Effective Monitoring Tools for Tortricid Moths in Apple Orchards

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Commercial apple orchards in eastern North America face persistent threats from various insect pests, particularly those belonging to the Tortricidae family. Common pests include the codling moth (*Cydia pomonella*) (CM), oriental fruit moth (*Grapholita molesta*) (OFM), redbanded leafroller (*Argyrotaenia velutinana*) (RBLR), and obliquebanded leafroller (*Choristoneura rosaceana*) (OBLR) (Figure 1). Tortricid moth larvae are particularly destructive, feeding on leaves, shoots, buds, and fruits. Most tortricid larvae feed on the fruit epidermis, causing deep gouges or tunneling to the core, leaving behind frass on the fruit's surface. Codling moth larvae are notorious for tunneling into the core to feed on seeds, while leafrollers use silk to curl leaves as a defense mechanism against predators and insecticides. The number of generations per year varies across populations due to factors like latitude and weather, resulting in damage throughout the growing season.

Figure 1: Pictures showing OFM (A) (Source: Giligan and Epstein), CM (B) (Source: growing produce.com), RBLR (C) (Source: Jerry Armstrong) and OBLR (D) (Source: Mark Dreiling)

Sex pheromone lures in traps are used to monitor seasonal populations of CM, OFM, RBLR and OBLR in conventional and mating disruption orchards. Monitoring female moth populations is crucial for refining predictive models and establishing precise action thresholds. Augmenting sex pheromone lures with plant volatiles, or kairomones, has shown promise in enhancing moth monitoring and mating disruption systems.

Tortricid moth dynamics in Massachusetts orchards

The line graph (Figure 2) illustrates four years of tortricid moth capture data (2020, 2021, 2022, and 2023) collected across nine orchards in Massachusetts. Among the three moth species studied, OFM exhibited the earliest emergence around last week of April, with its first peak occurring around the second week of May, followed by two subsequent peaks throughout the season. Optimal deployment of OFM pheromone traps (Figure 3) is recommended around mid-April, coinciding with the silver tip or half-inch stage of apple bud development. Following OFM, CM emerged as the second moth species, with initial captures observed during the first to second week of May, maintaining consistent captures throughout the season. This pattern is likely due to the synchronous emergence of the overwintering generation in spring, followed by one to two slightly overlapping emergence peaks later in the season. The CM moth's life cycle is known to be influenced by temperature and day

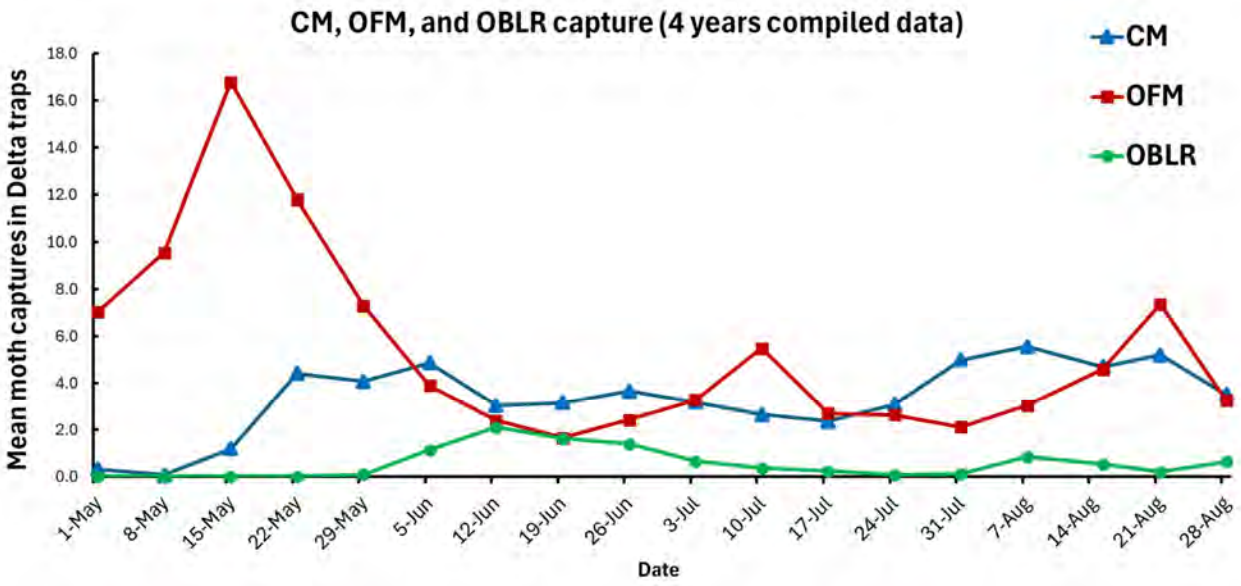

Figure 2: Population dynamics of three moth species (CM, OFM and OBLR) collected and averaged over a span of four years using delta traps deployed across nine orchards in Massachusetts.

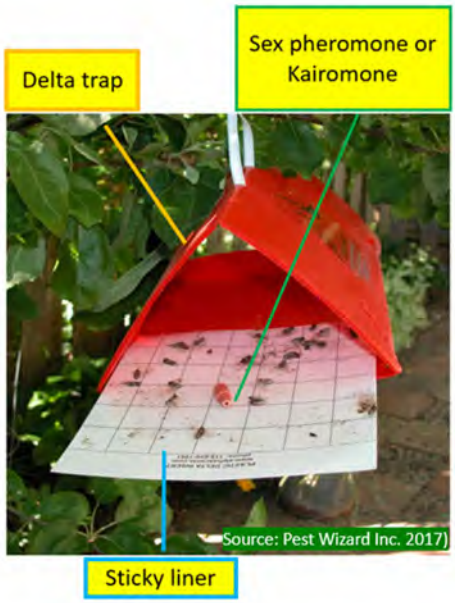

Figure 3: Delta trap baited with lure and sticky liner.

length, resulting in diverse emergence patterns. The third species to emerge was OBLR, with trap captures typically observed at the end of May. However, trap captures of OBLR remained low across all orchards, with some orchards reporting no captures. For effective monitoring of CM and OBLR populations, deploying pheromone traps during the last week of April, coinciding with the half-inch green to tight cluster stage of apple bud development, is recommended.

Commercially available lures for codling moth, Oriental fruit moth, and oblique-banded leafroller

Numerous commercially available lures serve as effective tools for monitoring populations of CM, OFM, OBLR, and other moth species. These lures primarily utilize sex pheromones to attract male moths from the targeted populations. However, enhancing female moth captures can be achieved by incorporating plant volatiles or kairomones alongside the sex pheromones. For instance, traps baited with CM sex pheromone can be augmented with pear ester (ethyl (E,Z)-2,4-decadienoate) and acetic acid, resulting in increased attraction of female CM (Knight et al., 2019). Moreover, a synergistic blend of plant volatiles, known as "Megalure CM 4K dual," has been developed, which, even without sex pheromones, can effectively lure females of both CM and OFM.

Table 1 provides a comprehensive list of commercially available lures designed for monitoring CM, OFM, and OBLR populations. These lures typically utilize a rubber septum as the standard method for dispensing the sex pheromone, offering a longevity of 4 to 6 weeks in the field. Alternatively, a gray halo butyl rubber septum, referred to as OFM L2 or CM L2 in trade names, can extend this longevity to up to 8 weeks. Notably, Trécé has recently introduced a proprietary

PVC matrix as a delivery medium, capable of sustaining the release of sex pheromones or kairomones for up to 12 weeks in field conditions. Combo lures, commonly packaged with two components—sex pheromone and a kairomone—typically feature the sex pheromone loaded in either a rubber septum or PVC matrix, while the kairomone is housed in a membrane cup.

Acknowledgements

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Table 1: List of lures for monitoring selected tortricid moths.

Moth species	Trade name	Attractant type	Replacement	Notes	Pictures
Oriental fruit moth	Trécé Pherocon OFM lure	Male only	4 weeks	Red rubber septa	
	Trécé Pherocon OFM L2 lure	Male only	8 weeks	Gray halo butyl rubber. L2 stands for long lasting. Can be loaded with higher rate of pheromone.	
	Trécé Pherocon OFM Combo Dual	Male and female	8 weeks	Comes with kairomone combo in a peelable membrane cup.	
	Scentry OFM lure	Male only	4-6 weeks	Black rubber septa	
Codling moth	Trécé Pherocon CM Standard 1X	Male only	4 weeks	Red rubber septa for standard monitoring	
	Trécé Pherocon CM Standard 10X	Male only	2-3 weeks	10X higher dose than standard for use in mating disrupted orchard	
	Trécé Pherocon CM L2	Male only	8 weeks	Gray halo butyl rubber. L2 stands for long lasting. Can be loaded with higher rate of pheromone.	
	Trécé Pherocon CM L2-P	Male only	12 weeks	Pheromone loaded in PVC material. L2 stands for Long lasting, and P stands for PVC.	
	Trécé Pherocon CMDA Combo-P	Male and Female.	12 weeks	The DA in CMDA is pear ester (a plant volatile/kairomone). The combo is Acetic acid (AA).	
	Trécé Pherocon CMDA Combo-S	Male and Female.	8 weeks	The DA in CMDA is pear ester (a plant volatile/kairomone). The combo is Acetic acid (AA). S stands for Rubber Septa.	
	Trécé Pherocon Megalure CM Dual 4K	Male and Female.	8 weeks	4K stands for 4 different Kairomones. Studies carried out in Massachusetts also showed its attraction to both sex of OFM.	
	Scentry CM Lure	Male only	4-6 weeks	Red rubber septa for standard monitoring	
Oblique banded leafroller	Trécé Pherocon OBLR lure	Male only	4 weeks	Red rubber septa. Due to overlapping of sex pheromone component in OBLR and RBLR, trap baited with OBLR lure can also attract significant number of RBLR.	
	Scentry OBLR lure	Male only	4-6 weeks	Red rubber septa. Also attractive to RBLR.	

Note: Information generated from Trécé Inc. and Scentry Biologicals Inc.

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