

Effect of Surround™ Particle Film on Fruit Sunburn, Maturity and Quality of 'Fuji' and 'Honeycrisp' Apples

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Sunscreen for Apples?

The variety Fuji constitutes a large portion of new apple plantings in the US. However, producing high-colored (red) Fuji without sunburn is a major challenge for apple growers, especially in regions or seasons noted for hot, sunny weather. Fuji fruit is more prone to sunburn when trees are grown on size-controlling rootstocks because there is less foliage to protect the fruit from the sun. Fruit from trees on more vigorous rootstocks usually have less sunburn and less red color due to the presence of more foliage and the shade it produces.

Red color development of 'Honeycrisp' fruit may require temperatures similar to that of 'McIntosh' and other cool climate cultivars where the commercial production of such cultivars is largely confined to cool apple growing

regions. New York's Hudson Valley is considered by many to be the southern limit for good color development of 'McIntosh'. Sunburn (Fig. 1), and lack of red fruit color reduced packout of 'Honeycrisp' grown in the Hudson Valley in the unusually hot drought year of 1999.

When researching the possibility of using sprays of kaolin clay as an insecticide, scientists at the USDA-ARS lab in Kearneysville, WVA, found some horticultural side effects relating to reduced heat stress of apple trees. Surround leaves a thick chalky residue on the foliage and fruit that deters insects and reflects some of the sunlight (Fig. 2). During hot weather, trees sprayed with kaolin had increased photosynthesis, increased fruit yield and/or size, and in some cases, increased red fruit color (Stanley, 1998). As a result of these findings, the kaolin clay product, Surround™, is labeled for reducing sunburn and improving red fruit color of apple, in addition to its labeled use as a pest management tool. Surround™ has been promoted to apple growers for reducing sunburn and improving red fruit color (Heacox, 1999; Warner, 2000a; Werblow, 1999).

Even in orchards where insects were controlled with a conventional pesticide spray program, the additional cost of Surround sprays might be justified if it resulted in reduced sunburn or increased red color, and thereby increased crop value. To test this hypothesis, two studies were conducted in 2000 to determine the effect of Surround™ on sunburn, color and maturity of 'Fuji' apple in Idaho and 'Honeycrisp' apple in New York.



Figure 1. 'Honeycrisp' with sunburn injury.

The kaolin clay based material Surround™ was effective for reducing sunburn but also reduced fruit size and fruit color especially with applications made later than June. Later applications also resulted in residues that were difficult to remove with conventional packing equipment.

Research Description

Idaho Experiment

This experiment was conducted on six-year-old 'Fuji' apple trees on Malling 26 EMLA (M.26 EMLA) and Budagovski 118 (B.118) rootstocks planted at 8 x 18 ft spacing at University of Idaho Parma Research and Extension Center, Parma, Idaho. Blocks of trees on both rootstocks were sprayed with Surround™ (Engelhard Corp., Iselin, NJ) on 10, 17, and 24 July 2000, and compared to blocks of untreated trees.

The rate of Surround™ was 50 lbs in 200 gal of water. In each application, Surround™ was applied with an air-blast sprayer calibrated to apply 200 gal/acre. Buffer trees were used to prevent overspray between sprayed and non-sprayed trees.

Fruit sunburn status was visually estimated as the percentage of sunburned fruit on each tree relative to the total number of fruits on the tree. A random sample of fruit from each tree was weighed and fruit color was visually ranked on a scale



Figure 2. Chalky residues on 'Honeycrisp' fruit after Surround™ applications

of 1 to 5, with 1 = 20 percent red progressively to 5 = 100 percent red. Fruit firmness and soluble solids concentration and fruit mineral concentration was measured. Fruit maturity was evaluated by starch index, respiration activity in respiration chambers, and ethylene concentration.

New York Experiment

Six-year-old 'Honeycrisp' / M.26 EMLA apple trees growing in a commercial orchard in Milton, NY at 8 x 16 ft spacing were used for this experiment. Ten-tree plots were treated as follows: 1) untreated control; 2) Surround™ applied weekly from 15 May to 26 June (Surround™-early); 3) Surround™ applied weekly from 6 July to 17 Aug. (Surround™-late). Each spray of 50 lb Surround™ in 200 gal of water was applied with an air-blast sprayer calibrated to apply 200 gal/acre.

A fruit sample was collected from the central trees in each plot for evaluation of fruit weight, fruit color, and fruit maturity. The fruits were weighed and visually rated for the percentage of the surface covered with red blush. Color characteristics of the fruits were further measured using a Chroma Meter. Color descriptors for the blushed side were used to evaluate the effects of treatment on red color development, while those for the non-blushed side were used to evaluate chlorophyll disappearance, a fruit maturity indicator. Fruit maturity was further evaluated by measuring the internal ethylene concentration by gas chromatography, and by rating starch disappearance.

Research Results

Idaho 'Fuji' Experiment

Surround™ reduced fruit weight, color, and percentage of sunburn (Table 1), but had no effect on yield per tree, fruit sugar concentration, firmness or mineral nutrient concentrations of 'Fuji' apples (not shown). Fruit maturity, as measured by starch disappearance, respiration and ethylene evolution of 'Fuji' apples was not influenced by Surround™ (not shown).

'Fuji' trees on B.118 had greater yield per tree than did those on M.26 EMLA (not shown) due to the larger tree canopy of trees on B. 118. Fruit from trees on M.26 EMLA were firmer and had higher incidence of sunburn than that from trees on B.118 rootstock, perhaps because fruit on M.26 EMLA were more exposed to light than those on B.118.

New York 'Honeycrisp' Experiment

Although 'Honeycrisp' is sensitive to

sunburn, none occurred in this trial (data not presented). Cool weather experienced in eastern New York during much of the 2000 season was not favorable to sunburn formation. The Surround™-late treatment reduced fruit weight, amount of blushed fruit surface, and color saturation (chroma) on the blushed side of the fruit (Table 2 and Fig. 3). Hue angle of Surround™-late fruit was greater (less red) than that of the controls. Surround™ had no effect on fruit ethylene concentration and starch rating, or on the green color of the non-blushed side of the fruit (Table 3).

Discussion

In our studies, application of Surround™ after June reduced fruit weight of 'Fuji' and 'Honeycrisp' by 13 percent and 12 percent, respectively. This size reduction could very likely result in a loss of return to growers, and the loss could be even more severe in small-fruited varieties, such as Empire or Gala. USDA researchers previously reported that kaolin clay particle films increased fruit size in four of seven experiments, with no effect on size in three experiments. All but one of the previous studies were carried out under environmental conditions with temperatures over 86 °F and with trees exhibiting heat stress. Under such conditions, temperature—not light—would limit the ability of the trees to conduct photosynthesis. Under less stressful temperatures, kaolin sprays reduce photosynthesis, due to reduced light reaching the leaf surface.

Surround™ applied in May and June had no effect on fruit color of 'Honeycrisp' apples (Fig. 4) compared to the untreated controls (Fig. 5). Surround™ applications beginning in July reduced red fruit color on both Fuji and 'Honeycrisp'. Surround™ had no effect on fruit mineral nutrient concentration or maturity in either study, thus, the reduction in red color development we observed in both Fuji and 'Honeycrisp' was not related to mineral nutrients or to a delay in fruit maturity.

Later applications of Surround™ were timed to reduce sunburn, in accordance with the label recommendations. While very effective for this purpose (Table 1), this timing resulted in less of the skin surface that was red, and also in a less intense red color on that portion of the surface that was blushed (Tables 1 and 2). Reductions in fruit color and size in our study are possibly due to a decrease in the amount of available light to the leaves and

fruit for coloring and photosynthesis. Surround™ reduced fruit size and color under environmental conditions where light was more likely to be limiting than was high temperature.

Discussions with the grower cooperator in New York revealed that Surround™ applications resulted in undesirable resi-

TABLE 1

Effects of Surround™ on 'Fuji' fruit.			
Treatment	Avg. Fruit Wt. (g)	Sunburn (%)	Color Rating (1-5)
Control	224 a	28 a	3.3 a
Surround	195 b	6 b	2.6 b

TABLE 2

Effect of Surround™ on 'Honeycrisp' fruit color.				
Treatment	Blush %	L Value	Chroma	Hue
Control	59 a	44	37	34 b
Early	60 a	43	37	35 b
Late	46 b	47	35	44 a

TABLE 3

Effect of Surround™ on fruit maturity and size of 'Honeycrisp' fruit.				
Treatment	IEC (ppm)	Starch rating	Hue angle	Fruit Wt. (g)
Control	27	7	107 ab	214 a
Early	24	7	106 b	208 ab
Late	27	7	109 a	188 b



Figure 3. Color development of 'Honeycrisp' apples treated with Surround™ weekly from July 6 to August 17 was poor.



Figure 4. 'Honeycrisp' apples treated with Surround™ weekly from May 15 to June 26 had little reduction in fruit color at harvest.



Figure. 5. Color development of untreated 'Honeycrisp' apples.

dues at harvest that were not satisfactorily removed by brushing on a commercial packing line (J. Crist, personal communication). Following brushing, residues in the depressions around the stem and the blossom end had to be removed manually. Difficulty in removing these residues from these depressions on the fruit has also been seen as a problem in Washington (Warner, 2000b).

Summary

These results suggest that Surround™ is ineffective for increased red fruit color development of apples. While Surround™ was effective for reducing sunburn, study is needed to find residue removal methods that are both economical and effective.

Reductions in fruit color and size in our study are possibly due to an increase in the amount of reflected light, resulting in shading of the leaves and fruit. Based on our results, growers who choose to use Surround™ sprays should recognize that applications later than June may reduce

red fruit color of apples and result in smaller fruit.

Literature Cited

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Acknowledgements

We thank Engelhard Corp. for partial support of this research. Thanks to Crist Bros. for allowing us to conduct this study in their orchard. We also thank Rick Schoonmaker, Richard Christiana and Jay Osborne for their assistance with this project.

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