

Keeping Indianmeal Moths out of Your Food Facility

The Indianmeal Moth (*Plodia interpunctella*) is a common stored product moth pest, prevalent in food manufacturing facilities and warehouses that are processing grain, nut, or cocoa-based foods. Management of stored product pests is essential to the safety of your brand and products. Mating disruption is a common control method used for Indianmeal Moth infestations in food facilities and is discussed in this white paper.

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The Indianmeal Moth

The Indianmeal Moth (*Plodia interpunctella*) is a common stored product moth pest, prevalent in food manufacturing facilities and warehouses that are processing grain, nut, or cocoa-based foods (grouped together as stored products). Adult moths lay their eggs in the food and the egg hatches into a hungry larvae, which is the most damaging stage. That larvae devours whatever it can because the adult stage doesn't eat. All of the energy requirements fall on to that larvae, so they will consume the food that they were born in, defecating and leaving webbing behind. As they prepare to pupate, they'll typically leave the food they have called home for the last 30 or so days, and find a dry, undisturbed crevice to build their pupae case in. Once pupation is complete, an adult moth emerges. Not hampered by the need to eat, the moth spends its entire adult life, approximately two weeks, searching for a mate, and laying eggs in the food.



Indianmeal Moth Mating

With just two weeks (on average) as an adult, the adult Indianmeal Moth is not alive for long. Therefore, they must remain focused on completing just one task: finding a mate to propagate the species. With the metaphorical timer ticking, they must find one another, which can be challenging in some environments. To make this process more efficient, the female moth releases a sex pheromone, a communicative semiochemical undetectable to others. That pheromone essentially tells Indianmeal Moth males "I'm here and I'm ready to mate." Sex pheromones are species-specific (for the most part, there are closely related species that will also detect the pheromone), so when an Indianmeal Moth is ready to mate, only other Indianmeal Moths will respond to that pheromone. This will help the male find her faster, to beat the clock that ticks off the seconds until their death.



Indianmeal Moths mating. Photo credit Trece.

The male is able to detect the sex pheromone in contrast to the normal air he is surrounded by. It's comparable to walking through a whiff of perfume. The perfume is invisible, but you're able to detect a change in the air through your nose. This is similar for the moths, only they're detecting the pheromone with their antennae. Once the male detects the change in the air he will try to find the female by flying in and out of the pheromone plume. He zig-zags in and out from the widest portion of the plume towards the narrow, more concentrated portion of the plume, essentially zooming in on the female moth. Once he finds her, they mate.



Mating disruption in a warehouse. Photo credit Trece.

Control Options

As with most stored product pests, Indianmeal moths live in the food they are feeding on. Unlike many other pests, they're not going back and forth from harborage or nest to food. The food is their "nest." While the adult will fly outside of the food, they're looking for a good food source to lay their eggs in, to ensure sustenance for their offspring. When those eggs hatch into larvae, the larvae will begin devouring the food that they were born in. For this reason, we may find ourselves limited with control options – control needs to happen in or around the food. Typically, the most effective control tool is sanitation. If we can identify the food they're living in and re-

move it, we have eliminated both their food source and their home. The facility and environment will dictate how feasible this is. In a home, we can usually find and remove the dog food or brownie mix that the moths are breeding in. And we can often eliminate or freeze all the other foods that the moth may be attracted to. Couple that removal with a good wipe-down of the cabinets, and we typically can eliminate the population easily. But, imagine a huge food plant, processing grain-based foods all day. Even with a strong sanitation program, there's the potential for food debris to lodge in cracks and crevices in the facility, providing sustenance for stored product pests. Often, we may not know where the source is, one forgotten bag of cocoa powder in a sea of pallets stored high on racks may be the reason why a food manufacturing plant or warehouse has the Indianmeal Moth infestation, but identifying that bag is a real challenge.

Monitoring tools and inspection are key to identifying infestations early, before they become unmanageable. If they do become widespread, we have a problem, because we sure can't throw out all the food in a food plant, the way we might do in a kitchen. Sanitation alone will probably not control a wide-spread problem. We then need to consider other tools. For a plant-wide infestation, we may turn to chemical control through fumigation. Fumigation will introduce toxic chemicals to the facility, killing all within. We may consider a heat treatment, which pumps heat into a facility at temperatures that are lethal for insect survival. Both solutions are effective, but are dangerous and take time, often around 3 days in a typical food plant. Any facility-wide treatment, whether it's chemical or non-chemical, comes with a hefty price tag. Not only for the cost of treatment, but whether heat or chemicals are used, the facility needs to shut down, as it is not safe for employees to be in the building. So, the cost of treatment is often shadowed by the cost of shutting down for 3 days.

Indianmeal Moth Mating Disruption

The key to the male moth finding the female moth lies in the zooming in and out of the pheromone plume. He's got to detect that contrast in the air in order to find her. Mating disruption removes that contrast – there's no change in the air because the entire facility is saturated with her pheromone. Imagine trying to find your beloved in a room only by smell. You might wader throughout the room, hoping to detect his or her cologne or perfume, and when you do, you'd know you were close to them. What if the entire room was saturated in their perfume or cologne? You'd be unable to find them based off of smell alone. Mating disruption works similarly.

Manufacturing companies take the sex pheromone and impregnate pieces of rubber or other pheromone-holding matrices, with a very high percentage of the sex pheromone (see images of three popular mating disruption brands produced by Trece, BASF, and J.F. Oakes). These pieces of material are then hung throughout the facility, radiating out high concentrations of sex pheromone. The spacing and longevity will vary depending on the manufacturer's label. Once hung, the pheromone begins permeating throughout the facility. Since nearly all of the air is pheromone-saturated, the males cannot find the females, there is no plume in which to zig-zag in and out of because the entire facility is a "plume." The females' pheromone gets lost amongst the synthetic pheromone emitting from the dispensers. The result is that the male and female search for one another unsuccessfully for the rest of their short adult lives. In approximately 2 weeks, their time will be up, and without mating, there will be no eggs to lay to continue the species. The population is effectively reduced, and with time, all of the adults that emerge from their pupae in the next month or so will be unable to find one another to mate, controlling the population.

While this treatment is most effective in a contained space, such as a building or room where we can permeate all of the air with the sex pheromone, we have also had success in facilities that need partial protection. For example, the pet food aisles in a retail facility. We will install the dispensers over a portion of the building, protecting the areas with grain-based foods, where the moths are more likely to go in order to find mates and a place to lay eggs. Though currently we only have this tool for Indianmeal Moth, similar mating disruption research is on-going for the Cigarette Beetle (*Lasioderma serricorne*) and the Warehouse Beetle (*Trogoderma variable*), two other economically important stored product pests that utilize strong sex pheromones. The flexibility, ease of use, and chemical-free aspects of this type of treatment make it a very attractive and effective method of control in a variety of facilities.

Mating disruption is marketed under several brands. Here are the dispensers produced by Trece (Cidetrak), and J.F. Oakes (DisMate), and BASF (Allure MD)



Indianmeal Moth Mating Disruption Case Study Report

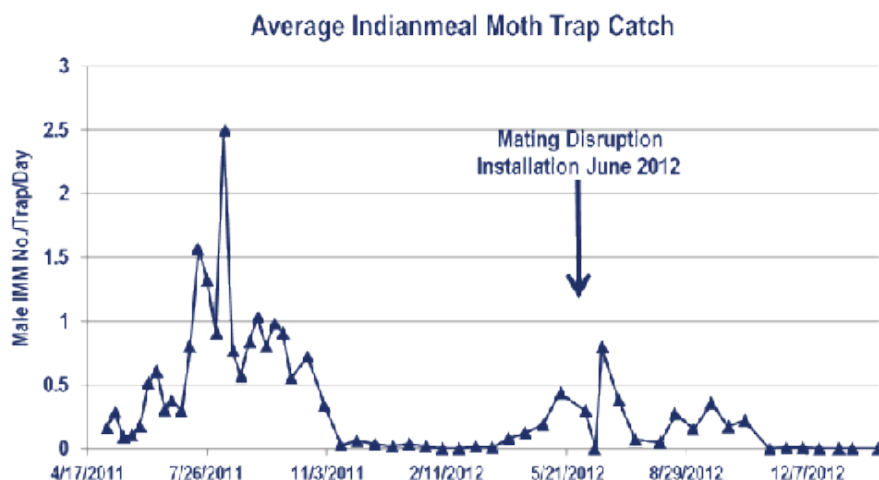
Due to the specific climate cocoa beans require, the United States is unable to produce cocoa (Florida and Hawaii may have small-scale production) to meet our processing needs, so cocoa beans are imported into the United States. With the beans, we often find Indianmeal Moth infestations that have to be identified and controlled before or at the production stage. One of our clients, a chocolate-manufacturing facility, handled the inevitably infested raw ingredients by fumigating the entire facility during every 3-day weekend. They chose 3-day weekends because the facility was in operation 24 hours a day, 7 days a week, closing only on holidays. So, by fumigating over a 3-day weekend, they only had to shut down 2 days instead of 3, as they were already closed for the holiday.

For this client, that shut down time negatively impacted their financial bottom line, but was a necessary evil. The shipment would always come with moths and there were lots of nooks and crannies for cocoa powder to build up in, both in the building itself and in the processing equipment. They had a strong sanitation team, but by frequently reintroducing the moths, it was near impossible to get a handle on the population without shutting down for fumigation.

McCloud Services approached the company in 2012 with a fairly new control tool for Indianmeal Moths – mating disruption. Mating disruption was first manufactured for agricultural pests, so having it as an option for a structural pest such as the Indianmeal Moth, was a fairly new development at that time. McCloud Services installed little discs impregnated with the same pheromone they were using to monitor, but at very

high concentrations. These little disks would emit the pheromone high above the equipment, and were attached to pipes that crisscrossed the ceiling. The client listened critically as McCloud Services went through the details of the science and of the process. As their only pest was the Indianmeal Moth, this would be an effective non-chemical approach. What we learned, though, is that while the “green” approach was certainly an important element to the client, even more than reducing the chemicals, the client wanted to decrease the amount of time that the facility was not in operation. After listening to the process and how safe the product was, the client cut to the chase and asked “Do I have to shut down for this?” Realizing what this meant for the company’s operation, we confirmed that the facility absolutely did not, unlike fumigation or heat treatments, employees can continue working while the dispenser released the pheromone. Though the cost of the treatment was comparable to a fumigation or heat treatment, there was not the additional cost of shutting down the operation. The client took a leap of faith on a new technology and purchased the Indianmeal Moth Mating Disruption program.

McCloud’s service specialists installed the dispensers throughout the building, on all floors. After monitoring the population for about a month, a month, service specialists saw a dramatic reduction in Indianmeal Moths in the monitoring traps (see graph). The client was thrilled – not only were the Indianmeal moths effectively controlled using non-chemical means, but the client saved money by not having to shut down operations.



Data from McCloud Services chocolate processing client shows decrease in Indianmeal Moth catches after mating disruption treatment.