FINAL PROJECT REPORT

Project Title: Monitoring leafrollers and codling moth with one non-pheromone lure

PI:	Alan Knight	**Co-PI**:	Jay Brunner
Organization:	USDA, ARS	**Organization**:	Washington State University
Telephone:	(509) 454-6566	**Telephone**:	(509) 663-8181 x238
Email:	alan.knight@ars.usda.gov	**Email**:	jfb@wsu.edu
Address:	5230 Konnowac Pass Rd	**Address**:	1100 N. Western Ave.
City:	Wapato	**City**:	Wenatchee
State/Zip:	WA, 98951	**State/Zip**:	WA, 98801

Cooperators: Bill Lingren, Trécé Inc., Adair, OK

Other Funding Sources: $22,000, Trécé Inc.

Total Project Funding: $52,500

Budget History:

Item	2011	2012
Salaries	19,255	19,450
Benefits	2,145	2,200
Wages		
Benefits		
Equipment		
Supplies	2,500	2,600
Travel	2,100	2,250
Plot Fees		
Miscellaneous		
Total	26,000	26,500

ORIGINAL OBJECTIVES

The overall objective of this two year project was to develop and assess the use of a combination lure to monitor both codling moth and leafrollers within a single trap. Studies were conducted with both Pandemis and oblique banded leafrollers in apple and pear. The first specific objective was to use a standard lure loaded with the sex pheromone of codling moth in combination with a host plant volatile and a second lure loaded with acetic acid. We tested a number of potential host plant volatile attractants for their relative contribution to the combination lure. The final specific objective was to assess the correlation of leafroller adult captures in traps baited with the most effective multi-species lure with local infestations of leafrollers.

SIGNIFICANT FINDINGS

- ✓ The addition of an AA lure (TRE3321) to the sex pheromone-pear ester combo lure-baited traps significantly increased codling moth catches, especially of female moths.

- ✓ A commercial acetic acid plastic cup lure, Pherocon AA, was developed by Trécé Inc. for use with the CM-DA Combo lure for codling moth as a result of this research.

- ✓ The optimal daily release rate of acetic acid from lures required to be effective for leafrollers was found to be higher than for codling moth. A second lure (TRE0421) was developed for eventual commercial use by growers to monitor both codling moth and leafrollers.

- ✓ Studies showed that the cardboard lure holder developed to hold both the CM-DA Combo lure and the acetic acid cup lure significantly reduced catches of codling moth and this device was discontinued by Trécé Inc. Instead, the acetic acid lure is placed horizontally on the sticky surface of the liner.

- ✓ Studies conducted with five host plant volatiles in addition to pear ester combined with codling moth's sex pheromone and used with an acetic acid lure found these lures all performed similarly in traps for Pandemis and oblique banded leafrollers. However, pear ester provided the highest catch of codling moth, especially of female moths.

- ✓ A new attractant (International patent pending) developed in New Zealand was found to be significantly more (2 to 7-fold) attractive than pear ester when used with acetic acid for both leafroller species and the eye-spotted bud moth.

- ✓ Field studies with both species of leafrollers found that the single trap baited with codling moth pheromone, pear ester, and acetic acid provided useful information about the presence of local infestations of leafrollers.

- ✓ Several factors were found to be of significant concern with the use of this monitoring approach.

    - o 'False negatives' where the trap fails to catch adult leafrollers and larvae were detected occurred in a few sites with the presence of overwintering larvae and no subsequent adult catches. This was likely due to the use of control tactics against the spring generation of leafroller larvae which eliminated the subsequent emergence of the summer generation adults in the orchard. No cases occurred where traps failed to catch moths and larvae from the subsequent generation were detected. The occurrence of 'false negatives' also appeared to have occurred in some pear blocks

where the eye-spotted bud moth was present and injured fruits were misclassified as oblique banded leafroller damage.

- 'False positives' where the trap catches leafroller adults but no larvae are found was more common and always occurred in blocks with adjoining cherry blocks. Due to the immigration potential of leafroller adults from cherry these catches are considered to be useful information for apple and pear growers to assess their risk. Growers need to sex moths to ascertain if females are moving into the orchard.

- In the great majority of orchards the use of the CM-DA Combo lure with acetic acid caught one or more leafroller adults when leafroller pressure was ranked as moderate to high (based on the presence of larvae or injury); and traps failed to catch any adult leafrollers when the pest pressure was rated low to nonexistent.

RESULTS & DISCUSSION

1. Benefit of Adding AA to traps with the CM Combo lure

The positive effect of adding an acetic acid lure to codling moth traps baited with a CM-DA Combo lure has been clearly shown in both conventional and sex pheromone-treated orchards. During 2011 we evaluated this effect in a collaborative project including 21 orchards with Dr. Diane Alston at Utah State University, Rick Hilton at Oregon State University, and several consultants in Washington (Table 1). Both the total number and number of female moths caught per trap was significantly higher with the addition of the acetic acid lure. The nearly 4-fold increase in female moth catches was of particular interest. A precision management program has been developed that uses action thresholds based on female and total moth catches. The development of a more sensitive monitoring tool for female moths could be a useful addition to this program. Further studies are required to determine if the current threshold of a single female moth should be increased with the adoption of this more powerful combination lure.

Table 1. Codling moth catches with the Pherocon CM-DA Combo lure with and without the addition of a Pherocon AA lure in 21 orchards in Washington, Oregon, and Utah, 2011.

	Mean (SE) moth catch per trap		
Lure	Male	Female	Total
Combo	18.1 (3.8)	3.0 (1.4)	21.1 (4.1)
Combo + AA	28.1 (7.3)	11.4 (3.8)	39.5 (8.7)
ANOVA	$F_{1, 40} = 1.70$ $P = 0.20$	$F_{1, 40} = 6.59$ $P < 0.0001$	$F_{1, 40} = 4.53$ $P < 0.0001$

2. Optimal AA loading for lure

The use of an acetic acid lure was developed during a four year project with Trécé Inc. to improve the CM-DA Combo lure for codling moth. Various trials were conducted to assess the optimal emission rate of acetic acid required to synergize pear ester. This work led to the Pherocon AA lure which has now been added to their commercial catalogue. However, our studies in 2011 found that the Pherocon AA lure is not optimal for catching leafrollers (Table 2). A higher emission rate is required and thus we were forced to replace all of the Pherocon AA lures in early summer of 2011 with a vial with a 3.1 mm hole. This vial was also used during 2012. Meanwhile, we have been testing larger cup lures for their effectiveness with both leafroller species and codling moth (Table 2). The new lure tested in 2012 (TRE0691) has a 10-fold higher emission rate than the Pherocon AA and appears to perform similarly in catching leafroller adults as the 3.1-mm vial. This acetic acid dispenser may not be completely optimized for leafrollers and codling moth, but a similar high emission prototype should be available from Trécé Inc. in 2013 for further testing by consultants.

Table 2. Moth catches of Pandemis leafroller and oblique banded leafrollers and weight loss from acetic acid lures in three trials with traps (N = 10) baited with the Pherocon CM-DA Combo lure plus one of several AA co-lures.

	PLR				OBLR	
	June – July 2011		Aug. – Sept. 2011		August 2012	
AA co-lure	Lure wt loss (mg/d)	Moth catch	Lure wt loss (mg/d)	Moth catch	Lure wt loss (mg/d)	Moth catch
Vial, 3.1 mm hole	40	11.5	55	3.0	53	0.6
Vial, 1.7 mm hole	17	9.3	20	4.3	-	-
Pherocon AA	3.5	1.6	4	1.4	3.8	0.0
TRE0421	-	-	12	3.9	-	-
TRE0691	-	-	-	-	40	0.4

3. Comparison of Host Plant Volatiles with AA

Studies were conducted to compare six host plant volatiles as lures for codling moth and Pandemis leafroller in an orchard situated near Naches, WA in 2011 and four volatiles for codling moth and oblique banded leafroller in an apple block in Medford in 2012 (Table 3). In both tests the different host plant volatiles were equally effective in catching leafroller adults when combined with the AA lure. Beta ocimene, farnesol, and nonatriene lures all caught good numbers of codling moths, but no lure outperformed pear ester, especially in the catch of female moths. Because pear ester is already commercialized it seems that the use of the CM-DA Combo lure with an acetic acid lure similar to TRE0691 would be an effective approach going forward.

Table 3. Comparison of moth catches of codling moth and Pandemis leafroller (PLR) in Yakima and codling moth and oblique banded leafroller (OBLR) in Medford in traps (N = 10) baited with one of six host plant volatiles in combination with the sex pheromone of codling moth and the addition of a AA vial with a 3 mm hole.

	Yakima - 2011				Medford - 2012			
	Codling moth		PLR		Codling moth		OBLR	
Host plant volatile	Total	Females	Total	Females	Total	Females	Total	Females
Pear ester	0.9	0.3	9.4	3.4	6.2	1.1	0.6	0.6
Beta ocimene	0.8	0.3	12.0	4.6	2.7	0.1	0.7	0.6
Nonatriene	0.9	0.4	9.0	4.2	1.4	0.7	0.8	0.6
Farnesol	0.5	0.1	10.1	3.3	3.2	0.5	0.9	0.6
Beta farnesene	0.0	0.0	8.6	2.8				
Butyl hexanoate	0.4	0.1	8.5	2.5				

4. New Attractant for Leafrollers

We have been testing lures with Dr. Ashraf El-Sayed from HortScience in New Zealand for several years to allow us both to utilize the reverse growing seasons. During 2012 in one of these trials we found that the B3 volatile in combination with acetic acid caught greater numbers of both sexes of Pandemis and oblique banded leafroller adults (Table 4). However, B3 was not effective for codling moth. The combination of pear ester with B3 plus acetic acid provided the highest catches of both codling moth and leafrollers. The use of B3 with acetic acid was also an interesting bisexual lure for the eye-spotted bud moth. Dr El-Sayed has found that this volatile is effective for a number of important pest species and has applied for an international patent to protect his intellectual property. Further testing of this volatile is planned for 2013, including its use in attract and kill studies for OBLR and eye-spotted bud moth.

Table 4. Evaluation of three new attractants for leafrollers including pear ester (PE) and acetic acid (AA).

	Mean moth catch (Male / Female) per trap				
	Yakima 2012		Medford 2012		
NZ lures	CM	PLR	CM	OBLR	ESBM
B1 + PE + AA	11.2 / 18.4	2.0 / 1.2	0.0 / 0.4	0.0 / 0.4	0.0 / 0.0
B2 + PE + AA	13.0 / 15.2	1.0 / 0.2	1.0 / 1.0	0.0 / 0.6	0.0 / 0.0
B3 + PE + AA	4.6 / 4.8	3.8 / 1.4	0.4 / 0.2	1.2 / 3.4	0.4 / 0.6
B3 + PE	0.2 / 1.2	0.2 / 0.2	0.4 / 0.0	0.0 / 0.4	0.0 / 0.0
B3 + AA	0.4 / 0.4	4.8 / 2.6	0.0 / 0.0	1.2 / 4.6	0.2 / 0.6
B3	0.4 / 0.0	0.4 / 1.0	0.0 / 0.0	0.0 / 0.0	0.0 / 0.0
PE + AA	14.2 / 19.2	1.0 / 2.0	2.2 / 2.6	0.4 / 0.4	0.0 / 0.0

5. Effect of the cardboard lure holder on moth catches.

During the course of the season it became obvious that the use of the cardboard lure holder for the septum and the acetic acid cup lure provided by Trécé Inc. was negatively impacting moth catches (Fig. 1). To be sure we conducted a specific experiment to compare moth catches when the lures were placed in the cardboard hanger, pinned to the roof, or placed on the sticky liner (Table 5). A similar study was also repeated by collaborators in Chile. These trials showed that the acetic acid lure needs to be placed horizontally on the center of the trap's sticky liner to avoid this repellency. Trécé Inc. has discontinued this holder as a result of this study. This finding also suggests that the data in Table 1 might have been impacted, and the benefit of adding the acetic acid co-lure was likely underestimated as the holder was used in all 21 sites.

Table 5. Effect of Trécé Inc. lure holder on moth catches of codling moth with the Combo lure and the Pherocon AA lure.

		Yakima 2012	Chile 2012
CM-DA Combo lure	AA lure	Mean Male / Female catch	Mean Male / Female catch
In holder	In holder	1.4 / 0.2	6.2 / 0.4
On liner	On liner	4.8 / 1.0	-
Pinned to roof	On liner	-	24.6 / 0.8
In holder	On liner	-	14.0 / 0.0

6. 2011 correlation of moth catches with local leafroller populations

Studies were conducted with both Pandemis and oblique banded leafrollers in apple orchards near Brewster, Quincy, Wenatchee, and Yakima, WA in 2011 (Table 6). Sites outside of the Yakima and Brewster studies were chosen based on some expectations that orchards would be infested with leafrollers. Visual sampling for leafroller larvae and the presence of fruit injury late in the season were conducted in most orchards. No leafroller adults were caught in CM-DA plus AA-baited traps in 11 orchards. No signs of leafroller larvae were found in these orchards except that spring larvae were sampled in the Wenatchee2 site which was also nearby known infested blocks. Low levels of leafroller adults ($\leq$ 1 moth) were found in two sites in which larvae or fruit injury was not detected. These were both sprayed orchards. In five orchards, leafrollers were caught in traps and no larvae or injury was found in the monitored block, but known infested hosts, such as mature and non-bearing cherry blocks and backyard unsprayed fruit trees, were near the orchard. The most interesting block in this category was Naches1 that had very high levels of leafroller adults without any injury occurring. At harvest the grower unexpectedly found high levels of fruit injury in a 'Honeycrisp' block that was < 0.2 miles away. In addition, the Naches1 orchard was surrounded by several cherry blocks that

were not sampled. Traps in all blocks in which leafroller fruit injury was detected caught leafroller adults.

Table 6. Summary of moth catches and leafroller infestations in orchards monitored during 2011 with the Pherocon CM-DA Combo lure plus a vial with a 3.1 mm hole loaded with AA.

	Mean catch PH trap		Mean catch Combo + AA trap		Infestation
Orchard	PLR	OBLR	CM	LR	presence or potential
Naches1	294	81	61	24	Nearby injury & hosts
Naches2	66	9	86	1	No
West Valley	23	35	30	0	No
Wiley City	42	31	22	0	No
Moxee1	2	18	41	0	No
Moxee2	19	123	23	1	Nearby hosts
USDA Farm W	53	40	30	7	3.6% injury
USDA Farm E	248	36	46	30	14.0% injury
Wapato1	74	97	59	0	No
Wapato2	88	62	57	0	No
Wapato3	79	43	8	2	N.A.
Wapato4	86	60	28	1	N.A.
Brewster1	-	30	0	0	No
Brewster2	-	11	1	0	No
Brewster3	-	28	1	0	No
Brewster4	-	61	1	0	No
Pasco	-	4	9	0	No
Quincy1	-	217	6	4	High fruit injury
Quincy2	-	228	6	1	Some fruit injury
Quincy3	-	42	21	1	Nearby hosts
Quincy4	-	52	13	4	Nearby hosts
Wenatchee1	0	45	-	1	Spring/summer larvae
Wenatchee2	0	94	-	0	Spring larvae
Wenatchee3	1	125	-	4	Nearby hosts
Wenatchee4	20	184	-	4	Spring/summer larvae
Wenatchee5	2	3	-	2	Spring larvae
Wenatchee6	0	15	-	7	?

7. 2012 correlation of moth catches with local leafroller populations in apple

During 2012 a portion of this project was conducted with cooperation from consultants in the Orondo and Quincy area to assess if CM-DA+AA lure baited traps would capture OBLR and if these captures were reflective of OBLR densities in monitored orchards (Table 7). Codling moth and oblique banded leafroller were monitored at 12 locations. At each location traps baited with CM/DA+AA lures and traps baited with OBLRW lures were used to monitor CM and OBLR. Monitoring traps were placed in orchards in late May and checked through August. The traps were checked weekly and number of CM and OBLR counted and removed in the CM/DA+AA traps and OBLR in the OBLRW traps. The risk rating for each orchard was determined by consultants who monitored the orchards for presence of OBLR larvae, pheromone trap captures, and injury.

The capture of OBLR in CM/DA+AA lure-baited traps seemed to be a good predictor of OBLR pressure in the first flight in blocks in the Quincy area and in the Orondo 1-4 blocks (Table 7). In the Quincy area orchards those blocks classified as high pressure both captured some OBLR in the first flight, the block classified as moderate pressure caught only one OBLR moth, and in the block

classified as low pressure no OBLR moths were captured. In the Orondo 1-4 blocks, all classified as low pressure, there was only one OBLR moth captured, in the second flight period.

There was not as good of relationship between OBLR capture in CM/DA+AA lure-baited traps and OBLR pressure classification in the Orondo 5-6 sites. The one block, Orondo 6, classified as high due to the presence of several overwintering larvae, the trap did not capture any OBLR moths in the first flight, One Orondo site caught OBLR in the CM-DA baited trap in the first flight (Orondo 8) and these were all caught on one date. Orondo 8 was close to a sweet cherry orchard which could have harbored an OBLR population but this orchard was not monitored nor sampled for presence of OBLR in the spring. OBLR moth captures in the CM/DA + AA traps were higher in the second flight in the Orondo blocks and this matched a higher capture of OBLR in traps baited with the OBLR-W lures.

Table 7. Summary of results from the Wenatchee area over both OBLR generations, 2012.

	Mean catch	Mean catch with Combo + AA		
	OBLR PH lure	CM	OBLR	
Orchard	1st / 2nd	1st / 2nd	1st / 2nd	Rating risk
Orondo 1	9 / 29	1 / 3	0 / 1	Low
Orondo 2	N.A.	4 / 0	0 / 0	Low
Orondo 3	12 / 24	0 / 0	0 / 0	Low
Orondo 4	N.A.	0 / 0	0 / 0	Low
Orondo 5	1 / 0	2 / 0	0 / 4	Low
Orondo 6	<1 / 4	1 / <1	0 / 2	High
Orondo 7	1 / 0	0 / 0	0 / 5	Low
Orondo 8	8 / 2	2 / 0	4 / 1	Low
Quincy 1	183 / 21	<1 / 0	3 / 0	High
Quincy 2	86 / 34	0 / 0	1 / 0	Mod
Quincy 3	144 / 17	1 / 0	3 / 0	High
Quincy 4	0 / 0	0 / 0	0 / 0	Low

8. 2011-12 correlation of moth catches with local leafroller populations in pear

Studies were conducted in pear blocks in Medford over both years of the project (Table 8). These blocks were selected based on an expected moderate to high pest pressure from OBLR. OBLR counts in the pheromone traps were high in both years. Counts of CM in pheromone traps were more variable among orchards. Orchards ranged from organic to conventional and generally received few sprays during 2012. OBLR adults were captured in all but one orchard in 2011 and two orchards in 2012. Fruit injury in 2011 from leafrollers was found in four blocks. The Medford 7 block did not have fruit injury but leafroller larvae were sampled in June. The two other blocks had no injury and no signs of larvae and had either 0 or 1 leafroller adult caught in traps.

Results in 2012 were somewhat more difficult to interpret. Considerable injury purportedly from leafrollers was found in two blocks. Counts of OBLR were low in all blocks in the CM-DA + AA baited traps with no evident pattern. However, we discovered that the eye-spotted bud moth was present in high numbers in some of these blocks. Field scouts in the spring generally ignored the large number of larvae found in developing buds because they were not oblique banded leafrollers and efforts to rear and identify them failed. Later in the season while testing the lures previously mentioned it became obvious that these larvae were likely eye-spotted bud moth and orchards had an unmanaged population of a new pest. Unfortunately, fruit injury by OBLR and the bud moth are nearly identical and there was no way to differentiate the injury. We believe this confusion may have been responsible for the poor correlation that occurred in 2012 and not in 2011. These new findings

have stimulated further research into the attractant from New Zealand and the potential to develop attract and kill tactics for both pests simultaneously. Studies are planned for pear in Medford in 2013.

Table 8 Summary of results from Medford pear blocks

	Mean catch in PH trap		Mean catch Combo + AA trap		Infestation presence or potential
Orchard	CM	OBLR	CM	LR	
		2011			
Medford1	31	298	55	6	Some fruit injury
Medford2	81	260	126	5	Some fruit injury
Medford3	2	320	1	1	No
Medford4	0	57	0	0	No
Medford5	2	335	4	4	Some fruit injury
Medford6	97	149	122	4	Some fruit injury
Medford7	37	408	26	8	June larvae
		2012			
Medford 1	4	174	17	0	No injury
Medford 8	0	376	1	1	6% injury
Medford 5	1	262	2	2	No injury
Medford 3	161	233	95	1	No injury
Medford 6	0	373	0	2	7% injury
Medford 9	118	203	17	0	No injury

DISCUSSION

The use of traps baited with CM-DA plus acetic acid lures to monitor both codling moth and leafrollers appears to be a promising new tool for pest managers. These traps provide useful information at a minimal cost and training. Implementation of action thresholds based on moth catches for codling moth and use of higher densities of traps can allow growers to use less insecticide and target their valuable resources to treat 'hot-spots'. The detection of leafrollers in these traps alerts the farm manager to a potential problem. Control actions can then be taken based on this information as well as the orchard's pest history, other monitoring data, and grower's risk preferences.

In general, these traps when placed in commercial orchards will catch < 10 leafroller adults per season. The capture of one or more leafroller adult suggests that a local infestation of leafrollers is present either in the block with the trap or in adjacent blocks. Unfortunately, the catch of leafrollers without the occurrence of local injury can be relatively high depending on the proximity and severity of the infestation. Pome fruit orchards adjacent to cherry blocks are at the greatest risk from female moths immigrating and laying eggs during the season. The CM-DA Combo plus acetic acid lure catches both sexes of leafrollers and data interpretation (as with codling moth) would likely be improved if moths were sexed. Female adults of both leafroller species can be readily identified by their larger size, female genitalia, and the greenish hue of their abdomen due to the presence of eggs.

The second major consideration when using this trap is that monitoring the adult stage occurs at a different time period than other sampling protocols used for larvae and larval injury of the fruit. Thus, the detection of overwintering larvae in the spring may not always correlate with adult captures in orchards where subsequent curative treatments are applied. Also sprays applied for codling moth and other pests can impact leafroller larval density; and levels of parasitism can be very high in some orchards which would also disrupt this correlation. Larval populations in the summer and/or fruit injury in our study generally occurred where traps previously caught leafrollers. Populations

developing in cherry after harvest can build up and adults can then move into pome fruit. Thus more temporal information is needed to assess the specific correlations of trap counts (each sex) with summer and fall larval populations. These types of data proved to be very difficult to collect from sprayed commercial orchards.

Figure 1. Trap with both codling moth and leafroller adults.

Figure 2. The cardboard lure holder developed by Trécé. Inc.

EXCUTIVE SUMMARY

Studies were conducted to develop the use of acetic acid with the sex pheromone of codling moth and pear ester for monitoring codling moth and leafrollers in a single trap. The concept is important because monitoring is expensive and traps baited with sex pheromone lures of leafrollers do not provide a useful measurement of pest pressure for orchardists.

First we optimized the acetic acid lures that would be effective for both codling moth and leafrollers. We encouraged Trécé Inc. to develop a commercial acetic acid lure, Pherocon AA, for codling moth. We found that codling moth is attractive over a wide range of emission rates of acetic acid but that both leafrollers require a higher emission rate. A similar lure with a higher emission rate for leafrollers will be available for testing in 2013.

Field studies found that the novel lure holder developed by Trécé Inc. to hold both the combo septa and the acetic acid lure interfered with moth catch. Instead, we showed that the acetic acid lure must be placed on the trap liner's adhesive in the middle of the trap. Trécé Inc. has adjusted its label to reflect this finding.

Pear ester is widely used in a combo lure with codling moth sex pheromone and its attractiveness is synergized by acetic acid. Studies were conducted with alternative host plant volatiles for both codling moth and leafrollers. Several compounds other than pear ester were found to be similarly attractive for leafrollers when used with acetic acid. However, pear ester remains the most attractive plant volatile in combination with acetic acid for codling moth, especially for female moths.

A new host plant volatile was discovered in tests with Dr. Ashraf El-Sayed from New Zealand. This compound is attractive for a number of species. Patent protection for this compound has been submitted. Further studies are planned to use this volatile in 'attract and kill' studies of oblique banded leafroller and eye spotted bud moth in 2013.

Studies showed that the use of a single trap for codling moth and leafrollers can provide useful management information. Traps failed to catch leafrollers in orchards where leafrollers were not present, except in some orchards adjacent to cherry blocks. These catches provide some indication of the orchard's risk from immigrating moths and are useful data. It is important to sex the leafrollers caught in traps and establish a threshold based on female moth catches as well as total catch of leafrollers. In a few cases, overwintering larvae were sampled in orchards in which local traps did not later catch moths. Due to the use of insecticides it is possible that this can occur and does not discount these results. More importantly, no cases were found in which traps failed to catch adult leafrollers but leafroller larvae were detected during the subsequent generation. Correct identification of fruit injury and alternative monitoring of rare pests are both important for this approach to be reliable.

In summary, the numbers of leafroller adults caught in traps baited with codling moth pheromone, pear ester, and acetic acid are low in most commercial orchards, but any catch of leafroller adults appears to be closely correlated with local pest pressure. Thus, growers at no additional cost while monitoring codling moth can also obtain additional information about their potential need to treat for leafrollers.