Whole orchard recycling

The process and management of second generation replanted almond orchards

Whole-orchard recycling (WOR) involves grinding whole trees into wood chips, spreading them evenly on the soil surface, then incorporating them into the soil before replanting. Almond Orchard 2025 Goals (https://www.almonds.com/almond-industry/2025-goals) promote the use of innovative, responsible, and sustainable growing practices that protect the farm of the future by finding high-value uses for orchard waste, including wood chips, to achieve zero-waste from orchards. The WOR approach may offer a sustainable method of tree removal that could enhance both air and soil quality without compromising tree health, yield, and economic benefits to growers.

"sustainable growing practices protect the farm of the future by finding high-value uses for orchard waste, including wood chips to achieve zero-waste from orchards"

Until recently a large portion of orchard waste was either burned in the field or used to generate power at cogeneration plants across the state. Air quality regulations have decreased the number of burning day permits, and most cogeneration plants are no longer accepting orchard waste.

WOR: an alternative to burning and cogeneration processing

There are over 1.2 million acres of bearing almonds in California. Of these, over 88,000 acres are over 20 years old and soon to be removed and require disposal. A majority of these acres will be replanted to almonds in the coming years. Until recently, a large portion of orchard waste was either burned in the field or used to generate power at cogeneration plants across the state. Restrictions on agricultural burning has decreased the number of permissive burn days, and most cogeneration plants are no longer accepting orchard waste.

Tree fruit and nut growers, who wish to remove dead trees and unproductive old orchards, need an alternative method of orchard removal that is sustainable. A decade worth of research on WOR points to increased yields, carbon storage, irrigation efficiency, and improved soil health (Holtz et al. 2018; Jahanazad et al. 2020). A 2,000-pound kernel per acre increase was observed during 6 years of production where trees were planted after the previous orchard was recycled in comparison to

Benefits of WOR:

- **Equal or better tree growth and yield**
- **Increased soil organic matter**
- **Improved soil fertility**
- **Enhanced soil moisture retention and improved infiltration**

trees growing where the previous orchard was burned.

How to implement WOR

From end of productive orchard life to replant

1. **Excavate** the trees are removed from the ground with as much tree roots and crown as possible.

2. **Grinding:** Trees are carried to a stationary horizontal grinder with a front-in loader, and ground into wood chips using either two-or-four-inch screen sizes that will limit chip size.

Smaller is better:

2-4" size chips will be less likely to interfere with orchard floor management activities or harbor potential pathogens

3. **Spreading:** Wood chips are loaded into modified manure spreaders and spread on the orchard floor.

Spreading the wood chips evenly one to two inches thick over the entire soil surface helps incorporate chips more easily

4. **Ripping:** Deep rip (5-6 feet deep) to break up soil compaction layers, hard pans, or to pull up large roots.

5. **Smoothing:** Stubble disks, plowing, or roto-tilling is needed to smooth out ruts, created by the ripper, and to incorporate the wood chips.

Stubble disk to incorporate chips and smooth the surface for planting

6. **Fumigate:** WOR has not interfered with fumigation efficacy in initial trials. The wood chips are generally incorporated in the top 6 inches of soil, the fumigant is injected deeper at depths between 18 and 24 inches
7. **Disk, level, build berms, install irrigaiton system, and planting** same as in conventional orchards. Attempting to complete orchard removal and replant in a few short months is very difficult. It is recommended growers take a year off between taking out an orchard and replanting. Potted trees can provide growers more flexibility to replant in the late summer or fall if desired.

Nitrogen recommendations

Years 1 and 2 after WOR

Rate: Research is ongoing but at this time 5-8 oz nitrogen (N) per tree after recycling is recommended in the first year. A recent study found no additional growth benefit with applications exceedin 9 oz N per tree in the first year after WOR (Holtz and Culumber, 2019). The 5-8 oz N is more than the 3 oz N per tree recommendation for the first leaf conventionally planted trees (Brown et al. 2020). Trunk growth data indicate trees planted after WOR reach the same size as conventionally planted trees by the end of the second season. Second year trees replanted after WOR can be fertilized with the standard 4 oz N per tree, no more than 6 oz is suggested.

Timing: N application soon after planting, in small frequent doses, has achieved the most succesful growth in WOR trials. Newly recycled and replanted orchards have a high soil C to N ratio, which immobilizes the available N for trees. One-quarter oz N in the form of triple 15 at planting time, applied every two weeks with each irrigation application resulted in significantly larger trees than conventionally planted trees (Holtz et al. 2020). No more than 1 oz N per tree should be applied in a single application during the first two seasons.

Timing is critical

Comparison of winter planted trees receiving different ratse and timing of N fertilizer. Tree on the left received 1st fertilizer (1.73 oz N) in April compared to tree (right) receiving 1st application (0.8 oz N) early March and 1.73 oz N in April.

Table 1 Nitrogen fertility recommendations for the first two seasons after conventional planting and WOR replanting.

	1st leaf	2nd leaf
	Ounces N per tree	
Conventional planting	3	4
WOR replant	5-8	4-6

References:

Holtz, B., Browne, G.T., Doll, D., Culumber, C.M., Yaghmour, M.A., Jahanzad, E., Lampinen, B. and A. Gaudin. 2018. Whole almond orchard recycling and the effect on second generation tree growth, yield, light interception, and soil fertility. Acta Hortic. 1219, 265-272 DOI: 10.17660/ActaHortic.2018.1219.41 https://doi.org/10.17660/ActaHortic.2018.1219.41

Holtz, B. and C.M. Culumber. 2019. "2019 Nitrogen Considerations". West Coast Nut, February, 2019, 14-18.

Jahanzad, E., Holtz B. A., Zuber C.A., Doll D.,. Brewer K.M, Hogan S., and A. Gaudin. 2020. Orchard recycling improves climate change adaptation and mitigation potential of almond production systems. PloS one 15 (3), e0229588

Brown, P.H., S. Saa, S. Muhammad, and S. D. Khalsa. 2020. Nitrogen Best Management Practices. Almond Board of California