days post vine kill in 2007 and 2008, respectively.

^b Silver scurf ratings courtesy of P. Hamm; tubers were incubated in moist chambers for three weeks prior to rating.

^c --- Product not tested.

^d Pre-nuclear seed tubers not available in 2008 for the silver scurf-free seed control, thus G1 seed lots used instead.

^e Each cultivar analyzed separately. All cultivar by seed treatment sample combinations consisted of 25 tubers replicated four times. Means followed by same letter, not significantly different (NSD) by Fisher's Least Significant Difference (LSD) test.

Table 2. Silver scurf severity on four cultivars randomly sampled from WSU Mount Vernon NWREC experimental field plots at different intervals between vine kill and harvest.

Time of harvest	Severity as % of tubers surface with lesions ^b			
	Cascade White	Chieftain	Russet Norkotah	Yukon Gold
Early ^a	8 a ^b	8 a	15 a	15 a
Regular	25 b	15 b	19 a	17 a
Late	21 b	28 c	30 b	22 b
LSD ($P = 0.05$) ^c	5.4	3.9	5.5	5.3

^a Early, regular, and late harvest dates were 21, 42, and 61 days following vine kill, respectively.

^b Each sub-sample consisted of 10 tubers from two plants in four replications. Sampled tubers were incubated in moist chambers for 3 weeks at 68°F before the severity rating.

^c Means followed by same letter, not significantly different by Fisher’s Least Significant Difference (LSD) test.

Methods

Yukon Gold seed potatoes from a lot having high incidence (100%) and severity (57–90%) of naturally-occurring silver scurf lesions (Figure 1) caused by *H. solani* were planted in late May at WSU Mount Vernon NWREC using a randomized, complete block design with four replications. The trial was maintained according to cultural practices typical for growing specialty potatoes under western Washington conditions, with the exception of being drip irrigated (0.5 in. delivered, twice per week). The belowground plant parts and seed and progeny tubers from four replications of three plants each were destructively sampled seven times at regular intervals during the growing season to document belowground infection and sporulation by *H. solani*.

At each sampling, plant tissues were carefully hand dug and placed in separate paper bags, then immediately brought to the laboratory and directly observed (without washing) for signs of *H. solani* using a dissecting microscope at 40x. Finally, the tissues were photographed within only a few hours of sampling. A few tubers from the pre-harvest sample date were used for culturing the fungus and Fed-Ex shipped overnight to the Franceschi Microscopy and Imaging Center at WSU to obtain scanning electron micrographs on the next day. Twelve weeks (84 days) after planting, the vines were killed. Following a six-week interval, all remaining tubers were machine harvested. The interval between vine kill and harvest was



Figure 1. Lesions produced by the silver scurf fungus on seed potato tubers of Yukon Gold. Image courtesy: B. Gundersen.

maximized to ensure silver scurf development. Note: to help minimize silver scurf disease, it is important for growers to remember that they should harvest tubers soon after they mature.

Results and Discussion

Direct observations made on hand-dug tubers in a western Washington field setting indicated that *H. solani* can sporulate profusely on seed tubers belowground after planting, even if the seed is rotted, aged, shriveled, or dried. Sequential photographs (see Figure 2 through Figure 8) show that conidia formed first on seed tubers and then moved progressively onto belowground potato plant parts, developing roots and stolons, and then ultimately, progeny tubers. Oftentimes, spore formation via newly emerging conidiophores was detected on these potato tissues, showing that infection cycles were repeating. Although many

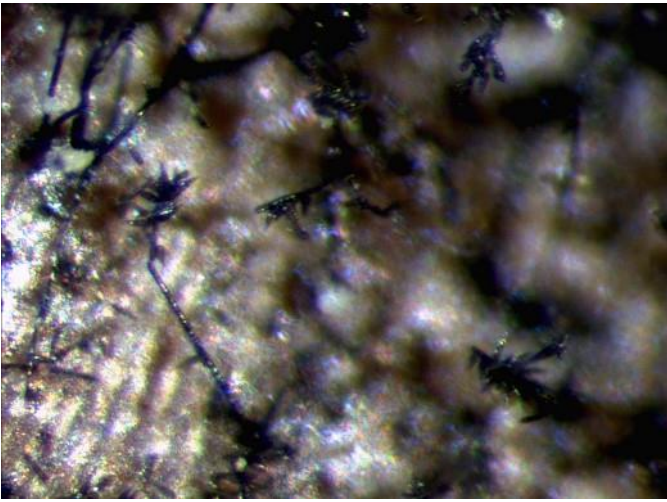


Figure 2. *H. solani* sporulating, belowground, on a planted seed potato of Yukon Gold 47 days after planting (40x magnification). Photo courtesy: B. Gundersen.



Figure 5. *H. solani* sporulating, belowground, on stolon surface of Yukon Gold, 103 days after planting and 19 days post vine-kill (40x magnification). Photo courtesy B. Gundersen.

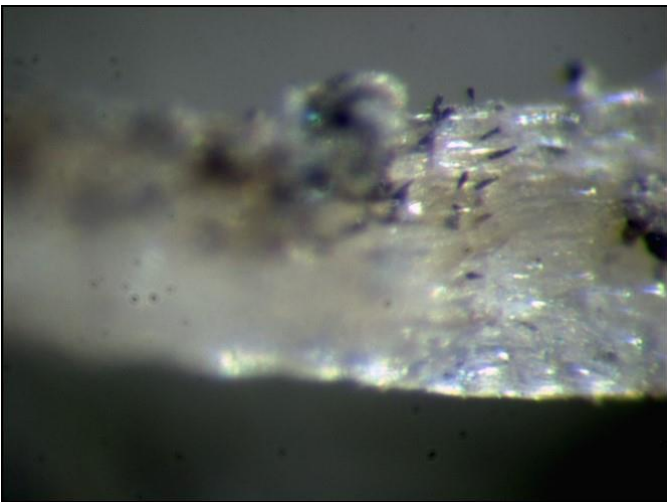


Figure 3. *H. solani* spores on fibrous root of Yukon Gold plant, belowground, 47 days after planting (40x magnification). Photo courtesy B. Gundersen.

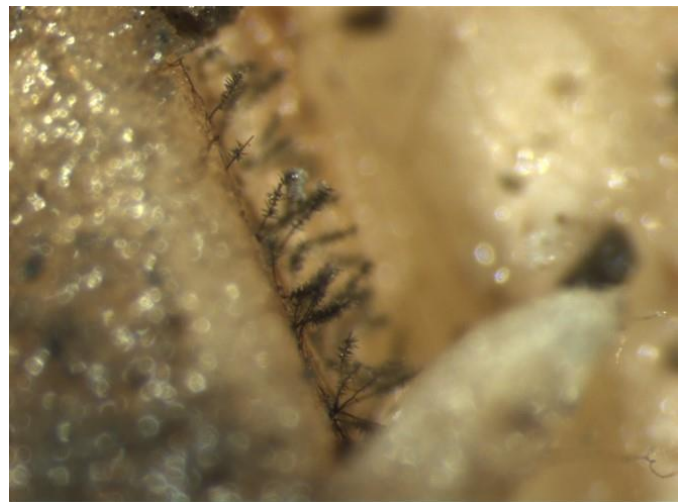


Figure 6. *H. solani* sporulating, belowground, on potato root of Yukon Gold, 103 days after planting and 19 days post vine-kill (40x magnification). Photo courtesy B. Gundersen.

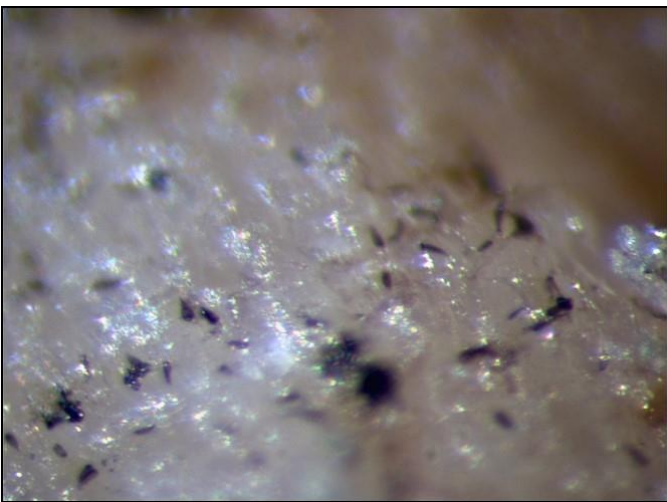


Figure 4. *H. solani* spores on stolon surface of Yukon Gold, belowground, 60 days after planting (40x magnification). Photo courtesy B. Gundersen.



Figure 7. *H. solani* sporulating, belowground, on new progeny potato tuber of Yukon Gold, 103 days after planting and 19 days post vine kill (40x magnification). Note the Christmas tree shaped structures (conidiophores) on which the conidia (spores) are being produced. Photo courtesy B. Gundersen.

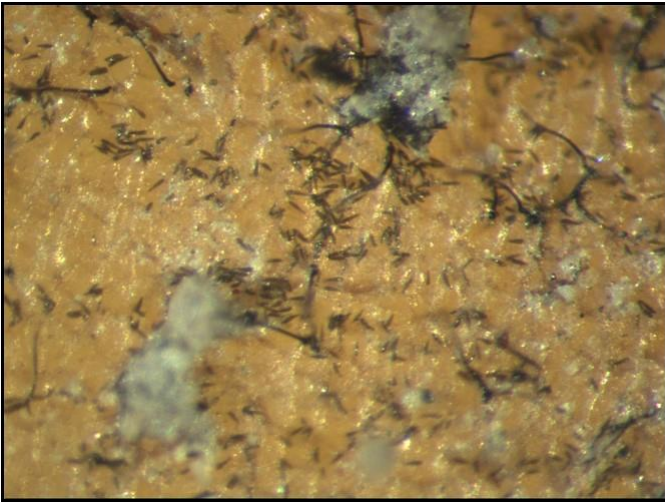


Figure 8. *H. solani* spores on potato tuber surface, belowground, of Yukon Gold, 8 days after harvest. Some spores have started to germinate on tuber surface (40x magnification). Photo courtesy B. Gundersen.

other authors have stressed the importance of seedborne inoculum in silver scurf development and have implicated its role in disease spread, this report provides direct photographic evidence of multiple sporulation cycles occurring belowground.

The identity of *H. solani* on selected sampled tubers was confirmed via pure culture isolations in the laboratory and also by scanning electron microscopy (Figure 9) on samples removed from the field prior to harvest. Of the seed pieces and progeny tubers sampled 100 days after planting or 16 days after vine kill, 43% (39 of 91) were confirmed as positive for *H. solani* (Table 3).

Crevices and depressions on tuber surfaces near the stolon end, at eyes, and adjacent to sprouts were frequent sites where *H. solani* sporulated. Presumably, plant and tuber exudates or soil moisture was higher near these sites. Moreover, irrigation and rain water percolating through the soil likely facilitated movement of *H. solani* conidia through the soil once the spores had been produced, leading to infections and, subsequently, additional spore formation on roots, stolons, and progeny tubers. Tuber samples recovered from a companion trial planted at OSU-Hermiston resulted in recovery of only a few silver scurf lesions that were sporulating belowground, implying that western Washington soil moisture and temperature

conditions may be especially conducive to repeating, belowground disease cycles.

Given that planted seed potato tubers can be a primary source of inoculum for *H. solani*, seed potatoes either need to be free of silver scurf, or seed tuber fungicide treatments must have long-term residual activity in order to be effective against *H. solani*. Otherwise, spore formation and spread of *H. solani* spores from infected seed tubers will not be satisfactorily suppressed, and multiple infections of belowground plant parts and progeny tubers can ensue.

Hilling, vine kill, and harvest operations, during which soil is disturbed, likely contributed to *H. solani* spore movement belowground. Since dislodged conidia from spore-forming conidiophores were abundant on progeny-tuber surfaces at the time tubers were harvested (Figure 8), they likely contaminated the soil in which the tubers were produced as well as the soil adhering to tubers entering storage. This type of soil contamination supports the suggested control practice of rotating crops so that a field is out of potatoes for three years.

Commonly recommended potato storage management practices all still hold true, such as harvesting and storing tubers soon after they mature, drying tubers with non-humidified air when they enter storage, storing potatoes below 40°F to slow

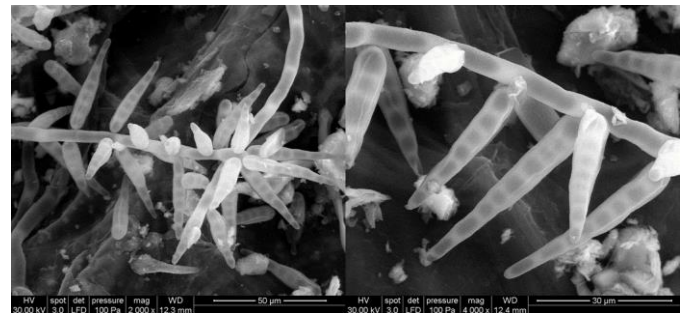


Figure 9. Spores observed directly on hand-dug potato tubers of Yukon Gold prior to harvest, confirmed to be *H. solani* by scanning electron microscopy (2000x and 4000x magnification). Photos courtesy of WSU Franceschi Microscopy & Imaging Center.

Table 3. Silver scurf ratings on hand-dug seed and progeny tubers of cv. Yukon Gold plants^a that were destructively sampled during the growing season at WSU Mount Vernon NWREC and directly observed for signs of *Helminthosporium solani*.

Sample time and (DAP) ^b	Seed tubers			Progeny tubers			Microscopic observations			
	Seed piece decay, %	<i>H. solani</i> rating ^c			No./plant	Wt.(g)/plant				<i>H. solani</i> rating ^c
		1	2	3			1	2	3	
14 Jul (47)	0	0/1	1/1	0/1	.	.	.	.	.	<i>Hs</i> sporulating on seed tuber belowground—destructive sampling initiated
21 Jul (54)	2	12/12	4/12	0/12	6.2	53.1	.	.	.	<i>Hs</i> sporulating on seed tubers especially in crevices and protected depressions
30 Jul (63)	0	12/12	2/12	12/12	6.2	331.8	.	.	.	Conidiophores remain on seed tubers but no longer have numerous conidia; ‘dehisced’ conidia on eyes/sprouts/rootlets of developing tissues
12 Aug (76)	16.7	10/12	2/12	5/12	5.5	439.3	.	.	.	Some conidiophores with conidia; dehisced conidia on stolons and progeny tubers, especially in protected depressions or protected areas like eyes
21 Aug (85)	.	.	.	.	.	.	51/65	24/65	0/65	<i>Hs</i> actively sporulating on belowground tissues, including surfaces of progeny tubers
5 Sep (100)	70.8	12/12	3/12	0/12	6.6	744.7	3/79	24/79	10/79	<i>Hs</i> still actively sporulating on seed tubers--especially progeny tuber in protected depressions of tuber surface; some <i>Hs</i> spores dehisced and appear to be germinating on progeny tubers
30 Sep (125)	.	.	.	.	5.6	700.7	60/67	0/67	60/67	Conidiophores on progeny tubers mostly with dehisced conidia; these appear on tuber surfaces and on stolons

^aThe seed tubers were naturally infected with high levels of *Hs* prior to planting on 28 May.

^bEach sample was composed of 4 replications of 3 plants. DAP = days after planting.

^c*H. solani* sporulation on tuber: 0 = none; 1 = conidiophores but no conidia; 2 = conidiophores + conidia; 3 = dehisced conidia on tuber surface.

disease development if possible, completely removing tubers from storages, and also, sanitizing storages upon tuber removal. However, because progeny tubers may become contaminated or infected prior to storage, fungicide treatments applied curatively to infected tubers in storage, rather than protectively to non-infected or contaminated tubers, most likely have limited efficacy. Since prolific sporulation and infection events by *H. solani* can occur on progeny tubers prior to placement in storage, new disease interventions need to be investigated in lieu of the practice of applying fungicides onto tubers as they enter storage.

Based on this work, suggested research topics for the future include: developing seed fungicides with time-release or longer-term residual activity than currently available products (i), testing appropriate in-furrow fungicides drenched at planting (ii), evaluating soil-applied fungicide applications prior to hilling (iii), managing irrigation strategically (iv), and forecasting for silver scurf based on belowground soil environmental conditions (v).

In the meantime, by using registered seed treatment fungicides and planting only seed potatoes with no detectable or a very low incidence of silver scurf, growers will have a greater likelihood of reducing silver scurf on progeny tubers and avoiding contamination of the surrounding soil.

Acknowledgements

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Further Reading

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