X-Mate™ F.C.M.

Thaumatotibia leucotreta

Reg No: L10320, Act 36 of 1947

Pheromone Based Mating Disruption

- *Pest specific*
- *Easy to apply*
- *Season long control*
- *Hinders chemical resistance*
- *Rain fast and no chemical drift*
- *No damage to the environment*

Manufactured by

INSECT SCIENCE®

X-Mate™ F.C.M.

Introduction

The false codling moth (FCM), *Thaumatotibia* (=*Cryptophlebia*) *leucotreta* (Meyrick) (Lepidoptera: Tortricidae) is a pest of citrus fruit, macadamias, avocadoes, stone fruit, peppers and other crops in sub-Saharan Africa (Newton, 1998). In 2004, the estimated annual loss incurred by the citrus industry of South Africa, as a result of FCM infestation was about R100 million (US$14 million) (Moore et al., 2004a). Not only does the insect damage citrus crops pre-harvest, but also its phytosanitary status (quarantine status) is such that the detection of a single larva in fruits marked for export could result in the entire consignment being rejected (Moore, 2002; Hattingh, 2006).

Conventional control methods – using chemical insecticides are fraught with problems. The most common being the high residues left on fruits (post harvest), warranting stricter residue restriction limits imposed by overseas markets. Another big problem is the non-target effects of sprays – which kill other beneficial organisms, leading to secondary pests outbreaks. Other problems include the safety and environmental risks involved in their usage, coupled with the recent development of resistance - of the pest, to some of these chemical insecticides (Hofmeyr & Pringle, 1998).

These increasingly strict regulations regarding chemical "pesticides" usage in African importing countries have also forced growers to change from traditionally chemicals to more integrated pest control programs including technology like "attract & kill" and "mating disruption". X-Mate FCM "mating disruption" technology releases a high concentration of pheromone per device and therefore requires fewer devices per hectare. The X-Mate FCM pheromone dispenser (Figure 1) works by saturating the orchard environment with a blend off synthetic false codling moth sex pheromone, marking it impossible for the male moths to locate female false codling moth. The major advantage of X-Mate FCM is that no chemical and hence no residue are deposited on the fruit.

Pheromone Based Mating Disruption

The success of the application of the mating disruption method as protection against the false codling moth depends, in addition to other factors, on the grower's knowledge of the biology and behaviour of the pest and, in general, on the implementation of the method in question. The aim of this manual is to provide technical information relevant to achieving this success.

Economic Importance

Smith (1936) and Myburgh (1965) report that, FCM continues to be a pest of economic importance to citrus. According to Smith (1936), in an experiment conducted on the extent of damage caused by fruit-fly and FCM in two successive seasons in the Western Transvaal in South Africa, the damage caused by FCM alone on the Washington navel cultivar of citrus, was 83.2% as opposed to 0.8% by the fruit fly. He emphasises this when he states that, 'the damage done by fruit-fly alone was so slight that the insect could hardly be considered as a pest of economic importance' (Smith, 1936). Although the dry season tends to limit FCM host availability, it continues to thrive due to abundance of irrigation systems in citrus orchards in southern Africa (Reed, 1974). In Samaru (Northern Nigeria) FCM became a major problem of cotton in 1967 due to the introduction of irrigation regimes during the dry season (Reed, 1974). FCM continued to have a preference for ripening citrus fruits, of which the Washington navel was most susceptible (Newton, 1998). According to Newton (1998), FCM larval development in limes and lemons was rarely completed, of which he attributed to their high acid content.

Economic Importance

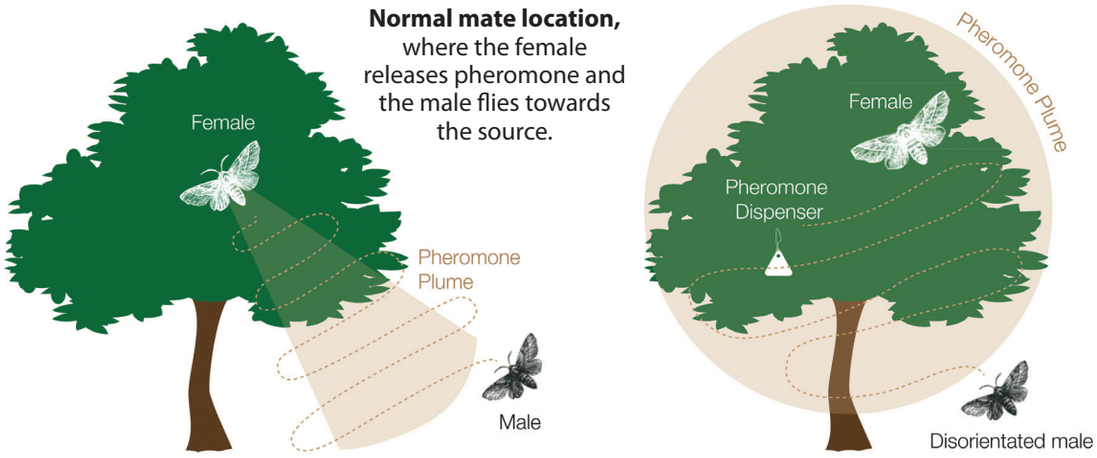
A single larva can destroy an entire orange. The subsequent moth produced within a few days, depending on temperature, could then lay more eggs leading to the build up of large larval populations leading to the destruction of a large number of fruits. However, the degree of fruit damage was highly variable from orchard to orchard and even between seasons (Begemann & Schoeman, 1999). Fruit losses as a result of FCM attacks, range from below 2% to as high as 90% (Newton, 1998). FCM causes an annual loss of about R100 million (US$14 million) to the South African citrus industry (Moore et al., 2004a). Not only does the insect damage citrus crops pre-harvest, but also its phytosanitary status (quarantine status) is such that the detection of a single larva in fruits marked for export could result in the entire consignment being rejected. This is because the pest does not occur in countries where citrus is exported (Moore et al., 2004a; Hattingh, 2006).

Principals of the mating disruption method

Male moths find potential mates by following the trail of a scent (pheromone) emitted by the female of the same species. In this insect species, the principal chemical component is E-8-dodecenyl acetate (77 %) 962.5 mg and Z-8-dodecenyl acetate (23 %) 287.5 mg. This substance attracts males, causing them to initiate a particular sequence of behaviour that begins with their guided flight and ends with mating. Mating disruption consists of disturbing mating by saturating the atmosphere with synthetic pheromones released by dispensers. In an atmosphere saturated with this pheromone, the males cannot locate the females, which emit pheromones at a lower concentration than the dispenser. The aim is to prevent mating so that no eggs or larvae are formed, thus, no damage is incurred in the area covered by the pheromone.

The concept of mating disruption. Within the cloud of pheromone released by the dispensers, the male cannot locate the pheromone released by the female.

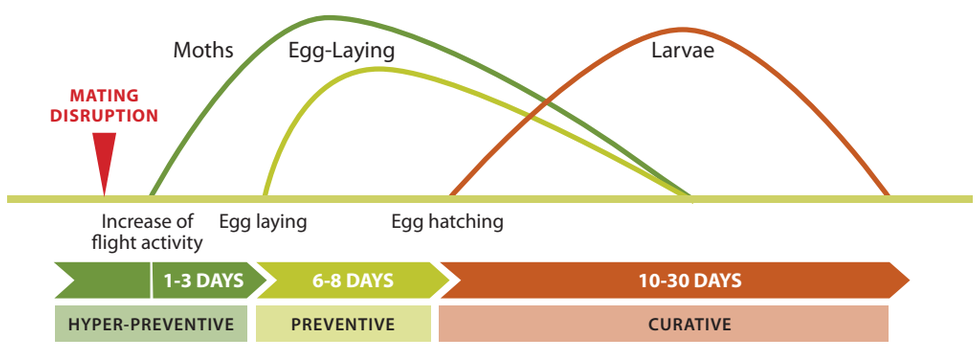
Mating disruption concept



Normal mate location, where the female releases pheromone and the male flies towards the source.

In **mating disruption**, pheromone is released from dispensers that act as false sources, or pheromone is released at such a high rate that the male is disorientated or unable to detect the plume of the calling female.

The use of mating disruption in the protection of crops against pests, particularly against False codling moth, is considered a hyper-preventive means of protection



Strategies of protection against false codling moth

Dispensers

The synthetic pheromone used in the orchard is distributed by dispensers. Several types of dispenser are currently available in the market. The dispensers most frequently used against false codling moth are ISOMATE, commonly known as "spaghetti". The use of mating disruption against the False codling moth has been approved in South Africa.

X-Mate F.C.M. Release devise

Application density

Each X-Mate dispenser covers an average area of 250 m^2. Thus, the dispensers should be applied at a density of 40 dispensers per hectare, with an increase of approximately 20% around the edges of orchard where heavy prevailing winds are present or steep slopes are being treated to prevent part of the orchard atmosphere from not being saturated by pheromone.

Factors to consider in the installation

- **Size of the orchard**
  The area of intervention should be sufficiently large and isolated to prevent the entry of fertilised females from adjacent orchards. The recommended minimum area for the effective application of mating disruption varies depending on the homogeneity of orchards. This area should reflect factors such as the shape of the orchard, their slope and relief, climatic conditions (wind speed), and the population density and flight capacity of the pest. The larger the area covered by the method, the greater the possibilities of its successful application. For X-Mate™ F.C.M. it is recommended that this area be at least 10 hectares.

- **Climate**
  The wind has an effect identical to the border effect, preventing the pheromone cloud from maintaining the necessary concentration. Thus, it is recommended that the application start on the outer side of the boarder. The wind and temperature in the orchard influences the pheromone release rate, which influences the persistence of the pheromone. It is essential for the pheromone release period to cover the entire mating period.

Application density

- **Border or security zone**
  For the reasons cited above, it is convenient to increase the number of dispensers (20% more) in a strip along the border. It is also necessary to install dispensers in other sources of pest infestation near the orchard, such as hedges and trees that may act as alternative hosts.

- **Dispenser placement date**
  The dispensers should be placed in the field before the start of the first peak flight to prevent the first mating in August - September. As a precaution, it is advisable to install a Yellow Delta Trap and F.C.M. PheroLure® (Reg No L7875) that detects the start of flight at the end of July.

- **Population density**
  As the population density of the pest increases, the probability that a male will find a female increases, whereas at low population densities, the likelihood of casual encounters between individuals is reduced. Consequently, in the case of high population densities, the success of mating disruption may depend on the application of an insecticide treatment aimed at reducing the population.To prevent the population growth, the pheromone must be present in the atmosphere before the temperatures start to increase and the moth flights increase.

The installation of the dispensers to make the pheromone last longer is not advisable because the release rate depends on the temperature. At the start of the programme (September), the temperature is relatively low. As a result, a later application of the dispensers does not produce significant gains in the economies of the dispenser load.

Several years of consecutive application of the method helps to reduce the damage caused by the pest. Therefore, mating disruption can be considered a means of protection with a cumulative effect. However, this cumulative effect can only be achieved if the dispensers are installed just before the increased moth activity, otherwise the moths will continue to settle in the orchard and the effectiveness of the method will be threatened.

In South Africa, the flight of false codling moth begins to increase as the days temperatures rise, peaks in November December and starts to slow down as winter starts to set in or early June. The dispenser persistence is approximately 150 - 180 days (5-6 months), which is sufficient for the F.C.M. season.

Calculation of the number

Practical examples

The distance between dispensers should be calculated according to the plant spacing. This calculation will be illustrated on the product packaging for the grower's convenience. The spacing tables can be seen below in Table 1, 2 & 3 and it is important to remember that each dispenser covers an area of 250 m^2.

Citrus, Stone Fruit and Avocado orchard placement guideline

Row spacing (m)	Tree spacing (m)	Trees per ha	Dispenser per Ha	Instruction (1 dispenser per 250 m^2)
6	3	550	40	Start application in 2nd row tree no 3 there after in every 7th tree in the row. Repeat application in every 2nd row.
5	3	660	42	Start application in 2nd row tree no 2 there after in every 6th tree in the row. Repeat application in every 3rd row.
7	4	357	42	Start application in 2nd row tree no 2 there after in every 4th tree in the row. Repeat application in every 2nd row.
6	4	417	40	Start application in 2nd row tree no 3 there after in every 5th tree in the row. Repeat application in every 2nd row.

Tree Nuts and Litchi orchard placement guideline

Row spacing (m)	Tree spacing (m)	Trees per ha	Dispenser per Ha	Instruction (1 dispenser per 250 m^2)
5	5	400	40	Start application in 2nd row tree no 3 there after in every 5th tree in the row. Repeat application in every 2nd row.
6	3	555	40	Start application in 2nd row tree no 4 there after in every 7th tree in the row. Repeat application in every 2nd row.
6	4	416	40	Start application in 2nd row tree no 3 there after in every 5th tree in the row. Repeat application in every 2nd row.
7	3,5	408	40	Start application in 2nd row tree no 3 there after in every 5th tree in the row. Repeat application in every 2nd row.
7	4	357	40	Start application in 2nd row tree no 3 there after in every 4th tree in the row. Repeat application in every 2nd row.
8	3	416	40	Start application in 2nd row tree no 2 there after in every 5th tree in the row. Repeat application in every 2nd row.
8	4	312	40	Start application in 2nd row tree no 3 there after in every 4th tree in the row. Repeat application in every 2nd row.
10	5	200	40	Start application in 2nd row tree no 2 there after in every 3rd tree in the row. Repeat application in every 2nd row.
10	10	100	40	Start application in 1st row tree no 2 there after in every 2nd tree in the row. 2nd row begin application in 3rd tree in the row there after in every 2nd tree in the row. Repeat sequence application in every row there after.

Vineyards and Pomegranate orchard placement guideline

Row spacing (m)	Tree spacing (m)	Trees per ha	Dispenser per Ha	Instruction (1 dispenser per 250 m^2)
3	2	1666	40	Start application in 2nd row vine no 5 there after in every 7th vine in the row. Repeat application in every 6th row.
3,5	2	1428	40	Start application in 2nd row vine no 3 there after in every 9th vine in the row. Repeat application in every 4th row.
3	1,8	1852	40	Start application in 2nd row vine no 5 there after in every 8th vine in the row. Repeat application in every 6th row.
3,5	1,8	1587	40	Start application in 2nd row vine no 3 there after in every 10th vine in the row. Repeat application in every 4th row.
2,5	1	4000	40	Start application in 3rd row vine no 8 there after in every 17th vine in the row. Repeat application in every 6th row.
2,5	1,4	2857	40	Start application in 3rd row vine no 6 there after in every 12th vine in the row. Repeat application in every 6th row.
2,5	1,8	2222	40	Start application in 3rd row vine no 5 there after in every 9th vine in the row. Repeat application in every 6th row.

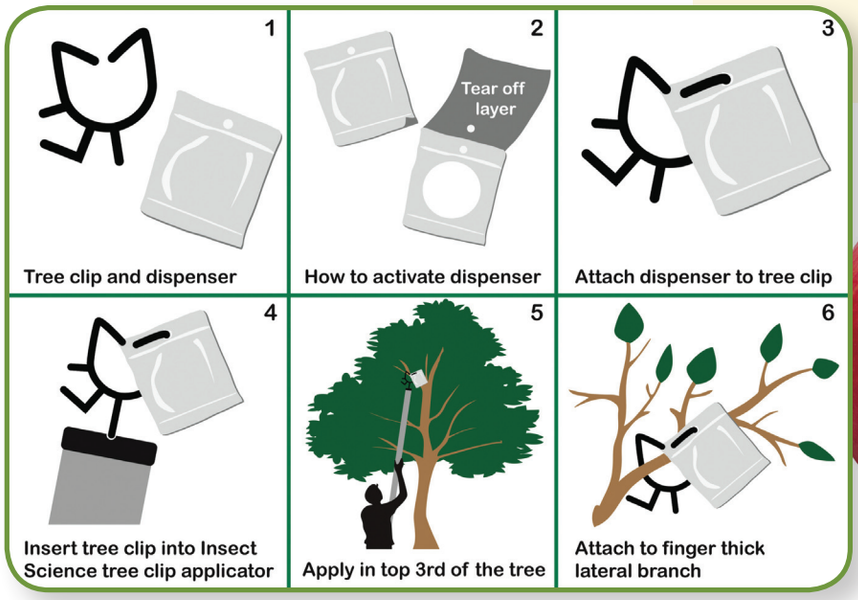
Installation of the dispensers

It is advisable for the installation of dispensers in the orchard to be supervised by a technician responsible for coordinating the personnel who will carry out the work. A brief advance meeting with the personnel should be held to explain the importance of the correct manner of application of dispensers along the row and the management of the borders. See below for insulation instructions.

At the preparatory meeting, the following points should be specified:

- The dispensers should be applied in the top third of the canopy of the orchard by using the Insect Science (Pty) Ltd X-Mate™ applicator.
- If there is no tree where a dispenser was supposed to be placed, the dispenser should be placed on the tree situated just before or after the space. The dispensers should only be applied to a diagonal tree if there is a large space of more than 15m without a tree.
- The placement of the dispensers must begin on the orchards with the greatest susceptibility and history of attacks and to ensure the number of dispensers used on those orchards are as previously calculated.
- In the border zone, where strong prevailing winds or steep slopes are present be sure to start the application outside of the treatment block, the distance between dispensers must be in accordance with plant spacing.

Instulation of X-Mate F.C.M.



How to test the effectiveness

The first evaluation of the method's effectiveness involves the observation of the pheromone base traps located in the orchard treated with mating disruption and the comparison of the number of captures with those obtained in traps located outside the area treated with mating disruption.

Captures in pheromone traps

If the method works well, the male moths will not be able to locate the pheromone trap, and there will be no captures in the orchard where mating disruption is applied. This result means that the males will also be unable to find the females, and therefore no mating or damage will occur.

Calculation of damage

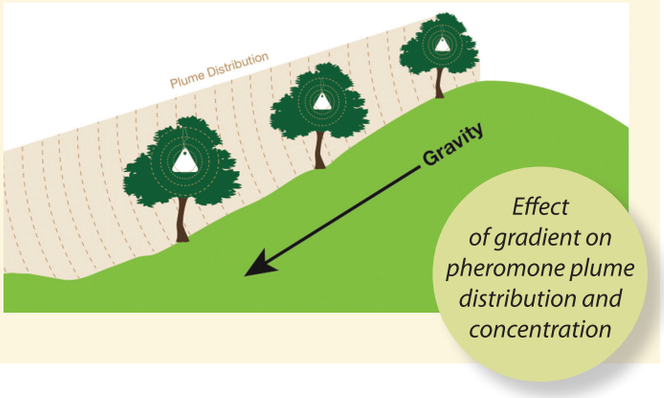
The absence of captures in a trap is not a guarantee that a particular orchard has not been infested. If the pheromone is not uniformly distributed in the orchard and certain conditions are present the risk of mating will increase. Thus, in addition to monitoring the pheromone traps, sampling should be conducted to assess the damage in each generation. The samples should be collected both in orchards treated with mating disruption and in control orchards.

Advantages of the method

- Does not affect Beneficial's, safeguarding the presence of predators and parasitoids that limit the presence of pests in the orchard. **Its use enables a balance between the pest and his antagonists to be achieved in time.**
- **Non-toxic** to the labour applying the product.
- **Does not leave marks** or residues on the fruit.
- Has a **cumulative effect** if used repeatedly over the course of several years.
- The **pest does not develop immunity** or **resistance** to the product.
- It is **easy and rapid to apply**, and application is required only once a year, at the start of the programme, and at a time when there is little work in the orchard to be done.
- Can be used as a commercial argument to promote agricultural production through the use of an "**environmentally friendly**" means of protection against pests.

Limitations of the method

- The **minimum area** required is **10 ha**.
- Orchards with **less ideal conditions** (very windy, steep slope, or varied orchards) make it **difficult to maintain** the pheromone cloud on the site see figure below.
- On sites with high levels of attack, the **1st year of application** generally **requires application of an insecticide** to reduce the initial population.
- Under **certain conditions** (e.g., significant pest density, small orchards, strong winds, or late placement of dispensers), mating disruption **may not guarantee the** required **effectiveness**.
- Due to its specific characteristics, mating disruption **does not ensure protection against other pests**.



X-Mate™ F.C.M.

Reg No: L10320, Act 36 of 1947

Active ingredients

E-8-dodecenyl acetate (77 %) 962.5 mg
Z-8-dodecenyl acetate (23 %) 287.5 mg
Each dispenser contains a minimum of 1250 mg active ingredients.

Product information

X-Mate™ F.C.M. is a ready-to-use, pheromone based, mating disruption product, which disorientates male False Codling Moth (*Thaumatotibia leucotreta*) resulting in the failure of the male moths to locate the female moths and thus reducing mating. ***X-Mate™ F.C.M.*** is used in Avocados, Citrus, Litchis, Pomegranates, Stone Fruit, Tree Nuts and Vineyards and is ideal where Integrated Pest Management programs are followed.

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