DOES SURROUNDÒ HAVE NON-TARGET IMPACTS ON NEW ENGLAND ORCHARDS?

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The University of Vermont Apple Program received a USDA grant to study the long-term effects of "particle film technology" on Northeast apple orchards. This technology has been commercially available to growers since 2001 in the kaolin clay–based product Surround®. Surround® is viewed as a potential alternative for some organophosphate uses in orchards. It is considered a "Reduced Risk Pesticide" by the EPA, indicating that it has characteristics such as very low toxicity to humans and non-target organisms including fish and birds, and low risk of groundwater contamination or runoff. The material also meets all Federal and State standards for use in organic crop production, and may be an important component in that expanding field. Currently for apples Surround® is labeled for control of leafhoppers and overwintering oblique banded leafroller, and suppression of codling moth, plum curculio, apple maggot, green fruitworm, and a number of other insects.

When applied to the tree, Surround® forms a white physical barrier on the surface of fruit and foliage. This particle film barrier acts as a pest deterrent by either directly repelling insects or making feeding, egglaying, or colonization sites unrecognizable or unsuitable. By its nature, this technology is extremely dependent on thorough coverage of the fruit and foliage. Dilute or near dilute applications are necessary and application rates can range from 25 to 50 pounds per acre on apples.

The current material label states that "When applied at recommended rates and frequencies, benefits such as increased plant vigor and improved yields may occur in certain apple cultivars. Under high ambient temperatures, Surround® reduces canopy temperature and, therefore, can help to reduce heat and water stress. Many cultivars have shown improved fruit color, smoothness, and size with less sunburn, and cracking when Surround® is used." However, much of the previous research on these variables has been performed in warmer, semi-arid, and sub-humid environments.

Application of Surround® at full rates has been suggested to reduce canopy temperature due to reflectance of solar energy from the white film. The objectives of our research are to determine potential non-target effects of thorough coverage of kaolin film on apple tree vigor, productivity, and fruit quality, including an economic assessment of the gross monetary value of the crop, and to determine non-target effects of kaolin film on diseases and bird damage (we are referring to these effects as 'non-target' because kaolin films have been developed and subsequently labeled primarily to manage insect pests) under the relatively cool and moist climate of the Northeast.

Materials & Methods

The research is being conducted at the UVM Horticultural Research Center in South Burlington, VT on 'McIntosh' trees on M.26 rootstock planted in 1988. In 2001, preliminary data were collected. The study officially began in 2002 and continues through the 2004 growing season.

The experiment uses a completely randomized design with five treatments replicated six times. Each replicate consists of single tree plots of 'McIntosh' with four treated guard trees. Treatments include:

1) Surround® beginning at green tip plus fungicides.
2) Surround® beginning at green tip without fungicides.
3) Surround® beginning at petal fall plus fungicides.
4) Standard IPM.
5) Nontreated control. In 2001 this treatment received fungicides. For 2002 and beyond the protocol was amended to remove fungicides treatments.

Fungicides used include mancozeb pre-bloom and captan post-bloom, applied as needed according to weather and disease cycle monitoring. The insecticide used for the IPM treatment was Imidan applied as monitoring dictated. Surround® sprays were applied weekly through first cover, then bi-weekly through mid-August. Treatment sprays were applied near-dilute with a handgun at 100 psi in 100 gallons of water per acre. All treatments received standard horticultural sprays including foliar nutrients and thinning sprays as determined by crop load monitoring. Thinners used include Sevin XL at 1 quart per acre and NAA as needed. Two percent prebloom oil was applied to the entire block. Whole block oil, thinner, and nutrient sprays were applied via airblast sprayer. Surround® rate varied with the previous spray's coverage, from 25 to 50 pounds per 100 dilute gallons per acre. Imidan, mancozeb, and captan were applied at standard labeled rates.

In this comprehensive study, data on numerous variables within the block are being collected. These include fruit quality and appearance characteristics (fruit weight, color, firmness, soluble solids, and incidence of bitter pit, sunburn, and russeting), and tree data (spur characteristics, bloom density, leaf density, foliar nutrient analysis, defoliation rate, harvested yield, and preharvest drop). In addition, arthropod pest incidence and damage on fruit and foliage and disease incidence are being assessed along with bird peck damage at harvest. Since the results presented here are preliminary, we have chosen to report only on those variables of the experiment that evaluate general horticultural characteristics.

Fruit quality measurements. A random sample of 30 fruit in 2001 and 2002 was collected from each tree and evaluated for weight (g), skin color (visual estimate of % red blush), and percent russet covering fruit surface (a value of zero indicated no russet; one, 5% or less of the fruit surface covered; two, 5-25%; three, 26-50%; four, 51-75%; and five, over 76 %).

Yield. Yield efficiency (kg/TCA) was measured by weighing all the fruit on the tree, and dividing by the tree's trunk cross-sectional area. Pre-harvest drop (kg/TCA) was measured by collecting and weighing all the fruit on the ground before harvest and dividing it by the TCA.

Tree vigor. Spur diameter (mm) of five fruiting spurs per tree diameter of the next year's fruiting buds was measured for ten buds per tree in October. Specific leaf weight (dg. dry weight/square cm. leaf area) was assessed by measuring the mass and area of 25 fruit spur leaves per tree in August

Bird-peck damage. In both years, fruit with bird pecks in both dropped and harvested fruit were counted.

Results

Fruit quality. Fruit weight: In both 2001 and 2002, in plots where Surround® and fungicides were used (treatments 1 and 3), fruit size was significantly greater than the IPM standard (Table 1). The data were taken from observations made on 600 fruit samples (when available) per treatment. Satisfactory red fruit color was achieved in all treatments in both test years Where Surround® was applied without fungicides (treatment 2), color was consistently the best. This may be due to the increased ethylene production in the scabby fruit in that treatment. Where fungicides were applied, we consistently saw an increase in red color development in the Surround® treated fruit (treatments 1 and 3) (Table 1). While these increases were found to be significant statistically, it is important to also look at the magnitude of the increase. In 2001 the IPM fruit (treatment 4) had an average red color of 58% while the Surround® and fungicide treated fruit (treatments 1 and 3) had 61% red color. The increase between these treatments in 2002 was numerically greater, with 62% red color in the IPM treatment versus 66 and 68 percent in the Surround® treatments. While the increase in red color may be small it has been consistent to date and may be of importance at packout. Fruit russet at packout was evaluated in both years. For each fruit a value of zero to five was assigned according to percent of fruit surface with russet. For both years there were fairly low russet values, although the presence of frost rings in 2002 was indicated by the relatively higher values in that year (Table 1). Since 'McIntosh' is not known for having russet problems, work on more russet-prone varieties may shed some more light on any effect Surround® might have on fruit finish. Based on research to date, it does not appear that Surround® *increases* russeting on 'McIntosh' under our growing conditions.

Table 1. The effects of Surround® application on fruit weight (g), percent red color, and mean russet on 'McIntosh'/M.26 in 2001and 2002.

	Fruit weight (g)		% Red color		Mean russet	
Treatment	2001	2002	2001	2002	2001	2002
1- Sur GT + Fung	200 A[z]	173 A[z]	61 B[z]	66 C[z]	0.11 A[z]	0.34 B[z]
2- Sur GT no Fung	172 C	160 C	67 A	76 A	0.07 C	0.20 C
3- Sur PF + Fung	200 A	166 B	61 B	68 B	0.07BC	0.41 AB
4- IPM	188 B	158 C	58 C	62 E	0.14 A	0.50A
5- NTC	189 B	128 D	61 B	64 D	0.11AB	0.49 A

[z]Means within a column with the same letter are not significantly different (Fisher's Protected LSD test, P<0.05)

Yield. Yield efficiency: No statistical difference between treatments in the 2001 season was found. Data from 2002 however indicate Surround® treated plots where fungicides were also used had similar or better yield efficiency over the IPM standard (Table 2). If Surround® application helps to reduce heat and water stress on trees, one might expect that pre-harvest drop would also be reduced. In 2001 the IPM standard (treatment 4) had less drop than all other treatments but the difference was not statistically significant (Table 2). The 2002 data provided similar results but the difference was statistically significant between the IPM standard and all other treatments.

Table 2. The effects of Surround® application on yield efficiency and fruit drop on 'McIntosh'/M.26 in 2001and 2002.				
	Yield efficiency (kg/TCA[z])		Number of dropped fruit / TCA	
Treatment	2001	2002	2001	2002
1- Sur GT + Fung	0.72 A[y]	0.59 AB[y]	1.41 A[y]	1.38 A[y]
2- Sur GT no Fung	0.47 A	0.41 BC	1.25 A	1.38 A
3- Sur PF + Fung	0.71 A	0.71 A	1.59 A	1.71 A
4- IPM	0.71 A	0.59 AB	1.02 A	0.53 B
5- NTC	0.65 A	0.32 C	1.51 A	1.34 A
[z] TCA = trunk cross-sectional area [y]Means within a column with the same letter are not significantly different (Fisher's Protected LSD test, P<0.05)				

Tree Vigor. There were no significant differences in spur diameter between the treatments in 2001 or 2002 (Table 3). Spur leaf density showed differences in 2001, where the Surround® treated leaves (treatments 1,2, and 3) were less dense than IPM or nontreated leaves (treatments 4 and 5). Data the following year did not replicate these results and showed no difference between treatments (Table 3). Analysis of these indirect measurements of photosynthesis will become more important as the trees receive the treatments over multiple seasons and the results can be analyzed together. At this point no conclusions can be made whether or not Surround® treatments measurably affect tree vigor.

Table 3. The effects of Surround® application on 'McIntosh'/M.26 on spur bud diameter and spur leaf density during 2001and 2002.				
	Spur Diameter (mm)		Leaf density (dg/cm2)	
Treatment	2001	2002	2001	2002
1- Sur GT + Fung	4.1 A[z]	4.4 A[z]	0.127 BC[z]	0.115 A[z]
2- Sur GT no Fung	3.9 A	4.3 A	0.127 BC	0.121 A
3- Sur PF + Fung	4.1 A	4.1 A	0.121 C	0.119 A
4- IPM	4.1 A	4.2 A	0.139 AB	0.116 A
5- NTC	4.3 A	4.3 A	0.135 A	0.120 A
[z] Means within a column with the same letter are not significantly different (Fisher's Protected LSD test, P<0.05)				

Bird peck damage. Bird damage on harvested fruit was minimal, with seven pecked fruit harvested between both years. Dropped fruit showed more damage (Table 4), where pecked fruit ranged from 0.7 to 5 per cent of the total, with no statistical separation between the treatments in either year.

Conclusions

The data represent only preliminary results from a multi-year study, which will continue for the next two growing seasons. Documenting any horticultural impacts will require looking at

repeated applications of Surround® to the same trees over a period of years. Conclusions will be made after analyzing the study's full data set through repeated measures analysis.

Table 4. The effects of Surround® application on 'McIntosh'/M.26 on bird peck damage on dropped fruit during 2001and 2002.

	% Bird Pecked Damage	
Treatment	2001	2002
1- Sur GT + Fung	4.3 A [z]	3.5 A [z]
2- Sur GT no Fung	4.7 A	0.7 A
3- Sur PF + Fung	3.8 A	2.2 A
4- IPM	2.8 A	1.2 A
5- NTC	5.0 A	2.3 A

[z] Means within a column with the same letter are not significantly different (Fisher's Protected LSD test, $P<0.05$)