

CODLING MOTH CONTROL – 2003

By

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(A Report of Research: What Worked, What Didn't and Why)

The ease and extent of codling moth (CM) control during the 2003 growing season varied greatly from grower to grower and area to area within Southern Utah County. Signs of resistance to 'conventional' materials of long use, particularly 'Guthion' appeared more wide-spread and intense. Also there were indications that the degree of susceptibility of CM populations to 'Imidan' and Danitol is continuing to decrease in several sites within the area.

During 2003, mating disruption (MD), as a component of CM control again proved to be extremely helpful. Several blocks and/or growers have used this technique over the past few years with significant success. Some growers who used or experimented with the technique in the mid 1990's, tested the technique and found it helpful, but were obtaining adequate control with 'Guthion' at a lower cost, so, have not instituted the program over their entire operations.

The increasing intensity and extent of CM resistance to organo-phosphates⁽¹⁾, the need to limit the use of synthetic pyrethroid materials⁽²⁾, the cost of alternative materials⁽³⁾, the need to preserve the effectiveness of the materials that are available⁽⁴⁾, and the need to achieve consistent high levels of control require the apple growers of the state adopt a more aggressive, multi-tactic approach to CM control.

Mating Disruption: What it Can Contribute and Making it Work:

Over the last 12 years, with the cooperation of several growers we have explored the use of MD for CM control. After closely observing and using the technique on significant acreage in Utah, Idaho, and Washington it has been determined that MD is not a "stand alone" technique or method of CM control. MD can contribute a great deal to an effective CM control program, particularly in locations where conventional control methods are not performing because of resistance and/or heavy pressure (internal or external).

A Utah County grower's experience in 2003 is typical. This grower placed MD dispensers in a block of Fuji apples adjacent to other Fuji's on the south and Red Delicious on the north. Adequate numbers of well placed traps were maintained and monitored and the information was utilized to supplement the MD with chemical control when necessary. The 2003 season was the worst CM season in my memory and the non-MD blocks required the application of 6 full covers, and CM damage was still considerably higher than desired. In the block where MD was used, only 3 cover sprays were used and control was excellent; much better than in the adjoining conventional blocks. Other Utah County growers who used MD during the 2003 season obtained excellent control with only 1 cover and limited "spot" or "boarder" spraying.

The following discussion on how to conduct an effective MD program, is based on 12 years of research and experience. Each component of an effective program is discussed and conclusions are drawn that best 'fit' the author's experience, though it is acknowledged that there are different approaches that may work equally as well.

The Dispenser: Over the years a considerable number of different dispensers and placement techniques have been marketed. The dispensers have evolved and improved, but the quality and effectiveness of different brands (or types) of dispensers is still highly variable. What is desired is a method of dispensing adequate quantities of the pheromone, from an adequate number of points in the orchard, over the entire season (most dispensers release more material early in the season and then trail off later). In my experience there are only 2 dispensers currently on the market that meet these requirements. They are, the Isomate TT, and the Checkmate 1000 dispensers. These dispensers will emit adequate amounts of the pheromone for at least 110 to 120 days following placement, but will be a weak toward the end of a very warm season (as in 2003) in which we experience a 3rd generation of CM. In this case, the grower may need to supplement the dispensers with an application of “spray applied” pheromone at the beginning of the 3rd generation.

Dispenser Placement & Placement Timing: In order to conduct an effective MD program the placement of dispensers is extremely important. When we first began using this technique our chemical control materials were still killing the adult CM. We could, under those circumstances, wait until just before the time for application of the 1st cover to install the dispensers. The cover spray would kill any mated female moths, leaving enough residual material to kill any eggs or larvae as they hatched. With the degree of organo-phosphate tolerance in the CM populations of today, this timing of dispenser placement is no longer effective.

The dispensers must be in the trees when the first males emerge and begin to search for the female moths. This timing generally occurs near the first to full bloom stage of development, a very busy time for most apple growers. Because of operational labor requirements and restraints, I now recommend that growers place the dispensers at the late pink to first bloom stage of development. The longer life of the recommended dispensers, the generally cool temperatures at that timing, and the known labor and equipment demands of the full bloom through petal fall stages of development argue strongly for this ‘early placement’ (if the grower is late he will need to apply the first cover and possibly a second that may otherwise be avoidable **A WEEK EARLY BEATS A DAY LATE**). Placing the dispensers at this ‘early’ stage may interfere with the establishment of the bio-fix date in a block, which must be compensated for (see ‘bio-fix’ in section on Trapping and Monitoring).

The number of dispensers and their placement within the block and the tree is also a critical component of a successful MD program. The pheromone is slightly heavier than air meaning it will move down the slope, and into the canopy below where it is placed. If the dispenser is placed too low in the tree, the top portion of the canopy, which is the preferred mating location for the CM, will be “outside” the chemical sphere of influence resulting in significant mating and damage. It is recommended that the dispensers be placed within 18 inches of the top of the tree, but the grower must remember that the tree will grow as the season progresses, so it is important to place the dispenser as high as possible. The Isomate TT and the “bread bag clip” of the Checkmate dispensers tend to move down the shoot to the first lateral or spur below where they are placed so caution is required to compensate for this movement after placement.

Within the block, a minimum of 200 dispensers (or points from which the material is dispersed) is required to provide adequate ‘coverage’. Along the up-slope-border, and along borders next to

outside sources of infestation the dispenser density should be equal to 400 dispensers per acre in the outer 150' to 200' of the orchard.

Monitoring CM Populations: Establishment of the bio-fix date (date on which first males are flying, searching for mates) is extremely important because it sets a starting point, reflective of CM development, from which degree days can be accumulated. In MD blocks the dispensers should be in place when this event occurs, meaning that the dispersal of pheromone in the block may interfere with the attraction of adult males to the traps being used. To compensate for this probability the grower should: 1. Use a 10X louver in his traps, 2. Place traps in the "hot spots" in blocks, 3. Place traps in the warmest portion of his blocks, and 4. Place a trap where possible in a neighbors 'uncared for' tree which is in a similar micro-climate.

If the weather at the 'pink' stage of development is warm (above 70° F) the traps should be checked daily. Under warm conditions establishment of the bio-fix is generally easy because the grower will find several moths in the traps when development and 'moth flight' conditions are right, or he will find some moths on successive nights. Under these conditions the first moth catch is the bio-fix.

When weather conditions are cool the establishment of the bio-fix is more difficult. For example, in the spring of 2003 a grower found 1 moth in each of 2 traps out of a total of 22 traps in his orchard on 4/21. The following night this grower caught 1 moth in a different trap and then caught no moths for the next 11 days. On May 3 this grower caught 13 moths in his 22 traps. So when was "bio-fix"? The cool, wet, windy weather between 4/22 and 5/3 resulted in conditions which were not favorable for male moths to 'move around' and mate (or get caught in traps), so generally, under light pressure conditions it would be safe to use 5/3 as the "bio-fix". The "safety" of choosing 5/3 was increased because of the extensive numbers and placement of traps in this orchard and also was increased by the fact that these MD blocks with low pressure for several years. In MD blocks, scattered, individual moths are unlikely to find mating partners, hence a little more "safety" in choosing the latter date.

In another instance, in a non-MD block, the grower placed his traps in the 'normal' locations, with the one 'highest' in the orchard in the 15th row from the high point in the block. In this area, like the one discussed previously, there were 2 evenings on 4/21 and 4/22 when conditions were favorable for moth flight and then an extended period (11 days) when conditions were unfavorable. There was no trap catch on 4/21 or 4/22, but there was significant catch of 5/3. As a result of this "bio-fix" data the first cover was placed at 240 degree days from 5/3. As the season developed, there were a significant number of worms that survived the first cover in the upper corner of this block, above the highest trap. There had been significant flight activity on 4/21 which was missed because of the trap location. In the intervening 11 days there had been approximately 41 degree days, meaning that in this small area, the 1st cover had been applied at 281 degree days after the first mating had occurred. Some worms had hatched and entered the fruits before the first cover was placed. Had this been a MD block, and the dispensers been placed as I now recommend (at pink to first bloom) it is doubtful that any mating would have occurred because population numbers and mating were at low levels, though they did occur.

It should also be noted, that in the case just discussed, the mating and survival of a limited number of females and resultant 'worms' is highly significant because it represents the establishment of an

internal source of 2nd generation pressure, which can multiply greatly, particularly in a year in which there is a 3rd generation.

Monitoring CM activity is a critical factor in any CM control program, and should consist of 2 components, which are: 1. Placement and monitoring of “traps” and 2. Frequent visual inspection of the orchard to spot stings and worm entries. The days of chemical control materials so ‘strong’ that the grower could spray 21 days post bloom and then at 21 to 28 day intervals and “forget about it” are gone. The use of ‘sticky’ traps with pheromone dispensers inside to attract male moths is an extremely helpful tool. Even if the grower is not using mating disruption (MD), the use of traps will help him understand the timing and degree of potential infestation.

In MD blocks, I recommend the use of traps in ‘pairs’ on opposite sides of adjacent trees. One trap is equipped with a 1X louver and the other is equipped with a 10X louver. The 1X trap should mimic closely a single female and provide an indication of “mating frequency”. The stronger 10X trap will draw from further away and is a good indicator of presence and numbers of CM.

The purpose of trapping is to monitor population densities where they are the highest, hence most likely to result in mating and “worms”. In other words, place the traps in areas which have a history of being the ‘hot spots’ for CM infestation. Generally, the greatest frequency of CM occurs in the “up-hill” side of a block because these areas tend to be warmer and CM move (fly) up-slope in an orchard. Also, areas which border external sources should be ‘trapped’. As a general rule, the more extensive the trap network within a grower's orchards, the more confidence the grower can have in using trap catch numbers to determine when to spray. Determination of the required trap numbers and placement within blocks is still in the “art” phase, because of the many variables involved, but in most cases growers know where the potential “hot spots” are.

Another important aspect of trap placement is how and where the traps are placed within the trees. Since CM tend to fly and mate in the upper portions of the canopy it is necessary to place the traps as high in the tree as possible. Also placement should be so the open ends of the trap are not blocked by limbs or leaves⁽⁵⁾.

Traps should be checked, cleaned and the moth numbers recorded frequently; the minimum is once a week and the grower will benefit greatly by checking 2 or 3 times a week. There are 2 major benefits of monitoring traps on a Mon, Wed, & Fri. schedule. First, as the grower (or other designated person) moves from trap to trap and block to block they can visually inspect fruits for the presence of stings or worms, an extremely important part of the control effort. Second, when a trap catches 4 moths in a 7 day period indicating the probable need for a chemical control application, the grower will know when the moths were caught. If the traps are monitored on a seven day interval, the grower must assume that the moths were all caught the evening following the last cleaning of the trap. If the trap is monitored 3 times a week the grower will know when the economic threshold was passed.

For Example: During May of 2003 a particular trap was monitored on Friday 5/23 and found to contain 0 moths. The trap was next checked on Friday 5/30 and on that date contained 5 moths, which is above the ‘economic injury threshold’. Because of the 7 day interval involved, and the warm weather (an average of 22 degree days/day) the grower must assume that the 5 moths were caught the evening of 5/23 and a total of 154 degree days had accumulated since economic levels

of mating had occurred. This means he will need to spray no later than Mon 6/2. If the grower had been monitoring the trap 3 times a week and found 0 moths on Fri 5/23, 0 moths on Mon 5/26, 1 moth on Wed 5/28, and 4 moths on Fri 5/30 he would know that the 'economic injury threshold' had been passed no sooner than the evening of Wed 5/28. The proper timing of the chemical control application could then be determined to be 5/28 plus 220 degree days or June 6th or 7th. By closely monitoring the traps and orchards, the cover spray would have been applied 5 days later than in the case of weekly monitoring.

A Further Example: Supposing, that in the above instance the grower had 3 traps in the block mentioned, 1 at the South East corner, a known "hot spot", 1 placed 1/3rd of the way down the block, and 1 at the bottom of the block. If only the trap in the "hot spot" had any moths caught, the grower may choose to only apply a chemical application along the 'easterly 3 or 4 rows and along the south side of the block as a border spray. This approach, combined with close monitoring of fruit within the block for stings or worm entries can be used to greatly reduce spray usage and expense, with little risk of economic injury if close monitoring is done.

A trapping program can be no better than the lour used. Know your lour and change it before the suggested interval. If it is a 3 week lour change it every 14 days.

Making a CM Control Program Work:

Under expected CM conditions for 2004 and beyond I recommend that the grower use MD as the basis of his control program. The following steps should be followed (any questions as you go along can be directed to me at 435-427-3202 or at earlseeley@yahoo.com)

Step 1: The grower should purchase a sufficient number of traps and lours in mid-March, and arrange for the purchase of his dispensers at the same time to make sure they will be available for installation at the 'pink' stage of development. The number of dispensers purchased should be sufficient to place 400 per acre around the outer 150' of the blocks or orchard, and 200 per acre in the internal areas. These dispensers will cost approximately \$0.50 each, making the purchase price approximately \$100/acre, plus \$100/acre for the border areas. This is costly, but in most cases in the 1 year term will add less than \$50 per acre to your control program and in the longer term may be totally offset by lower spray material purchases for CM and mite control.

Step 2: Before 'pink' place the traps in the orchard as discussed previously⁽⁵⁾. And arrange to place the dispensers in the trees before first bloom. Over the years we have developed some labor saving techniques for placement of the Isomate TT and Checkmate 1000 dispensers. Your supplier can 'fill you in' on these techniques, or contact me. Closely monitor the placement of the dispensers in the trees so they are spaced properly and placed 'high' in the canopy.

Step 3: Beginning at tight cluster monitor the traps on a Mon. Wed. and Fri. schedule if the temperatures are cool and daily if the weather is warm. Observe the "first moth catch" to set bio-fix. **Use a 10X lour in your traps because you want to know when the males become active.** If you are using mating disruption and catch 1 moth and then go several days before the next catch wait and establish bio-fix as the date when you catch moths on successive nights. (questions? Call or contact me). Remember that CM tend to fly near dusk, in relatively calm weather when the temperatures are above 65°F. If you catch 1 or 2 moths and then have an extended cool period

then catch a significant number you should be safe using the later date if the MD dispensers were up when the initial catch occurred.

Step 4: Once bio-fix is determined begin to add the daily accumulation of degree days from the growing degree day chart (if you do not have one the Pest Management Manual published by the Goodfruit Grower is an excellent source). When the accumulated degree days post bio-fix reaches 220 degree days **you must make a decision:**

Case 1. If you have been monitoring your traps regularly and have not found more than 4 moths in any one trap in a 7 day time period, you may be able to skip the cover. **In most cases I recommend the application of the 1st cover if any moths at all are caught because I would like to reduce the egg pressure as low as possible early in the season. Use Danitol if your orchard has Guthion resistance.**

Case 2. If you have been catching moths in your traps generally you should apply your first cover so it is in place at 240 degree days post bio-fix.

Step 5: Following the application of your first cover you should continue to monitor the traps and inspect the orchard for any signs of stings or worms. If you used Danitol or Guthion for the first cover you should be able to count on 14 days of protection. In most cases you will continue to see moths in the traps because the 1st cover materials are only partially effective against adult CM. It is extremely important to monitor the fruit for any signs of stings or worms during this period to assure that your coverage and control is sufficient. If your application of the 1st cover is properly done you should see no stings or worms. If, the catch of CM drops to less than 4 moths in any one trap, in any 7 day time period, you may be able to skip the second cover. **On day 15:**

Case 1. If you have caught 1 to 3 moths in any trap during the previous 7 days do not spray, but continue to monitor the orchard for stings and worms (if you catch 2 or 3 moths in every trap you probably should spray). Often you will experience a mated female from outside your orchard that will fly or be blown in and she will lay from 1 to 30 eggs that may cause wormy fruit. It is important that when this occurs you find the fruits and remove them from the trees and orchard. If you find larger numbers of stings you should immediately place the 2nd cover and determine what is going wrong. (call or contact me).

Case 2. If you have caught 4 or more moths in any trap you should apply the 2nd cover before the 18th day if you used Danitol, and before the 16th day if you used Guthion.

Case 3. If you have a number of traps in the block and you catch 4 or more moths in a 7 day time period in only 1 trap and the others you catch 0 to 2 moths in the preceding week you may choose to only spray the area covered by the trap where the catch was made. If you decide to take this approach you will probably want to apply the second cover to the borders of the block or orchard and also along any roads that may transect the block or orchard because these are the areas where scattered mated females from external sources tend to lay their eggs. **Continue to monitor your orchard, particularly the untreated areas for worms or stings.**

Case 4. If you have a number of traps in the block and/or your orchard and you catch 0 to 2 moths per trap in all the traps during the preceding week, you should be able to safely skip the 2nd cover. **Continue to monitor your orchard for worms and stings.**

Based on my research and experience and also Dr. Alstons' research I would recommend 16 ounces of Intrepid per acre for the 2nd cover. It will give you 14 to 18 days of protection. Use a resin based spreader/sticker (see research note on Intrepid).

Following the 2nd cover timing continue to monitor your orchard for worms or stings and monitor the traps for adult moths. In most cases you will find occasional moths in the traps, but if they are 0 - 3 moths per trap per week you will not need to apply a cover when the 3rd cover timing occurs. Often this 3rd cover timing will fall "between generations when the numbers of moths are low or very low. At these times, if the MD dispensers are properly placed the few moths that are in the orchard will not mate effectively. At this point continue to monitor the orchard for any worms or stings and if you find a limited number in limited areas remove them from the trees and orchard. If you have a block or a portion of a block which needs to be sprayed, based on the trap catch (follow the directions in Case 2 and Case 3 above) I would recommend that you use 2.5 ounces of Assail per acre at 3rd cover timing (see research note on Assail).

As long as your traps are maintained and monitored properly and you are inspecting the orchard for worms and stings you can continue to 'skip' any additional cover sprays as in Cases 1 and 4 above. If you should catch significant numbers of moths (as in cases 2 and 3 above) you should track the accumulation of degree days from the time you passed the 'economic injury threshold' and spray at 220 to 240 degree days post EIT.

The grower should continue to monitor the traps and his orchard for worms and stings through the remainder of the year and only spray as necessary, which will be, in most cases, very seldom unless something was not done at the proper timing, or with sufficient thoroughness, **or** if a significant source of external pressure exists. In many cases as the grower determines that there is external pressure and where it is coming from he can handle the problem by spraying 100' to 150' of the orchard along that border.

As the grower plans and executes his CM program our IPM coordinator Shawn Stephan and his IPM updates are a tremendous source of information. For growers in Utah County Dr. Earl Seeley will be glad to discuss any situation that may arise if you contact him by phone or email as indicated above.

Throughout this discussion, I have referred to the monitoring of the traps, and inspecting the orchard for worms and stings. This requires a commitment of resources and time but it can significantly increase the quality of the results obtained and can return huge returns in terms of reduced costs, reduced incidence of wormy fruit, and since it requires close observation of the orchard, it will often result in better management based on the early observation of needs or problems. Wormy fruit has a very high cost, directly in terms of less packed fruit per bin and indirectly as it affects the marketing of the fruit in a negative way. One grower in Utah spends 4 to 6 hours per week in monitoring traps and orchards, and another 1 to 3 hours per week in record keeping and analysis. In return he has been able to have very low levels of CM damage, has lower overall CM control costs and after several years of MD has re-established biological control of his mite population

During the 2004 growing season I look forward to working with you through our bi-weekly meetings, orchard visits, and personal contacts.

Note: A brief comparison of costs of a MD and Conventional CM control program follows.

Operation	Material	Conventional Program			Mating Disruption Program		
		Mat. Cost	App. Cost	Total \$	Mat. Cost	App. Cost	Total \$
Dispensers	Checkmate 1000				\$ 110.00	\$ 12.00	\$ 122.00
First Cover	Guthion	\$ 21.60	\$ 16.00	\$ 37.60	\$ 21.60	\$ 16.00	\$ 37.60
Second Cover	Intrepid	\$ 26.00	\$ 16.00	\$ 42.00	\$ -	\$ -	\$ -
Third Cover	Guthion	\$ 21.60	\$ 16.00	\$ 37.60	\$ -	\$ -	\$ -
Fourth Cover	Intrepid	\$ 26.00	\$ 16.00	\$ 42.00	\$ -	\$ -	\$ -
Fifth Cover	Assail	\$ 36.00	\$ 16.00	\$ 52.00	\$ 36.00	\$ 16.00	\$ 52.00
<u>Sixth Cover</u>	<u>Guthion</u>	\$ 21.60	\$ 16.00	<u>\$ 37.60</u>	\$ -	\$ -	<u>\$ -</u>
Annual Cost				\$ 248.80			\$ 211.60

In the above chart it was assumed that the grower would: 1. Do the necessary trapping and monitoring no matter which approach was used, 2. That under MD two full covers were required, realistic for 1st year, in some heavy pressure areas a 3rd may be required the first year but the numbers of covers should decrease. 3. Costs of the dispensers may be slightly higher if only 1 or 2 small blocks are done in an area so ‘boarders’ are a higher percentage of the acreage.

(1) In the early 1960’s when ‘Guthion’ was first introduced, essentially complete control of CM could be achieved with one application of 1 lb. active ingredient per acre per generation. Well into the 1980’s a 28 day effective residual was experienced in most areas. The partial resistance of CM populations increased gradually until applications were required at 14 to 21 day intervals, 2 or 3 times per generation to avoid stings and/or worms. During this phase, mid and late 1990’s, more and more of the adults were surviving ‘Guthion’ applications with only the larvae and limited numbers of the adults killed by the ‘spray’.

For several years the resistance was very spotty in that, some grower blocks had severe problems and relatively short distances away lesser problems were experienced. In the last 4 years the survival of adults has increased in all areas in southern Utah County, effective intervals are now less than 21 days in all areas (14 days or less in most) and the frequency of “stings” is increasing.

(2) Synthetic pyrethroids such as Danitol and Asana are effective against CM but they also kill many of the beneficial insects and predators, resulting in mite, leaf miner, and other pest “flare-ups”. For this reason horticulturists and entomologists have resisted their widespread use. Under present conditions the use of 1 application early in the season may be very useful and in most cases the negative side effects can be minimized (1st cover is ‘best’).

(3) Most of the new CM control agents are more costly on a per acre per application basis and the required re-application interval is relatively short. This results in significantly higher material and application costs when these agents are used in a strictly chemical control program. For many growers, who for years, could spray once every 21 to 28 days and “forget it”; these shorter lived softer materials require an “adjustment of attitude”.

(4) For over 30 years 'Guthion' worked so well that most growers forgot how rapidly resistant strains of CM can be selected. In commercial orchards, problems with Diazinon began to occur after 3 to 4 years of use. With the relatively high costs and slow appearance of new effective materials, growers must take all reasonable steps to avoid selecting strains of CM that will be resistant to the new materials available.

(5) The two lures recommended for use here-in are both claimed to be effective for 140+ days. At our elevations (2500' to 3500' higher than Washington) the diffusion of these materials from the dispenser is significantly more rapid than at lower elevations. When the lower atmospheric pressure is combined with a hot summer and the higher solar radiation load these dispensers do not release enough material to provide significant disruption of the mating of the third generation. In this case (years similar to 2003) the grower should expect to apply 1 application of sprayable material at the beginning of the 3rd generation if he still has significant trap catch. **Because of this limitation, it is a mistake to delay the installation of the dispensers until bio-fix, with the attendant risks of being too late.**