Small-plot Trials of Surround™ and Actara™ for Control of Common Insect Pests of Apples

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Given the likelihood of removal or restriction of some current chemical tools for management of key pests of apple in the Northeast, pursuit of improved chemically or biologically based alternatives to standard materials has gained emphasis. In the 2001 growing season, we will begin a project designed to evaluate and improve efficacy of multi-tactic approaches to management of major arthropod pests. Under this project, our research goals for the 2001-2002 growing seasons rely on the availability of potentially effective new chemicals to substitute for current standards, particularly Guthion and Imidan. Of recently (or soon-to-be) labeled materials, a few may fill potential gaps in arthropod management in the absence or restriction of organophosphate and carbamate insecticides. As a lead-in for the 2001-2002 project phase, we conducted small-plot tests of two new insecticides: Actara (thiamethoxam) and Surround (kaolin clay).

In this study, our objectives were to (a) evaluate two rates of Actara for control of early-season fruit-injuring pests (principally European apple sawfly and plum curculio) and (b) evaluate Surround for control of all insect pests of fruit active after pink (European apple sawfly, plum curculio, apple maggot, leafrollers, codling moth, oriental fruit moth, San Jose scale, and stink bugs).

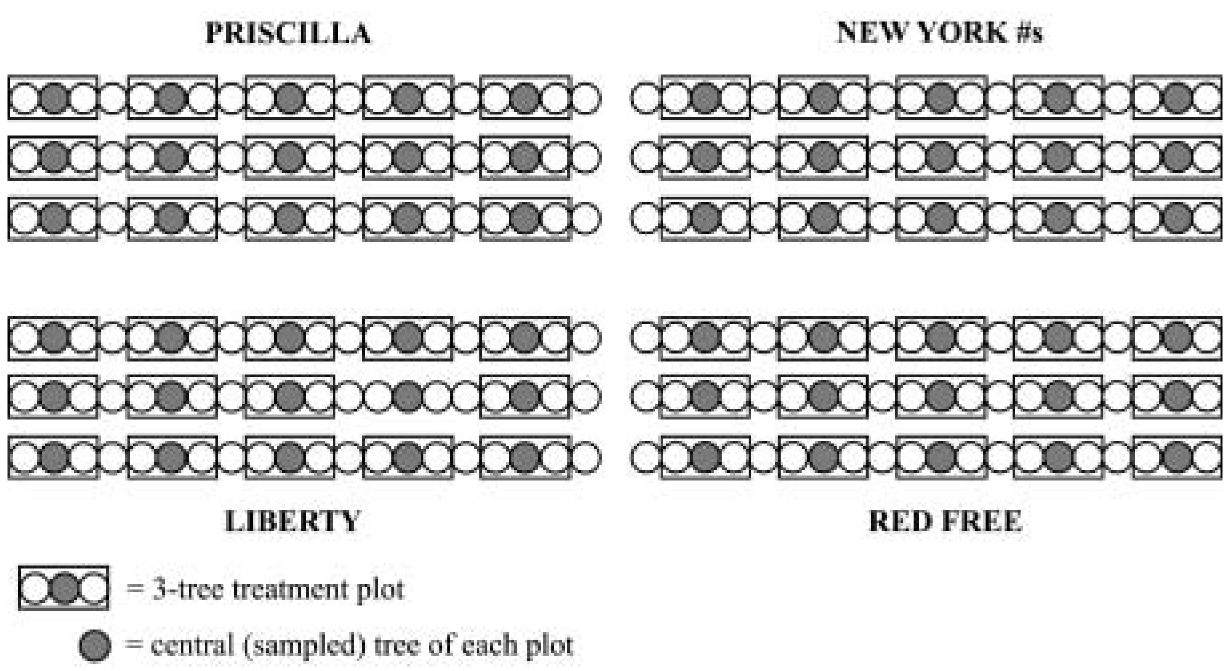

Figure 1. Plot design, University of Massachusetts Horticultural Research Center. Treatments were applied to three-tree plots, with each treatment randomly distributed within a variety/row. Each treatment was replicated 12 times. Fruit samples were drawn from the central tree in each plot.

Materials and Methods

Actara 25WG (25% thiamethoxam). As discussed in the Fall 1999 issue of *Fruit Notes* and the 2000 *March Message*, Actara is a second-generation neonicotinoid compound with a mode of action similar to its cousin, Provado. This material at 4-6 oz. per acre (formulated) is locally systemic and has demonstrated effectiveness against sucking insects (such as leafhoppers, aphids, and pear psylla). Efficacy against tissue-feeding pests (such as leafminer, sawfly, and plum curculio) is under study. As of this writing, Actara has not received a full federal label.

Surround WP Crop Protectant (100% kaolin clay). As reported in the Summer 1999 issue of *Fruit Notes* and the 2000 *March Message*, Surround WP Crop Protectant is a nontoxic, mineral-based, sprayable particle barrier film. A sprayed application of the clay (25-75 lbs. per acre, depending on tree size) physically deters a wide range of pests—at the start of the 2000 growing season, this product was labeled for use against European red mites, rust mites, two-spotted spider mites, codling moth, plum curculio, leafminers, lygus bugs, leafrollers, tarnished plant bug, stink bugs, apple maggot, thrips, green fruitworm, and aphids.

Test Block (Horticultural Research Center, Belchertown). The test block consisted of a 1-acre planting of 240 scab-resistant trees planted in 1988-1990 on M26 rootstock. In this block, four scab-resistant varieties were planted in quadrants, 20 trees long x three rows wide (Figure 1). Each treatment was applied to 3-tree plots (distributed randomly within each row of each quadrant), yielding a total of 12 replicates for each treatment. All treatments (Table 1a) were applied with an airblast sprayer at 100-240 gallons per acre (depending on treatment). All fruit samples were drawn from the center tree of each treatment.

Results

Early-season pests. Beginning at pink bud stage, we evaluated three experimental spray programs (Treatments 2, 3, 4—Table 1b) in comparison with both a label standard

Table 1a. Formulations and rates of tested materials.

Material	Formulation	Rate per 100 gallons	Rate (formulated) per acre
Imidan	70W	.75 lb.	1.8 lb.
Actara Low	25WG	4.5 oz.	4.5 oz.
Actara High	25WG	5.5 oz.	5.5 oz.
Surround	100WP	50 lb.	50 lb.

Table 1b. Chemical treatments and application intervals.

Date	1 Imidan	2 Actara Low	3 Actara High	4 Surround	5 Untreated
May 5 (PK)	Imidan			Surround	
May 15 (PF)	Imidan	Actara	Actara	Surround	
May 25	Imidan	Actara	Actara	Surround	
June 5	Imidan	Actara	Actara	Surround	
June 15	Imidan			Surround	
END OF EARLY-SEASON TREATMENTS					
July 1	Imidan			Surround	
July 15	Imidan			Surround	
August 1	Imidan			Surround	
August 15	Imidan			Surround	

(Treatment 1) and an untreated control (Treatment 5) for management of European apple sawfly and plum curculio. In accordance with label recommendations, we applied four sprays of Imidan (=label standard) at 10-day intervals beginning at pink (May 5), four sprays of Surround at 10-day intervals beginning at pink (May 5), and three sprays of Actara at 10-day intervals beginning at petal fall (May 15). For the duration of the study, the untreated control received no insecticide or fungicide.

Table 2. Mean % fruit damaged by European apple sawfly. Means within a row followed by the same letter are not significantly different at odds of 19:1.

Date	1 Imidan	2 Actara Low	3 Actara High	4 Surround	5 Untreated
June 2*	0.5ab	0.9ab	1.7a	0.0b	0.8ab
June 19*	0.5a	0.0a	1.7a	0.0a	0.9a
Harvest**	0.0b	0.2b	0.4b	0.2b	2.3a

* 20 fruit sampled per replicate (total = 240 fruit per treatment).
** 50 fruit sampled per replicate (total = 600 fruit per treatment).

Table 3. Mean % fruit damaged by plum curculio (oviposition injury). Means within a row followed by the same letter are not significantly different at odds of 19:1.

Date	1 Imidan	2 Actara Low	3 Actara High	4 Surround	5 Untreated
June 2*	0.5b	1.4b	1.7b	1.7b	6.7a
June 19*	12.4b	10.9b	7.8b	9.1b	23.0a
Harvest**	4.2b	9.8b	10.3b	6.3b	20.8a

* 20 fruit sampled per replicate (total = 240 fruit per treatment).
** 50 fruit sampled per replicate (total = 600 fruit per treatment).

To monitor the buildup of early-season pest damage, we sampled 20 fruit from the central tree of each treatment plot (240 fruit per treatment) for damage inflicted by European apple sawfly and plum curculio. Such samples were taken twice during the growing season, in early June and mid June. At harvest, we increased our samples to 50 fruit from the central tree of each treatment (600 fruit per treatment).

For control of European apple sawfly (EAS), we found no significant differences among treatments (including untreated controls) in samples drawn during June (Table 2). These data indicate fairly clearly that pressure from EAS was too light throughout the block to allow judgment of treatment effectiveness with limited fruit samples (mean damage=0.0% to 1.7%). However, more thorough samples taken at harvest yielded a significant difference between all chemically treated plots (mean damage=0.2%) and untreated controls (2.3%). These data suggest that Surround and Actara (at either rate) can offer control of a light EAS population comparable to that of a standard Imidan program.

No treatments provided a commercially acceptable level of plum curculio (PC) control through June, with damage reaching 7.8% to 12.4% in chemically treated plots by June 19 (Table 3). However, for this trial, it is important to bear in mind the likelihood that many PCs found safe harbor in untreated controls (which would not be found in commercial orchards) during June, likely spilling over into treated areas. This may account for the high level of PC injury seen across all chemical treatments. That said, all treatments yielded significant reduction of PC oviposition injury in comparison with untreated controls (23.0% PC injury) through June 19. Further, all chemical treatments provided statistically identical control of PC, again suggesting that Surround and Actara (at either rate) may offer control of PC comparable to Imidan. In samples taken at harvest (reflecting the full effects of June drop and possible late-June buildup of PC injury), all experimental treatments maintained a level of PC control that was statistically equal to treatment with Imidan. However, in late-season samples, it was often difficult to distinguish between distorted PC oviposition scars

Table 4. Mean % fruit damaged by apple maggot fly. Means within a row followed by the same letter are not significantly different at odds of 19:1.

Date	1 Imidan	4 Surround	5 Untreated
July 21*	0.0a	0.0a	0.0a
August 11*	1.2a	0.0a	0.8a
Harvest**	8.3b	1.2b	24.0a

* 20 fruit sampled per replicate (total = 240 fruit per treatment).

** 50 fruit sampled per replicate (total = 600 fruit per treatment).

and hail damage that occurred in June.

Mid- to late-season pests. After June 19, we revised our sampling protocol to focus on one full-season experimental treatment regimen (for Surround) in comparison with both a standard interval-spray program (for Imidan) and a control (untreated). From July 1-August 15, we applied four sprays (at 15-day intervals, Table 1b) of either Imidan or Surround, and compared levels of insect injury in each with an untreated control. To monitor the buildup of all insect pest injury, we sampled 20 fruit from the central tree of each replicate (240 fruit per treatment) and recorded all insect injury. These samples were taken twice during the growing season, in mid-July and mid-August. As with early-season pests, we increased samples at harvest to 50 fruit per replicate (600 fruit per treatment). Although we recorded damage from each pest individually, data here are compiled into five groups: apple maggot, external Lepidoptera (leafrollers and lesser appleworm), internal Lepidoptera (codling moth and oriental fruit moth), San Jose scale, and incidental pests (notably stink bug).

Despite a statewide apple maggot fly (AMF) population that was extremely low, the test block in this study endured substantial pressure from AMF in late August. Even under relatively high pressure, Surround (1.2% AMF injury at harvest) actually outperformed Imidan (8.3% AMF injury at harvest), and both treatments yielded AMF injury levels significantly lower than the untreated control (24.0% injury at harvest, Table 4). These data strongly suggest that Surround holds promise for control of AMF equal to or better than calendar sprays of Imidan, likely owing to the lengthy residual effectiveness of Surround coverage in the absence of substantial rainfall (as characterized the peak of AMF pressure in late August, Figure 2).

For external lepidopteran pests (combined leafroller and lesser appleworm), both Surround and Imidan yielded fruit damage rates (16.7% and 20.5% damage at harvest, respectively) far below damage inflicted in untreated controls (40.5% damage at harvest, Table 5). Although no treatment offered a level of control that is considered commercially acceptable, this is likely again due to pest spill-over from untreated trees (as seen with PC). As was the case with control of apple maggot, Surround actually provided control of LR and LAW that was numerically superior to calendar sprays of Imidan.

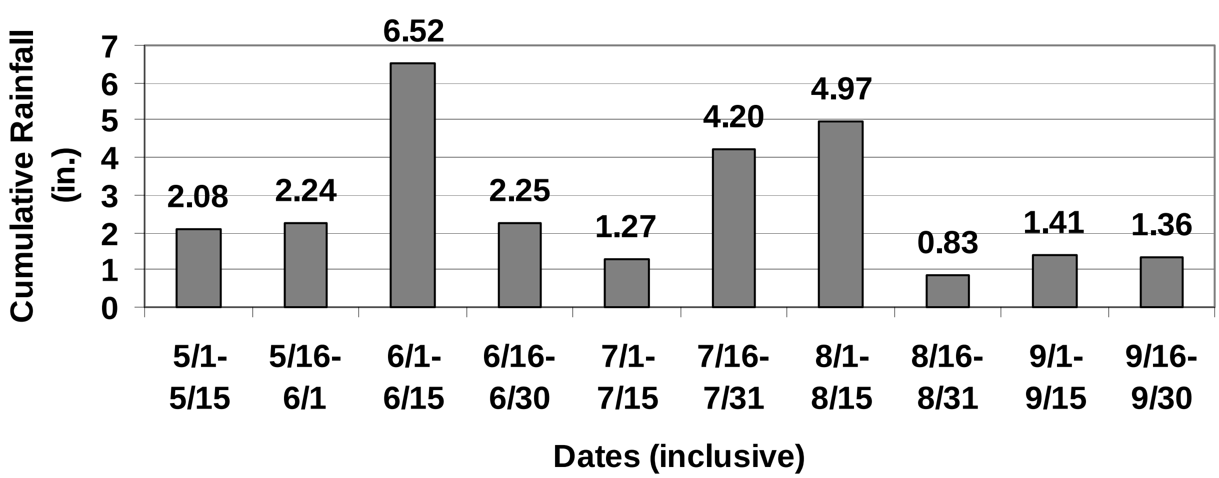

Figure 2. Cumulative rainfall for each 15-day period from May 1 through September 30. Imidan and Surround were applied on May 5, 15, 25, June 5, 15, July 1, 13, August 3, and 16. Actara was applied on May 15, 25, and June 5.

For control of internal Lepidoptera (combined codling moth and oriental fruit moth), samples at each interval revealed a consistent pattern. Both Surround and Imidan (1.5% and 0.5% damage at harvest, respectively) provided significantly reduced levels of damage in comparison with untreated controls (5.2% damage at harvest, Table 6). For this pair of pests, Imidan sprays yielded slightly better control, particularly in early August (the period of greatest rainfall, Figure 2), when a significant amount of Surround coverage may have washed off. Even so, levels of control of CM and OFM through harvest were comparable between Imidan and Surround.

San Jose scale (SJS) has been identified (by other researchers) as a pest for which Surround may not offer optimal control, likely as a result of the seamless coverage needed (with any chemical) for consistent control that is difficult to achieve with this material. In this trial (Table 7), control provided by treatment with Surround (0.5% SJS damage at harvest) was nearly equal to that offered by Imidan (0.2% SJS damage at harvest), and both far outperformed the untreated control (4.0% SJS damage at harvest). However, it is likely that the overall population of SJS was limited within the block (given only 4.0% SJS damage to untreated fruit at harvest), and we can only conclude that Surround offered acceptable control of SJS under limited pressure.

Although our sampling protocol focused on pests that are consistently targets of insecticide sprays in the Northeast, we also sampled for damage inflicted by pests that are

Table 5. Mean % fruit damaged by leafroller and lesser appleworm (combined damage). Means within a row followed by the same letter are not significantly different at odds of 19:1.

Date	1 Imidan	4 Surround	5 Untreated
July 21*	0.0b	1.3ab	4.2a
August 11*	0.8b	2.1b	5.8a
Harvest**	20.5b	16.7b	40.5a

* 20 fruit sampled per replicate (total = 240 fruit per treatment).
** 50 fruit sampled per replicate (total = 600 fruit per treatment).

Table 6. Mean % fruit damaged by codling moth and oriental fruit moth (combined damage). Means within a row followed by the same letter are not significantly different at odds of 19:1.

Date	1 Imidan	4 Surround	5 Untreated
July 21*	0.0b	0.4b	3.3a
August 11*	0.0b	1.3ab	2.5a
Harvest**	0.5b	1.5b	5.2a

* 20 fruit sampled per replicate (total = 240 fruit per treatment).
** 50 fruit sampled per replicate (total = 600 fruit per treatment).

Table 7. Mean % fruit damaged by San Jose scale. Means within a row followed by the same letter are not significantly different at odds of 19:1.

Date	1 Imidan	4 Surround	5 Untreated
July 21*	0.0a	0.0a	0.0a
August 11*	0.0a	0.0a	0.0a
Harvest**	0.2b	0.5b	4.0a

* 20 fruit sampled per replicate (total = 240 fruit per treatment).
** 50 fruit sampled per replicate (total = 600 fruit per treatment).

Table 8. Mean % fruit damaged by stink bugs. Means within a row followed by the same letter are not significantly different at odds of 19:1.

Date	1 Imidan	4 Surround	5 Untreated
July 21*	0.0a	0.0a	0.0a
August 11*	0.8b	0.8b	3.3a
Harvest**	0.0b	0.2b	1.8a

* 20 fruit sampled per replicate (total = 240 fruit per treatment).
** 50 fruit sampled per replicate (total = 600 fruit per treatment).

not generally targeted, but may flare up in the absence of organophosphate sprays. These were grouped as incidental pests, and damage within this group was dominated by stink bugs. The pattern of control of these pests (Table 8) was very similar to the pattern of internal Lepidoptera. In each sampling interval, treatment with either Surround or Imidan (0.8% and 0.8% damage at harvest, respectively) significantly reduced damage by incidental pests such as stink bugs in comparison with untreated control (1.8% damage at harvest). As with internal Lepidoptera, the bulk of injury was observed to occur in early August. All told, control of these incidental pests by Surround was consistently comparable to control provided by Imidan.

Conclusions

Data from this study strongly confirm the potential effectiveness of alternative chemicals to replace Imidan or Guthion for control of common apple insect pests. We are particularly encouraged by the fact that Actara provided control of both European apple sawfly and plum curculio nearly equal to control provided by calendar sprays of Imidan. Somewhat discouraging, though, are recent developments surrounding labeling of Actara. It has not yet received a federal label for use in the 2001 growing season and will not include apple maggot (not studied here) in its near-term use recommendations. Even so, when labeled, this material may offer a reasonable alternative to Imidan or Guthion for control of early-season pests, particularly PC.

There is no question from this and other studies that Surround can provide very good season-long control of many (if not all) common insect pests of apple fruit in the Northeast. However, we find several weaknesses in large-scale, season-long use of this material: (1) difficulty of handling and distributing each application effectively (at 25-75 lbs. per acre); (2) risk of wash-off of effective residue by rainfall, which dictates nine treatments per season; (3) need to keep rapidly expanding fruit and foliage completely and uniformly covered throughout the growing season; (4) cost of a season-long Surround program ($225-$675 per acre, depending on tree size and treatment interval); and (5) the challenge of thoroughly rinsing clay residue after harvest. In addition, there are a few negative pest management impacts that have not been fully studied, such as suppression of beneficials (particularly predaceous mites and leafminer parasitoids) and the potential for rapid buildup of secondary pests that can quickly proliferate if spray coverage is not ideal (such as is suspected for San Jose scale). We believe that Surround may still hold potential as an insect management tool in small-scale, limited-spray programs, though application of this material at any scale is challenging, particularly with a backpack sprayer (as in *Fruit Notes*, Summer 1999).

Given slow progress toward labeling (and reported ineffectiveness against AMF) of Actara, along with the handling problems and potential expense of Surround, we will not pursue large-scale testing of either material of the 2001-2002 growing season.

Acknowledgments

We would like to thank the Horticultural Research Center in Belchertown for hosting this trial, along with Joe Sincuk and Alex Clark for applying the experimental treatments. Funding for this project was provided by the manufacturers of the tested materials, Syngenta (Actara) and Engelhard (Surround). Additional project funding was provided by state and federal IPM funds and a grant from the Massachusetts Society for Promoting Agriculture.

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