



**COVER CROPPING
IN
ORCHARDS & VINEYARDS**

Developed by

Fred Thomas

CERUS Consulting

and

Ann Mayse and David Chaney

University of California

Sustainable Agriculture Research and Education Program



Vineyard with bell beans.

Cover crops have been grown in orchards and vineyards at least since Roman times, when bell beans were planted between the rows of grapes..



Crimson clover in almond, Butte County.

Today cover cropping in California is a common practice that is being used or tested as a management tool in nearly all crops.



Alternate row cover crop for soil building. Annual rye and crimson clover, King City.

It used to be that only the small grower or the organic farmer used cover crops. Now, many larger ranches are experimenting by planting a portion of their acres to different cover crops.

Why do farmers grow cover crops in orchards and vineyards?

There are many reasons. In *General Viticulture*, published in 1962, there is a reference to creating high quality wine with the use of a cover crop.



Side-by-side comparison showing differences in water infiltration due to cover crops.

This improvement in fruit quality is most specific to grapes. But cover crops have other benefits that are more widely applicable in a range of cropping systems. The major ones are: improvements in soil tilth, increased water infiltration, and better soil fertility. These three benefits often interact. For example, cover crop roots encourage the growth of soil microbes, which produce substances that increase soil aggregation, which in turn leads to improved water infiltration.



Nitrogen fixation nodules on berseem clover.

Certainly the ability of legumes to fix 100 to 150 units of nitrogen is the reason many farmers initially consider cover crops. However it's usually the overall soil improvement that keeps them using cover crops. In vineyard production, properly managed cover crops can be used to stress vigorous vines in the spring to reduce vigor.



Erosion on hillside vineyard.

In the hilly terrain of California, the control of topsoil erosion has been promoted often with cost share funding from the Natural Resources Conservation Service. One of the best early guides to cover crops was *Cover Crops in California Orchards and Vineyards*, a USDA publication by Finch and Sharp.



Vineyard terracing and cover cropping for erosion control.



Weed suppression, subclover in almonds, Butte County.

The ability of cover crops to suppress weeds between tree and vine rows is often overlooked. This is a major benefit of using cover crops. Many farmers grow a thick winter cover crop and let it remain tall to discourage bermudagrass, puncturevine, purslane, nutsedge, yellow starthistle and other common weeds.



Syrphid fly on common vetch.

Another clear benefit from cover crops is that they can be used as insectary plants to bring in beneficial insects and spiders that feed on the pests. Growers often report reduced spider mite and leaf hopper problems in cover cropped and non-tilled vineyards. Some research has been conducted in this area, but many unanswered questions remain about whether beneficials actually reduce pest populations on tree and vine crops. Having a cover crop in an orchard or vineyard will usually increase beneficial insects compared to a clean cultivated soil, and will often prevent outbreaks of pests.



Lacewing eggs on bell bean.

**Farmers use cover crops
for specific purposes.**

There are also specific reasons for planting covers that are related to the cultural operations or special problems with the orchard or vineyard site.



Perennial clover in pears, Ukiah.

Most stone fruit growers, especially in Northern California where more rainfall occurs, have trouble getting into their orchards for mummy shaking, stump removal, and pruning during wet weather. A cover crop can help alleviate this problem.



Dust reduction, walnut sweeper.

Growing conditions in orchards and vineyards can be improved by reducing dust around the perimeter and during harvest operations. Air quality standards in farming areas will be more closely scrutinized in the future. Currently cover crops offer an important option in reducing airborne dust.



Cahaba white vetch.

For San Joaquin Valley growers and others, nematodes have always been a problem. Now that there are fewer chemicals registered to combat nematodes, many growers are searching for alternatives. Although limited research-based information is available, some growers are turning to rotations of cover crops such as sudangrass, mustard, Cahaba white vetch, cowpeas, and others to eliminate specific nematodes.



Mustards in bloom in walnuts, Sutter County.



Barley cover crop prevents nitrogen leaching in a Napa County vineyard.

The use of a winter cover crop will help reduce nitrogen leaching by winter rains. Barley, oats, and triticale are planted between vine rows of sandy Central Valley vineyards to help capture nitrogen, and recycle it following incorporation.

**Can't cover crops create problems
by making trees more susceptible to
frost, encouraging gophers, and
increasing water use?**

Yes, they definitely can cause production problems. When the proper cover crop is selected to match the cropping system, however, problems can be minimized or eliminated.



Frost hazard, walnuts.

Cover crops can increase the danger of frost damage to newly emerging leaves and blossoms of trees and vines. Bare soil that is firm and moist is best for storing solar heat during the day and re-radiating the heat during the night. A tall, dense cover crop stand can reduce nighttime temperatures by up to 5 or 6 degrees F; however, orchards or vineyards with closely-mowed cover crops and moist soil may be only about 1 degree colder than bare soil, and alternate row cover cropping may make the difference even less. If you are not sure you'll be able to mow, consider planting low-growing cover crops. Grasses may increase frost risk because frost-nucleating bacteria that live on them can migrate to the trees. Again, if mowing can be done before bloom then frost damage can be avoided.



Gopher escaping flood irrigation.

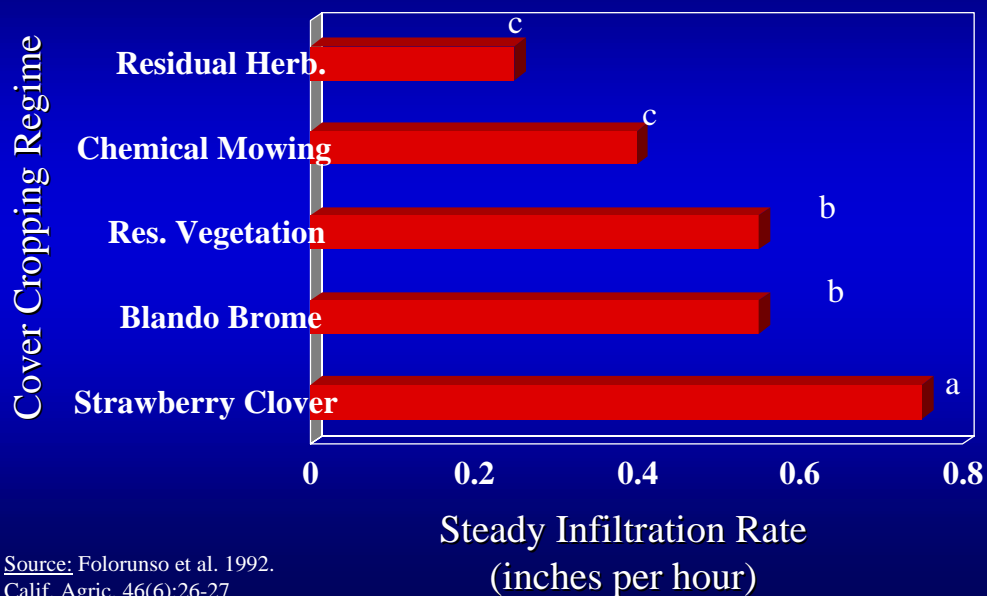
Having a standing cover crop in the spring provides additional cover for gophers and prevents predators from finding them. Also a cover crop mix that includes tap rooted perennial legumes like alfalfa, strawberry, white or Berseem clovers, trefoil, and even radish will almost always increase an existing gopher population. Squirrels on the other hand do not like cover and will usually establish colonies in open areas.



Trash at harvest, grass residue.

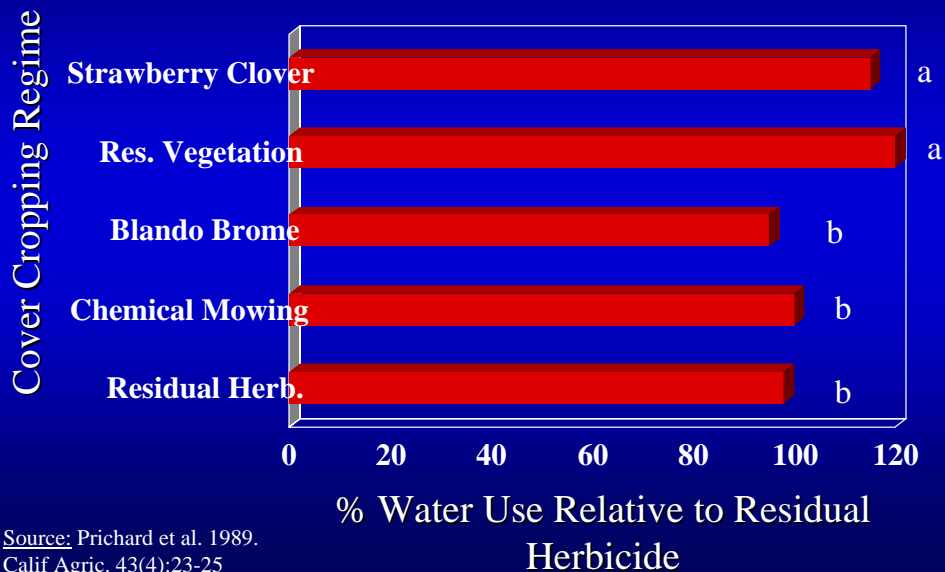
For almond growers, and to a lesser degree walnut growers, trash at harvest is always a large concern. To prevent cover crop residues from being a problem in nut harvesting operations under non-tillage, it is best to grow a legume cover crop mix which will easily decompose during the summer. Most often the trash at harvest is from summer grasses.

Cover Crops Affect Water Infiltration



In UC research looking at water use in a sprinkler-irrigated orchard in Merced County, the type of cover crop affected the amount of water use. The graph of this trial shows extra water use by the perennial clover during the summer months, but the amount of water used by Blando brome was in fact equal to the amount of water used when Roundup spray was applied. Winter growing annuals that rely upon rainfall tend to not use very much extra water and sometimes even help conserve soil moisture during the summer with a surface mulch.

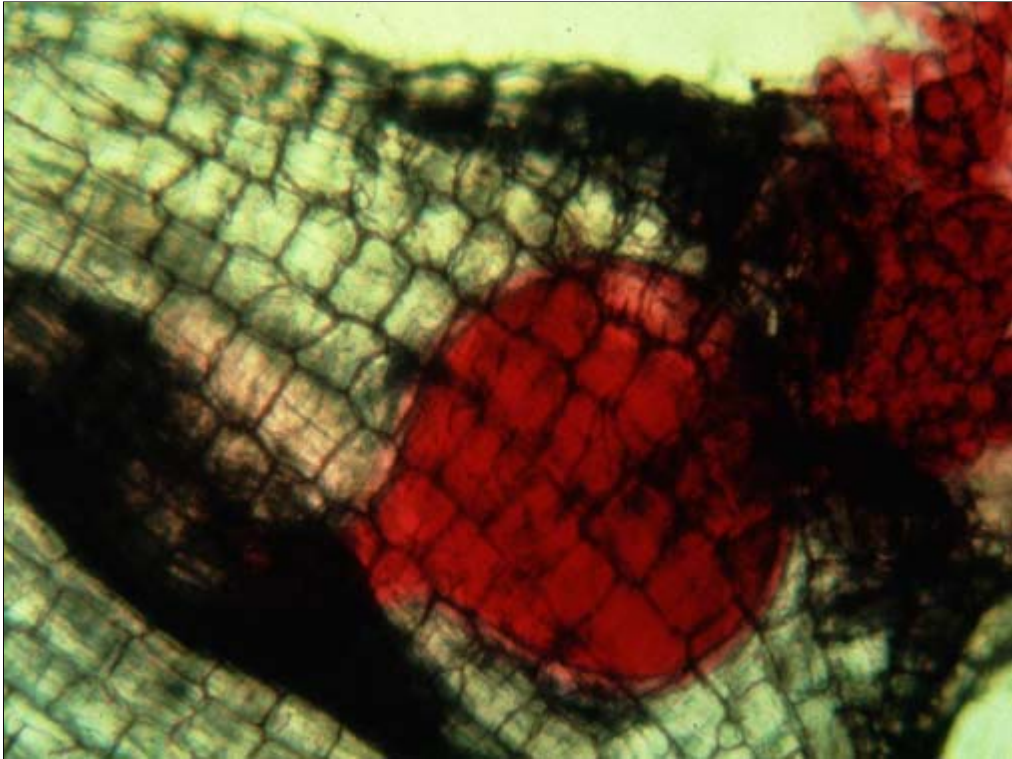
Effects of Cover Crops on Water Use





*Disease increase. Severe brown rot (*Monilinia laxa*) in apricot.*

Some people believe that a lush spring cover crop may lead to extra brown rot, shot hole, rust, mildew, and other fungal diseases, although this relationship has not been tested. If the orchards have protective sprays, this problem is minimized. Other concerns center around the inclusion of specific cover crops that may vector diseases such as Pierce's Disease or Cherry Buckskin. However, this question needs further research.



Female root-knot nematode in root, with egg mass on outside.

Nematode populations may increase by using the wrong cover crops, especially cover crops that grow during the summer.

Isn't it cheaper to buy nitrogen fertilizer than to plant a cover crop?

Yes. Ever since synthetic fertilizers replaced legumes as the source of nitrogen in the 1940s, the appeal has been the cost savings and ease of application over organic sources. While nitrogen is always a nice benefit from growing a cover crop, most often the greater benefits are improved water infiltration, increased cation exchange sites, and orchard and vineyard access.



Cover crops offer a long term return, soil under common vetch.

The effects of growing a cover crop are usually noticeable for several years and the cost of this management practice should be amortized over several years to properly compare the costs of cover cropping versus synthetic fertilizers, much the same as one would do for an application of gypsum or potassium banding.

Considering all the potential benefits and problems, how do I choose the right cover crop for my situation?

Most people go through a selection process based upon desired benefits, and the physical limitations and management of the orchard or vineyard.



Perennial ryegrass and creeping red fescue in prunes.

The process of selecting the right cover crop species begins with a close look at your cultural practices. A key consideration is whether you mow....



Grapes being cultivated.
...or disc.



Walnut micro-sprinklers.

The next important item to consider is the amount of rainfall and irrigation that is available during the year for the cover crop. This determines whether the cover will be grown in the winter, the summer, or not at all. Full irrigation with solid set sprinklers allows a wide range of choices, but drip or dryland culture limits the choices to winter annuals or drought-tolerant perennials.

When selecting a cover crop, consider:

Soil Characteristics
soil type, depth, pH

Field History
weeds, nematodes, diseases

Vineyard or orchard characteristics must also be considered so the cover crop and management do not create problems. Even with surface irrigation, a sandy soil will support a cover crop such as barley or Merced rye better than oats. A vineyard on sandy soil with a drip irrigation system cannot support a perennial sod unless it is in or near the coastal areas. Some plants are very specific in their pH requirements and while most will do well on slightly acid soils, when the pH climbs above 8.0 the choices are limited to barley, medics, fescues, trefoil, strawberry clover, and other alkaline adapted plants.



Prune orchard with star thistle.

This prune orchard with star thistle should be planted to a weed smothering winter green manure which will block the sunlight and smother the star thistle.

What are your objectives in planting a cover crop?

By far the most important part of the selection process is to choose a cover crop for the purposes that you have determined to be integral to your management goals and objectives.



Effect of driving on wet soil in peach orchard, Sutter County.

While farmers would like nitrogen, the need for winter access for spraying may necessitate planting a grass sod. The additional soil improvement and improved water infiltration will be side benefits.



Perennial grass in prunes.

Information Resources

- ⇒ **UC Cooperative Extension**
- ⇒ **Publications**
- ⇒ **UC Sarep Cover Crops Database**
- ⇒ **Neighbors and others with experience growing cover crops**

It can be difficult to sort through all the information and research on cover crops, so where can I get help in deciding what's best for my particular system?



Farm Advisor Lonnie Hendricks (R) with Glenn and Ron Anderson

Your local Farm Advisor has seen what works best over the years and will be able to provide assistance. For in-depth information, UC SAREP has an extensive database available on the Internet of the characteristics of many different cover crop species. Another place to get information on what works best for your particular soil, climate, and crop is to ask neighbors who are using cover crops. Most are glad to share their knowledge and can often help you avoid the mistakes they have made.

**An important tip for new cover
crop growers**

**Inoculate legume seed with
correct nitrogen-fixing bacteria**

There are many good hints on how to be successful with cover crops



Pouring inoculant directly on to seed.

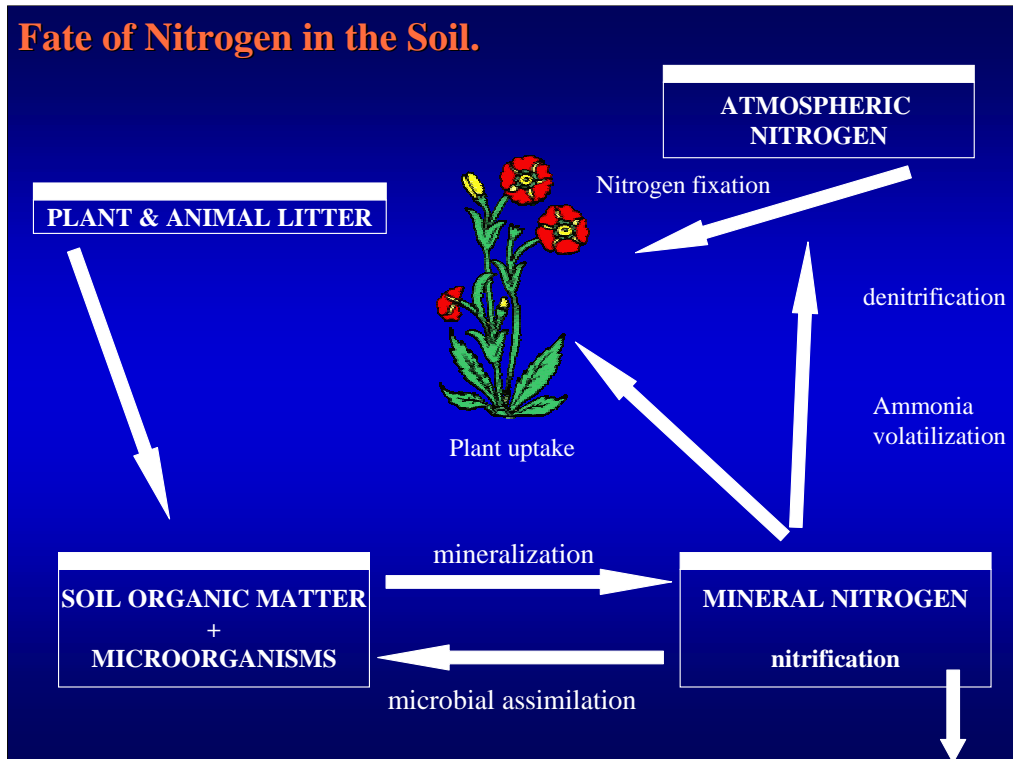
Making sure your legumes, such as vetch, peas, bell beans, clovers, medics, and cowpeas are inoculated with nitrogen-fixing bacteria is very important because they will grow poorly or die without the bacteria. Most small seeds are pre-inoculated by the seed suppliers, but large-seeded legumes must be inoculated prior to planting.



Effect of proper inoculation on growth of rose clover.

The bacteria has to be specific to the particular species of legume. While the soil already contains Rhizobium bacteria, inoculation saturates the seeds with the proper type of bacteria, ensuring adequate colonization and effective nodulation.

Fate of Nitrogen in the Soil.



Rhizobium and Nitrogen Cycle.

The role of nitrogen fixation in the nitrogen cycle is explained in this illustration. The bacteria infect the emerging root, grows inside and lives off of the plant nutrients. In return the bacteria is able to absorb nitrogen from the air in the soil and fix it into usable protein molecules for use by the plant.

Other Strategies for Growing Cover Crops

- ⇒ **Plant early**
- ⇒ **Control weeds**
- ⇒ **Irrigate after planting when possible**
- ⇒ **Use a starter fertilizer on grasses**
- ⇒ **Plant mixtures of cover crops**

Other methods which help ensure success include planting early, controlling the weeds before planting, and irrigating for maximum growth. Another method often used on lighter soils is the addition of starter fertilizer such as 16-20-0 in the same drill row as the seed. This will supply the legumes with the phosphorus and sulfur they need. Another helpful practice is to plant compatible mixtures of cover crops. This practice will guard against the complete elimination of the cover crop stand by a pest, disease or other adverse conditions.

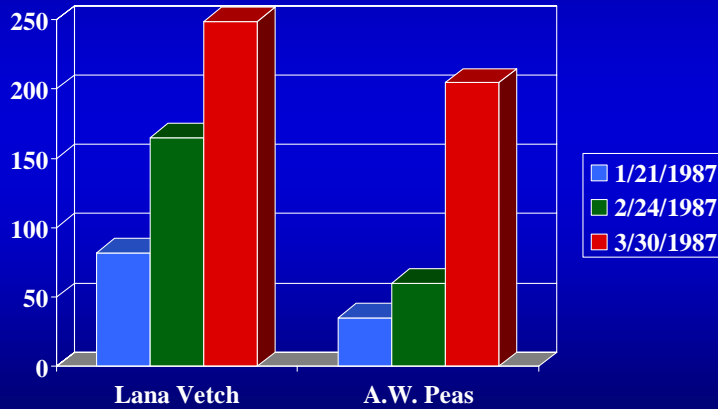


Flail chopping lana vetch.

How soon can I remove the cover crops? You can remove the cover at any time, especially to prevent weeds from going to seed or for frost control. However, the benefits of weed suppression, biomass production, and nitrogen fixation should be considered, along with the possibility of allowing annual clovers or vetch to set a seed crop for next year.

Content in Aboveground Biomass (Davis)

Planting Date: 10/16/86



Covercrops for California Agriculture. 1989

Nitrogen fixation data.

Nitrogen fixation is always greatest when the cover crop is allowed to grow until flowering. At this point the legume has reached the best balance of nitrogen and biomass. Thereafter, biomass continues to increase, but the nitrogen is partitioned to seed production.



Mow for trash control, remnant strip left in orchard.

Mowing the cover crop is often necessary, but doing it in such a way as to avoid excessive clippings requires careful management. Early mowing can lead to summer grasses and then more trash. Mowing too late can also lead to the summer grasses pushing through and causing problems. A thick stand of legumes is the best defense. Mowing should be accomplished before the cover crop grows out of the soft, high-nitrogen stage to the fibrous high-carbon / low-nitrogen stage.



Power spader at work.

Usually disking or incorporating a cover crop is easy unless there is too much biomass or is allowed to grow to maturity and dries the soil. Often a knock down mowing with a rotary mower helps to make the incorporation more manageable.



After incorporation.

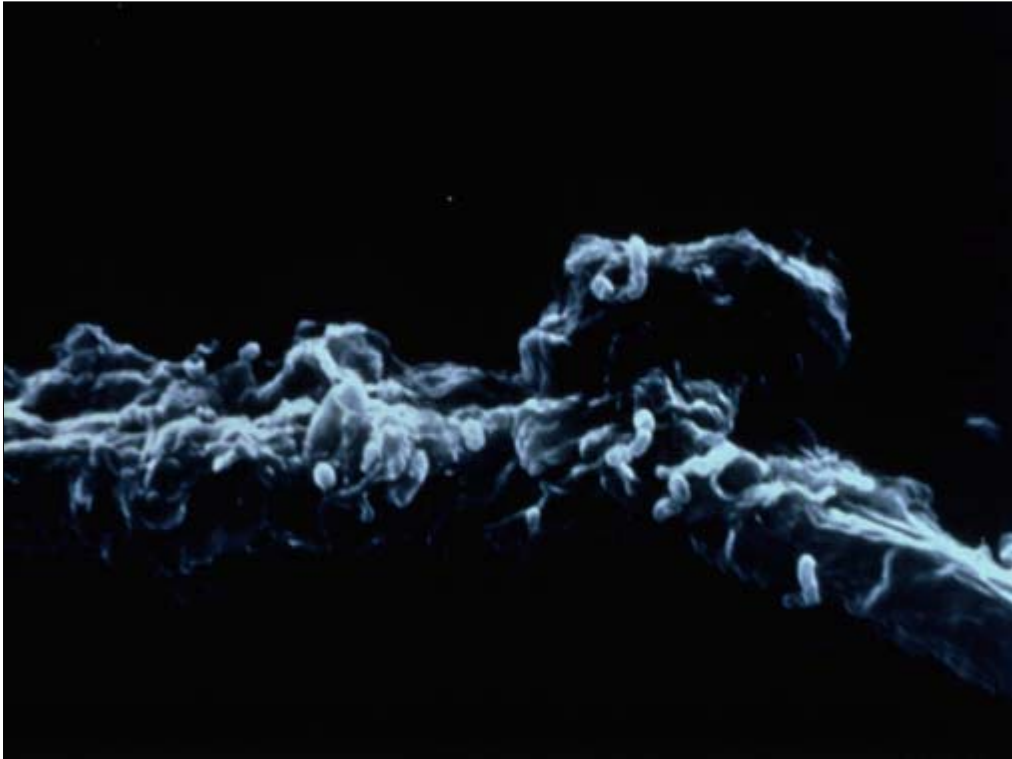
Is there anything else I need to know about cover crops?

Yes. Most of the benefits of a cover crop occur in the soil after it has been mowed or disced.

Farming the Soil

Bacteria
Fungi
Nematodes
Earthworms

There is a whole set of events that happen during the decomposition of cover crop tops and roots. When the cover crop is disced in, one-celled bacteria first breakdown the plant material. Aided by moisture and warm soils, up to half of the nitrogen from a legume cover crop can be released within 7 or 8 weeks.



Bacteria.

Once the bacterial bloom has started to die, fungi and actinomycetes move in to clean up and decompose both bacteria and cellulose material. This type of nutrient cycling is much more prevalent under no-till orchards and vineyards than the bacterial decomposition which thrives on aeration provided by discing.



Fungi and actinomycetes.



Predaceous nematode ingesting another nematode.

Most nematodes aren't pests. Many graze through the soil feeding and recycling fungi, bacteria, plants, and other nematodes. Plant parasitic nematodes are the ones we are most concerned about, but in reality they are a minority. The main recyclers are the non-parasitic nematodes whose populations grow with the addition of carbon to the soil from the cover crops. Cover crops get carbon by extracting it from the air as CO₂. More cover cropping results in increased soil carbon material, which feeds the herds of nematodes, which in turn fertilize the crop with their waste.



Earthworms (3 types).

Farmers have traditionally equated earthworms with good fertile soil. These animals, as well as the complex of soil feeding insects, are good visual indicators of a healthy soil system.



Annual clovers in almonds.

A lot of orchardists are using cover crops successfully,



Crimson clover in grapes.
...as well as many vineyardists.



California native grasses in grapes, Lodi.

No matter what kind of crop,....



Strawberry and white clover in kiwis.

...climate, soil, irrigation system or management,



Green manure mix in citrus.

...there is a cover crop that will work effectively to help you reach your goals.



Strawberry and white clovers in prunes.

By experimenting with cover cropping, you will gain experience,



Perennial grass.

...in how to improve the soil and production of your ranch or farm operation.



Lana vetch climbing grass.



Clover.



Crimson and rose clovers.



Zorro Annual Fescue cover crop in vineyard, Napa County.



University of California

Division of Agriculture and Natural Resources

Sustainable Agriculture Research and Education Program

**Thank you to all who helped develop this slide set,
particularly Chuck Ingels, Glenn McGourty, Lonnie
Hendricks and the many individuals who shared their
slides.**