UC IPM | University of California Agriculture and Natural Resources | Integrated Pest Management Program

Almond & Walnut Harvest Evaluation: Identifying Sources of Damage

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The 2017 almond harvest is underway and early walnuts won't be far behind. While the bulk of the in-season pest management decisions are behind us, now is the time for a key activity in your year-round integrated pest management (IPM) program – harvest sample evaluation.

Obtaining harvest samples and taking the time to crack out and identify the sources of damage is well worth the investment. Grade sheets alone will not distinguish among the various types of damage. Knowing the culprit provides valuable information, such as: How successful was my pest management program this season? How effective were my treatment decisions, timings, materials, and applications? What might I need to do differently next year?

Information from annual harvest samples should be kept to establish block-specific historical records, which help focus pest management activities in subsequent years. With worm damage, noting the size and stage of development (larvae, pupae, emerged pupae) indicates when the initial infestation occurred and can be compared with monitoring and treatment records to improve future pest management decisions.

Ideally, UC IPM guidelines recommend collecting a sample of 500 nuts per block at almond harvest and 1,000 nuts per block in walnuts. However, you know your orchards best. Obtain a **representative sample** of nuts from each block at harvest. In walnut orchards with two shakes, obtain a proportional sample at each shake. Collect nuts from multiple areas of the block. If you are collecting after nuts have been blown into rows, make sure to collect a stratified sample from the pile (not just nuts sitting on the top layer – infested nuts may weigh less and be a larger proportion of those on the top layer). Larger blocks may require more samples to provide an accurate estimate of damage identification. However, smaller blocks with a great deal of variation in pest pressure may require more samples than larger, more uniform blocks. Multiple years of sampling and site-specific historical records can help guide your harvest sampling process.

In a perfect world, samples should be processed soon after collecting. However, storing harvest samples and cracking out once things slow down is often necessary. At a minimum prior to storing for any length of time, refrigerate the samples, remove hulls within a few days of collection, and record any hull infestation or damage. This will limit rotting and movement of pests between nuts. Once hulls are off, relatively dry nuts will hold for a period of time in cold storage (refrigerator temperatures); however, freezer temperatures are best for longer term storage or when seeking to identify pest developmental stage.

Almonds: The main insect pests responsible for much of the damage observed at harvest in almonds include: navel orangeworm (NOW), peach twig borer (PTB), oriental fruit moth (OFM), ants, and plants bugs (leaffooted bug and stink bugs). If worms are present in your samples, they can be visually distinguished by the following key characteristics:

- NOW: Larvae milky white to pinkish with brown head capsule. Look for the dark crescent shapes on second segment behind the head capsule on either side (Photo 1).
- PTB: Larvae brown and white striped with dark head capsule (Photo 2).
- OFM: Larger larvae pinkish with brown head capsule (newly hatched larvae are whitish with black head capsule). Somewhat similar in appearance to NOW but without crescent-shaped markings. A hand lens can be used to detect presence of an anal comb on the last abdominal segment (Photos 3 and 4).

Photo 1. Navel orangeworm larva showing characteristic crescent-shaped marking.

Photo 2. Peach twig borer larva.

Photos 3 & 4. Oriental fruit moth larva (left) and anal comb (right).

Table 1 and Photos 5-8 summarize some key distinctions for determining the likely source of insect damage in almond harvest samples.

Table 1. Summary of insect damage characteristics in almond harvest samples.

	KERNEL DAMAGE	FRASS	WEBBING	BORING	FEEDING BEHAVIOR
NAVEL ORANGEWORM	Deep chewing into nut	Often quite a lot	Yes	Yes	Feed in groups
PEACH TWIG BORER	Shallow channels & surface groove on kernels	No	No	No	Generally solitary
ORIENTAL FRUIT MOTH	Shallow channels & surface groove on kernels	Very little, reddish-brown	No	No	Feed in groups
ANTS	Scraping or peeling of kernel skin, deep hollowing of nut, "sawdust" present	No (don't confuse "sawdust" for frass)	No	Hollowing	Varies
PLANT BUGS	Dark spots on the kernel	No	No	No	Piercing-sucking

Photo 5. Navel orangeworm kernel damage in almond.

Photo 6. Peach twig borer and oriental fruit moth kernel damage in almond.

Photo 7. Ant kernel damage in almond.

Photo 8. Plant bug kernel damage in almond.

Walnuts: Insect damage typically encountered in walnut harvest samples include codling moth (CM), navel orangeworm (NOW), and walnut husk fly (WHF). In addition, damage caused by environmental and physiological problems (e.g., sunburn, oilless nuts, water or nutrient stresses) and disease (e.g., blighted nuts caused by bacterial blight or the Botryosphaeria/Phomopsis fungal complex) may be evident in harvest samples.

- CM: Similar in appearance to NOW, but lacking crescent shaped markings (Photo 8).
- NOW: described above (Photo 1).
- WHF: Small, legless maggots. Early instars are whitish; older instars yellow (Photo 9). Other maggots you may encounter in the hulls of already damaged/dropped/blackened nuts belong to a different group of flies (vinegar flies). These are secondary invaders of nuts already damaged by other causes and do not require in-season treatment. Try to distinguish vinegar fly infestation from WHF damage at harvest. Vinegar flies are narrower in shape and remain white throughout development.

Photo 8. Codling moth larva.


Photo 9. Walnut husk fly maggot.

Table 2 and Photos 10-17 summarize typical damage associated with key walnut pests and disorders.

Table 2. Summary of insect and sunburn damage characteristics in walnut harvest samples.

	KERNEL	SHELL	HULL	FRASS	WEBBING	BORING	FEEDING BEHAVIOR
CODLING MOTH	Deep chewing into kernel	Entries may be visible	Entries may be visible	Frass at point of entry and in distinct feeding tunnel	Very little	Into husk and kernel	Single larva feeds per kernel
NAVEL ORANGEWORM	Deep chewing into kernel	Entries may be visible; Shells of heavily infested nuts appear oily	None	Often quite a lot throughout kernel	Often quite a lot throughout kernal	Into kernel	Larvae feed in groups; Can be many per kernel
WALNUT HUSK FLY	Shriveled, darkened kernels (early-season infestation); Little kernel damage (late-season infestation)	Shells stained black	Hulls blackened; Cannot be removed cleanly from shell	No	No	Into husk	Larvae feed in groups; Many per husk
SUNBURN	One side of kernel darkened and shriveled	One side of shell darkened	One side of hull darkened and shriveled; Can be cleanly removed from shell	NA	NA	NA	NA

Photos 10 & 11. Codling moth damage in walnut. Note that codling moth infestation does not necessarily result in a darkened kernel at harvest as shown (left). Earlier season infestation shown at right.

Photos 12 & 13. Navel orangeworm damage in walnut.

Photo 14. Walnut husk fly damage to walnut hull.

Photo 15. Walnut damage caused by sunburn.

Photo 16. Botryosphaeria-infected walnuts. Hulls of Bot-infected nuts will initially turn black and soft, but by late summer to early fall will dry to a black/brown color. (Photo: Themis Michailides)

Photo 17. Oilless nuts. (Photo: UCCE Yuba-Sutter, Skip Miller)

For more information, visit the UC IPM Pest Management Guidelines for Almond and Walnut at ipm.ucanr.edu and sacvalleyorchards.com