

Surround™: A Realistic Choice for Control of Insects in Organic Apple Orchards in the Northeastern United States?

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Currently, most apples that are produced for organic markets throughout the US are grown in the West. There may be several reasons for this concentration of organic apple production. However, the reduced incidence of insect pests and diseases in terms of numbers of pest species and their relative severity is a major factor favoring organic apple production throughout the Western region. The most important insect pest in the Western apple production regions is the codling moth, although other insect species and mites can occasionally be severe problems. In contrast, in the Northeastern US, apple growers are constantly threatened by multiple major insect pests that directly damage apple fruit: the plum curculio; a complex of three species of lepidopteran larvae that feed within fruit (codling moth, oriental fruit moth, and lesser appleworm); and the apple maggot. The apple maggot and plum curculio are native insect species in the Northeastern US, and populations of these two indigenous species are not regulated at low levels in unsprayed apple trees in feral habitats. Various studies have shown that in unsprayed areas throughout the Northeast, nearly 100 percent of the apples on feral trees are infested by these two pests year after year.

Climatic and landscape differences near areas of major commercial apple production are also quite different in the Western and Northeastern regions. Major areas of apple production in the West are usually concentrated in more arid regions, and there are usually limited reservoirs of hosts for apple insect pests in close proximity to commercial orchards.

Throughout the Northeast, many commercial orchards are fairly close to wooded and semi-wooded areas with larger numbers of feral apple trees, hawthorn trees, and other *Rosaceous* plants that can serve as host reservoirs for many different species of apple insect pests. Therefore, in the Northeast, apple insect management programs must be designed not only to control or eliminate indigenous infestations of insect pest species, but also to prevent the immigration of insect pests into orchards from heavily infested nearby native alternate host plants.

Conventional apple producers in the Northeastern US have relied upon broadspectrum organophosphate insecticides for the last 30 years to control the primary complex of insect pests feeding directly on apples. However, growers interested in organic production throughout the Northeast have generally had little success with the limited available approved materials such as: *Sabadilla*, *Bacillus thuringiensis*, petroleum oil, neem based products (Aza-Direct), pyrethrums, rotenone, and insecticidal soaps (M-Pede).

Organic apple growers on the West Coast have been more successful in managing their primary fruit pest, the codling moth, with a combination of mass release of pheromone to disrupt mating and sprays of some selective insecticides such as *Bacillus thuringiensis*. However, organic growers on the East Coast are generally not able to use mating disruption for control of codling moth and other internal lepidopterous pests for several reasons. First, this program does not control the other major fruit pests in the Northeast,

Surround™ has great potential to serve as a major tool to control direct pests of apple fruit in the Northeast for growers interested in organic production. The major constraints for effective seasonal use of this product include relative ineffectiveness of airblast sprays, need for frequent reapplication, high cost, and the residual accumulations of unsightly residues in the stem and calyx end of fruit at harvest.

the apple maggot and plum curculio, which are also active at the same time as internal feeding lepidopterous pests. Therefore, attempting to integrate additional control measures into a mating disruption program for these additional pests would be very costly and complicated. Secondly, mating disruption works best when it is applied to large plots that have relatively low indigenous populations of internal Lepidoptera, and are isolated from outside sources of potentially immigrating mated codling moth females. Many organic apple farms throughout the Northeast are very small, sometimes already heavily infested with relatively high populations of internal Lepidoptera, and, as previously mentioned, usually located next to unsprayed areas harboring large infestations of fruit insect pests.

Recently, a new type of crop protectant, Surround™, has begun to be widely tested in apple orchards throughout the US. This compound is a formulation of kaolin clay (a food grade component) and has been approved for use in organic production systems. This material is based on a relatively new pest control concept called "Particle Film Technology." When applied, the material forms a dry, white, physical barrier that may affect insect pests by: 1) reducing or preventing host recognition; 2) preventing normal

movement and feeding, and; 3) causing irritation leading to repellency or eventually death. The label for this compound suggests that application should begin before an insect or mite outbreak occurs; leaves and fruit must be thoroughly covered; and consistent coverage is essential for effective control. Surround™ is recommended at rates of approximately 50 lbs/100-200 gallons of water, and for best results, the material should be applied at weekly intervals.

Because of the label recommendations for thorough coverage, high rates, and frequent applications, we decided to test the effectiveness of Surround™ treatments applied with a high-pressure handgun sprayer and with different types of conventional airblast sprayers against the apple insect pest complex in New York.

Handsprayer Trials

Seasonal Pest Control, 2000-2001

The results of the two handgun trials against the general apple insect pest complex in heavily infested research orchards in the Hudson Valley and Geneva are shown in Table 1. Although treatments in both regions were applied with a high-pressure handgun sprayer dilute to runoff, to single tree plots of different apple cultivars, the timing and rates of Surround™ used/100 gallons of water were different in the two trials. In the Hudson Valley, Surround™ was applied at a lower rate (25 lbs/100 gallons of water). Sprays began at petal fall (May 8) and seven additional cover sprays were applied at ca. 10-14 day intervals thereafter throughout the season. At Geneva, Surround™ was applied at a higher rate (50 lbs/100 gal). Sprays began at petal fall (May 22) and 13 more cover sprays were applied weekly, until the last spray on August 22.

In both locations, the Surround™ treatments were as effective in controlling the plum curculio, internal Lepidoptera, and apple maggots as the organophosphate standard programs, although apple maggot pressure was not heavy in the Geneva research orchard as indicated by the low level of damage (1.0 percent) in the untreated check plots. Surround™ was also as effective as the Guthion standard program in controlling the European apple sawfly in the Hudson Valley.

The percentages of control of San Jose scale were quite variable in the Surround™ treatments in the two locations. This variability probably reflects the spotty distribution of scale among in-

TABLE 1								
Comparison of the Effectiveness of High-Pressure, Handgun Sprays of Surround Against the Complex of Apple Insect Pests Attacking Fruit in the Hudson Valley and at Geneva, NY.								
		Percentage						
		Apple Sawfly	Leaf Roller	San Jose Scale	Plum Curculio	Int. Lep	Apple Maggot	Clean Fruit
Treatment & form/100 gal								
Hudson Valley*								
Surround WP	25.0 lbs	1.3a	9.6a	4.6a	0.5a	1.6a	0.9a	46.7a
Guthion 50W	8.0 oz	0.4a	11.5a	5.1a	1.2a	0.2a	1.3a	43.6a
Untreated Check		6.3b	51.5b	35.4b	15.5b	30.2b	43.6b	4.7b
Geneva**								
Surround WP	50.0 lbs	--	1.6a	32.3b	4.6a	6.3a	0.0a	51.7a
Imidan 70 WP	16.0 oz	--	7.3a	0.0a	7.3a	0.0a	0.0a	90.3b
Untreated Check		--	19.0b	0.0a	35.0b	19.0b	1.0a	30.3a

Treatment means within a column at each location followed by the same letter are not significantly different (Fishers Protected LSD (P<0.05)).

* Sprays applied at early petal fall and in 7 cover sprays at 2-week intervals. A single spray of Lorsban (12.3 oz form/100 gal) instead of Guthion was applied on the third cover spray in the standard Guthion program.

**Surround sprays applied at petal fall (22 May, and in 13 more cover sprays until 22 August). Imidan was applied at petal fall then 7 more sprays were applied on a 14-day schedule.

dividual trees in the different research orchards. Because of this variability, the presence of low levels of scale in some treatments may be due to lack of infestation of the pest in some trees rather than the effectiveness of the material in preventing damage. Therefore, the high levels of fruit infestation by San Jose scale in the Surround™ treatments in the Geneva orchard suggest that this material is not effective in protecting fruit from infestations of summer crawlers of the pest. Because of the generally high levels of effectiveness of Surround™ against pests directly attacking fruit, the overall percentage of clean fruit in the Surround™ treatment in the Hudson Valley was similar to that in the Guthion standard program.

However, because of high levels of fruit infested with San Jose scale, the overall percentage of clean fruit in the Surround™ treatment in the Geneva orchard was significantly lower than that in the standard Imidan program and was not significantly different from that in the check plots.

The results obtained in these two trials clearly show that Surround™ applied with handgun sprayers can provide excellent control of all pests directly attacking fruit, except San Jose scale, even when the material is used at lower than labeled rates (25 lbs/100 gallons) and applied at two-week intervals throughout the sea-

Apple Maggot and Internal Lepidoptera, 2001

Additional studies were conducted to compare the effectiveness of handgun sprays of Surround™ against apple maggot and the later summer generations of internal Lepidoptera in a Western New York apple orchard that has been in organic production for several years. Dilute sprays were applied with a high-pressure handgun sprayer (450 psi) to single-tree plots of 'Cortland' apple trees. Sprays were applied starting on July 6, several days after the first apple maggot flies were captured on monitoring traps in the orchard, and continued on either a weekly or bi-weekly schedule until August 21. Eight sprays of Surround™ WP (50 lbs/100 gal) and Spintor 2 SC (2.5 oz/100 gal) were applied on a weekly schedule. Four sprays of Guthion 50W (8.0 oz/100 gal) were applied on a bi-weekly program. Apples were evaluated for damage from apple maggots and internal lepidoptera on August 29, which was several weeks before the normal predicted harvest data for 'Cortland' apples.

The organic test orchard was heavily infested with both apple maggot and internal Lepidoptera as shown by the relative high levels of damage from both pests (35.1 percent apple maggot damage and 20.1 percent int. lep.) in the unsprayed check plots as shown in Fig. 1. The weekly handgun sprays of Surround™ WP were as effective as the

Guthion standard treatments against apple maggot and although damage from internal Lepidoptera was significantly higher than that in the Guthion plots, the overall damage from both pests was similar to that in the Guthion program. Although the weekly sprays of Spintor were as effective as Surround™ and Guthion against the later summer generations of internal Lepidoptera, apple maggot damage in the plots treated with weekly applications of Spintor was not significantly different from that in the unsprayed check trees.

Airblast Sprayer Trials

Plum Curculio Control, 2000

A trial was set up to compare the effectiveness of Surround™ WP and Guthion in controlling the plum curculio in plots set up in a research orchard of processing apple cultivars. Two replications of each treatment were compared in the test orchard. All sprays were applied to plots of ca. 1.0 acres with a Durand Wayland Silverliner 300 airblast sprayer. Guthion 50W (24 oz / A) was applied at petal fall in 100 gpa sprays at petal fall on May 22, and as cover sprays on June 6, and June 19. Surround™ WP (25 lbs/100 gallons) was applied to trees at either 100, 150, or 200 gpa in different sized plantings of trees within the block to provide dilute coverage based on the calculated tree row volume of canopy for each set of trees. Surround™ treatments were applied at petal fall (May 22), and as cover sprays on May 29, June 6, June 11, and June 19. The last sprays of both materials were applied to coincide with the predicted end of the plum curculio ovipositional period in the block determined according to predictions from a Degree Day accumulation model developed at Cornell University. At harvest, significantly less fruit was damaged by the plum curculio in the Guthion plots (8.1 percent) than in the Surround™ treatments (20.2 percent).

Control of the Apple Pest Complex in an Organic Orchard, 2001

Two programs were set up to evaluate Surround™ based programs of organically approved insecticides in a Western New York apple orchard that has been certified for organic production. Sprays were applied by the grower with a FMC airblast sprayer (300 psi) calibrated to deliver 100 gpa. Insecticide applications began at petal fall (May 5) and continued until a final cover spray was applied on

August 14. The orchard was divided into two unreplicated plots of ca. 5 acres: One plot was treated exclusively with Surround™ WP (50 lbs / 100 gal) applied weekly between petal fall and the last spray on 14 August (13 applications). The other plot was treated with Surround™ WP (50 lbs / 100 gal) applied weekly starting at petal fall, followed by 5 weekly cover sprays. These early season sprays of Surround™ were designed to control plum curculio and early generations of internal Lepidoptera. Then Aza-Direct EC (32 oz / 100 gal), an insecticide formulation of neem products, was applied starting on June 18 after the estimated end of plum curculio oviposition and continued as weekly sprays until the last application on 14 August (8 applications). These later season Aza-Direct sprays were targeted against later generations of internal Lepidoptera, the oblique-banded leafroller, and apple maggots.

The seasonal schedule of Surround™ was slightly more effective in controlling internal lepidoptera and plum curculio than the Surround™/Aza-Direct, but control of other pests was similar in the two programs (Fig. 2). Because of the heavy pest pressure in this organic orchard, the percentages of clean fruit were relatively low in both programs. Most of the observed fruit damage was caused either by internal Lepidoptera or plum curculio. The cost/acre of insecticides in the Surround™ and Surround™/Aza-Direct programs, were \$422.50 and \$615.68, respectively. These two programs of organically approved materials were considerably more expensive than a standard seasonal program of seven applications of Guthion 50W, which would cost about \$85.40/acre.

Discussion and Conclusions

Surround™ is currently the only available organically approved material

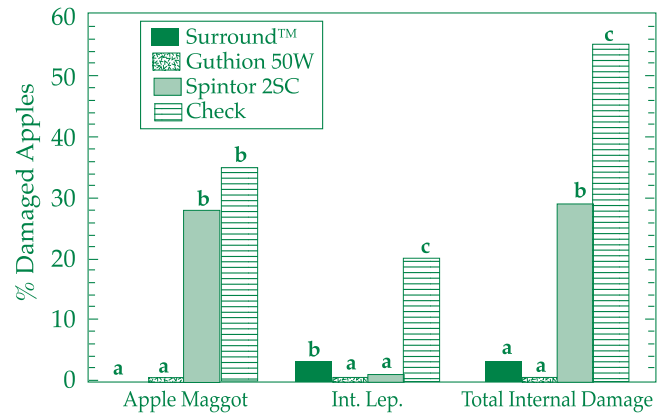


Figure 1. Control of apple maggot and later summer generations of internal lepidoptera with handgun treatments. Bittner Orchard, 2001.

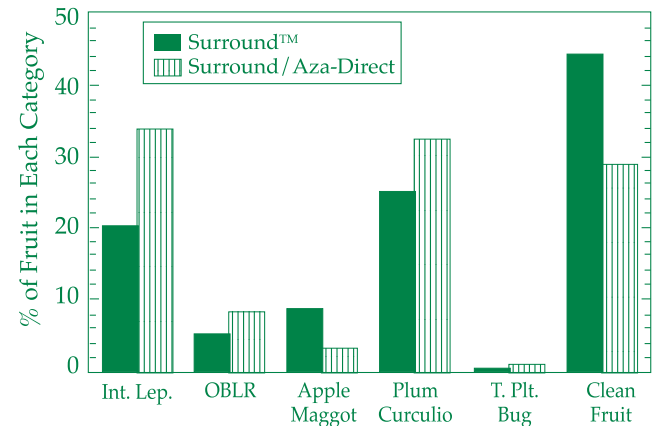


Figure 2. Comparison of the effectiveness of a seasonal program of Surround™ WP with an early season Surround™ program followed by Aza-Direct applied with an airblast sprayer.

that has the potential to control the primary pests damaging fruit in the Northeastern US, the complex of internal Lepidoptera, the plum curculio, and apple maggot, as effectively as the standard broad spectrum insecticides such as organophosphates. However, in order to achieve high levels of control in trees severely infested with these key insect pests, it is essential to be able to completely cover apple fruit and leaves with a continuous unbroken layer of this material and maintain the integrity of this layer throughout the season. It is rela-



Figure 3. Surround™ WP on apple fruit using a high pressure handgun sprayer.



Figure 4. Surround WP distribution on apple fruit applied using a conventional airblast sprayer at 100 gallons/acre.

tively easy to obtain this kind of coverage of fruit and apple leaves when Surround™ is applied with a high-pressure handgun sprayer (Fig. 3). Furthermore, the data collected from the Hudson Valley suggests that excellent control of most pests can be obtained with handgun applications even when the rate of Surround™ is reduced to ca. 25 lbs/100 gallons, and spray intervals can be stretched to approximately 14 days under normal weather conditions in the Northeast.

However, this study has also shown that it is virtually impossible to obtain adequate control of direct insect pests of fruit when Surround™ is applied with a conventional airblast sprayer (Fig. 4), even when relatively high volumes of water are used in an attempt to obtain dilute coverage.

Although in this study it was not possible to directly compare the effectiveness of Surround applied with a handgun

sprayer to treatments applied with an airblast machine, airblast sprays were clearly less effective than handgun applications against all the insect pests attacking fruit. Damage from the individual pests, apple maggot, plum curculio, and the complex of internal lepidopterous pests was usually between 10-20 percent when Surround™ was applied with an airblast sprayer. These levels of

control of these pests would probably not be adequate for most conventional orchards, but could be useful in some organic production systems. For example, during the previous growing season in 1999 because of the heavy indigenous infestations of direct pests of fruit in the Bittner organic apple orchard, only 1.4, 0, and 35 percent, respectively, of the McIntosh, Cortland, and Delicious apples were free from insect pest damage. However, in the seasonal program of Surround™ applied with an airblast sprayer during the 2000 production season, more than 40 percent of the apples were classified as non-insect damaged.

Summary

Surround™ has great potential to serve as a major tool to control direct pests of apple fruit in the Northeast for growers interested in organic production. This material can be effective even when ap-

plied to small plots of apple trees that are either already heavily infested with these types of insect pests or located nearby unsprayed areas heavily infested with these fruit feeders. However, the major constraints associated with effective seasonal use of this product: relative ineffectiveness of airblast sprays, need for frequent applications, high cost, and residual accumulations of unsightly residues in the stem and calyx end of fruit at harvest, will probably prevent its widespread use throughout the region. Future research is necessary to determine if airblast sprayers can be modified to apply Surround™ more effectively or if some other less expensive or more convenient type of application equipment than a high pressure handgun sprayer can be used to apply this material to commercial apple trees. If more effective application techniques for Surround™ can be developed, it is likely that the other major problems associated with this material can be overcome, and the product will be used by apple growers with smaller acreage who are interested in organic production.

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