

# Control of Codling Moth In Organic Pear Orchards



## Abstract

Codling moth (*Cydia pomonella*) (CM) mating disruption (MD) has become the standard practice in the California pear industry. Organic growers are currently permitted to utilize only hand-applied dispensers. In 1991, 2001 and 2003 potentially effective, organically acceptable alternative insecticides were tested to supplement CMMD. Various combinations of CMMD and *Bacillus thuringiensis* (BT), petroleum based oils, CM Granulosis Virus (CMGV), spinosad, pyrethrum and kaolin clay were applied in ten replicated trials in Lake, Mendocino, Sacramento and Solano counties. Trials were either grower or handgun applied and all conducted in orchards with a history of CM damage. Materials were applied 3-11 times, depending on the trial. In most cases MD alone was the control treatment. Completely untreated controls were included in two trials. Overall results showed that MD alone provided about 60% added control. MD plus supplemental insecticides provided an average of 65% control above MD alone and 89% above untreated plots. Of the materials tested, only the commercial pyrethrum product, Pyganic<sup>®</sup>, failed to provide significantly more control versus MD alone. Entrust<sup>®</sup> simultaneously controlled pear slug (*Calliroa ceras*) in one trial, while counts of European red mites (*Panonychus ulmi*) were significantly higher in plots treated with Surround<sup>®</sup> in two trials. While many applications may be required in high population orchards, results showed that several new materials are available to organic pear growers to supplement CMMD.

## Materials and Methods

In 1991, 2002 and 2003 (2004 trials are in progress) ten replicated field trials were carried out in pear orchards in Lake, Mendocino, Sacramento and Solano counties of Northern California. Each trial compared various organically-acceptable materials versus mating disruption (MD) and/or completely untreated controls. Treatments were applied either by these researchers using a handgun sprayer or by cooperating growers using commercial air-blast sprayers. Replicate size ranged from single-tree to 1 or 2 acres. In each case codling moth (CM) presence and damage was evaluated just prior to commercial harvest. Additional CM samples included first generation damage on tree and ground fruit, bins at harvest and post-harvest (data not shown). Pear psylla, 2-spot spider mites, European red mites and pear slug were also evaluated in several of the trials. Sample size ranged from 20-250 fruit per plot in single tree plots to 1000-2000 fruit per plot in large scale trials. In most cases data was transformed and analyzed by ANOVA using an arcsine square-root transformation ( $P > 0.05$ ) and means separated by Fisher's protected LSD or Tukey's multiple range tests (Table 1).

## Results

Average overall results from all trials are presented in Table 2. Results of harvest samples from each individual trial are in Tables 3-7. Entrust significantly controlled pear slug in one trial and Surround exacerbated European red mite populations in two trials (data not shown).

## Conclusions and Discussion

- Control using MD plus supplemental materials, (except Pyganic<sup>®</sup>) > MD alone > untreated controls.
- The two CMGV products, Caprovirusine<sup>®</sup> and Cyd-X<sup>®</sup>, as well as Entrust, Surround, and oil, all controlled CM to some extent in all trial locations.
- Control at harvest using supplemental materials = 70% vs. MD alone and 90% vs. untreated controls.
- Effects on secondary pests varied with material, e.g. Entrust controlled pear slug, Surround increased European red mite.
- All materials will likely require frequent applications, increasing cost.
- In summary, organic growers have several new relatively effective tools to supplement CMMD in pear orchards.



Table 1. Codling Moth Control Trials Using Organically Acceptable Materials - 1991, 2002, 2003

Treatments	Year	County			
		Lake	Mendocino	Sacramento	Solano
MD alone	1991		X		
MD plus BT (Dipel <sup>®</sup> )	1991	X			
MD plus 415 oil	1991	X			
MD plus BT plus oil	1991	X			
CMGV alone:					
Virosoft <sup>®</sup>	2002				X
Cyd-X <sup>®</sup>	2003		X		X
Caprovirusine <sup>®</sup>	2003		X		X
MD plus:					
Virosoft	2002		X		X
Cyd-X	2003, 2004 <sup>†</sup>	X	X		X
Caprovirusine	2003		X		X
Kaolin clay (Surround)	2003	X			
Pyrethrum (Pyganic)	2003	X			
Spinosad (Entrust)	2003	X		X	X

<sup>†</sup>Data not shown as product failed to show any activity in bioassay tests performed after the trial was completed.  
<sup>‡</sup>Data not shown as product failed to be certified for organic use (2003 data was only from conventional orchards).  
<sup>§</sup>Data from 2004 not shown; trial is in progress.

Table 2. Mean Percent Control of Codling Moth 1991, 2002, 2003

Treatment	No. Trials	% Above MD Alone	% Above Untreated
MD alone	2	...	62
MD plus:			
BT (Dipel)	1	88	93
BT + 415 Oil	1	85	92
BT + CMGV (Cyd-X <sup>®</sup> )	4	71	77
Kaolin Clay (Surround)	1	100	...
pyrethrum (Pyganic)	1	12	...
spinosad (Entrust <sup>®</sup> )	3	59	94
All materials combined	13	69	89

<sup>†</sup>Omits results of other CMGV products, Caprovirusine<sup>®</sup> and Virosoft<sup>®</sup>. The former has yet to receive organic certification; the latter showed no activity in the year tested (1999).  
<sup>‡</sup>Total amount of Entrust<sup>®</sup> applied exceeded the current allowable limit of 9 oz. per season.

Table 3. Mean Percent Codling Moth-Damaged Fruit Inspected at Commercial Harvest in Covelo, Mendocino Co., CA - 1991 (large scale, grower-applied)

Treatment	Rate/Acre	No. Applications	Mean % Damaged Fruit <sup>a</sup>
MD alone	400 ses	2	12.7 a
MD + Dipel 2X	1 lb.	6	1.5 b
MD + 415 Oil	4 gal.	2	2.6 b
MD + Dipel 2X+415 Oil	1lb. + 4 gal.	7 + 2	1.9 b
Untreated Control	...	...	23.0 ...

<sup>a</sup>Means followed by the same letter within a column are not significantly different (Duncan's multiple range test,  $P < 0.05$ ).

Table 4. Mean Percent Codling Moth-Damaged Fruit Inspected at Commercial Harvest in Fairfield, Solano Co., CA - 2003 (single tree, hand-gun)

Treatment	Rate	No. Appl.	Mean Percent Damaged Fruit <sup>a</sup>
Caprovirusine <sup>®</sup>	7.6 X 10 <sup>12</sup>	11	30.5 b
Cyd-X <sup>®</sup>	5.9 X 10 <sup>12</sup>	11	26.9 b
Entrust	0.15	11	39 a
Untreated	-	-	70.2 c

<sup>a</sup>Means followed by the same letter within a column are not significantly different (Fisher's protected LSD,  $P < 0.05$ ). Data analyzed using an arcsin transformation.  
<sup>†</sup>Treatments contained 0.0625% NUPem-17.

Table 5. Mean Percent Codling Moth-Damaged Fruit at Harvest in Courtland, Sacramento Co., CA - 2003

Treatment	Rate	No. Appl.	1st Gen. (%)	Harvest (%)
MD plus oil	2 gal.	7	2.5 a	10
MD+oil then Entrust	2 gal. + 3oz.	7 + 3	1.6 a	10.2
MD+Cyd-X <sup>®</sup>	6 oz.	7	2.0 a	6.4
MD alone, then oil	2 gal.	3	8.1 b <sup>†</sup>	14.6

<sup>a</sup>Means followed by the same letter within a column are not significantly different (Fisher's protected LSD,  $P < 0.05$ ).  
<sup>†</sup>Cyd-X applied with 16 oz. Nuflex 17.  
<sup>‡</sup>Number of entries significantly higher in lower fruit.

Table 6. Mean Percent Codling Moth-Damaged Pear Fruit Inspected Prior to Commercial Harvest in Ukiah, Mendocino Co., CA - 2003

Treatment	Rate/Acre	No. Appl.	% Damage <sup>a</sup>
MD alone <sup>†</sup>	20 g	4	1.0 b
MD plus Cyd-X <sup>®</sup>	3 oz.	6	0.1 a
MD plus Caprovirusine <sup>®</sup>	1 L	6	0.2 a

<sup>a</sup>Means followed by the same letter within a column are not significantly different (Fisher's protected LSD,  $P < 0.05$ ).  
<sup>†</sup>Cyd-X applied with 16 oz. Nuflex 17.  
<sup>‡</sup>Number of entries significantly higher in lower fruit.  
<sup>§</sup>Sprayable CM pheromone (Sutris, LLC, Bend, OR) non-allowable for organic use.

Table 7. Mean Percent Codling Moth-Damaged Fruit in Potter Valley, Mendocino Co., CA - 2003

Treatment	Rate	No. Appl.	1st Gen. (July 14)	% Damaged <sup>a</sup> Harvest (Aug. 7)
MD plus 415 oil <sup>b</sup>	2.5 gal.	4	0.5	4.0 ab
MD plus Entrust <sup>®</sup>	2 oz.	4	0.8	3.7 ab
MD plus Cyd-X <sup>®</sup>	3 oz./1/6 oz.	4	1	2.3 a
MD alone	-	-	0.7	7.2 b
Untreated Control	-	-	3.8	34.0

<sup>a</sup>Means followed by the same letter within a column are not significantly different (Fisher's protected LSD,  $P < 0.05$ ).  
<sup>b</sup>Data analyzed using an arcsin square root transformation.  
<sup>c</sup>3 gal. 415 oil applied to all treatments on August 4 to control spider mites.  
<sup>d</sup>1 oz. Entrust<sup>®</sup> applied to all treatments on July 12 to control pear slug.  
<sup>e</sup>Cyd-X applied with 16 oz. Nuflex 17.

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## Authors:

R.B. Elkins, University of California Cooperative Extension, Lakeport, CA  
 C.A. Ingels, University of California Cooperative Extension, Sacramento, CA  
 R.A. VanSteenwyk, Dept. of Environmental Science, Policy and Management,  
 University of California, Berkeley, CA  
 L.G. Varela, University of California Cooperative Extension, Santa Rosa

University of California  
 Agriculture and Natural Resources  
 COOPERATIVE EXTENSION