

THE SCOOP

on fruits and nuts in Stanislaus County

Navel Orangeworm (NOW) Hull Split Spray Considerations 2023

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Hull split is that time of the year when almond growers become both excited and nervous at the same time. Excited that the crop is maturing and near the harvest, nerve-racking as navel orangeworm (NOW) can obliterate the crop if not managed. So, there are three important things that growers and pest control advisers (PCAs) should keep in mind when planning for NOW management:

- 1) what are the nuts doing (i.e., hull split status of the nut)
- 2) what is happening with navel orangeworm flight
- 3) how to use information derived from tree phenology and pest population to make informed decisions.

1. Determining hull split status

Splitting of the almond hull is a natural process of maturation. The nuts on the southwest side and top of the canopy mature first, so checking for the hull split should start there first. Up to five percent of the nuts can have blank kernels, called “blank nuts”, split 1-2 weeks earlier and should not be confused with the sound nuts. Hull split timing varies among varieties, geographic regions, and weather conditions. The UC hull split prediction model (google “UC almond hull split prediction model” or use this [link](#)) helps to estimate the hull split timing in different locations based on the full bloom date and temperature. Based on the 2023 survey, the full bloom date for the Nonpareil variety at UC varietal trial location in Salida, CA, was March 1st. Using that date and temperature from the CIMIS Station #206 (Denair, CA), the projected hull split time for Nonpareil is July 21, at least 8 days later than the previous year. See the estimated hull split dates for major varieties for the recent seven years in the Table.

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The Scoop on Fruits and Nuts in Stanislaus County is a combined effort of UC Cooperative Extension Farm Advisors Roger Duncan, Jhalendra Rijal, and Abdelmoneim Z. Mohamed and covers topics on all tree crops, irrigation and soils, and associated pest management.

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Hull Split Calculator

Please Select a Station

Full Bloom Date

CIMIS Station

Cultivar	2023	2022	2021	2020	2019	2018	2017
NonPareil	07/21	07/13	07/15	07/14	07/15	07/16	07/12
Sonora	08/05	07/26	07/28	07/27	07/29	07/30	07/25
Price	08/08	07/31	08/02	07/31	08/02	08/03	07/30
Wood Colony	08/19	08/11	08/13	08/12	08/13	08/14	08/10
Winters	08/19	08/11	08/13	08/11	08/13	08/14	08/10
Aldrich	08/20	08/12	08/14	08/13	08/14	08/15	08/11
Padre	08/22	08/14	08/16	08/14	08/16	08/17	08/13
Butte	08/25	08/19	08/20	08/19	08/21	08/21	08/18
Ruby	08/30	08/22	08/24	08/23	08/24	08/25	08/21
Carmel	08/31	08/25	08/26	08/25	08/27	08/27	08/24
Monterey	09/01	08/24	08/26	08/24	08/26	08/27	08/23
Mission	09/03	08/26	08/28	08/27	08/28	08/29	08/25

2. Keeping track of navel orangeworm activity

Navel orangeworm has 3-4 generations a year. As temperature increases during the summer, the NOW development rate rises accordingly by accumulating growing degree-days based on lower (55⁰F) and upper threshold (94⁰F) temperatures. The first generation NOW (i.e., egg/larvae from overwintering moths and developed in mummy nuts) needs about 1056-degree days to complete one generation. However, Later generations that feed on seasonal hull split nuts can complete one generation much faster, about 700-degree days, due to the better nutritional quality of the nuts.

Three trap types (egg, female, and male) are common for tracking NOW seasonal activity in nut crop orchards. None of these traps can provide the exact thresholds, but information one can decipher from these traps is vital to determine spray timings. Figure 1 shows what's happening in the almond orchard regarding this year's NOW activity. This summary is based on multiple NOW traps (3 of each type – pheromone, Peterson, and egg) placed in orchards in the Modesto area. Later than previous years - the egg laying began on April 26 (i.e., biofix), and the egg counts in the trap have increased until the end of May; this is a much longer stretch of egg laying than the previous years in our experience, and the similar trend holds for male and female counts as well.

3. Strategizing hull split spray

Although the second-to-fourth generations of NOW can infest hull split almonds, the second generation is the most critical because it coincides with the Nonpareil hull split. This may not be the case for this year as NOW egg laying from the second generation is predicted to begin before the hull split by 10-15 days in the Modesto area. The 1050 degree-days from the spring biofix would be when we expect the beginning of the 2nd generation adult activities, and the projected time for that is July 5. If we add roughly 100 degree days (~4 days in July) for larval emergence, the first hull split spray timing would be July 9, while the predicted hull split in the Modesto area is July 21, so there is a clear gap between these two dates. Remember that both predicted second generation egg laying and hull split timing this year are later than most years. So, if you plan to apply hull split spray on a date based on your previous years' experience, you can be early by two weeks or more. Also, it is not advisable to apply insecticide to nuts that are not at hull split as NOW females are not attracted to those nuts to deposit eggs, or larvae won't survive on them if some lay eggs. In the absence of the hull split nuts, navel orangeworm recycles the mummy nuts for egg laying. Both parameters hull split and NOW activity can vary based on orchards and lo-

cations, and that's why it is vital to base your decisions by using your own monitoring and sampling data.

It is common knowledge that unless an orchard is in an isolated location with no other nut orchards nearby and/or has a history of low NOW damage and NOW activity, most almond orchards warrant 1-2 insecticide sprays at the hull split. Commonly used reduced-risk insecticides are effective against newly hatched larvae or eggs. These insecticides can have residuals for 2- 4 weeks. Still, a second application may be necessary for two weeks because of the appearance of untreated hull split tissue of Nonpareil and the beginning of the hull split in some pollinizers. Late-season susceptible pollinizers such as Monterey can be at risk from the third and fourth generations.

Insecticide options for hull split sprays

Navel orangeworm damage in almond orchards varies tremendously, even within the block. Due to such variations, the performance of even the most efficacious insecticides varies significantly. For NOW management, four groups of insecticides, in general terms:

- 1) pyrethroids/combo - broad-spectrum (e.g., Besiege, Intrepid Edge, Bifenthrin, Warrior II)
- 2) larvicidal - reduced risks (e.g., Altacor, Intrepid, Proclaim)
- 3) relatively soft and biological-based (e.g., SpearLep, DiPel, BT NOW, Rango, Neemix, Venerate)
- 4) for organic orchard use (e.g., Success or Entrust, DiPel, BT NOW, Venerate, etc.) are some of the options.

Figure 2 shows the relative efficacies of commonly available insecticides tested against NOW using insecticide-treated nuts. Since these insecticides were tested in nut strands prepared from the previous year's dry nuts, the overall infestation rate looks higher than the normal orchard conditions. However, these trial results still should provide a relative efficacy among insecticides tested. Keep in mind that broad-spectrum insecticides can negatively impact beneficial insects and natural enemies such as sixspotted thrips, the most reliable predator for mite control in almonds. Also, NOW resistance to pyrethroids has already been documented in the San Joaquin Valley. Having said that, there might be a situation when pyrethroid insecticides might fit, such as the case of green stink bug activity in the orchard migrated from other fields late in the season. The insecticide is just one component of the NOW IPM, so other non-insecticidal interventions such as winter sanitation, mating disruption, and timely harvest should be considered. Other best practices include using a suitable tractor speed- 2 miles/hour with enough water volume depending on the product, sprayer type, and tree structure, and applying spray during early morning or night when the weather condition is hot and dry.

Fig. 1. Average NOW counts/week in pheromone (solid line, y-axis) & Peterson (dash line, z-axis) and egg (patterned bars, left axis) traps. Numbers shown in the graph are weekly egg counts/trap

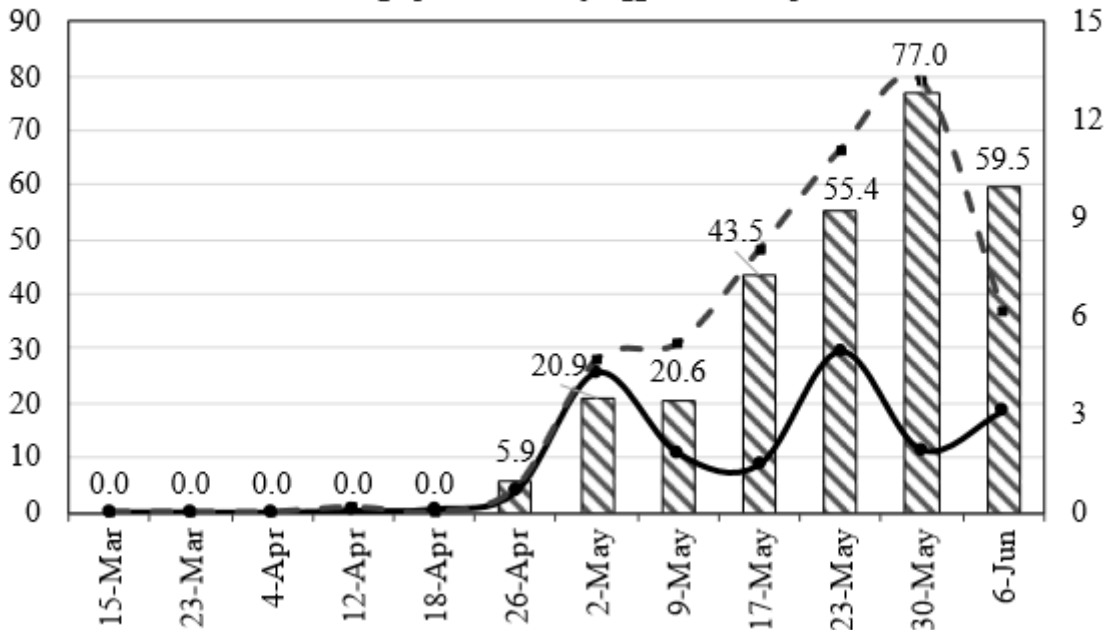
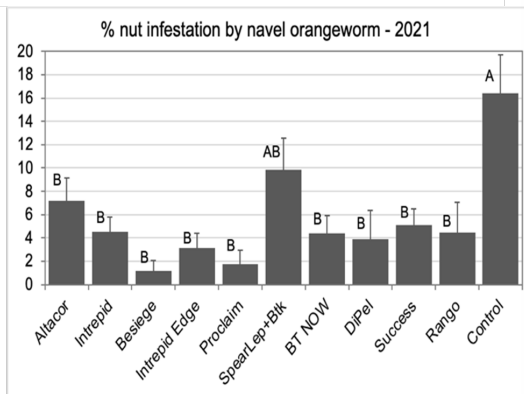
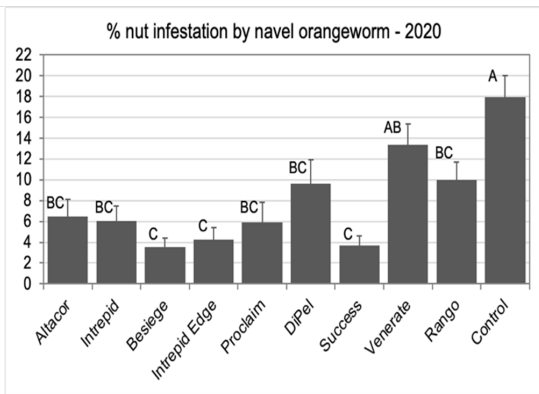


Fig. 2. Efficacy of various insecticide products against navel orangeworm. The products were applied in 1-ft long strand of 20 nuts glued together and put them out in the orchard to allow navel orangeworm for egg laying



Disclaimer: In this article, discussing research results requires the use of pesticide trade names, but this does not constitute an endorsement of the products, nor does it imply that other products are not available. Some products mentioned may be for experimental use only and included for informational purposes. Pesticide Label is the law! Please follow all instructions and safety precautions on the label when applying pesticide products.

Irrigation Non-uniformity is Unimportant Under Certain Situations in Orchards

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Micro sprinkler irrigation systems are commonly installed in tree crops and account for 50% of all the irrigation systems in California. Micro sprinklers are adapted to newly planted or replanted tree acreage due to their flexibility in irrigation schedule and the uncertainty of surface water during the recurring drought in California. Growers prefer these systems since they have a wider wetting pattern (5-8 feet) compared to drip irrigation, and they use less water than a sprinkler irrigation system. Micro sprinkler irrigation systems allow for root expansion and better water and nutrient uptake. They have many other advantages such as improved chemical applications, reduced weed growth, reduced salinity problems, broad use on different soils, reduced clogging from the larger orifice sizes, and reduced energy requirements. However, capital cost and salt accumulation near the root zone are major problems for these systems. Of course, they have the risk of nitrate leaching compared to drip irrigation and discounting irrigation during harvest to prevent wetting nuts on the orchard floor.

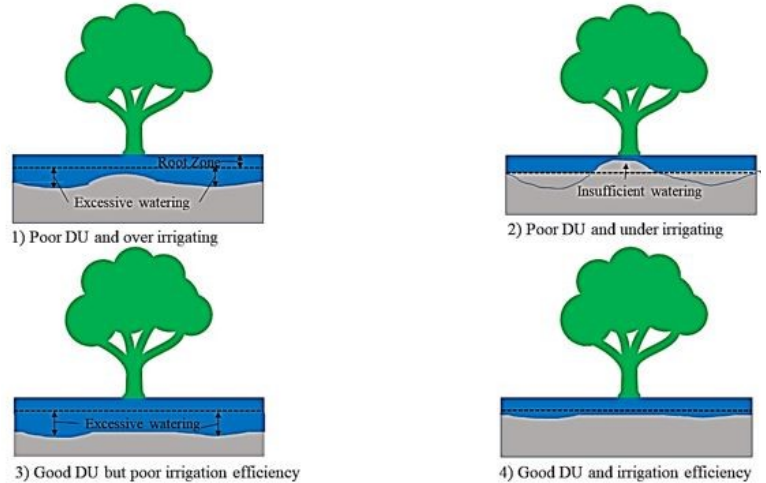
Irrigation uniformity means applying water uniformly and evenly distributed to the whole orchard. It is an important measure of the performance of irrigation systems and ensures evenly crop growth and nutrient uptake. Micro sprinkler irrigation is generally impacted by some degree of non-uniformity. Irrigation uniformity is calculated as follows:

$$\text{DU (Distribution Uniformity)\%} = \frac{\text{Average of low quarter depth of applied water}}{\text{Total average depth of applied water}} \times 100$$

The more % DU, the more efficient the irrigation system. However, an orchard can have a good DU but poor water application efficiency since more water is applied than trees need, and this can lead to nitrate leaching (Fig. 1). Application efficiency is the amount of water that reaches trees and beneficially used to the total amount of pumping water to the orchard. The optimal irrigation management practice is to have both a good DU and application efficiency.

The total water application is a function of DU, and many researchers found a strong relationship between yield and distribution uniformity. The above-mentioned equation does not account for water redistribution after infiltration from the soil surface to the layers below. The large variability from the catch cans test comes from the variability on a small scale that does not affect the trees since they have well-established roots that can

reach the water from neighboring areas. We proposed a method to adjust DU to account for the less important variability on a small scale. This method would adjust the gross water application for poor DU and save a significant amount of water. Irrigation systems should be designed to consider actual irrigation distribution uniformity.



When water is applied unevenly, over or under irrigation can occur in some parts of the orchard, significantly affecting irrigation performance, and thus, trees' yield. There are many causes of non-uniformity such as differences in operating pressure, emitter clogging, emitter flow variation, and elevation differences. Growers intend to over-irrigate to ensure the low areas are adequately irrigated. However, there are some conditions where non-uniformity is unimportant. This includes:

Multi-age trees

Due to some diseases, growers intend to replant young trees to replace the infected trees that are not producing anymore. Young trees are subject to a higher degree of non-uniformity. A good overlap pattern of sprinklers is important for these trees to ensure good growth. These new planting trees will require less water than mature trees. A grower should use different crop coefficients tailored to young trees for irrigation scheduling to meet their water demand and avoid over-irrigation. Design



micro sprinklers around these trees to apply less amount of water to match their evapotranspiration considering their small root zone by installing different nozzle sizes or control valves. This can affect the distribution uniformity in the orchard; however, irrigation non-uniformity is important in this case, and this would save a significant amount of water for growers dealing with this issue.

Soil spatial variability

Applying water evenly to the orchard without considering the orchard soil spatial variability (soil heterogeneity) and layering could cause over or under-irrigation in some areas of the orchard, leading to root diseases or yield and nutrient losses. Variable rate irrigation (VRI) is recommended in orchards with different soil types to apply a different amount of water based on the water holding capacity and infiltration rate of these soils. Irrigation uniformity will differ among VRI zones, and different DU tests should be conducted separately in these zones.

Areas without trees due to diseases

Tree diseases such as canker in almonds can lead to yield losses and eventually, tree removal. Continuing to apply water to this area would benefit neighboring trees; however, evaporation losses from the soil surface may contribute to major water losses. It is recommended to remove and block sprinklers in that area. This can cause irrigation non-uniformity, however, that is unimportant and in fact, saves a significant amount of water.



Salinity accumulation and nutrients uptake

Salts tend to accumulate more frequently in the low-watered area. Applying more water to these areas would decrease irrigation uniformity, however, irrigation non-uniformity, in this case, is beneficial to cope with this issue. Fertigation distribution uniformity (FDU) could be worse than irrigation DU, but how they interact is largely unknown in tree crops. We believe that areas with low water deliver poor FDU, however, the

irrigation non-uniformity would likely compensate for that. Some studies in field crops showed that non-uniformity irrigation has less impact on nitrate leaching.

Root growth

Given the fact that tree roots expand more under micro sprinkler than drip irrigation, the consistent non-uniformity as a result of the above-mentioned cases is less of a problem than inconsistent non-uniformity since roots grow to where there is water, and non-uniformity on a smaller scale is less of a concern. The horizontal movement of water below the soil surface and redistribution uniformity is more important than water distribution uniformity at the soil surface where it is available to roots and consequently affects yield.

Initial moisture content

Rainfall storms can cause extreme variability of water distribution to the soil surface; however, water redistribution and initial soil moisture content in the soil profile are more important to consider for the first irrigation in the season. Another key factor to consider for irrigation distribution uniformity is Agricultural-Managed Aquifers Recharge on orchards (Ag-MAR) in the winter while trees are dormant. Ag-MAR practice will likely pose more water at the end of the orchard.

Conclusion

Growers should adjust irrigation uniformity to consider the redistribution of water below the soil surface. This adjusted DU is more representative of the irrigation system's actual effect in the field and help prevent over-applying irrigation water to compensate. In some circumstances, like tree removal, replanted trees, and soil spatial variability, irrigation non-uniformity is unimportant and, in fact, saves a significant amount of water.

