Fundamental and Novel Methods of Silver Scurf Control in Storage

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Although not a disease that causes the tuber to actually rot, silver scurf, caused by the fungus *Helminthosporium solani***,** causes grey to silvery blotches on the surface of the tuber. There is no internal damage with infection by the silver scurf fungus but the affected skin has a silvery sheen, appears thicker, and can be unappealing to the consumer on fresh marketed potatoes and can also cause problems on processed potatoes. This disease actually has two distinct phases. One phase occurs while the tubers are still in the field and results in infected areas that are generally on or near the stem end of the tuber called “primary lesions.” Probably more important from a cosmetic standpoint are the “secondary lesions” that result from conidia from primary infections that spread through the ventilation system while the tubers are in the storage facility. Secondary lesions occur anywhere on the tuber and can be so numerous as to cover virtually the entire surface of the tuber. Secondary spread may be greater under warm and moist conditions (eg. condensation) in storage. In storage, these infected tubers lose water at a greater rate compared to healthy tubers due to the disruption made in the periderm by the pathogen. The infected skin can also produce thickened areas making it more difficult to peel for processed potatoes.

Since there are two components or phases to silver scurf infection, the field or primary infection component and the storage or secondary component, managing silver scurf requires an integrated approach combining both field and storage tactics. Additional information on this integrated method for control can be found at:

http://extension.oregonstate.edu/catalog/pdf/pnw/pnw596.pdf.

The following list includes a few suggestions to help reduce silver scurf:

1. Plant seed with a low level or preferably no incidence of silver scurf
2. Use effective seed treatments
3. Clean and disinfect storages
4. Harvest tubers as soon as skins have set; avoid delays in harvest after vine kill
5. Store at the lowest temperature possible for the end-use of your crop
6. Lower storage humidity can reduce spread but it will equate to greater shrink in storage
7. Apply an effective post-harvest product

Reliance on one method alone will not be effective and in some situations the use of all these practices may not provide adequate control, particularly in smooth skin cultivars. This article will focus on recent research related to post-harvest product applications to minimize silver scurf in storage.

Volume of post-harvest spray application

Although research has been performed looking at post-harvest products applied to the potatoes while in storage either via the humidification system or thermal applications, most of the research presented in this article was evaluated using a spray application going into storage. Our research based information recommends no more than 0.50 gallon of aqueous product/ ton of potatoes (Figure 1). That converts to less than half a cup (3.2 ounces) of liquid per hundredweight (cwt). In order to maximize the usefulness of a post-harvest product, careful application of the rate and volume applied is necessary. Applying less than 0.5 gal/ton of potatoes may result in incomplete coverage and applying greater than 0.5 gal/ton of potatoes may add too much free moisture to the surface of the potato. Stewardship of application may take more time and effort, but the consistency of disease control will be greater.

Application of post-harvest products

The currently registered post-harvest products for control of silver scurf appear to have limited efficacy on controlling the disease in storage. Thiabendazole (Mertect 340-F) can be used for silver scurf suppression in storage but this postharvest application is no longer recommended due to fungicide resistance. Additional products are available although research has shown limited or no efficacy for the following products:

- General biocides such as ozone, hydrogen peroxide/peroxyacetic acid mixtures, and chlorine dioxide (spray application and in-storage application)
- Biological products such as *Bacillus subtillus* (Serenade) and *Pseudomonas syringae* (BioSave 10 LP)
- Clove oil (Biox C; thermally applied)

Research over the last 8 years has shown that azoxystrobin sprayed on potatoes prior to storage can be effective in reducing spread of silver scurf in storage (Table 1). Azoxystrobin is NOT CURRENTLY REGISTERED but registration is being pursued by Syngenta for the near future. Once registered this product will be a good tool to add to the silver scurf control toolbox. A resistance management plan, likely to include using a mixture of effective products including azoxystrobin will be established since this product is also utilized in controlling foliar diseases in the field.

<u>Phosphorous Acid</u>

For the past several years the potato industry has been fortunate to have access to a highly effective post-harvest material to control pink rot and late blight in storage. This material is called phosphorous acid or is also known as phosphite, phosphonate or salts of phosphorous acid. Several products are available to the potato industry that contain this active ingredient. Research results in the Pacific Northwest have been obtained using Crop-phite, Fosphite, Phostrol and Resist 57. Multiple studies over many years comparing several potato varieties have shown highly effective control of pink rot and late blight when phosphorous acid is applied at the 12.8 fl oz/ton as a post-harvest spray application prior to storage (Table 2). Tubers that have symptoms of late blight and pink rot coming out of the field can contaminate healthy tubers during the harvest operation. This post-harvest application works to help keep the healthy tubers from becoming infected.

For three years studies were conducted to evaluate the efficacy of phosphorous acid on the control of *Helminthosporium solani* (silver scurf) on naturally infected ‘Russet Norkotah’ tubers in storage. Tubers were treated after harvest, prior to storage, and treatments included phosphorous acid (12.8 fl. oz/ton), other potential post-harvest products, and an untreated control that was treated with water only. All treatments were applied in a volume of 0.5gal/ton of tubers as a low pressure spray. Tubers were evaluated for disease after 3 and 6 months in storage at 95%RH and 48°F (years 1 and 2) or 42°F (year 3).

In the first year under low disease pressure, the incidence of silver scurf was significantly reduced with phosphorous acid compared to the untreated control after 6 months in storage (Table 3). Disease pressure was relatively high in the second year and phosphorous acid treated tubers had significantly lower silver scurf incidence after 3 months (5%) compared to the control (67%; data not shown). The same level of control was not achieved after 6 months (Table 3). In the third year of the study, there was no significant reduction in silver scurf by 6 months (Table 2) between the control and phosphorous acid treated tubers, although significant differences were apparent after 3 months in storage. Four additional separate research trials in the third year with two potato varieties showed similar results to the previous years' data. Significant reductions in total silver scurf incidence ranged from 17 to 42% with phosphorous acid treatments compared to the untreated control. In some years, phosphorous acid was compared to Thiabendazole (TBZ or Mertect) which is still registered for post-harvest use although there is limited use due to disease resistance issues. In comparison, phosphorous acid was consistently more effective than TBZ (Table 3). This research indicated greater consistency in phosphorous acid control of silver scurf when applied at the 12.8 fl. oz/ton rate.

Additional studies looked at the potential of phosphorous acid as a seed treatment. Seed treated with phosphorous acid showed delayed emergence and silver scurf was not controlled on the daughter tubers. The lack of disease control and the potential for crop damage indicate that at this time phosphorous acid should not be used as a seed piece treatment for silver scurf control.

These studies show that phosphorous acid use will suppress silver scurf in storage. Additional studies to evaluate application methodology and to better understand why phosphorous acid is effective against silver scurf are needed to fully maximize the potential use of the product. In addition, studies evaluating application of phosphorous acid products after potatoes are in storage are currently in development. Post storage applications may be important particularly if potatoes are to be stored for 6 months or longer given the reduced long-term control by phosphorous acid when applied following harvest but pre-storage. Phosphorous acid should not be thermally applied. Fortunately the potato industry may now have a multi-purpose post-harvest tool that is effective against late blight and pink rot and potentially silver scurf.

<u>Clove oil</u>

One of the newcomers to the potato sprout control sector of the industry is clove oil. The mode of action of clove oil is completely different from CIPC by physically damaging the sensitive sprouting tissue. Clove oil is distilled directly from the evergreen plant *Syzygium aromaticum* (L.). The plant is native to Indonesia but is now grown in several other countries such as Madagascar and Brazil. The active ingredient of clove oil is eugenol and other eugenol-based components in the distillate product. The products used in the potato industry are 100% naturally derived clove oil and are approved for organic use. Due to the chemistry and volatility of clove oil it can be applied with a thermal applicator and distributed throughout the storage similar to applications of CIPC. This mode of application makes it ideal to apply to potentially control silver scurf development in storage. Research has indicated that clove oil (Biox C) has some suppressive action against silver scurf when applied repeatedly in storage as a thermal fog (Table

4). The incidence of silver scurf was reduced by approximately 40% when nine applications were made throughout the storage season. The limited level of control may not warrant the use of clove oil solely for the purpose to control silver scurf in storage.

Conclusions

Managing silver scurf requires an integrated approach that uses all management tools available to a grower. Buying clean seed, treating with an effective seed treatment, cleaning and disinfecting storages and applying an effective post-harvest treatment are effective tools. Using these tools and others in an integrated manner will help growers minimize the effects of silver scurf of their stored crop.

Table 1. Effectiveness of post-harvest fungicide applications on silver scurf incidence after 3 and 6 months in storage. All products were applied in an aqueous volume of 0.5 gal/ton of potatoes. Values in the same column followed by the same letters are not significantly different from each other at p=0.05.

Treatment (rate)	*% Incidence*[1]
Untreated	26 abc
Mertect (0.42 fl. oz)	24 abc
Ozone (hooded tunnel)[2]	54 a
Oxidate (1:50 dilution)	34 b
Messenger (2 oz)	36 ab
Aluminum Chloride (0.2 M)	10 bc
Serenade WPO (0.1 lb)	9 bc
Potassium sorbate (0.2 M)	6 bc
Azoxystrobin (0.6 fl. oz)	1 c

[1] percentage of tubers with silver scurf symptoms.
[2] 500 ppm applied for 30 seconds in an enclosed tunnel.

Table 2. Effect of post harvest applications of phosphorous acid and hydrogen peroxide/peroxyacetic acid (HPPA) on percent potato tuber rot[1] after 77 days (approximately 2.5 months) in storage (48°F) in a 1-ton bin. Values in the same column followed by the same letters are not significantly different from each other at p=0.05.

Treatment	**Rate/ton tubers**	*Late blight (%)*	*Pink rot (%)*
Untreated control		90 a	61 a
HPPA	1:25 dilution	84 a	73 a
Phosphorous acid	1.6 fl oz (1:40 dilution)	26 b	32 b
Phosphorous acid	3.2 fl oz (1:20 dilution)	14 bc	10 b
Phosphorous acid	12.8 fl oz (1:5 dilution)	0 c	0 c

[1]Tubers with typical disease symptoms or showing symptoms of secondary soft rot were counted as rotted tubers.

Table 3. Efficacy of post-harvest fungicides on the incidence of silver scurf on potato cv. Russet Norkotah following 6 months in storage at Kimberly, Idaho. Values in the same column followed by the same letter are not significantly different from each other at p= 0.05.

Treatment (rate)	*Incidence (%)*		
	Year 1	Year 2	Year 3
Untreated Control	18 b	69 a	15 a
Phosphorous acid (12.8 fl oz/ ton)	0 c	37 b	5 a
TBZ (Mertect; 0.42 fl oz/ton)	38 a	47 b	NA

Table 4. Silver scurf disease severity and incidence after nine months of storage and nine Biox C applications. Values in the same column followed by the same letter are not significantly different from each other at p= 0.05.

Treatment (rate)	**Silver scurf**	
	*Severity rating***	*Incidence (%)*
Untreated Control	3.3 a	97 a
Clove oil 67 ppm	2.6 bc	77 b
Clove oil 134 ppm	2.2 cd	60 c

**Disease severity rating based on a scale of 1-4: 1=no infection, 2=slight infection, 3=moderate, 4=heavy infection

Dry tuber 0.25 gal/T 0.5 gal /T 1.0 gal/T 2.0 gal/T

Figure 1. Post-harvest spray application volumes. The desired volume of a spray application is 0.5 gal/ton of potatoes.