

Evaluation of lime sulfur and sulfurix for control of Exobasidium and Phomopsis diseases of blueberry and vinifera wine grapes, respectively

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Objectives: (1) Determine and compare the efficacy of lime sulfur and Sulfurix for a late-dormant (bud swell) application for control of exobasidium fruit and leaf spot of blueberry; (2) likewise compare dormant applications of lime sulfur and Sulfurix products for comparative management of Phomopsis cane and leaf spot in wine grape vineyards.

Justification: Blueberries are the number one fruit crop in Georgia, having an annual farm gate value of over \$250 million. Exobasidium fruit and leaf spot is an emerging disease affecting both southern highbush and rabbiteye blueberries. Fruit symptoms include circular lesions which may be sunken and tinged with red color, diseased fruit tissue which is generally green and unripe, and sparse white fungal growth on spots. Leaf symptoms include light green spots on the upper side of the leaf, pure white spots on the underside of the leaf due to a thin layer of fungal growth; both of which become necrotic with age. These lesions compromise the aesthetic qualities of the fruit, as well as the taste, rendering them unmarketable. Packing lines have to slow down to allow human sorters to remove fruit with lesions which increases production costs, and affected fruit are still able to make it into the package, thereby increasing customer complaints.

The wine grape industry in Georgia has seen increased growth in the past 10 years as well. Many wine grape vineyards are located in north Georgia, and most are a 1-2 hour drive from metropolitan Atlanta. Expansion will likely continue due to increased exposure and marketing in high-population centers. Phomopsis cane and leaf spot (caused by *Phomopsis viticola*) is a common disease in Georgia wine grapes. Phomopsis has been observed in many grape-producing regions throughout the world. Many varieties, including native, hybrid, and vinifera, are susceptible to this disease. Phomopsis overwinters as pycnidia and mycelium in the bark of grape vines. When vines are repeatedly rained on during budbreak, spores are spread from pycnidia by water splash to shoot tips. Phomopsis is commonly seen in the spring as dark brown to black lesions on shoots. Lesions may coalesce and spread to cluster stems. Shoot breakage and stunted growth often result. Phomopsis can establish in the woody portions of vines, allowing for repeat infestations in future years.

In Georgia, preliminary studies have shown lime sulfur to be effective when applied at late-dormant (bud swell approximately two weeks before first green tissue or flowers are exposed) for treatment of Exobasidium fruit and leaf spot. If lime sulfur or Sulforix can be equally utilized to manage Exobasidium, this would be good, as Sulforix is utilized at a lower rate and is generally more user-friendly than lime sulfur. No information is available relative the efficacy and utility of either material for wine grape production in Georgia. For both commodities, more information is needed about these spray options with regard to efficacy, as well as the potential for phytotoxicity.



Figure 1. Symptoms of Exobasidium fruit (A) and leaf spot (B). Fruit symptoms are green, firm spots and blotches that do not mature with the rest of the berry. Leaf symptoms are light green spots on the upper leaf surface which are white or lighter green on the lower surface.

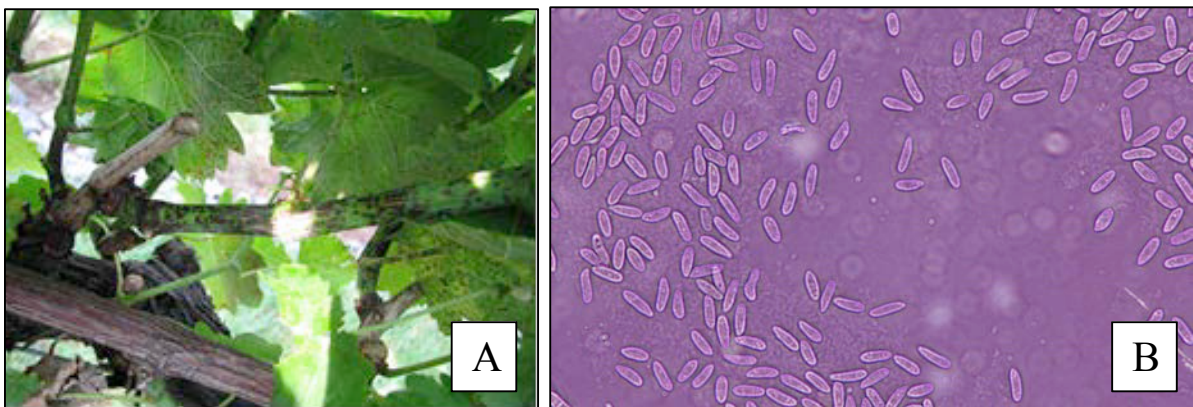


Figure 2. Symptoms of Phomopsis cane and leaf spot (A) and prolific conidial production (B). Conidia survive in pycnidia on old canes, and following sporulation, they rain down on newly exposed tissue each spring. Dark brown to black lesions are observed on spring shoots. Lesions may coalesce and spread to cluster stems. Shoot breakage and stunted growth often result.

Methodology: In 2014, fungicides were evaluated for control of *Exobasidium* on the rabbiteye cultivar ‘Premier’ in the south Georgia counties of Appling, Bacon (3 locations), Clinch, Irwin, and Jeff Davis. Treatments included lime sulfur (5 gal/A), Sulforix (2 gal/A) or Captan 4L (2.5 qt/A; Bacon County locations only) applied at a late-dormant phenology (plant growth stage) with an airblast sprayer (~70 gallons/A total solution); no additional fungicides were applied. At least four replications of each treatment and the untreated control were applied to a randomized complete block design, with each plot consisting of ten plants; the outer two plants in each plot were considered to be buffers and were not utilized for treatment evaluation. All cultural practices were in keeping with rabbiteye blueberry production methods commonly observed in the Southeast. Leaf disease incidence was recorded from 13 May to 16 May with ~200 leaves per plot. Mature fruit were collected from 30 May to 10 June, and disease incidence was assessed on ~300 fruit per plot.

Fungicides were also evaluated at six vineyards in north Georgia for control of *Phomopsis*. Treatments included lime sulfur (5 gal/A), Sulforix (2 gal/A) applied at a late-dormant phenology (plant growth stage) with an airblast sprayer (~70 gallons/A total solution), as compared to a grower standard. Additional grower standard fungicides were applied at each location and across all plots, to include those treated with lime sulfur or Sulforix. At least four replications of each treatment were applied to a randomized complete block design, with each plot consisting of ten vines; the outer two vines in each plot were considered to be buffers and were not utilized for treatment evaluation. All cultural practices were in keeping with wine grape production methods commonly observed in the Southeast. On 21 May, plants were observed at each of the six sites, and no disease of significance was recorded for any treatment. No additional data was collected.

Results: Grape studies. It was concluded that neither lime sulfur nor Sulforix improved *Phomopsis* disease control over the grower standard, assuming that a good grower standard program were utilized. No site showed significant disease, without regard to

treatment. This indicates that the grower standard was sufficient, without the addition of either lime sulfur or Sulforix.

Blueberry Studies. Rainfall was more than adequate for disease development, with an average of 15% of the leaves and 16% of the fruit showing symptoms in the untreated control. The single late-dormant application of either lime sulfur or Sulforix provided substantial and statistically equivalent management of *Exobasidium*, whereas Captan was not effective. The epidemiology of *E. maculosum* has not been elucidated, but the high level of disease control afforded with both Sulforix and lime sulfur may indicate that overwintering inoculum and/or early-season infections are of primary importance to disease development. The difference in efficacy between lime sulfur and Sulforix was diminutive, but Sulforix consistently outperformed lime sulfur with the exception of fruit spot incidence in Clinch County.

Table 1. *Exobasidium* leaf and fruit spot incidence following treatment with lime sulfur, Sulforix or Captan.

Leaf spot incidence ^y							
Treatment and rate/A ^z	Appling County	Bacon County Site 1	Bacon County Site 2	Bacon County Site 3	Clinch County	Irwin County	Jeff Davis County
Untreated control	2.6 a	25.0 a	20.7 a	9.7 a	16.0 a	20.1 a	5.7 a
Lime Sulfur (5 gal)	0.7 ab	4.1 b	4.2 b	2.5 b	0.9 b	2.2 b	0.2 b
Sulforix (2 gal)	0.4 b	3.3 b	4.0 b	2.1 b	0.5 b	1.6 b	0.1 b
Captan 4L (2.5 qt)	N/A	27.42 a	16.52 a	6.62 a	N/A	N/A	N/A
LSD ($\alpha=0.05$)	1.9	5.7	4.2	3.6	9.3	13.5	2.5

Fruit spot incidence ^x							
Treatment and Rate/A	Appling County	Bacon County Site 1	Bacon County Site 2	Bacon County Site 3	Clinch County	Irwin County	Jeff Davis County
Untreated Control	2.3 a	14.3 a	15.4 a	13.3 a	8.1 a	27.3 a	31.8 a
Lime Sulfur (5 gal)	1.6 a	1.6 b	2.1 b	1.8 c	0.5 b	3.0 b	0.5 b
Sulforix (2 gal)	1.3 a	1.0 b	1.1 b	0.7 c	0.7 b	2.1 b	0.3 b
Captan 4L (2.5 qt)	N/A	13.8 a	13.4 a	7.2 b	N/A	N/A	N/A
LSD ($\alpha=0.05$)	1.5	4.0	5.0	3.2	2.5	7.4	14.3

^zTreatments were single late-dormant applications between Jan 17 and Feb 15, depending on location.

^yRecorded for 20 shoots per plot with ~10 leaves per shoot on average. Means followed by the same letter are not significantly different when using Fisher's protected LSD test ($P \leq 0.05$).

^xRecorded for ~300 fruit per plot on average. Means followed by the same letter are not significantly different when using Fisher's protected LSD test ($P \leq 0.05$).

Conclusions: Based on the results obtained this year, we recommend that Sulforix be utilized for a late-dormant application as a component in a comprehensive management program for suppression of Exobasidium on blueberry. Lime sulfur is still the product of choice for organic production, since Sulforix is not an organic product. As a result of this successful research project, we expect yields/pack-out to increase and consumer complaints to decrease in 2015. Relative grapes, lime sulfur or Sulforix will likely have a benefit if Phomopsis has increased due to a poor spray program. However, if good season-long management programs are utilized, then the addition of these calcium polysulfide products may have limited value for wine grape production.

Impact Statement: Blueberry producers now have a substantive management recommendation for control of Exobasidium, an emerging disease. Economic impact will be substantial, as infected fruit often abscise (direct loss) or slow packing lines (indirect loss) due to an attempt to remove them before they enter a package. Yields will be increased and consumer complaints will be minimized as a result of this research. Wine grape producers now realize that neither lime sulfur nor Sulforix will give a substantive benefit over a good standard Phomopsis spray program regimen, saving them time and money. If Phomopsis is a major issue, the addition of these materials would likely help to reduce inoculum, but under low disease pressure they are not likely needed.