

Chemical Control/New Products

EVALUATION OF CODLING MOTH CONTROLS: DIMILIN, NOVALURON AND  
AVAUNT

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*Keywords:* Avaunt, indoxacarb, Dimilin, diflubenzuron, novaluron, codling moth, *Cydia pomonella*, pear psylla, *Cacopsylla pyricola*, pear rust mite, *Epitrimerus pyri*, twospotted spider mite, *Tetranychus urticae*

*Abstract:* Two formulations of Dimilin and novaluron, both chitin synthesis inhibitors, were tested for control of codling moth on pear in a full season program consisting of four applications. Single tree replicates were sprayed with an airblast sprayer. All treatments along with a standard program using Imidan resulted in significant reduction of codling moth damage. The greatest reduction in fruit injury at harvest was seen in the novaluron treatment. In another trial three applications of Avaunt plus oil for control of first generation codling moth were made in an orchard using puffers for codling moth mating disruption. Plot size was 1 acre or greater. In comparing plots where a combination of Avaunt and oil was used to plots where only oil was applied, the addition of Avaunt reduced codling moth injury at harvest by 50% or more.

**Trial #1—Evaluation of Dimilin and Novaluron**

**Methods**

This trial was carried out in a block of 40-year-old pear trees, cv. Packham's Triumph, planted on a 24 x 12 ft spacing at the Research Center's Hanley orchard in Medford, Oregon. Four treatments and a check were applied to four single tree replicates arranged in a completely randomized design. The treatments consisted of: 1) Dimilin 25W 1 lb/acre plus oil 1 qt/100 gallons, 2) Dimilin 2F 1 pt/acre plus oil 1 qt/100 gallons, 3) novaluron 7.5WG, 4.44 lb/acre plus oil 1 qt/100 gallons, 4) Imidan 70W 5 lb/acre, and an untreated check. All treatments were initially applied on 4 May (80 degree days [DD] post codling moth biofix) at one-third of the rates listed above using an air carrier sprayer set to deliver 60 gallons per acre. Subsequent applications were made at the full rate with an air carrier sprayer calibrated to deliver 157 gpa. Dimilin and novaluron were applied three more times: 18 May, 3 July (984 DD), and 24 July. Additional Imidan treatments were applied at the typical cover spray timings, 18 May (250 DD), 15 June, 13 July (1250 DD), and 8 August.

Densities of pear psylla, twospotted spider mite, rust mite, and predator mites were estimated by randomly selecting 15 leaves and counting the number of arthropods present with the aid of a dissecting microscope. The initial leaf sample was taken on 1 May before any treatments had been made, later samples were taken following each application. On 14 August each replicate was evaluated for leaf burn due to spider mite feeding, with 0 indicating no mite burn present up to 5 indicating 100% of the leaves present expressing symptoms of spider mite injury. Adult pear psylla and natural enemies (spiders, parasitic wasps, green and brown

lacewings, snakeflies, lady beetles, predatory bugs, etc.) were sampled with a beating tray, three trays per tree on each sample date. The control of codling moth (CM) was evaluated on 19 June by examining 50 fruit per replicate on the tree and noting the presence of CM damage and again at harvest, 22 August, by randomly picking 100 fruit per replicate and cutting each fruit to determine the extent of codling moth damage and, if a larva was present, its stage of development.

## **Results**

Codling moth pressure was very high in the test block (Table 1). The cultivar used in this evaluation, Packham's Triumph, has Bartlett parentage and is very susceptible to codling moth injury. The initial fruit check on 19 June indicated that all the treatments with the possible exception of the Dimilin 2F were performing equivalently and had significantly lower levels of CM infestation than the check. However, by harvest, codling moth damage in all the treatments was high with the check being close to 85% infested. Only the novaluron treatment was less than 10% infested and was significantly better than any other treatment. Notably, the Imidan treatment, which received a full complement of cover sprays in addition to the initial application which was made at a reduced rate, had over 25% CM damage. Both Dimilin treatments, while significantly better than the check, had infestation levels close to or over 50%. The larval infestation comprised about 30% of the observed damage in check and all of the treatments with the exception of novaluron where fruit with larvae were less than one tenth of the observed damage. In this trial, the novaluron actually performed fairly well, considering that the initial application was put on at a low rate and the long interval following the second application, from May 18 to July 3, and following the final application on July 24 up to harvest on August 22. The lack of fruit with larvae seems to indicate that the residual activity of this material was high late in the season as compared to the other treatments. The fact that this block was overtree irrigated may have contributed to the apparent lack of good residual control of the Dimilin and Imidan treatments.

The results of the leaf brushing and beat tray (Tables 2-14) sampling generally fall into the category of typical organophosphate stimulation of spider mite and pear psylla populations. The Imidan treatment had higher levels of twospotted spider mite motiles than the check and two of the other treatments on the last sample date. The results of the mite burn rating (Table 1) confirm this finding as Imidan was the only treatment where mite burn was observed and the difference was statistically significant. Predator mite eggs and motiles were also significantly higher in the Imidan treatment on that last sample date most likely due to the high levels of spider mites also present at that time. Pear psylla levels were also elevated in the Imidan treatment. On the last sample date the Imidan treatment had the highest numbers of pear psylla eggs, nymphs, and adults, although only the older nymphs (stages 4 and 5) were significantly higher than the check. Pear rust mite numbers on the final sample date were significantly lower in the Imidan treatment than the check but no significant differences among the four treatments were seen. Very few significant differences were observed between the check and the insect growth regulators, novaluron and the Dimilin formulations, in the leaf brushing and beat tray samples.

## **Trial #2—Evaluation of Avaunt and Horticultural Mineral Oil**

### **Methods**

This study was conducted in a 15-acre experimental orchard in which Consep puffers had been deployed (1.2 puffers per acre) for mating disruption of codling moth. Avaunt was tested for control of 1<sup>st</sup> generation codling moth in conjunction with mating disruption. In four blocks Avaunt was applied three times (11 May, 29 May, and 25 June) at a rate of 6 oz/acre in combination with horticultural mineral oil (HMO) applied at 1% v/v. Spray gallonage varied from 100 to 133 gpa. In two sections of the orchard, HMO alone was applied at the above timings. With one exception the areas treated with Avaunt and/or HMO were treated with an organophosphate at third and fourth cover. In a Bosc block Avaunt and HMO were applied at third cover instead of the organophosphate. In one block, organophosphates were applied at standard cover spray timings. Imidan was applied at 4 lb/acre for first and second cover (16 April and May 7). With the exception noted above, the entire orchard was treated at third cover (7/19) with Guthion at 3 lb/acre. Following Bartlett harvest, a fourth cover (16 August) consisting of Imidan at 5 lb/acre was applied throughout the orchard. Bartlett, Bosc, and Comice cultivars were present in all the blocks, except where Avaunt and HMO were used at third cover. None of the blocks were less than 1 acre in size, planting distances ranged from 25 x 25 ft to 12.5 x 5 ft, and tree size varied accordingly. At harvest fruit were collected from each treated area, 100 fruit for Bartlett and 200 fruit for Bosc or Comice, and taken to the laboratory for evaluation.

### **Results**

The results of the harvest fruit evaluations (Table 15) indicate that HMO in conjunction with mating disruption for control of first generation CM resulted in a very high level of infestation in the Bartletts with considerably lower levels of infestation in the Comice and Bosc. The addition of Avaunt reduced the level of damage in the Bartletts, particularly with respect to percent of fruit which contained larvae or where larvae had exited. Total fruit injury in Comice and Bosc was only 0.5% in the areas where Avaunt had been used, including the Bosc section which also had the Avaunt treatment at third cover. The use of a full OP program with mating disruption resulted in complete control of CM. It should be noted that this orchard had very high CM pressure in 2001. The average seasonal catch in a 10 mg pheromone trap (n=6) was 38.3 moths and the average CM fruit infestation at harvest in the 2000 season had been about 4% in Bartletts. Considering the high CM pressure that was observed, it seems likely that the effect of the mating disruption was minimal at best. Applications of a pear psylla control material and an acaricide were required in all blocks before the end of the season to prevent economic injury from occurring.

**Table 1.** Mean codling moth damage and rating of mite injury to foliage

Treatment	Rate Form.	% CM damage		Mite burn rating (14 Aug)
		19 June	Harvest (22 Aug)	
Dimilin 25W plus Oil	1 lb/acre	1.5 a	56.00 c	0 b
	1 qt/100 gal			
Dimilin 2F plus Oil	1 pt/acre	6.5 a	48.75 c	0 b
	1 qt/100 gal			
Novaluron plus Oil	4.44 lb/acre	1.5 a	9.75 a	0 b
	1 qt/100 gal			
Imidan	5 lb/acre	1.5 a	25.25 b	1.5 a
Check		27.0 b	84.75 d	0 b

**Table 2.** Trial #1: pear psylla eggs

Treatment	Rate Form.	Mean number per leaf					
		Pre-count	7 May	21 May	27 June	20 July	15 Aug
Dimilin 25W plus Oil	1 lb/acre	0.30 a	0.13 a	0.10 a	1.48 b	1.00 a	4.00 a
	1 qt/100 gal						
Dimilin 2F plus Oil	1 pt/acre	0.20 a	0.13 a	0.03 a	0.70 a	0.50 a	3.00 a
	1 qt/100 gal						
Novaluron plus Oil	4.44 lb/acre	0.20 a	0.07 a	0.10 a	0.30ab	1.50 a	2.00 a
	1 qt/100 gal						
Imidan	5 lb/acre	0.53 a	0.16 a	0.03 a	0.70 ab	0.50 a	9.50 a
Check		0.43 a	0.33 a	0.23 a	0.13 b	0.50 a	2.00 a

**Table 3.** Trial #1: pear psylla nymphs, stages 1-3

Treatment	Rate Form.	Mean number per leaf					
		Pre-count	7 May	21 May	27 June	20 July	15 Aug
Dimilin 25W plus Oil	1 lb/acre	1.57 a	1.00 a	0.00 c	0.65 a	0.08 a	0.15 a
	1 qt/100 gal						
Dimilin 2F plus Oil	1 pt/acre	1.07 a	1.20 a	0.17 bc	0.35 a	0.08 a	0.14 a
	1 qt/100 gal						
Novaluron plus Oil	4.44 lb/acre	1.07 a	0.73 a	0.23 ab	0.30 a	0.03 a	0.08 a
	1 qt/100 gal						
Imidan	5 lb/acre	1.13 a	0.66 a	0.40 a	0.58 a	0.10 a	0.38 a
Check		1.63 a	1.03 a	0.37 a	0.33 a	0.03 a	0.08 a

**Table 4.** Trial #1: pear psylla nymphs, stages 4 and 5

		Mean number per leaf					
Treatment	Rate Form.	Pre-count	7 May	21 May	27 June	20 July	15 Aug
Dimilin 25W plus Oil	1 lb/acre	0.07 a	0.20 a	0.23 a	0.00 a	0.05 ab	0.03 b
	1 qt/100 gal						
Dimilin 2F plus Oil	1 pt/acre	0.10 a	0.07 a	0.40 a	0.00 a	0.03 ab	0.00 b
	1 qt/100 gal						
Novaluron plus Oil	4.44 lb/acre	0.07 a	0.23 a	0.10 a	0.00 a	0.00 b	0.03 b
	1 qt/100 gal						
Imidan	5 lb/acre	0.17 a	0.17 a	0.13 a	0.00 a	0.23 a	0.10 a
Check		0.23 a	0.17 a	0.36 a	0.00 a	0.05 ab	0.03 b

**Table 6.** Trial #1: pear psylla adults

		Mean number per tray					
Treatment	Rate Form.	Pre-count	7 May	21 May	27 June	20 July	15 Aug
Dimilin 25W plus Oil	1 lb/acre	0.60 a	0.17 a	0.77 c	0.43 a	0.93 ab	0.33 a
	1 qt/100 gal						
Dimilin 2F plus Oil	1 pt/acre	0.43 a	0.10 a	1.27 bc	0.33 a	0.43 b	0.60 b
	1 qt/100 gal						
Novaluron plus Oil	4.44 lb/acre	0.33 a	0.10 a	1.16 bc	0.93 a	2.27 a	0.83 b
	1 qt/100 gal						
Imidan	5 lb/acre	0.60 a	0.27 a	5.67 a	0.6 a	1.93 ab	3.10 b
Check		0.27 a	0.10 a	2.10 b	0.43 a	0.33 b	0.17 b

**Table 7.** Trial #1: twospotted spider mite eggs

		Mean number per leaf					
Treatment	Rate Form.	Pre-count	7 May	21 May	27 June	20 July	15 Aug
Dimilin 25W plus Oil	1 lb/acre	0.00 a	0.00 a	0.00 a	0.00 a	0.73 a	0.00 a
	1 qt/100 gal						
Dimilin 2F plus Oil	1 pt/acre	0.03 a	0.10 a	0.00 a	0.00 a	1.58 a	1.20 a
	1 qt/100 gal						
Novaluron plus Oil	4.44 lb/acre	0.00 a	0.03 a	0.00 a	0.00 a	0.55 a	1.73 a
	1 qt/100 gal						
Imidan	5 lb/acre	0.00 a	0.00 a	0.00 a	0.00 a	2.83 a	1.73 a
Check		0.00 a	0.00 a	0.00 a	0.00 a	0.23 a	0.00 a

**Table 8.** Trial #1: twospotted spider mite motiles

		Mean number per leaf					
Treatment	Rate Form.	Pre-count	7 May	21 May	27 June	20 July	15 Aug
Dimilin 25W plus Oil	1 lb/acre	0.00 a	0.00 a	0.00 a	0.00 a	0.33 a	0.05 b
	1 qt/100 gal						
Dimilin 2F plus Oil	1 pt/acre	0.00 a	0.00 a	0.00 a	0.00 a	0.18 a	1.80 a
	1 qt/100 gal						
Novaluron plus Oil	4.44 lb/acre	0.00 a	0.00 a	0.00 a	0.00 a	0.60 a	0.00 b
	1 qt/100 gal						
Imidan	5 lb/acre	0.00 a	0.00 a	0.00 a	0.00 a	0.73 a	4.70 a
Check		0.00 a	0.00 a	0.00 a	0.00 a	0.18 a	0.00 b

**Table 9.** Trial #1: predator mite eggs

		Mean number per leaf					
Treatment	Rate Form.	Pre-count	7 May	21 May	27 June	20 July	15 Aug
Dimilin 25W plus Oil	1 lb/acre	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 b
	1 qt/100 gal						
Dimilin 2F plus Oil	1 pt/acre	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 b
	1 qt/100 gal						
Novaluron plus Oil	4.44 lb/acre	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.03 b
	1 qt/100 gal						
Imidan	5 lb/acre	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.25 a
Check		0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 b

**Table 10.** Trial #1: predator mite motiles

		Mean number per leaf					
Treatment	Rate Form.	Pre-count	7 May	21 May	27 June	20 July	15 Aug
Dimilin 25W plus Oil	1 lb/acre	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 b
	1 qt/100 gal						
Dimilin 2F plus Oil	1 pt/acre	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 b
	1 qt/100 gal						
Novaluron plus Oil	4.44 lb/acre	0.00 a	0.00 a	0.00 a	0.03 a	0.00 a	0.00 b
	1 qt/100 gal						
Imidan	5 lb/acre	0.00 a	0.00 a	0.03 a	0.00 a	0.00 a	0.20 a
Check		0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 b

**Table 11.** Trial #1: pear rust mite

		Mean number per leaf					
Treatment	Rate Form.	Pre-count	7 May	21 May	27 June	20 July	15 Aug
Dimilin 25W plus Oil	1 lb/acre	0.00 b	0.20 a	0.20 ab	0.45 a	6.15 a	32.55 ab
	1 qt/100 gal						
Dimilin 2F plus Oil	1 pt/acre	0.00 b	0.20 a	0.20 ab	1.50 a	7.50 a	44.40 ab
	1 qt/100 gal						
Novaluron plus Oil	4.44 lb/acre	0.00 b	0.00 a	0.60 a	2.55 a	6.75 a	22.80 ab
	1 qt/100 gal						
Imidan	5 lb/acre	0.00 b	0.20 a	0.00 b	4.65 a	18.75 a	20.55 b
Check		0.60 a	0.40 a	0.80 ab	2.40 a	3.60 a	67.65 a

**Table 12.** Trial #1: spiders

		Mean number per tray					
Treatment	Rate Form.	Pre-count	7 May	21 May	27 June	20 July	15 Aug
Dimilin 25W plus Oil	1 lb/acre	0.50 a	0.17 a	0.10 a	0.10 ab	0.00 a	0.33 a
	1 qt/100 gal						
Dimilin 2F plus Oil	1 pt/acre	0.27 a	0.17 a	0.27 a	0.00 b	0.00 a	0.28 a
	1 qt/100 gal						
Novaluron plus Oil	4.44 lb/acre	0.10 a	0.5 a	0.17 a	0.10 ab	0.10 a	0.00 a
	1 qt/100 gal						
Imidan	5 lb/acre	0.10 a	0.10 a	0.00 a	0.00 b	0.00 a	0.10 a
Check		0.33 a	0.10 a	0.33 a	0.26 a	0.17 a	0.27 a

**Table 13.** Trial #1: parasitic hymenoptera

		Mean number per tray					
Treatment	Rate Form.	Pre-count	7 May	21 May	27 June	20 July	15 Aug
Dimilin 25W plus Oil	1 lb/acre	0.17 b	0.00 b	0.10 ab	0.10 a	0.33 a	0.33 a
	1 qt/100 gal						
Dimilin 2F plus Oil	1 pt/acre	0.60 a	0.27 a	0.00 b	0.00 a	0.00 a	0.17 a
	1 qt/100 gal						
Novaluron plus Oil	4.44 lb/acre	0.27 ab	0.17 ab	0.00 b	0.17 a	0.27 a	0.17 a
	1 qt/100 gal						
Imidan	5 lb/acre	0.27 ab	0.00 b	0.43 a	0.00 a	0.00 a	0.00 a
Check		0.10 b	0.10 ab	0.16 ab	0.10 a	0.00 a	0.00 a

**Table 14.** Trial #1: other natural enemies

Treatment	Rate Form.	Mean number per tray					
		Pre-count	7 May	21 May	27 June	20 July	15 Aug
Dimilin 25W plus Oil	1 lb/acre	0.17 a	0.33 a	0.00 a	0.17 a	0.00 a	0.10 a
	1 qt/100 gal						
Dimilin 2F plus Oil	1 pt/acre	0.17 a	0.27 a	0.10 a	0.27 a	0.10 a	0.10 a
	1 qt/100 gal						
Novaluron plus Oil	4.44 lb/acre	0.50 a	0.33 a	0.17 a	0.27 a	0.00 a	0.00 a
	1 qt/100 gal						
Imidan	5 lb/acre	0.43 a	0.10 a	0.10 a	0.00 a	0.17 a	0.00 a
Check		0.10 a	0.43 a	0.17 a	0.10 a	0.00 a	0.00 a

In Tables 1-14, means in a column followed by the same letter are not significantly different ( $p=0.05$ , Duncan's New MRT). Prior to analysis, data were transformed,  $\log(x+1)$  for counts and arc sine for percent damage, untransformed means are presented.

**Table 15.** Trial #2: Percent codling moth damage from three pear cultivars at harvest

Program	Cultivar	% CM exits	% CM larvae	% CM stings
OP (three cover sprays on Bartlett, four on Comice and Bosc)	Bartlett	0	0	0
	Comice	0	0	0
	Bosc	0	0	0
HMO (three sprays) + OP (3 <sup>rd</sup> + 4 <sup>th</sup> cover)	Bartlett	22.5	7.5	16.5
	Comice	2.0	0.5	1.5
	Bosc	0.25	0	0.75
Avaunt + HMO (three sprays) + OP (3 <sup>rd</sup> + 4 <sup>th</sup> cover)	Bartlett	3.0	2.33	13.67
	Comice	0	0.25	0.25
	Bosc	0.17	0	0.33
Avaunt + HMO (four sprays) + OP (4 <sup>th</sup> cover)	Bosc	0.25	0.25	0