walnuts.org

IMPROVING TREATMENT DECISIONS FOR NAVEL ORANGEWORM IN WALNUTS

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Project status in 2024: Year 3 of 3

PROJECT OBJECTIVES:

1. Develop new N15 and/or rubidium markers for tracking Navel Orangeworm (NOW) dispersal from almond and pistachio into surrounding walnuts orchards:
2. Determine application and uptake rates of N15 and rubidium in almond and pistachio trees, and
3. Measure marker transfer to adult NOW that develop on the nuts of marked trees. If all goes well with these efforts, we intend to then use.

BACKGROUND

The navel orangeworm (Lepidoptera: Pyralidae: Amyelois transitella) (NOW) is a primary pest of almonds, pistachios and walnuts (Wilson et al. 2020). Adults deposit their eggs directly onto new crop nuts, and the larvae that emerge feed on the developing kernel, causing reductions in crop yield and quality. Furthermore, infestation by NOW is associated with increased incidence of Aspergillus fungi that produce aflatoxins, which are known human carcinogens heavily regulated in key markets. As such, tree nuts growers have an incredibly low tolerance for NOW infestation.

Modern management of NOW involves winter sanitation, mating disruption, well-timed insecticide applications, and timely harvest. This moth has a high dispersal capacity (Sappington and Burks 2014) and is known to move between orchards (Bayes et al. 2014). Given these features, the efficacy of local NOW management can be undermined by colonization from nearby orchards (Meals and Caltagirone 1971). Given the staggered phenology of almonds, pistachios and walnuts, it may be that almond and pistachio orchards serve as sources of adult NOW that spillover into walnut orchards, a process that is especially punctuated by harvest events (i.e. rapid mass-removal of host material). As such, better information is needed on the timing and extent of NOW movement between orchards, as well as understand how the composition of crops surrounding a given may influence this. In order to study this phenomenon, use of nitrogen-15 (N15) marking is being developed for application in tree nut orchards to mark and track outward dispersal of NOW.

N15 is a trace element that is taken up and translocated in plants the same way as common nitrogen (N14). Navel orangeworm that develop on the nuts of marked trees will pick up the marker, and can then be recaptured and evaluated for presence of elevated N15 levels using stable isotope analysis. In addition to N15, we are also exploring the use of rubidium applied as a separate marking treatment. Rubidium is a nonessential element to plants that is readily absorbed due to its similar structure to potassium. Similar to N15, rubidium has been shown to move into various plant tissues, including leaves and reproductive structures of both field and orchard crops. Like N15, it can be applied as a foliar application as a water solution.

Characterizing these NOW movement dynamics is critical to improving our understanding of NOW dispersal into adjacent orchards. This information is especially important for walnuts, since they have the latest phenology of all the tree nuts and are therefore more susceptible to this late season colonization as nearby almond and pistachio blocks are harvested. The first step to evaluate these dynamics is to develop and refine suitable marking systems, such as N15 and rubidium, which is what we propose here.

KEY FINDINGS

Optimize Elemental Marker Application Rate and Timing

- In 2024, multiple replicate cohorts of almond and pistachio trees were sprayed at different times of the season with a high dose of rubidium solution.
- Spray timing treatments included three different timings ahead of hull-split or hull-slip in almonds and pistachios, respectively.
- Our aim was to see how long a marker would reside in the plant tissue following a single spray application, and how the timing of application influenced transfer of the marker to NOW adults that developed on the nuts.
- As before, leaf and nut tissue was collected 1, 4, 8 and 12 weeks after each application.
- Nuts were inoculated with NOW eggs and adult moths were collected as they completed development on the marked nuts.
- All plant and insect material was delivered to the UC Davis Interdisciplinary Center for Plasma Mass Spectrometry (ICPMS) on 10/23/24 and we anticipate results from their analysis by February 2025.
- Demonstrate Elemental Marker Uptake in Plant Tissue and NOW Adults
- Over a two-year period, multiple replicate cohorts of almond and pistachio trees were sprayed four times over the season with different concentrations (high and low dose) of N15 and rubidium solution.
- Leaf and nut samples were collected just prior to the sprays and then 1, 5, 10 and 20 weeks after the spray.
- Nuts were inoculated with NOW eggs and adult moths were collected as they completed

development on the marked nuts.

- Elevated levels of both N15 and rubidium were detected in the leaf and nut tissue. Higher doses of each element led to greater concentrations of each marker in the plant tissue.
- Elevated levels of rubidium were detected in NOW adults when the applied dose was in a high concentration. Levels of N15 were also increased in NOW adults but it was not statistically different from the unmarked controls.
- Results suggest that rubidium could be a useful marker for the type of studies described above.