Developing Cover Crop Systems for Almond Orchards

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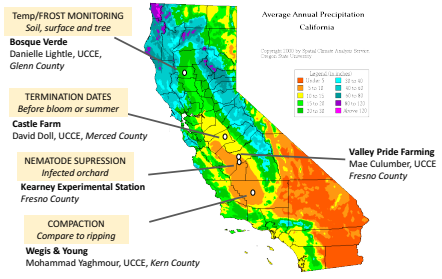
Introduction

Almond production in California is faced with multiple challenges associated with uncertainties of irrigation water supply. N and groundwater regulations, pollinator health and an urgent need to reduce its environmental footprint. Based on the BIOS project (Bugg et al., 1994) and farmers' experience, cover cropping is clearly compatible with almond production in California. However, it has not been widely implemented due to concerns regarding water usage, and push towards industrialized models to enhance almond productivity. Based on a recent Almond Board of California Sustainability survey, only 5.6% of growers keep a winter soil cover (planted cover crop). Renewed interest for soil health and ecological intensification is leading to a rising demand for soil-building resources and information on benefits and constraints of implementing cover crops in our unique Mediterranean climate. Literature suggests that cover crop trait selection could bring much-needed services to orchards including C sequestration, nitrogen fixation by legumes and non-chemical weed suppression. However, significant knowledge gaps remain to limit potential tradeoffs so as to make this practice relevant to different production regions and to increase the adoption and benefits of cover cropping at a larger scale. In particular, there is currently limited accurate data on water use requirements of cover crops and on the potentially increased risks of frost damage in the spring (Pritchard et al., 1989). Improved knowledge about opportunity costs involved with cover cropping could help develop strategies to enhance the sustainability of almond production in California.

Objective

Develop feasible and practical winter cover crop systems for almond growers, which maximize agronomic benefits and reduce operational concerns.

Experimental Sites



Site-Specific Studies

Compaction

What is the effect of cover cropping compared to ripping on soil compaction and resulting water infiltration and soil water retention?

Frost

How does cover cropping impact soil and surface temperatures and frost risk at blooming?

Termination date

How does termination date affect ecosystem services in orchard systems? (i.e. water usage, soil inorganic N dynamics, C returns…)

Experimental Design

4 treatments x 5 sites
RCBD, replicated

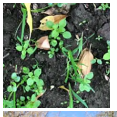
1) Soil Mix

(5 species/3 families) at 50 lbs./acre

BRASSICA
- ✓ 10% **Bracco White Mustard** (*Brassica hirtum*)
- ✓ 10% **Daikon Radish** (*Raphanus sativus*)

GRASS
- ✓ 30% **Merced Ryegrass** (*Lolium perenne*)

LEGUME
- ✓ 20% **Berseem Clover** (*Trifolium alexandrinum*)
- ✓ 30% **Common Vetch** (*Vicia sativa*)



2) Pollinator Mix

(5 species/1 family) at 8 lbs./acre

BRASSICA
- ✓ 15% **Bracco White Mustard** (*Brassica hirtum*)
- ✓ 20% **Daikon Radish** (*Raphanus sativus*)
- ✓ 15% **Nemfix Yellow Mustard** (*Brassica juncea*)
- ✓ 15% **Common Yellow Mustard** (*Brassica hirtum*)
- ✓ 35% **Canola** (*Brassica napus*)

Compared to

3) Perennial Resident Vegetation

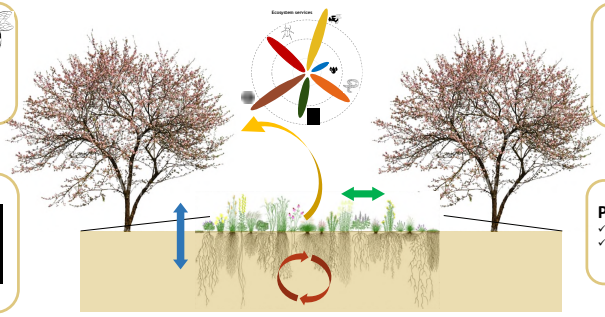
4) Bare soil – conventional herbicide control

Orchard measurements

Yields
- ✓ Almond yield productivity and quality
- ✓ Leaf nutrient & salt content
- ✓ Cover crop total biomass and C:N ratio

Water Usage
Dr. Jeffrey Mitchell, *UC Davis*
- ✓ Water mass balance model for each site
- ✓ Pressure bombing/Stem water potential of trees
- ✓ Cover crop evapotranspiration
- ✓ Neutron probes set to 7 feet depth

Pollination
Dr. Neal Williams, *UC Davis*
Kimiora Ward, *UC Davis Project Specialist*
- ✓ Average flower abundance (number of floral units/meter square)
- ✓ Visitation
- ✓ Spatio-temporal co-occurrence of flowers and animals (phenology)



Frost
- ✓ Monitor orchard temperatures from soil to tree (topsoil, 3 feet, 5 feet height) from December-March
- ✓ Orchard relative humidity
- ✓ Cover crop canopy temperature (IR thermometer)
- ✓ Monitor frost damage to tree at blooming

Weeds
Dr. Brad Hanson, *UC Davis*
Steven Haring, *Ph.D. Student*
- ✓ Weed pressure (square transects & number of weeds)
- ✓ Weed identity in each meter square section during cover cropping and after termination
- ✓ Total weed biomass
- ✓ C:N content of biomass

Pests
- ✓ Insect pest pressure
- ✓ Navel Orangeworm (NOW) monitoring

Parasitic Nematode
Dr. Andreas Westphal, *UC Riverside*
- ✓ Parasitic nematode host status of different cover crop species and mixtures (greenhouse study)
- ✓ Root-lesion and root-knot nematode monitoring
- ✓ Study of *Cratalaria juncea*, nematode suppressing cover crop

Roots & Soil Health
Dr. Amélie Gaudin, *UC Davis*
Cynthia Crézé, *Ph.D. Student*
- ✓ Biological analysis: microbial functional groups
- ✓ Chemical analysis: C:N cycling isotope study, organic matter content (%OM), root exudation characterization
- ✓ Physical analysis: aggregate stability, infiltration rate, water holding capacity
- ✓ Root functional trait assessment

Soil Food Web
Dr. Amanda Hodson, *UC Davis*
- ✓ Food web analysis (enrichment index and structure index)
- ✓ Nematode count, ID and group (i.e. entomopathogenic nematodes)
- ✓ Fungal feeders

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2017 California-Almond Cover Crop survey

This anonymous survey collects data on cover crop use in almond orchards and identifies the most important benefits and concerns of growers to shape research. We invite you to take this survey!

https://ucdavis.co1.qualtrics.com/jfe/form/SV_3UepPhXFE82QvS5