N E W Y O R K
FRUIT QUARTERLY

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Editorial

We Can Deliver Quality Apples to the Consumer!

My background in business has taught me that there are many similarities between agriculture and the corporate world! When the corporation I worked for faced troubled times, our CEO developed and prioritized 5 basic goals for our organization.

#1 Good Quality
#2 Good Sanitation
#3 Correct Pricing
#4 Good Stock Levels and Product Mix
#5 Good Customer Service.

He reached these goals through the strategies "let's work together", "everyone do their part", and "let's get back to basics." It appears that these same strategies are important for improving the apple industry. I believe that by striving for the five basics and working as a committed team where everyone does their part, that we can easily keep intact the quality chain from the apple orchard to the consumer.

Maturity — The first link of the chain is fruit inspection in the field. Fruit must not be picked without proper brix, pressure, and starch levels.

Harvest — The key elements for a good harvest include properly trained crews with good supervision, only the best picking practices, a timely completion of harvest, and rapid transportation to storage.

Quality — Quality evaluations are very important in the field and at the storage facility. Each lot of fruit should be catalogued for size, color, defects, and maturity.

Storage — The key factors for good storage are rapid cooling, rapid filling of rooms knowing the characteristics of the fruit in each location, proper atmosphere, and allocation of needs.

Packing — Packers must only use fruit that best match orders. Proper grading and labeling is a must. Packed fruit needs to be re-cooled immediately and rotation practiced 100 percent—FIFO ('first-in-first-out').

Marketing — Marketers must know consumer needs, develop seasonal and promotional marketing plans, work collectively, communicate with other marketers, and move all packs promptly.

Transport — Ship fruit at proper temperatures. Make sure to mix only compatible items on a load. Only use haulers with equipment suitable for the job such as air ride suspension, with dependable drivers and high service levels.

Retail — Our role is to help and encourage the retailer to train employees, turn product quickly, store and display apples properly, maintain the cold chain, and conduct customer surveys.

Consumer — This is the final link in the chain. Consumer education needs to include information on varieties, proper handling, and recipes. Sampling of unique varieties encourages new purchases.

Let's not break the chain! Everyone needs to do their part! A team effort is essential! Let's get back to the basics!

Jim Kankowski
Sales & Marketing
H.H. Dobbins
Lyndonville, NY

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FRONT COVER: The kaolin clay active ingredient in Surround™ leaves a heavy coating on fruit and leaves. This "particle film technology" creates a physical barrier that can reduce or prevent host recognition, prevent movement or feeding, or cause irritation to the insect leading to repellency or death. CREDIT: S. Hoying

BACK COVER: This typical group of New York apple insect pests can be partially controlled using Surround™. Control depends on timing and frequency of sprays and initial insect population. CREDIT: J. Ogrodnick/NYSAES/Cornell

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Testing Pre-plant Monoammonium Phosphate and Apple Compost For Improving the Growth of Newly Planted Apple Trees

Soil incorporation of compost increased tree growth and flowering into the third year after planting. Greater tree growth with compost was most likely due to improved N and K status of the trees, and through improved soil aeration and water holding capacity.

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Management practices that foster rapid early tree growth and early fruit production result in economic advantages to growers by hastening a return on investment. In many orchards in the Northeast, early yield is limited by tree growth, and trees are typically not cropped until the third or fourth season because tree growth is not vigorous enough. Decreasing the time required for trees to fill their space would allow growers to increase early yields. Two methods that have been used to increase early tree growth are the addition of organic matter or phosphorus fertilizer to the planting hole.

Organic matter is often low in many existing orchard soils. Increasing soil organic matter improves its water and nutrient holding capacity, which enhances root regeneration and promotes overall tree vigor. Adding compost as a source of organic matter to planting holes has been demonstrated to have beneficial effects on young apple tree growth in experiments in Massachusetts and Maine. The effects of planting hole treatments are most visible during the year of planting. As root growth extends beyond the volume of the planting hole, the effects of planting hole treatments diminish. If organic matter amendments were broadcast throughout the orchard soil, perhaps the beneficial growth response could be sustained for a longer period.

For pre-plant compost to be a feasible management practice, an economical, local source of compost must be available. University of Maine Cooperative Extension developed an apple pomace composting project in cooperation with Chick Orchards, Monmouth, Maine. Apple pomace from Chick's cider operation was mixed with leaf waste from the local waste transfer station, and chicken manure from a local egg farm at a 2:6:1 ratio by volume. Wood ash was used to adjust the pH to 5.8 prior to composting. Composting reduced the volume of apple pomace waste by 50 percent, and converted it into an organic soil amendment with highly desirable characteristics.

Well-rooted mature fruit trees are efficient at absorbing phosphorus (P) from the soil, and seldom need P fertilizer. Newly transplanted trees have impaired root systems and P fertilizer is often recommended for new plantings (Stiles and Reid, 1991). Since P is very immobile in soil, this nutrient is more beneficial when it can be incorporated prior to planting. Research results in British Columbia have shown that monoammonium phosphate (MAP 11-55-0) fertilizer, incorporated into the soil used to fill the planting hole, increased tree growth in the first two years after planting and increased flower production and fruit set in the early years of the planting. The addition of MAP to the planting hole has become a common practice in B.C. orchards, especially when replant problems are anticipated (Neilsen, 1994). It has been suggested that root uptake or utilization of P may be more efficient in the presence of ammonium. Moreover, MAP could be influencing tree growth by providing N. This study was performed to determine if pre-plant incorporated apple compost or MAP, either alone or in combination, would improve early apple tree growth and precocity.

Preplant Research

This experiment was conducted at Highmoor Farm in Monmouth, Maine, on land which had been fallow for six years, but in continuous apple production for the previous 37 years. The soil was a fine sandy loam, and soil properties prior to planting are listed in Table 1.

Macoun/Bud.9 apple trees were planted using a tractor-mounted tree planter on May 1, 1998 into plots that had received one of the following combinations of pre-plant treatments: 1) no compost, urea fertilizer; 2) no compost, MAP; 3) compost + urea; and 4) compost + MAP. Each plot consisted of three trees at a spacing of 6 feet between trees and 18 feet between rows. Cortland/Bud. 9 trees were planted as buffer trees between plots.

Prior to planting, MAP was applied to the plots at a rate of 332 lb per acre and urea at a rate of 79 lb per acre, so that each treatment received an equivalent amount of N (1.44 oz. per tree). Apple pomace compost was spread over the planting strip and leveled to a uniform thickness of four inches. All plots were then rototilled to a depth of 6 inches.

The trees were unfeathered whips, headed to a height of 28 inches at planting. The trees were attached to a galvanized conduit stake supported by a single wire at 7 ft. The two buds directly below the new leader were rubbed off, as were all buds that sprouted below 15 inches. The trees were minimally pruned, and

TABLE 1

Orchard soil properties before and after pre-plant monoammonium phosphate (MAP) or apple compost.

Treatment	pH	OM (%)	P (kg/ha)	K (kg/ha)	Mg (kg/ha)	Ca (kg/ha)	CEC (me/100g)
Pretreatment							
None	6.8	4.7	10.9	235	384	2664	7.6
Post Treatment							
Urea	6.4	4.5	11.1	235	342	2950	6.9
MAP	6.4	4.4	14.6	221	353	2861	6.8
Urea + compost	6.9	5.3	89.2	584	591	5579	11.1
MAP + compost	6.8	5.6	97.3	534	574	5489	10.4

trained to the vertical axis system. Insecticides, fungicides, and herbicides were applied as needed.

Results and Discussion

Tree growth was increased by compost, but not by MAP. Compost increased

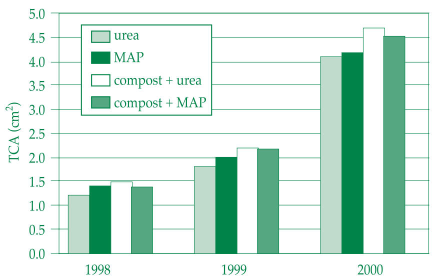

Figure. 1. Effect of pre-plant monoammonium phosphate (MAP) and apple compost on trunk growth of Macoun /Bud.9 apple trees in the first three seasons after planting.

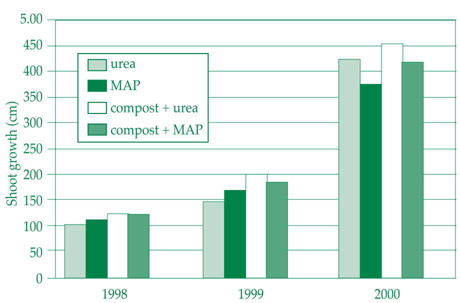

Figure. 2. Effect of pre-plant monoammonium phosphate (MAP) and apple compost on shoot growth of Macoun /Bud.9 apple trees in the first three seasons after planting.

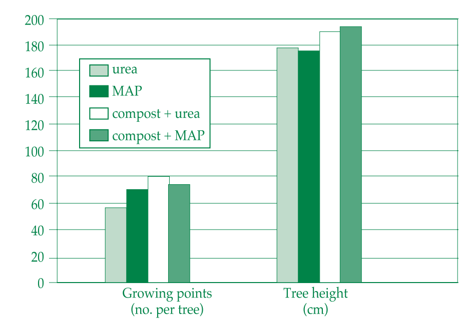

Figure. 3. Effect of pre-plant monoammonium phosphate (MAP) and apple compost on number of growing points and tree height of Macoun /Bud.9 apple trees in the third season after planting.

trunk growth in the first two seasons, but not in the third season (Fig. 1). Annual shoot growth was increased by compost in the first season, but not significantly in the second or third season (Fig. 2). Compost increased the number of growing points (the sum of spurs and shoots per tree) and tree height at the end of the third season (Fig. 3). MAP had no effect on trunk growth, shoot growth, number of growing points, or tree height in any season of the study.

Tree growth was increased by preplant incorporated apple pomace compost, similar to other studies that showed organic matter added to the planting hole increased shoot growth and trunk girth. In those studies, the effect of planting hole treatments was no longer evident by the second or third season, and this was attributed to roots growing beyond the planting hole. In our study, the effect of pre-plant organic matter on trunk circumference and shoot growth also diminished with time. The diminished effects observed in our study were possibly due to the depletion of soil K, Mg and Ca. Soil K in the compost plots was twice as great as in non-compost plots, but this difference was much smaller by the third season. Although trunk and shoot growth differences diminished with time, the increase in tree height and number of growing points was evident in the third season indicating that the cumulative effect of compost on tree size was not short-lived.

The total number of flower clusters per tree in May 1999 was not affected by any of the treatments (Fig. 4). In May 2000 and 2001, the number of flower clusters was increased by compost, but not affected by MAP. We were unable to determine if the increases in tree size and flowering were large enough to increase early yield because the trees did not attain sufficient size to permit cropping until after the third growing season. The trees in this

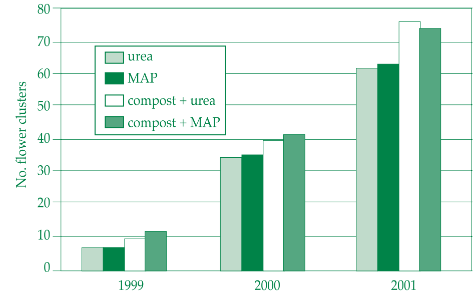

Figure. 4. Effect of pre-plant monoammonium phosphate (MAP) and apple compost on number of flower clusters of Macoun /Bud.9 apple trees in the first three seasons after planting.

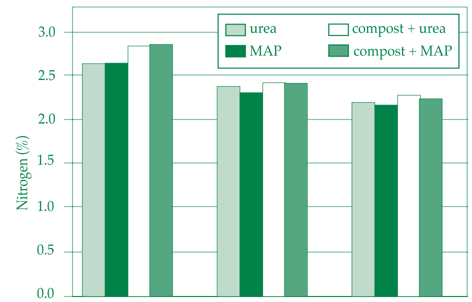

Figure. 5. Effect of pre-plant monoammonium phosphate (MAP) and apple compost on leaf nitrogen of Macoun /Bud.9 apple trees in the first three seasons after planting.

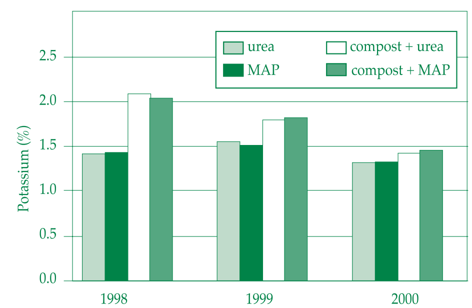

Figure. 6. Effect of pre-plant monoammonium phosphate (MAP) and apple compost on leaf potassium of Macoun /Bud.9 apple trees in the first three seasons after planting.

study were on Bud.9 rootstock, which is less vigorous than M.9 EMLA, and may be insufficiently vigorous for spur type varieties such as Macoun in northern New York and New England.

Soil fertility was enhanced by the addition of compost, but little influenced by the addition of MAP, as shown for the year of planting in Table 1. The addition of compost resulted in higher soil pH and cation exchange capacity in each of the three seasons after planting, compared to the plots without compost. Compost increased both soil organic matter and P in the first season, while MAP and urea had no effect. Compost also increased soil Mg, Ca, and K in each season of the study.

Compost increased tree growth and flowering by improving soil fertility and tree nutrient status, and most likely, by increasing soil water holding capacity and soil aeration. Foliar nutrient status was favorably affected by compost (Figs. 5 & 6). There was no difference between urea and MAP in their effect on leaf N or K (Figs. 5 & 6), or leaf P, Ca, or Mg (data not shown). Compost increased leaf N and K compared to trees in plots without compost in all three seasons after planting. Leaf P and Ca were not affected by compost.

Compost decreased leaf Mg in the first season after planting, but had no effect in the second or third season. The large increase in soil K following compost incorporation may have interfered with Ca and Mg uptake, so that even though soil Ca and Mg were greater, foliar levels were not. An increase in the water holding capacity of the soil would have been advantageous in 1998, when the newly planted trees were generating new roots to replace those lost in transplanting, and in 1999, a season in which little precipitation occurred before September. Leaf micronutrients were not affected by any of the pre-plant treatments (data not shown).

Pre-plant incorporation of P fertilizer had no effect on tree growth or flowering in this study. P fertilization has previously been shown to increase flowering when it results in greater leaf P (Neilsen, 1994). In our study the soil level of P was within the optimum range before treatment, and was increased to above optimum by compost. Although the level of P in the soil was increased with compost, there was no increase in foliar P. These results are consistent with most previous studies in showing no benefit from P fertilization for apple (Stiles, 1994).

Summary

The results of this study indicate that pre-plant compost incorporation was more effective than P fertilization for increasing tree growth during the establishment years. The practice of adding P to the planting hole may not be appropriate for Northeastern US sites, particularly those where the soil test indicates that P is adequate before planting. Soil incorporation of compost increased tree growth and flowering into the third year after planting. Greater tree growth with compost was most likely due to improved N and K status of the trees, and through improved soil aeration and water holding capacity. Our results suggest that trees planted in soil amended with apple pomace compost would potentially fill their space more quickly and be able to support more fruit growth in the first years of cropping.

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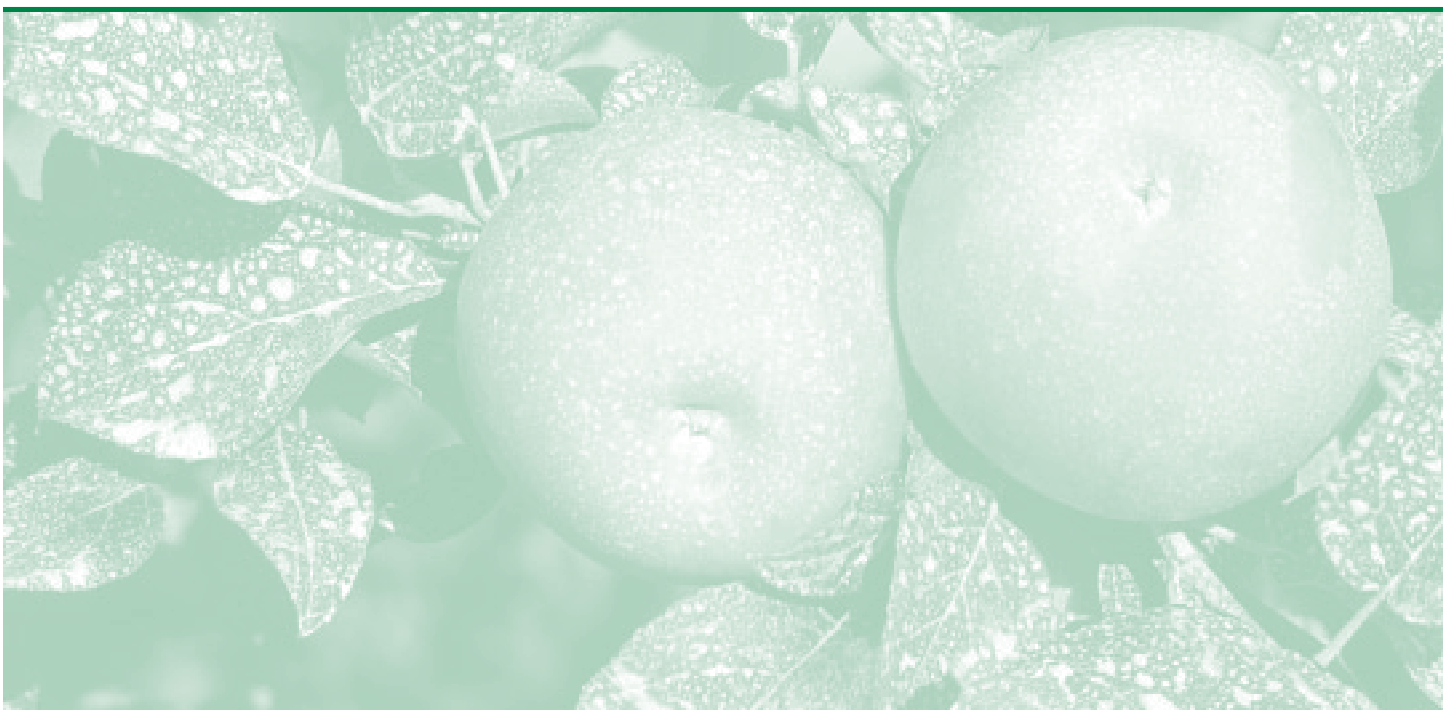

Figure 4.

Figure 5.

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

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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.

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 sucesss 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, 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.

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.

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 individual 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 than 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 season.

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 biweekly 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 unpsrayed 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.

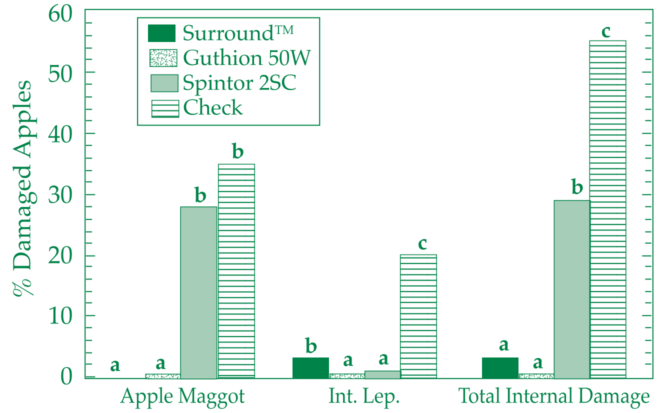

Figure 1. Control of apple maggot and later summer generations of internal Lepidoptera with handgun treatments. Bittner Orchard, 2001.

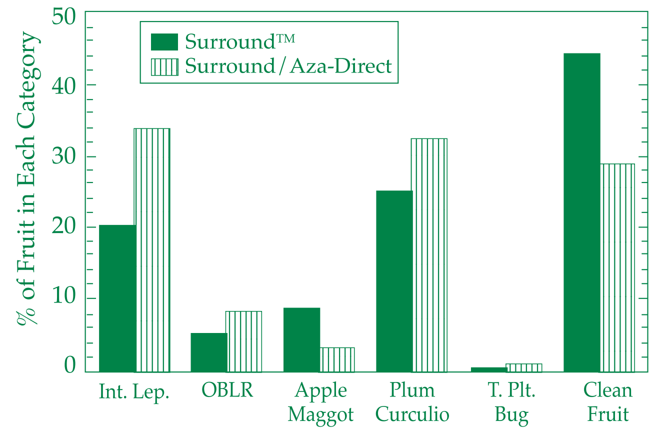

Figure 2. Comparison of the effectiveness of a seasonal program of Surround™ WP with an early season Surround™ program followed by Aza-Direct applied with an airblast sprayer.

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 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 lepidoperous 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 applied 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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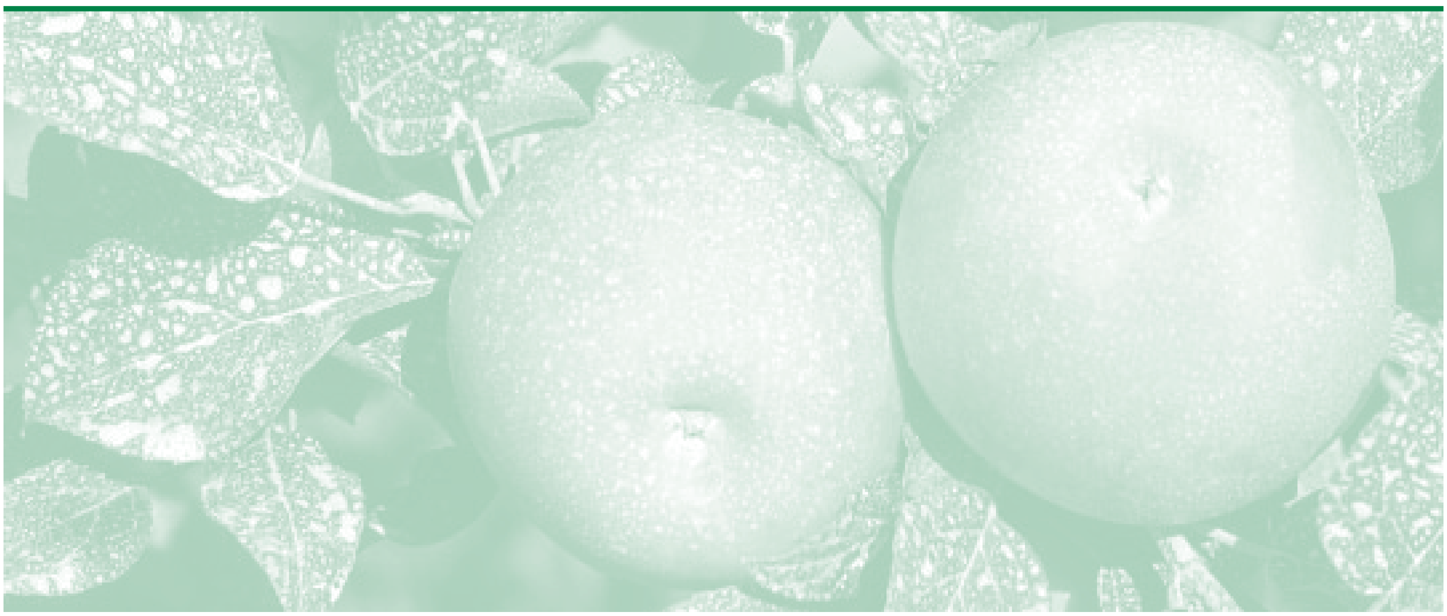

Effect of Surround™ Particle Film on Fruit Sunburn, Maturity and Quality of ‘Fuji’ and ‘Honeycrisp’ Apples

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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.

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.

Figure. 1. ‘Honeycrisp’ with sunburn injury.

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.

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
Earlyy	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

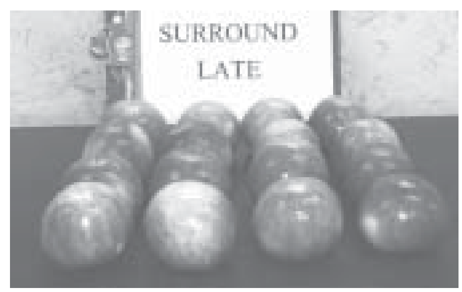

Figure. 3. Color development of 'Honeycrisp' apples treated with Surround™ weekly from July 6 to August 17 was poor.

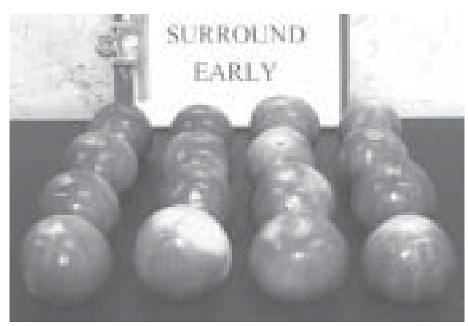

Figure. 4. 'Honeycrisp' apples treated with Surround™ weekly from May 15 to June 26 had little reduction in fruit color at harvest.

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.

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Acknowledgements

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Jim Schupp is an assistant professor of pomology at Cornell's Hudson Valley Lab, in Highland, NY. His research interests include the use of plant growth regulators, mineral nutrients, and other cultural practices for increasing fruit size and quality. Essie Fallahi is a professor of horticulture at the University of Idaho's Parma Research and Extension Center. His research interests include rootstocks, mineral nutrition, and plant growth regulators. Ik-Jo Chun was a post doctoral research associate at the University of Idaho. He now resides in Korea.

Pheromone Disruption of Oriental Fruit Moth in New York Peaches

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Pheromone disruption appears to have the potential for acceptable control of Oriental Fruit Moth within plots, but border sprays may need to be incorporated to prevent moths immigrating from non-disrupted areas.

During the past several years, peach growers in Western New York have experienced increased difficulties in controlling oriental fruit moth (OFM) [*Grapholita molesta* (Busck)] in their stone fruit plantings, particularly those in the most western regions along Lake Ontario, in Niagara and Orleans counties. After unacceptable fruit damage began to show up during the 1997 season, increased efforts were made in population monitoring and spray application timing. However, these still did not produce adequate results in 1998. By this time, the problems had begun to show up in nearby apple plantings as well. Although this insect previously has been controlled easily by common broad-spectrum insecticides such as organophosphates and carbamates, some initial screening of adult males from this region showed at least a tolerance, if not actual resistance, to these materials in approximately one-third of the specimens tested from two locations.

This pest attacks the growing shoots in its first generation, and feeds primarily within the fruit thereafter (Fig. 1). The larva enters the fruit, usually at the stem end, and proceeds to feed in the area around the pit. External evidence of this infestation may go unnoticed unless the fruit is cut. This concealed aspect of its feeding activity naturally makes chemical control of the insect very difficult unless it can be contacted with a pesticide spray before it enters a fruit or shoot. If pesticide resistance is indeed starting to develop in local populations, as it has already done in nearby growing areas of Ontario's Niagara Peninsula, alternative methods of control will need to be considered. Even if resistance is not developing, the imminent regulatory changes in the use of these compounds stemming from the Food Quality Protection Act will require at least a shift to different chemistries, assuming they will be available and economical.

Figure 1. Fruit damage to peach caused by oriental fruit moth infestation.

In this light, the use of pheromone mating disruption was considered to be a potentially useful tactic that needs to be evaluated under Western New York growing conditions. In contrast to other tortricid fruit pests commonly encountered in eastern orchard crops, the OFM has shown itself to be potentially amenable to acceptable control by using commercial mating pheromone dispensers that are already registered and available. Although peach growers would still need to apply some chemicals to prevent fruit damage from direct fruit pests such as plum curculio and tarnished plant bug, some of the newer pheromone dispensing technologies being developed could be affordable and effective components of a multi-tactic management strategy for this suite of pests in New York systems.

During the 2000 and 2001 seasons, we collaborated with a number of peach growers in Niagara County, who allowed us to evaluate the efficacy of several products that are either currently available or under development for commercial use in the control of OFM in orchard crops.

Methods

All work was conducted in non-replicated plots set up in orchards at five farms located between Appleton and Youngstown, in western Niagara County. Test plots ranged from 2.7–6.0 acres. Peach varieties included Babygold 5, Babygold 7, Red Haven, New Haven, Bellaire, Jay Daylee, Loring, and Crest Haven. At each of the sites, four plots of generally equal size were set up to compare the different products:

1. Isomate M-100 polyethylene rope dispensers, Pacific Biocontrol/CBC America Corp.; applied the second week of June at a rate of 120 (2000) or 150 (2001)/acre (Fig. 2).
2. Confuse-OFM paraffin-base liquid, Gowan Co.; applied at the beginning of the second (mid-June) and third

Figure 2. Application of twist-tie pheromone dispensers in young peach planting.

(end of July) summer flights, at a rate of 30 g a.i./acre (1-3 squirts/tree from a forestry tree-marking paint gun or plastic spray bottle), (Fig. 3).

3. 3M Sprayable Pheromone, OFM MEC (microencapsulated); applied by the growers beginning in mid-June at two-week intervals at a rate of 1.7 oz/acre. In 2001, NuFilm 17 was added at a rate of 1 pint/acre.
4. (2000 season only) 3M Sprayable Pheromone, OFM "Phase III" (microencapsulated, long-life); applied by the growers beginning in mid-June at four-week intervals at a rate of 3.5 oz/acre.

Wing-type pheromone traps baited with commercial lures were hung in the central interior section of each plot to assess the extent to which chemical communication between moths was being disrupted. Traps were also hung in non-disrupted plantings near the test sites at each farm, to serve as a check. All traps were checked two times per week from the beginning of the trials until the end of August.

Fruit damage was evaluated each season just before the respective harvest dates of the different peach varieties, by picking 100 random fruits from each of 4-5 trees per plot and inspecting them first for surface damage caused by OFM or any other insect pest, and then cutting each fruit to check for internal infestation. Similar samples were taken from trees managed using the growers' standard pesticide program, which generally consisted of a combination of Asana and azinphosmethyl sprays. All plots received applications of one of these materials during the petal fall to shuck split period for management of plum curculio.

Results

Pheromone trap catches of OFM adult males in the disrupted plots were impressively low throughout the entire season, essentially remaining at or near zero despite considerable population pressure, as reflected in the Check plots (Fig. 4). Two exceptions follow:

2000 In one case, Topp, some breakthrough in moth catches occurred during the last month before harvest, when small numbers of OFM moths were caught in the Confuse and Isomate plots.

2001 At the Kappus site, there was breakthrough in the Confuse plot traps, which occurred at two times, in each case approximately three weeks after the treatment's application date. Following re-application, moth numbers returned to zero in both instances. This level of breakthrough was not seen any of the other plots. It is assumed that the problem was caused by the fact that the Confuse plot at Kappus was directly adjacent to an apple planting, which likely had its own population of OFM that was being attracted into the traps of the pheromone plot.

In general, the growers did a good job of applying the 3M sprayable formulations at the appropriate schedule timings, which is a particularly important aspect of using these products at their highest level of effectiveness.

Results of the pre-harvest fruit inspection in 2000 showed fruit damage from OFM feeding and infestation to be quite low in all the treatments, surpassing 1 percent in very few of the plots (Table 1). OFM injury was placed into one of two categories, with "stings" representing incidence of skin puncturing or nominal pitting progressing less than a few millimeters into the fruit, and the "internal" injury category reserved for actual tunnelling in the fruit flesh, with either the larva or its trail or frass evident when the fruit was cut. Inspection of the data reveals that few major differences among treatments

Figure 3. Foliar residue of paraffin-base pheromone formulation applied using paint marking guns.

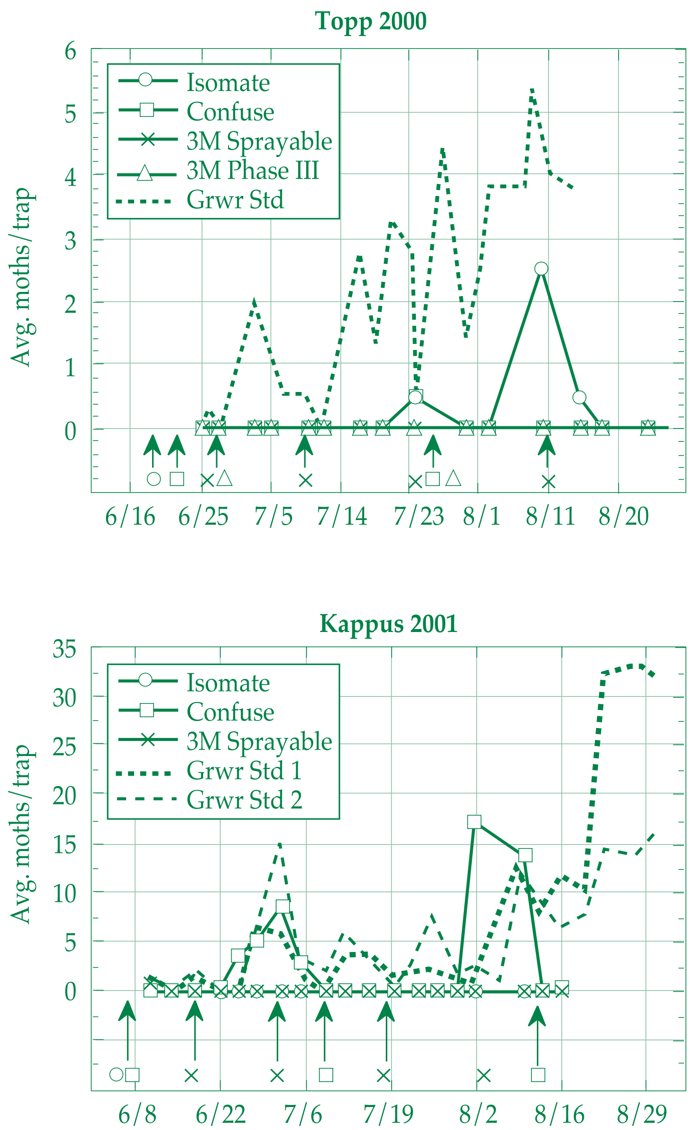

Figure 4. Oriental fruit moth pheromone trap catches in representative plots treated with different pheromone disruption techniques, showing the two instances of moth catch breakthrough.

were seen. The highest incidence of stings was found in the Tower Isomate plot (2.6 percent), and of internal injury in the Kappus Confuse plot (3.6 percent). However, the greatest threat to clean fruit in this region during the 2000 season was tarnished plant bug, which caused feeding damage in as much as 20 percent of the fruit evaluated in our plots. It is apparent that chemical spray programs can go only so far in solving this problem, and that other factors such as orchard floor weed management may likely hold the key to more effectively addressing this perennial stone fruit pest.

In 2001, pre-harvest fruit damage results were similar, but a further complication was noted. The occurrence of "stings" was generally in the range of 1.5-3.5 percent in all plots. Few major differences among treatments were seen in internal larval infestation except for the Kappus site, where it surpassed 10 percent in the Confuse plot. This corresponded with the pheromone trap results, and corroborates the assumption of mated female immigration from the apples, as the injury level was 3.3 percent in the Isomate plot (next in line after the Confuse plot) and only 1 percent in the 3M Sprayable (the plot farthest from the apples). Also, the three plots at this site had different harvest dates because of variety differences, and later dates of harvest corresponded with higher fruit damage levels (3M Sprayable, 6 Aug; Isomate M, 16 Aug; Confuse, 27 Aug). Fruits harvested later in the month would have had a longer period of exposure to potential infestation by any immigrating moths.

TABLE 1

Oriental fruit moth mating disruption trials, fruit damage at harvest, Niagara Co.

Block	Treatment	Application Dates	% Fruit Injury OFM Sting	Int.	TPB	PC
2000						
Murray	Isomate M-100	6/13	0.0	0.6	13.6	-
Topp	Isomate M-100	6/15	0.0	0.2	11.8	-
Topp	Confuse-OFM	6/19, 7/28	0.0	0.4	17.0	-
Topp	3M MEC Sprayable	6/23, 7/8, 7/28, 8/14	1.0	0.6	12.2	-
Topp	3M MEC Phase III	6/23, 7/28	1.0	0.8	13.2	-
Kappus	Isomate M-100	6/13	0.2	1.2	10.2	0.4
Kappus	Confuse-OFM	6/12, 7/28	0.0	3.6	16.8	0.4
Kappus	3M MEC Sprayable	6/17, 7/3, 7/18, 8/4	1.0	0.4	1.0	-
Kappus	3M MEC Phase III	6/17, 7/18, 8/4	0.0	1.2	15.8	0.6
Kappus	Grower Std Program	Asana: 6/17,7/3,7/18,7/25	1.2	0.2	11.4	2.4
Tower	Isomate M-100*	6/12	2.6	0.2	20.8	-
Tower	Confuse-OFM*	6/12, 7/28	0.2	0.0	11.4	0.4
Tower	3M MEC Sprayable*	7/14, 7/29, 8/10, 8/21	0.2	0.4	10.6	0.2
Tower	Grower Std Program	Asana: 5/11,5/15,7/6,7/29,8/9	5.6	0.0	11.8	-
2001						
Murray	Isomate M-100	6/8	3.8	0.5	0.3	0.0
Murray	Confuse-OFM	6/8, 8/2	3.5	0.0	0.8	0.0
Murray	3M MEC Sprayable	6/18, 7/3, 7/18	2.3	0.3	0.3	0.0
Topp	Isomate M-100	6/6	2.8	0.3	1.5	0.0
Topp	Confuse-OFM	6/6, 8/2	1.5	1.3	1.0	0.0
Topp	3M MEC Sprayable	6/18, 7/3, 7/18	1.3	0.0	2.3	0.0
Kappus	Isomate M-100	6/6	3.3	3.3	0.0	0.0
Kappus	Confuse-OFM	6/6, 7/9, 8/13	3.0	10.3	0.8	0.0
Kappus	3M MEC Sprayable	6/17, 7/2, 7/18, 8/3	1.8	1.0	0.8	0.0
Niagara	Isomate M-100	6/11	2.5	0.0	2.0	0.0
Niagara	Confuse-OFM	6/11	2.8	0.0	2.3	2.0
Niagara	3M MEC Sprayable	6/18, 6/29, 7/17, 8/2	1.5	0.0	2.3	0.0
Storage	Grower Std Program	Azinphosmethyl: 6/6, 7/20, 8/1	6.3	0.0	1.8	0.0
Transit	(both rec'd all sprays)	Asana: 6/14, 6/21, 6/29, 7/12	0.8	0.0	0.5	0.0

OFM, oriental fruit moth; TPB, tarnished plant bug; PC, plum curculio; Int., internal damage
*Also received Grower Std Prog sprays: Azinphosmethyl: 5/30,6/24,7/14,7/2; Provado: 6/1

Summary

All treatments appear to have the potential for acceptable control within plot interiors, but border sprays may need to be incorporated to forestall infestations by moths immigrating from non-disrupted areas when these products are used in typical commercial production areas in Western New York.

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Evaluation of Pheromone Disruption in Combination with Insecticide Applications for Control of Peachtree Borers in Peaches

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Evidence indicates that pheromone disruption alone provides adequate protection from Peach Tree Borerr and Lesser Peach Tree Borer infestations in commercial orchards. Recent labeling of Shin-Etsu Isomate-L ties in New York will give growers an effective non-chemical alternative to trunk sprays for managing this pest complex in their stone fruit plantings

In New York, there are two species of sesiid (clearwing) moths that attack peaches — the peachtree borer (PTB), *Synanthedon exitiosa*, and the lesser peachtree borer (LPTB), *Synanthedon pictipes*. The adult borers are striking clear-winged moths with yellow and steel-blue body markings (Fig. 1). Adults of these insects have from one to four yellow-orange stripes across the abdomen, depending upon species and sex. The PTB enters the tree near soil level and does not require the presence of wounds or breaks in the bark for entry, but the LPTB nearly always enters the tree at a pruning scar, canker, mechanical injury, or winter-injured area. Both species pass the winter as borers inside the tree. In the spring, they emerge as moths that lay eggs on or in the trunk during the summer. In New York, the LPTB moth emerges first, in late May, and the PTB doesn't show up until mid-June; both stay active (laying eggs) through August. When the borer stages hatch, the PTB tends to crawl down the tree to soil level and burrow in there, but the LPTB will move to the nearest injured area, which may be on the lower trunk or just as easily up in the scaffold limbs. LPTB completes its development in one year, but some PTB larvae take two years to develop, so any control measure a grower would elect will require repeating for at least two to three years.

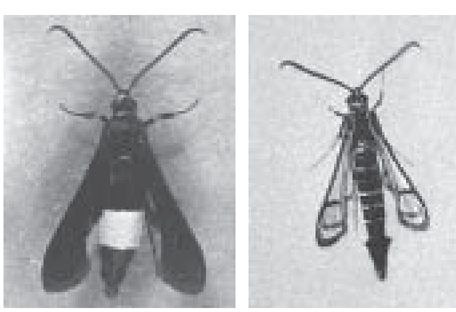

Figure 1. Adult female (left) and male lesser peachtree borer moths.

Injury is caused by larval feeding on the cambium and inner bark of the trunk close to the soil level (PTB) or on the upper trunk and lower scaffold branches (LPTB). Occasionally, larger roots are also attacked by PTB. Areas attacked often have masses of gum, mixed with frass, exuding from the bark.

All ages of trees are injured. Young trees are at times completely girdled and subsequently die. Older trees are often so severely injured that their vitality is lowered and they are rendered especially susceptible to attack by other insects or by diseases. Although both species may be found in infested trees, younger plantings and those not afflicted by extensive cankers or other bark splits are attacked primarily by PTB. Control is difficult, owing to the concealed habit of the larvae, and most growers must rely on one or more coarse insecticide sprays of the trunks and lower scaffold branches to deter egg laying and kill newly established larvae. Because this is a labor-intensive measure that often fails to completely control these pests, many growers choose not to elect treatment, or else do an incomplete job, with the intention of getting what they can out of a planting until infestations combine with other peach production factors to warrant tree removal. This approach has been common in the recent past, during which time there has been little demand for New York stone fruits outside of local farm markets. However, with a recent increase in the planting of new peach varieties and short-range distribution to processing markets, there is now more interest in examining currently available pheromone disruption tools for the control of these perennial pests.

This research involved trials testing the efficacy of pheromone disruption with and without directed trunk sprays. Here we report our findings after the second of a two-year trial to establish reliable guidelines for the use of mating disruption against these pests in commercial New York plantings.

Materials and Methods

This was a multi-year trial in commercial orchards having serious annual problems with borers. Because we were targeting both lesser peachtree borer (LPTB) and peachtree borer (PTB), we selected orchards infected with cankers (necessary for LPTB). Trials were conducted at two locations in Wayne Co., Furber (Sodus, NY) and Herman (Williamson, NY). In each location, we

Figure 2. Twist-tie dispenser for LPTB pheromone.

Figure 3. Fabric screen cages on trunk and branches of peach tree.

compared mating disruption versus no pheromone treatment in two separate orchards, each approximately 2.5 acres in size. We further selected a group of 10 trees in each of these orchards for treatment with insecticide using directed trunk sprays, so the following treatments were evaluated:

1. Pheromone disrupted + trunk spray
2. Pheromone disrupted, no trunk spray
3. Non-disrupted + trunk spray
4. Non-disrupted, no trunk spray

On 31 May (2000) and 22-23 May (2001), Shin-Etsu Isomate-L ties (Fig. 2) containing a 30:70 blend of (Z,Z):(E,Z)-3,13-octadecadienyl acetate were placed in the test blocks at a rate of approximately 200/acre (1/tree). This blend is formulated to be appropriate for disruption of both borers in situations where LPTB is the predominant species, such as we believed to be the case at these sites. On these same dates, three wing-style traps baited with pheromone lures for each species were hung in the interior of each disrupted and non-disrupted block; traps were checked twice per week from early June through August each year. On 22–28 May, 2001, screen cages made out of greenhouse netting (SolarGard 40 percent shadecloth, Tewksbury, MA) were used to enclose two canker/damage sites on the branches and one site on the trunk of each of 10 unsprayed trees in each plot (Fig. 3).

Insecticide treatments consisted of directed trunk sprays of Asana (4.0 oz/100 gal) applied three times during the season. In 2000, 2 June, 6–7 July, and 20 Sept (postharvest); and in 2001, 13 June, 18 July, and 19 Sept (postharvest), using a Nifty Pul-Tank handgun sprayer operating at a pump pressure of 150 psi. Applications of approximately 1.25 gal per tree were made to single-tree plots, and replicated 10 times per block.

In the fall, from 13–27 Oct (2000) and 10–11 Oct (2001), trees were examined for PTB larvae and larval damage. The bases of the trunks on all the sprayed trees, plus an equal number of unsprayed trees in each block, were excavated around their entire circumference to a depth of 3–6 inches. The surface of the trunk circumference was inspected for exudations of gum containing frass, as well as for pupal cases of any PTB larvae evident in the excavation. In 2001, the fabric sleeve cages on each tree were also examined for emerged adults or pupal cases of LPTB.

Results

The pheromone dispensers completely suppressed trap catches of both PTB and LPTB at both sites for both seasons, compared with relatively heavy flights noted in the non-disrupted comparison blocks (Figs. 4 and 5). Therefore, it may be concluded that this pheromone treatment was highly successful in disrupting the chemical communication of males and females in these two species. The PTB pheromone traps did regularly catch small numbers of a related species, determined to be lilac/ash borer, *Podosesia syringae*, which is not an economic pest of stone fruits.

The tree trunk inspections in 2000 turned up no evidence of any PTB larvae or gum exudations resulting from infestations, in both the treated and untreated trees. In 2001, very low levels of damage were detected that were consistent with PTB entry sites, although no empty pupal cases were found, and no significant differences were seen among any of the treatments (Table 1). These results were not entirely unanticipated, as the previous year's inspection had implied that the incidence of this species

TABLE 1

Infestation[a] of peachtree and lesser peachtree borers as determined by fall trunk inspections, 2001.

Block/Treatment	PTB trunk injury sites: Sprayed	PTB trunk injury sites: Unsprayed	LPTB pupal exuviae: Mean avg. no./tree	LPTB pupal exuviae: Proportion on trunk	LPTB pupal exuviae: Proportion on scaffolds
Furber					
Pheromone	0.1 a	0.3 a	0.1 a	1.0	0.0
No pheromone	0.1 a	0.1 a	0.7 a	1.0	0.0
Herman					
Pheromone	0.0 a	0.2 a	0.2 a	0.5	0.5
No pheromone	0.2 a	0.1 a	2.1 b	0.5	0.5

[a] Values in the same column followed by the same letter not significantly different ($P = 0.05$, Fisher's Protected lsd test).

was relatively low in these blocks, and any damage noted might have been caused by the small number of specimens that could have been in the trunk tissue from infestation during the year before this study began.

Inspection of the sleeve cages enclosing canker and damage sites on the trees revealed numerically higher numbers of LPTB pupal cases in the non-disrupted blocks than in those treated with the pheromones, although the difference was significant only at the Herman site. This is further argument for the effectiveness of the pheromone dispensers in disrupting the sexual behavior of this species to a noticeable degree.

After two seasons of these trials, there is sufficient evidence to determine that pheromone disruption alone is able to provide adequate protection from borer infestations in commercial orchards, and the recent labeling of this product in New York will give growers an effective non-chemical alternative to trunk sprays for managing this pest complex in their stone fruit plantings.

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