

## Summary of an Evaluation of Alternative Organic Fungicides for Apple Scab Management in Vermont

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A major challenge in organic apple production in Vermont is the available fungicide options for apple scab management. The standard lime sulfur/sulfur fungicide program can be injurious to the applicator, the apple ecosystem, and the apple tree itself. Because of these drawbacks of the standard program, it is necessary to evaluate potential alternative fungicides for organic apple production. The objective of this study was to compare the efficiency of potassium bicarbonate, neem oil, and *Bacillus subtilis* to a standard organic lime sulfur/sulfur fungicide program and a non-sprayed treatment for control of apple scab and other fungal diseases and to evaluate potential non-target

**Figure 1.** Treatments were applied with a 3-point hitch PTO sprayer with attached Green Guard Handgun with an L tip.



impacts on pest and beneficial arthropod populations. Treatments were applied to ‘Empire’ trees arranged in a completely randomized design with five single-tree replications at the University of Vermont Horticultural Research Center in South Burlington, VT. Fungicides were applied with a handgun to drip, using maximum label rates. During two growing seasons, applications began on 26 April 2007 and 23 April 2008 and continued on approximately a weekly schedule through the end of June and

then every two weeks through 23 July 2007 and 17 July 2008, respectively (Figure 1).

None of the alternatives managed disease as well as the standard lime sulfur/sulfur fungicide program. The neem oil treatment showed more activity against apple scab than the other alternative fungicides in 2008 (Table 1).

**Table 1. Apple scab incidence**

Treatment and rate/A (rate/ha)	Percent Scab Incidence			
	Terminal leaves <sup>z</sup>		Fruit <sup>y</sup>	
	22-24 Aug 2007	12-15 Aug 2008	10 Sep 2007	3 Sep 2008
potassium bicarbonate 3.75 lb (4.2 kg)	12.3 b <sup>x</sup>	41.5 b	11.2 bc	45.8 b
<i>Bacillus subtilis</i> 3 lb (3.4 kg).....	17.0 b	54.5 a	22.4 ab	62.4 a
neem oil 2 gal (18.7 L).....	9.9 b	28.7 c	11.6 bc	32.4 c
sulfur 15 lb (16.8 kg) or lime sulfur 2 gal (18.7 L).....	1.1 c	8.9 d	0.4 c	2.9 d
non-sprayed.....	29.2 a	55.7 a	25.2 a	64.0 a

<sup>z</sup>Assessment of 10 terminals per tree on 5 single-tree replicates per treatment

<sup>y</sup>Assessment of 50 fruit per tree on 5 single-tree replicates per treatment

<sup>x</sup>Numbers within columns followed by the same letter do not differ significantly, Fisher's Protected LSD,  $P \leq 0.05$ .



**Figures 2 & 3.** Phytotoxic burning seen in the lime sulfur/sulfur treatment in 2007.

However, both the lime sulfur/sulfur and neem oil treatments had disadvantages, including phytotoxic burning and/or significantly more russetting on the fruit at harvest (Figs. 2 & 3).

Although no significant differences of European red mite populations were found among the treatments in either year, the two-spotted spider mites were numerically higher in the lime sulfur/sulfur treatment than all other treatments in 2007 and significantly higher in 2008. However, predatory mites were not assessed and since very low levels of other beneficial organisms were observed, no assumptions can be made on the potential impact of lime sulfur/sulfur or the other alternatives on beneficial populations.

This research shows that potassium bicarbonate, *Bacillus subtilis*, and neem oil do not offer substantial advantages over the standard lime sulfur/sulfur fungicide program for organic apple scab management in Vermont.

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\*Research results are part of a study conducted by Morgan Cromwell for a Master of Science degree. Complete results can be found in: Cromwell, M.L. 2009. Evaluation of alternative fungicides for organic apple production in Vermont. M.S. Thesis, University of Vermont. 151 pp. June 2009