



Cover Cropping in California's Water-Scarce Environments: COVER CROPPING BEYOND WINTER IN PERENNIAL SYSTEMS

WHAT IS EXTENDED COVER CROPPING? **Intentionally maintaining winter-grown cover** **through the cropping season**

Background

Cover cropping is increasingly common in California's perennial cropping systems. This has led growers to innovate with cover crop practices and ask how cover crops impact water use. More specifically, **how do water conservation and water consumption change if cover crops are allowed to grow beyond spring?**

Perennial crops offer the potential for extended, even year-round, cover cropping. Unlike annual systems, cover crops in perennial fields do not need to be terminated for field operations at the start of each growing season. This means growers can extend cover crop growth later into the season or even maintain living cover year-round if it aligns with their management goals and system needs.

Keeping soils covered can provide multiple benefits, including support for biodiversity, pollinator habitat, and soil health. At the same time, growers want to understand if there are

water trade-offs to consider. While cover crops can help increase infiltration of winter rains, lower soil temperatures, and increase soil moisture, there are concerns that cover crops increase water use during the spring and summer. These concerns are amplified as groundwater use restrictions come into effect. Local agencies are implementing pumping allocations under the Sustainable Groundwater Management Act (SGMA), making water budgets an increasingly important consideration for growers.

This fact sheet combines the latest research and grower interviews **to provide evidence-based answers to common questions about the water footprint of extended cover cropping.** It summarizes research findings on water benefits and water use, and outlines practical management considerations for keeping orchard and vineyard ground covered beyond the winter months.

The Research

Water benefits from delayed cover crop termination

Research shows that cover crops can improve water infiltration and reduce runoff. These benefits occur as cover crops lower soil bulk density, enhance soil pore networks, increase soil organic carbon and aggregation, and reduce surface crusting. Many of these benefits extend months beyond cover crop termination (Haruna et al., 2020, 2022; Mitchell et al., 2024; Marshall et al., 2025).

Delaying or skipping cover crop termination may also extend other benefits. Ground cover after winter can increase soil shading, improve soil health, and potentially increase soil carbon sequestration.

Studies in orchard and vineyard systems provide additional insights:

- In sloped orchards, inter-row cover crops reduced water runoff and soil erosion compared to bare soil (Gomez et al., 2018).
- In vineyards, cover crops may enhance vine-row soil moisture in summer months when serving as a mulch (Fernando et al., 2024).
- In orchards, ground cover management, compared to clean tillage, can significantly enhance soil moisture content in orchards (Ding et al., 2024).

Still, the timing of termination can influence crop performance. In a study of rainfed European Mediterranean farms comparing cover crops to weeds controlled with tillage, the olive and vine yield declined slightly when cover crops were terminated in mid- to late-spring. In contrast, early spring control improved yield in the study context (Gomez, 2017). Researchers attributed these differences to water stress related to reduced soil moisture.

Several factors influence competition for water between cover crops and permanent crops, including root architecture, irrigation system,

and the cover crop seeding area. Because of this variability, decisions about delaying cover crop termination should consider harvest condition needs, water and nutrient competition risks, and potential frost risks associated with certain species and management approaches.

Water use for cover crops varies with season

In California, typical winter conditions (low temperatures, limited sunshine hours, and shorter daylengths) create conditions for very low evapotranspiration (ET). As spring and the growing season arrive, the drivers of ET increase: temperatures rise, skies clear, and daylight hours lengthen.

Increasing temperatures in spring also increase atmospheric demand—how ‘thirsty’ the air is for water. At the same time, soils often contain substantial moisture from winter precipitation and irrigation, which contributes to increasing ET as the season progresses. As permanent crops develop more leaf area, tree transpiration increases. Over time, the expanding canopy may begin to shade the cover crops in the orchard alleys.

A recent study quantified water use of five almond orchards in the San Joaquin Valley. It found that there was no significant difference in orchard-level year-round water use as estimated by ET from orchards managed for bareground and those implementing varying degrees of regenerative practices, including cover cropping (Flynn et al., 2025).

The study found that:

- ET of cover crops is relatively low during the colder and wetter winter months.
- ET increases as temperatures increase in spring and summer months.
- After almond tree leaf-out, cover crops grow in the shade of the trees and the same data

suggests that there is no evidence of increased water use with cover crops grown in a year-round context.

In other words, cover crops may increase ET during the dormant almond season in winter, but in bare soil orchards, water losses can be just as high, if not higher, during the growing season. Soil moisture measurements within the same study sites were limited, but they indicate greater infiltration of moisture into the root zone at cover cropped sites (Flynn et al., 2025).



Implementation considerations

Grower experience can teach us how to effectively and practically implement year-round cover strategies to reach management goals while mitigating potential tradeoffs. The following management considerations and principles are relevant across varying perennial cropping contexts.

Irrigation systems impact: living vs. dead cover in summer

In micro-irrigated systems, plan for natural dieback of the cover crops in summer, but keeping the residues in place as long as possible will support soil protection and shading. Irrigation with more surface coverage may sustain living cover longer, which benefits biodiversity, water infiltration, soil nutrient cycling, and reduces erosion (DeVincentis et al., 2020; Wauters et al., 2023; Marshall et al., 2025).

Potential water use tradeoffs can be minimized by adapting irrigation systems. For example, dangling irrigation lines in tree rows can deliver larger drops to the soil surface. If feasible, **schedule cover crop seeding prior to the final irrigation of the season to maximize the use of already scheduled water.**

Within season management: reducing biomass to reduce water loss

When the permanent crop canopy does not yet provide sufficient shade to alleyways, reducing cover crop biomass can help manage water use. High mowing or well-managed grazing can reduce aboveground biomass and limit water lost to transpiration while still allowing cover crops to regrow later in the season. Depending on the attributes of the cover crop species, the potential for self-reseeding is increased with delayed or omitted termination and well-timed mowing, lowering the overall cost of continued management.

Residue management - even a dead cover crop keeps working

Dead cover crop residues continue to provide important soil benefits. Residues act as a **mulch layer that lowers soil temperatures and reduces evaporation** (Mitchell et al., 2024). In orchards where crops are not harvested from the ground, cover crops can grow, or residues can remain in place year-round.

In systems with on-ground harvest, residue management may be necessary to prepare

alleyways. Growers may graze until 90 days before harvest for crops harvested above ground per FSMA and National Organic Program (NOP) standards, or 120 days for on-ground harvesting per NOP. Growers may also mow or lightly disc during summer to help residues break down.

An important consideration is nutrient timing. Delayed or omitted cover crop termination may delay nutrient release from green manures, missing the timing of crop nutrient demands (Brito et al., 2025). Selection of cover crop species with quickly decomposing residues may also help overcome these challenges (Wauters et al., 2023). Even vigorous stands of cover crops at peak winter growth (Image 1) can break down over the summer in time to have clean alleyways for harvest (Image 2).

Stacked practices - combining practices can multiply benefits

Combine soil covers with other soil-building practices for even more water and soil benefits. Many growers find that cover crops work best as part of a larger soil health system.

Combining practices can amplify soil and water benefits:

- Combining cover crops and organic amendments, like compost, improves infiltration and water-holding capacity more than either alone (Tautges et al. 2019).
- Minimal tillage preserves soil channels made by cover crop roots and keeps carbon and water in the soil (Mitchell et al. 2017).
- Grazing offers a low-cost way to control biomass while recycling nutrients and reducing mowing passes.
- A diverse and stacked application of soil health principles is the most effective strategy to enhance multiple soil ecosystem functions in perennial semi-arid agroecosystems (Marshall et al., 2025).

These systems can look different in different



Image 1: cover crop stand in late March



Image 2: orchard floor ready for harvest

farm contexts, but all have the goal of building orchard resilience. Start with one or two manageable changes and build from there.

Species selection - the right mix depends on your goals and climate

Choose drought-tolerant species or species mixes for lower water use, better persistence through the summer, and weed suppression. Mixes that provide staggered growth could provide cover starting in the winter and continue through more of the summer. Multi-species mixes also help you achieve more benefits (e.g., nitrogen fixation) and provide a variety of deep and fine roots for soil structure, infiltration, and aggregate stability. Even resident vegetation (cover and “weeds” that emerge without planting seeds) can have benefits—it’s adapted to the local context and offers a low-cost entry point to maintaining perennial covers (Wauters et al. 2025).

Insights from Growers

BRET SILL SILL PROPERTIES

Kern County | Almonds | Grazed cover crops

Bret Sill is a fourth-generation farmer in Kern County, CA who manages a diversified operation that includes 1,800 acres of almonds on double-line drip irrigation. Since 2021, he has been planting cover crops across orchard middles with a custom, diversified cover crop mix.

After planting, Sill takes a very hands-off approach, saying the rest of his cover crop management entails “watching it grow.” Rather than terminating his cover crop, he works with a shepherd to graze the biomass. The sheep enter the orchard around Valentine’s Day and make their way across the acreage through spring and depart at least 180 days before harvest—well before the 120-day National Organic Produce Standard. By late spring or early summer, most of the living cover has died back, forming a mulch residue. At that point, Sill makes a few passes with a mower before harvest to prepare for an on-ground harvest.



BENEFITS

Sill has observed improved water penetration in the soil and notices a difference in how water penetrates when the cover crop is living versus when it is not. His soil organic matter content has also increased substantially from about 0.5% to 2% since he began cover cropping. He has also noticed lower soil temperatures and more earthworm activity.

WATER FOCUS

“I observe my orchard and use apps that help me track water movement through my profile. I have not seen cover crops using more water and can not say that they have greater ET. People have told me that they are going to use an inch of water per year. To me, that’s an inch well used. I think the benefits of cycling nutrients with grazing and increased organic matter outweigh whatever water the cover crops use.” - Bret Sill

CHALLENGES

Sill’s biggest challenge has been figuring out his planting strategy and finding or modifying equipment to fit his needs. He has experimented with different planter types, added disc blades to enable no-till planting, and tested various seed mixes to find what works best in his orchards. He hopes that, in the future, a wider, low-profile seeder with two seed boxes—allowing separation of large and small seeds—will become commercially available.

SILL’S ADVICE

“Start small, try it, and make sure it is working in your context. Cover cropping is really easy—you just plant them and let them grow. To me, it’s a no-brainer for us to do them every year.”

LangeTwins Family Winery and Vineyards manages approximately 6,000 acres of wine grapes, 1,500 acres of Estate grape vineyards, and several hundred acres of olives. They have used cover crops for the past 30 years and helped implement them into the LODI RULES for Sustainable Winegrowing Program—a 25-year-old set of management standards that encourages the use of cover crops.

Of their acreage, 120 acres, known as Twin Oaks, utilizes permanent undervine cover crops in addition to inter-row cover crops, grazed by sheep for maintenance. These vineyards use high wire trellises and drip irrigation. Seed mixes are selected based on each block's needs: erosion control mixes used on sloped vineyards and soil building mixes used on the valley floor. Around May, they bring in sheep to graze the cover to about one inch.

BENEFITS

For LangeTwins, improved soil health is the primary goal of cover cropping. Living roots in the ground also provide erosion control, improve water infiltration, and increase soil organic matter. By reducing dust and lowering temperatures, they provide a more comfortable environment for both visitors and workers. More broadly, cover crops improve the overall aesthetic of a vineyard.

WATER FOCUS

Despite in-season cover crop transpiration, they have not seen increases in vine water stress, and they find cooler canopy temperatures in the summer months. They believe that any early-season losses of soil-water due to cover crops are made up for by benefits later in the summer.

CHALLENGES

Currently, wine grape margins are very thin, so any cost of cover crop seed and management that does not have a good return on investment will be hard for growers to justify. Scaling is another challenge, as mixes that work best in one area may not be optimal in others. It is also hard to scale, as most seeding drills were designed for large open spaces. There are generational perceptions that depict a “hairy vineyard” (i.e. vineyard with ground cover) as counterproductive, but these perceptions are changing.

SUCCESS

Maria and Chris are proud that they were able to achieve 100% ground coverage in the Twin Oaks block, which can now be maintained herbicide-free. They believe that permanent ground cover has contributed to the exceptional quality of many vineyards.

ADVICE

Think about soil bed preparation before seeding so you can set the seed swatch width to avoid planting a zone that would be hit with a berm herbicide. Plan well, as the timing of getting a cover crop seeded can fall very close to a late grape harvest.

Justin Wylie manages 4,000 acres of mostly pistachios and citrus near Madera, CA, with cover crops used across much of the operation. Several of his pistachio orchards are certified regenerative and organic. The orchards are irrigated with double-line drip and microsprinkler systems.



To maximize return on investment from cover crop seed purchase, Wylie

monitors weather closely prior to seeding: waiting to seed until he is confident that forecasted rains will support strong germination. This means they often plant later than the recommended fall window (sometimes as late as December), with cover crops emerging in late January or February. This timing allows them to assess what native vegetation is popping up prior to seeding, so they can select seed mixes that complement what's already growing. If the weather conditions aren't favorable, they skip seeding that year and save their cover crop seeds for next year.

Currently, they disc then drill-seed the cover crop. They expect the need to disc to decline over time as continued cover cropping loosens the soil. In many blocks, Wylie seeds cover crops across berms and row middles. Their seed mixes typically include 10-12 species of mustard, legumes, and grasses. In pistachios, he selects plant species with high carbon-to-nitrogen residues, which decompose slowly, providing better floor protection and reducing dust. In almonds, he would opt for lower carbon-to-nitrogen residues to accelerate decomposition prior to on-ground harvest. Cover crops typically dry out and senesce around April or May, depending on spring rains. They may mow them once or twice, depending on accessibility.

BENEFITS

Justin began planting cover crops to improve water infiltration, build soil organic matter, flush salts after rains, and accelerate nutrient turnover by boosting microbial activity. After cover crop adoption, Justin started implementing additional regenerative and organic practices.

“The way I see it, we’re losing crop care tools, and global export markets are going to continue to drive things this way. On top of that, many current tools are losing efficacy as pests gain resistance. We need to increase natural resilience to pests in our cropping systems.”

WATER FOCUS

With full ground cover in place, they no longer see water pooling after it rains and feel confident that the water is infiltrating, avoiding soil saturation. Erosion has also decreased on slopes. Justin believes that enhanced soil water infiltration after rains is of enough value that it should be credited by their GSA.

CHALLENGES

Many pistachio growers would terminate cover crops early or avoid them altogether, owing to their potential to increase bug pressure and damage to pistachio shells. For Wylie, the last 5-8 years of production have not been impacted by their approach to cover crop management—they have some bug-related staining on blanks, but their overall quality and yield have not been adversely impacted.

SUCCESSSES

In addition to improved water infiltration, their cover-cropped orchards experience cooler temperatures. Organic matter has increased from around 0.5-0.75% to 2.5%. For them, higher organic matter corresponds to higher micronutrients in their pistachio saps and tissues.

ADVICE

Justin believes that, biologically speaking, a covered soil is the most productive. Reducing the amount of uncovered soil in orchards is the best way to boost a soil's capacity to store and turnover nutrients.



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Resources:

This report and other mentioned resources can be found at: <https://linktr.ee/CoverCropGuidance>



Additional resources:

- [NRCS Plant Materials Center](#)
- [Western Cover Crops Council](#) (WCCC)
- [WCCC Cover crop selection tool](#): a resource to select cover crops based on specific management goals, farm location, and establishment windows

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