

# M3 Agriculture Technologies Interim Report:

## Sterile Codling Moth Release in California Apples

### Introduction

Lepidoptera such as codling moth (*Cydia pomonella*), cause significant damage (Klassen and Curtis 2005) and are among the most injurious pests to cropping systems worldwide (Vreysen et al. 2016). If left unchecked, Lepidoptera present a risk to international food and biosecurity (FAO/IAEA 2016). The threat posed by lepidopteran pests may compromise the export of American agricultural commodities to foreign trading partners. As a result, the USDA tracks lepidopteran pests and assesses their risk to American imports and exports. In order to combat this threat, several programs have developed Area-Wide Integrated Pest Management (AW-IPM) efforts to either suppress, contain, prevent or eradicate targeted insect species using the Sterile Insect Technique (SIT) (Hendrichs et al. 2005). Programs, such as the Area Wide Pink Bollworm Eradication Program / Navel Orangeworm Suppression Program (United States of America) and Okanagan-Kootenay Sterile Insect Release Program (Canada) have developed strong control methods, which incorporate AW-IPM practices with the Sterile Insect Technique geared specifically to lepidoptera. SIT is a species specific means of controlling targeted populations (Klassen 2005). SIT relies, primarily, on ionizing radiation to induce sterility and knock down the population through the release of sterile insects. Sterile Insect Release (SIR) is the practice of releasing sterile insects. Mating between crosses of sterile and wild type insects drives the population down by producing nonviable progeny. SIR achieves population control by releasing sterile insects, which mate with native populations, thereby reducing or potentially eliminating native populations. For an in-depth analysis of the current state of the arts in lepidopteran SIT, please refer to [Florida Entomologist](#). Vol. 99, Special Issue 1 (July 2016). Toward Greater Efficiency and Efficacy in Sterile Insect-Inherited Sterility Programs against Moth Pests.

### Codling Moth (*Cydia pomonella*)

Codling moth (CM) is a key pest of apple, which currently comprise approximately 14,000 acres of production in the state of California. Mating disruption is considered a foundation of CM management and has brought greater stability to CM control programs. However, both organic and conventional management regimes still suffer from 'hotspots' of CM infestation, and CM remains the most dangerous direct pest of apples in California. Codling moth has driven the pest management programs for over a century and given the favorable climate for reproduction of this pest, it is likely to continue in this role. The increasing frequency of a third CM generation has stretched insecticide resources, which previously were required only to prevent damage from two generations. While there are modes of action for CM control, there is an ever-present danger of insecticide resistance, and non-target effects on natural enemies. A non-insecticidal supplement



to control CM is a welcome alternative in California, and increases the long-term stability and sustainability of both conventional and organic apple systems. California apple orchards provide an ideal testing ground for implementation of SIR, in that there will be fewer insecticide impacts on released adults.

Sterile insect release (SIR) in California offers an alternative that could transform the management of CM. The approach entails sterilization of reared insects that are subsequently released in large numbers to compete with wild males for mating with wild females, thereby reducing fertile mating and consequently the production of offspring. Although initially considered as an eradication technique, SIR is now widely viewed as a tool within Integrated Pest Management (IPM) programs that can complement other tactics such as mating disruption or insecticides. The primary stumbling block to implementing SIR programs is the startup cost of the moth rearing and sterilization facility; however, a facility exists in Osoyoos, British Columbia, Canada, facilitating easy importation of sterilized moths by ground transport, with minimal risk of compromising the viability of the sterilized moths. After decades of use in British Columbia, SIR is considered a proven technique.

M3's Washington based sterile codling moth Unmanned Aircraft System (UAS) SIR is the most advanced lepidopteran SIR program in the world related to the handling, transport and release of sterile lepidoptera via UAS. This program has evolved the state of the arts surrounding UAS SIR significantly over two years. During 2016, a small proof of principle study demonstrated a 40% increase in recapture when compared to the existing ground release methods conducted by All Terrain Vehicle (ATV). During 2017, a more complex study was designed to assess the performance of UAS and ATV SIR in small, medium and large orchard environments. Here, the UAS outperformed the ATV and achieved a 70% increase in recapture. The 70% increase in recapture was a profound result and represents a significant evolution in the development of UAS as an emerging tool to release sterile insects as a part of broader AW-IPM goals and objectives.

M3 Agriculture Technologies and the California Apple Commission are currently conducting a 20 week pilot UAS SIR project to assess the operational viability of UAS technology in support of codling moth suppression. The objectives of this pilot study are to assess the efficacy of SIR in reducing wild populations of sterile codling moth in three specific field sites located in California near Modesto.

## California Apple Pilot SIR

Releases of sterile codling moth over California Apples began Tuesday April 27, 2021. Sterile codling moth are contained in petri dishes (800 per dish) and imported from Osoyoos, BC Canada Monday mornings under USDA APHIS PPQ and Fish and Wildlife import permits maintained by

M3 Agriculture Technologies. Once imported, sterile codling moth are packaged in an insulated box and overnighted via UPS by M3 personnel in Omak, WA. sterile codling moth arrive at a UPS Store in Oakgrove, CA Tuesday mornings by 10:30am. Upon receipt, insects are transferred from their insulated box and into M3's cold chain prior to release. The sterile codling moth remain inside petri dishes enclosures and are held at a precise temperature in order to maintain Torpor, or chill coma. Torpor is a key target for SIR programs, as the insects need to remain as sedate as possible in order to reduce the risk of mechanical damage caused by movement or asphyxiation caused by increased respiration. The insects are transported to the field site via M3's part 107 licensed UAS remote pilots. Upon arrival, the pilot loads the insects into the release device and executes preprogrammed missions customized for each field site. UAS operations require less than 10 minutes to execute from setup to release.

Table 1: Release dates

Date	Site 1	Site 2	Site 3
April 27, 2021	X	X	X
May 4, 2021	X	X	X
May 11, 2021	X	X	X
May 18, 2021	X	X	X
May 25, 2021	X	X	X
June 2, 2021*	X	X	X
June 8, 2021	X	X	X

\* June 2, 2021 release was shifted from June 1, 2021 to June 2, 2021 due to Memorial Day (Monday May 31, 2021). UPS does not ship on Memorial Day and therefore insects were not shipped until Tuesday June 1.