EFFICACY OF PHOSPHITE-BASED FUNGICIDES FOR CONTROLLING PINK ROT AND LATE BLIGHT

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Pink rot (caused by *Phytophthora erythroseptica*) and late blight (caused by *Phytophthora infestans*) are potato diseases caused by the "water-mold" pathogens. These pathogens are not true fungi, and as a result, not all "fungicides" are effective for managing these two diseases. Late blight and pink rot have historically been controlled very effectively by metalaxyl/mefenoxam based fungicides. Resistance to metalaxyl/mefenoxam is widespread in the late blight pathogen and fungicides based on this chemistry are not recommended for late blight control. Resistance to metalaxyl/mefenoxam has recently developed in pink rot pathogen populations in eastern Idaho. For late blight, many fungicide alternatives are available, but not for pink rot. Metalaxyl/mefenoxam resistance in the pink rot pathogen has created great difficulties for potato growers in eastern Idaho. However, phosphite based fungicides show some promise in managing water mold pathogens resistant to metalaxyl/mefenoxam.

Fungicides based on salts of phosphorous acid (H_3PO_3) have recently shown efficacy in protecting potato tubers against late blight and pink rot. Phostrol^{TM} (Nufarm Americas, Inc.; mono and di-basic sodium, potassium, and ammonium salts of phosphorous acid) and Fosphite® (JH Biotech, Inc.; mono and di-basic potassium salts of phosphorous acid) are two specific products that have been tested at the University of Idaho. Several others are slated for testing in 2005. The phosphorous in phosphorous acid is in a reduced state (lower positive charge) than the phosphorous in phosphate based fertilizers. The phosphite ($H_2PO_3^-$ or HPO_3^{2-}; also called phosphonate) molecule is what is active in controlling diseases caused by water mold pathogens. Phosphite has also been shown to induce natural defense reactions in plants (Guest & Grant, 1991). University of Idaho research has shown that these phosphite based fungicides directly inhibit the growth of the water mold fungi. It is likely that both direct fungicidal activity and promotion of plant defenses play a role in the efficacy of phosphite based fungicides for control of late blight and pink rot.

Foliar applications of phosphite based fungicides should begin at tuber initiation. Three applications of 10 pt/acre, with each application timed two weeks apart are necessary for pink rot and late blight control. (Be sure to check the label of different phosphite-based fungicides before use because some labels do not allow for that type of application.) If applications are started later than row closure, then product efficacy declines. In a trial conducted at Bonners Ferry, ID, three foliar applications of Fosphite® conferred protection to tubers against a mefenoxam-resistant isolate of the pink rot pathogen (Table 1). Healthy tubers in this trial were exposed to spores of the pink rot organism and the

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two treatments with Fosphite® (either alone or in combination with Quadris® and Dithane®) showed significantly less pink rot than tubers from plants not receiving Fosphite®. Foliar late blight and tuber late blight was significantly controlled by all treatments.

Post harvest applications of phosphite based fungicides can also be effective for managing pink rot and late blight. Currently, options for post-harvest treatment of tubers are limited and consistent data for labeled disinfectant products are lacking. Research has shown that tubers with pink rot symptoms at harvest can contaminate healthy tubers, leading to infection in the cellar. Post-harvest applications are designed to keep healthy tubers healthy, not to cure tubers already infected in the field. Phosphite based fungicides are very safe and the post-harvest use of these products was labeled under EPA's biopesticide directive in the summer of 2004.

A subsequent study looked at the efficacy of both foliar and post-harvest phosphite-based applications. Three applications of Phostrol™ (10 pt/acre, applied every two weeks beginning at row closure) were used as a foliar treatment. This was followed by a 12.8 fl oz/ton post-harvest treatment applied directly to the tubers after harvesting. Foliar applications of Phostrol® were found to be effective in reducing the incidence of pink rot compared to the control. Foliar and post-harvest treatments combined showed the greatest reduction in the incidence of pink rot, although not significantly better than the post-harvest treatment alone (Table 2). It should be stressed that this test was designed to simulate infection that would occur at harvest, and not infection that occurs in the field. For further information on the post-harvest use of Phostrol, see Phosphorous Acid Efficacy on Storage Disease Control in this edition of the Proceedings.

Research has shown that water mold fungi can develop resistance to phosphite based fungicides. The risk of fungicide resistance development is not as great as with metalaxyl/mefenoxam, but is present. Since there are really no other fungicide choices for managing mefenoxam-resistant pink rot populations, phosphite fungicides should be used as directed on the label. Using phosphite based fungicides as a "rescue" treatment when disease has already been observed in the field is not recommended. Applications will not work, and the risk of selecting fungicide resistant individuals increases.

Conclusions

Phosphite-based fungicides applied to potato foliage are effective in protecting tubers from pink rot and late blight. Three applications of 10 pt/acre, applied every two weeks beginning at row closure are the most effective. Be sure to consult specific product labels to ensure proper use of phosphite based fungicides.

Table 1. Effect of phosphite-based fungicides on late blight and pink rot (mefenoxam-resistant) for Ranger Russet potatoes.

Treatment (rate/acre)	Timing[1]	Late Blight Foliar[2]	Late Blight Stem[3]	Late Blight Tuber[4]	Pink Rot Incidence[5]
Untreated control	--	14.3 a	3.4 a	22.3 a	24 a
Fosphite® (10 pt)	Weekly	0.3 b	0.0 b	0.0 b	7 b
Fosphite® (10 pt) Quadris® (6.2 fl oz) Dithane® (2 lb)	F,Q,F,D,F,D	0.8 b	0.3 b	0.3 b	4 b
Dithane® (2 lb) Quadris® (6.2 fl oz)	D,Q,D,D,D,D	0.5 b	0.1 b	0.8 b	27 a
Dithane® (2 lb)	Weekly	0.0 b	0.0 b	0.3 b	Not tested

[1] Fungicide programs were initiated at row closure and applied every week. For programs with multiple fungicides, the first letter of the fungicide is used to denote which fungicide was used each week.

[2] Average percentage of potato foliage affected by late blight. Values followed by different lowercase letters are significantly different from each other at the 95% probability level.

[3] Average number of late blight lesions on plant stems. Values followed by different lowercase letters are significantly different from each other at the 95% probability level.

[4] Percentage of harvested tubers with late blight symptoms. Values followed by different lowercase letters are significantly different from each other at the 95% probability level.

[5] Percentage of tubers (out of 15) developing symptoms after inoculation with *P. erythroseptica* (mefenoxam resistant). Values followed by different lowercase letters are significantly different from each other at the 90% probability level.

Phosphite-based foliar applications provide residual control of the pink rot pathogen in tubers after harvest. Foliar and post-harvest applications may provide additional tuber protection over foliar application. Foliar program based on three applications of 10 pints/acre starting a row closure. Post-harvest program based on 12.8 fl oz/ton of tubers. Be sure to consult the label to ensure proper use of phosphite-based fungicide.

Table 2. Effects of foliar and post-harvest phosphite-based treatments in reducing the incidence of *P.erythroseptica*.[1]

Foliar Treatment	Post-Harvest Untreated	Post-Harvest Phostrol (12.8 oz/ton)
Untreated	95 a	8 c
Phostrol (10 Pints/Acre)	28 b	2 c

[1] Percentage of tubers (out of 15) receiving a specific phosphite treatment, (foliar treatment, post-harvest treatment, foliar & post-harvest treatment, or untreated), developing symptoms after inoculation with *P. erythroseptica* (mefenoxam sensitive). Values followed by different lowercase letters are significantly different from each other at the 95% probability level.