



**COVER CROPPING  
IN  
ROW & FIELD SYSTEMS**

# Developed by

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For thousands of years, farmers have known that crop rotations are important for maintaining agricultural productivity. Descriptions of crop rotations can be found in early writings from China, the Roman Empire and from Ancient Greece.



*Commercial fertilizer spreader.*

During this century, however, the trends toward specialization, mechanization, and agrichemical inputs have significantly reduced the length and diversity of the rotations that farmers used in the past. These trends have resulted in dramatic yield increases, but the lack of diversity in today's specialized agricultural systems carries some potential negative consequences: Cropping systems are frequently plagued by increased economic risk, pest outbreaks, and a degradation in soil quality.



*Berseem clover.*

Given these problems, farmers and ranchers are showing a renewed interest in rotations, and in cover crops as a part of those rotations. Most farmers and crop advisors are aware of the benefits of cover crops. However, there are questions about economics, and cover crops are often considered only as a last resort when the soil has become unresponsive to continued high-input methods. Let's look more closely at some of the reasons for growing cover crops as a regular practice in row and field crop systems.



# **Benefits of Cover Crops in Row and Field Crop Systems**

- ➔ **Nitrogen supplied by legumes**
- ➔ **Improved soil tilth and water infiltration**
- ➔ **Reduction in diseases and nematodes**
- ➔ **Weed control**
- ➔ **May trap nitrates to prevent leaching**

There are five important benefits of growing cover crops in row and field crop systems, listed here. We'll look at each one briefly and then weigh them against several potential risks.



*Nitrogen fixation nodules on berseem clover.*

A legume cover crop can provide sufficient nitrogen for the cash crops that follow it. Cover crops such as cowpeas, bell beans and vetch can supply from 50 to 200 units of nitrogen. However, since synthetic commercial nitrogen is still cheap, few farmers or ranchers would consider using cover crops if added nitrogen were the only benefit.



*Soil under common vetch.*

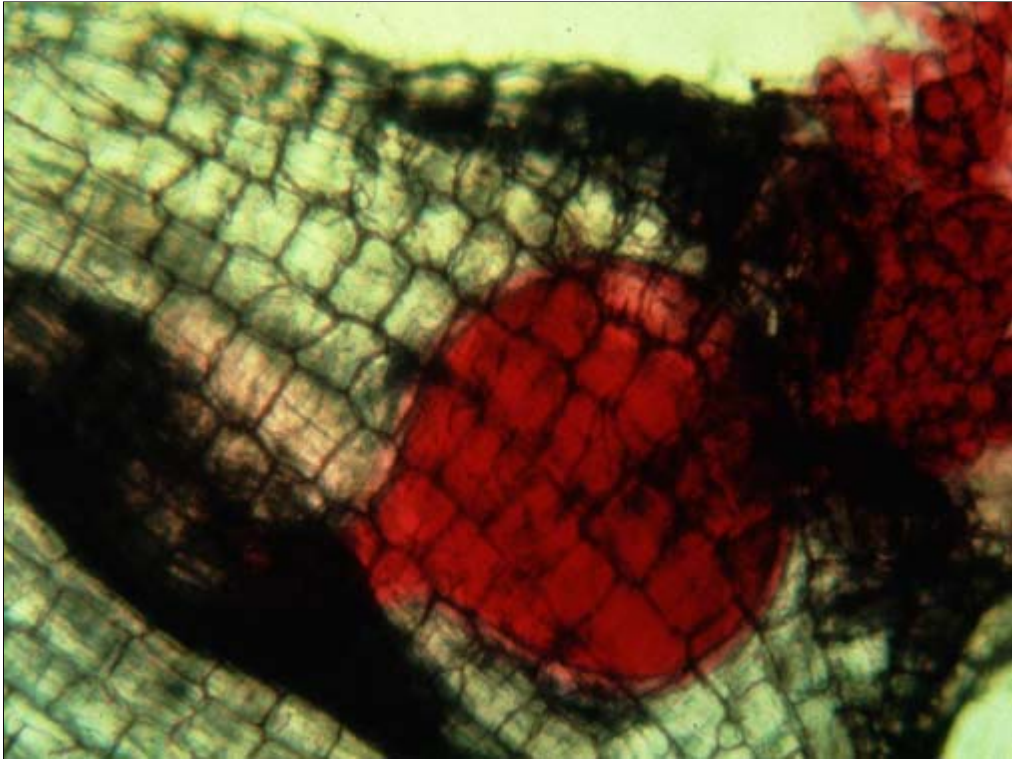
In fact, cover crops offer much more than nitrogen. Cover crops also improve soil structure and tilth. This benefit is often observed for several years after the cover crop is grown, and is the result of microbial decomposition, increased soil pore space and additional cation exchange sites for nutrients. Soil improvement is often the reason for cover cropping on heavy soils or intensively farmed and compacted fields. Adding organic matter through cover crops is often a low-cost, effective method of improving soil structure.





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

Another benefit related to soil structure is an improvement in water infiltration during the rainy season and during irrigation. This advantage is particularly important in heavy soils or those with clay pans or silt layers.



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

Growing and alternating cover crops such as barley following tomatoes, vetch following wheat, or rye grain before lettuce can be a very effective way of reducing the buildup of soil-borne pathogens. Other cover crops can be used to reduce populations of plant parasitic nematodes. Phacelia or oil seed radish, for example, can be used as cover crops prior to sugarbeets. Or, nematode-resistant varieties of cowpea can be grown before planting tomatoes.



*Lana vetch cover crop.*

Cover crops can also be an effective weed control tool, particularly where herbicide resistant weeds and plantback restrictions are issues. A cover crop can break the life cycle of a particular weed species, or act as a mulch or cover that suppresses weed growth.



*Sudangrass following melons.*

Some cover crops can act as nitrate trap crops. Phacelia, barley, or sudangrass covers are grown after the commercial crop to trap and recycle excessive nitrates rather than allowing them to leach into the groundwater.



## **Aren't there also risks involved in growing cover crops?**

Yes. One of the first to consider is how a cover crop will affect disease-causing organisms in the soil. Growing the wrong cover crop with inadequate rotations can cause serious problems. For example, a vetch cover crop can increase sclerotinia in a subsequent lettuce crop because it is a host for the organism that causes the disease. Cover crops, like cash crops, should also be rotated to give optimal results.



**During the last drought period, I had just enough water to grow my regular crops. How will I be able to grow a cover crop, too?**

Another consideration in growing a cover crop, especially in the water-short San Joaquin Valley is that cover crops may need supplemental irrigation to get established, or water stored in the soil may be used by the cover crop during its growth season. However, with a successful soil-building program, enough extra water can be stored in the soil during the winter for both cover crop growth and cash crop growth.



*Discing in a vetch cover crop using an asparagus disc.*

Water use is a double-edged issue that is tied to rainfall patterns and soil types. For example, during a wet winter, growers may be unable to remove the cover crop in time to plant the commercial crop and hit the higher value market window. In drier years, when soil moisture is lacking, growers can incorporate their cover crop in ways that maintain as much soil moisture as possible for the subsequent crop. These risks and problems can be mitigated by the right choice of cover crop, planting date, equipment and tillage practices.



*Cut worm.*

For the first three or four weeks after a winter-growing cover crop is incorporated into the soil, populations of soil insects such as cut worms and wire worms may increase because of the added organic matter. Many tomato, cotton, vegetable, and corn farmers have been hit hard by these pests if they rush the planting schedule and don't use some method of control. Seed corn maggot can also be a serious pest where cold, wet soil conditions follow the incorporation of large amounts of green manure cover crop biomass.



*Weedy cover crop.*

Unless managed carefully, cover crops can also lead to the build-up of noxious weeds, such as fiddleneck in vetch. To avoid such problems, careful attention must be given to soil characteristics, field history (particularly of weeds, nematodes, and diseases), and the biology and growth habits of the cover crop you have selected.



## Sample Cover Crop Seed Costs

<u>Seed</u>	<u>Cost per acre (\$)</u>
Green manure mix	50
Cowpeas	35
Bell beans	40
Field pea	35
Lana vetch	42
Barley	15

Another major consideration is the cost of the cover crop seed. As shown in this chart, there is great variation in the cost per acre of different species. These costs must be weighed against the potential gains the cover crop offers: providing nitrogen and other soil nutrients, improving soil tilth, and pest and disease control.





*Peppers near Gonzalez.*

When all of the costs of seed, planting, extra management, discing and incorporating, waiting for residue breakdown, and difficult scheduling are added together it is easy to understand why field and row crop farmers may be hesitant to make extensive use of cover crops like their tree and vine crop neighbors.



*Ventura County strawberries.*

Additionally, in many areas of California where land values are high or where land is leased on a short-term basis, the incentive to grow cover crops is further reduced. The opportunity costs are just too high and growers are forced to grow high-value cash crops on a continuous basis.



*Lana vetch smothering commercial wheat crop, Yolo County.*

Growing a good cover crop involves many tradeoffs. In the Sustainable Agriculture Farming Systems project at UC Davis, for example, where Lana vetch was chosen as the legume for cover cropping, the carryover of hard seed caused an increase in the amount of volunteer vetch until it became a weed in subsequent cash crops. Choosing peas or bell beans would have avoided this, but at a higher seed cost. Early maturing barley, mustard, sesbania and various hard seeded legumes can also become potential weeds requiring extra management.

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

There are risks and potential drawbacks involved in growing cover crops. When the proper cover crop is selected to match the cropping system, however, problems can be minimized or eliminated. This raises the question of how best to do that. An important concept developing out of the West Side Biologically Integrated Farming Systems project in the San Joaquin Valley is the *Window of Opportunity*.





### *Tomatoes.*

Growers on the West Side of the San Joaquin Valley find it difficult to justify planting a winter cover crop following cotton. The timing does not work because they are often planting early season, high-value tomatoes in January or February. The "window of opportunity" in this tomato/cotton rotation is to plant a summer cover crop such as sudangrass in August right after the tomato crop. This cover crop can be incorporated in the fall leaving sufficient time to prepare the soil for cotton the following spring. This window of opportunity uses some water, but it also controls weeds, suppresses nematodes, adds organic matter, improves soil structure, and provides flexibility in scheduling the cotton planting.





*Bell beans.*

In selecting a cover crop and evaluating where it fits into your rotation, it is also important to ask: 1) What would you like to accomplish by growing a cover crop? and 2) How do you expect it to improve the yield and net profit on your field?

# Cover Crop Selection Criteria

- ➡ **Reasons for Planting Cover Crop**
- ➡ **Field History (Long-Term Rotations, Previous Crop, Next Crop)**
- ➡ **Neighboring Crops**
- ➡ **Irrigation Methods**
- ➡ **Soil (type, pH, problems)**
- ➡ **Weeds**
- ➡ **Pest Problems**
- ➡ **Cover Crop Window (planting - removal)**

Addressing these questions head-on is essential to a successful cover crop program. A work sheet that explicitly addresses the criteria listed here may also be helpful in guiding you through the cover crop selection process. The key considerations are: your reasons for planting a cover crop, field history, neighboring crops, irrigation methods, soil characteristics, weed problems, pest problems, and the cover crop "window."



*Young cotton plants.*

This process can help you identify a "window of opportunity" within your normal rotation and select varieties to minimize pest and disease problems. For example, following wheat or barley, a summer planting of cowpeas, lab lab, sesbania will add nitrogen and improve soil active bacteria. There is also the possibility of planting sudangrass, sudan-sorghum crosses, or even corn (with a little extra nitrogen) to either clean up field bindweed, or blend with the legumes to get an extra 5 tons of biomass.



*Cowpea.*





*Oat/vetch/pea mixture.*

It is possible to follow safflower or wheat with winter cover crop mixtures such as: oats-bell beans-vetch-peas, or triticale and peas, or other combinations that take advantage of the winter rainfall. Such mixtures could be used before melons or transplant tomatoes. There would be time to incorporate the cover in April and establish the cash crop without problems. Again, the choice of cover crop should be made with existing weed, disease, nematodes, and other soil problems in mind.



### *Broccoli.*

Under very intensive, high-value vegetable rotations where two or even three crops are planted every year, some growers have been willing to pick a window as small as 50 to 60 days to grow a quick cover crop of sudangrass, cowpeas, phacelia, buckwheat, radish, canola, barley, or other combinations. On any particular field, a cover crop may appear only once in three years, but even under such circumstances, they feel there is a payback in terms of soil improvement and subsequent increases in yields and net returns.

# 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 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 also seen what works best over the years and will be glad to share this information. For more in-depth information, UC SAREP has an Internet database 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**

As I said, there are always tradeoffs in growing cover crops. No formula or recipe will guarantee success. There are, though, some practices that provide a degree of certainty in getting a good cover crop stand. One of the most important ones, for legume cover crops, is to inoculate legume seed before planting. Cowpeas, vetch, peas, bell beans, clovers, medics and trefoils need to be inoculated with the correct type of bacteria in order to fix nitrogen from the air. Without this step, the cover crop will grow poorly or may even die.



*Pouring inoculant directly on to seed.*

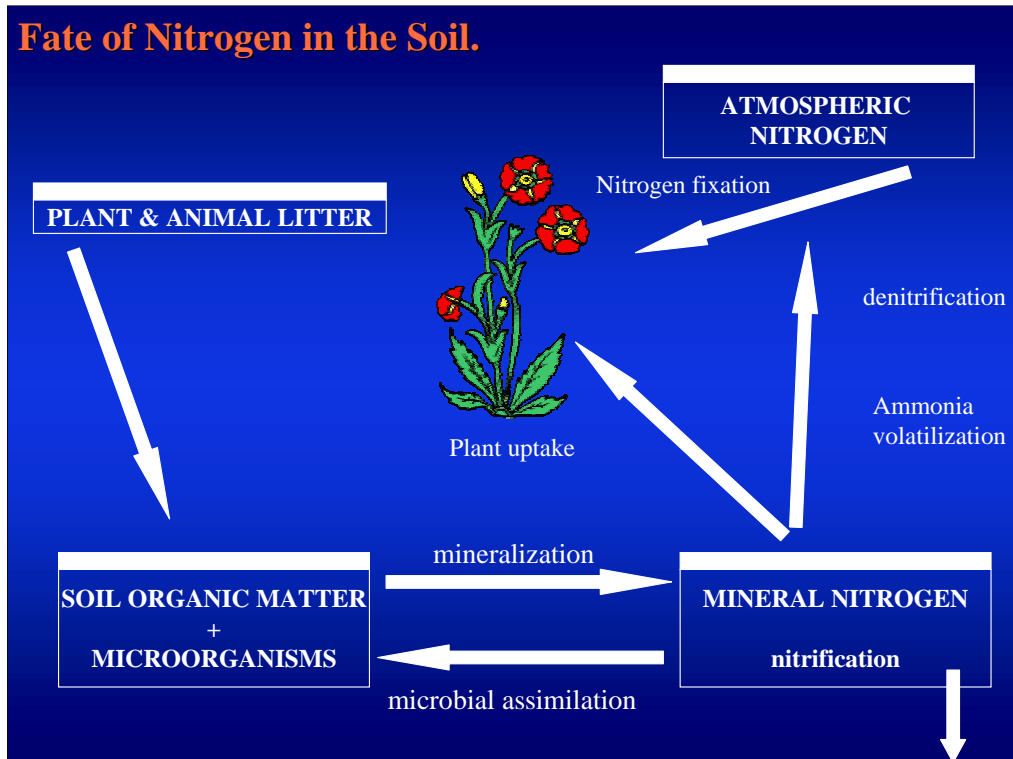
Many small seeds are preinoculated by the seed suppliers, but large-seeded legumes must be inoculated prior to planting. It is also wise to purchase high-quality cover crop seed from a reliable supplier.



*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 seed with the proper type of Rhizobium, 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, grow inside and live 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 practices that may help ensure success include planting early, careful soil preparation, correct seed depth, controlling weeds before planting, and if possible, irrigating for maximum growth—in essence, treating the cover crop as you would a cash crop. A method often used on lighter soils is the addition of a small amount 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 consideration is to plant compatible mixtures of cover crops, this helps to prevent a disease, pest or wet winter from completely eliminating the stand.

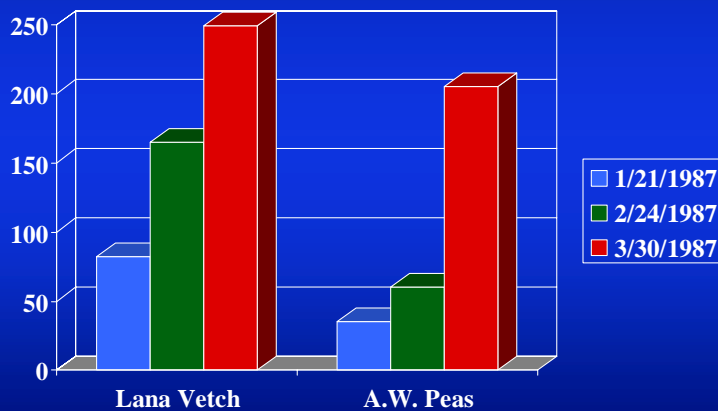


*Power spader incorporating vetch cover crop.*

How soon can I incorporate the cover? You can disc or mow or incorporate the cover crop at any time. Your decision, however, should be based on whether or not it has accomplished what you planted it for, or if it is causing problems with weeds or planting schedules.

## 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 and will not be as easily available to the following crop. In most situations, cover crops are not allowed to set seed because they may become weeds.

## **Will I have any difficulties incorporating the cover crop?**

Possibly. In low rainfall years, the cover crop may dry out the top of the soil. At other times, an extra discing may be needed to breakdown and incorporate the cover crop residue throughout the soil. A better seed bed usually results from the extra work, but if not anticipated, the additional field work can throw off equipment schedules. Most successful cover crop growers have developed special practices (and in some cases specialized equipment) to skillfully manage the cutting and incorporation of cover crops.



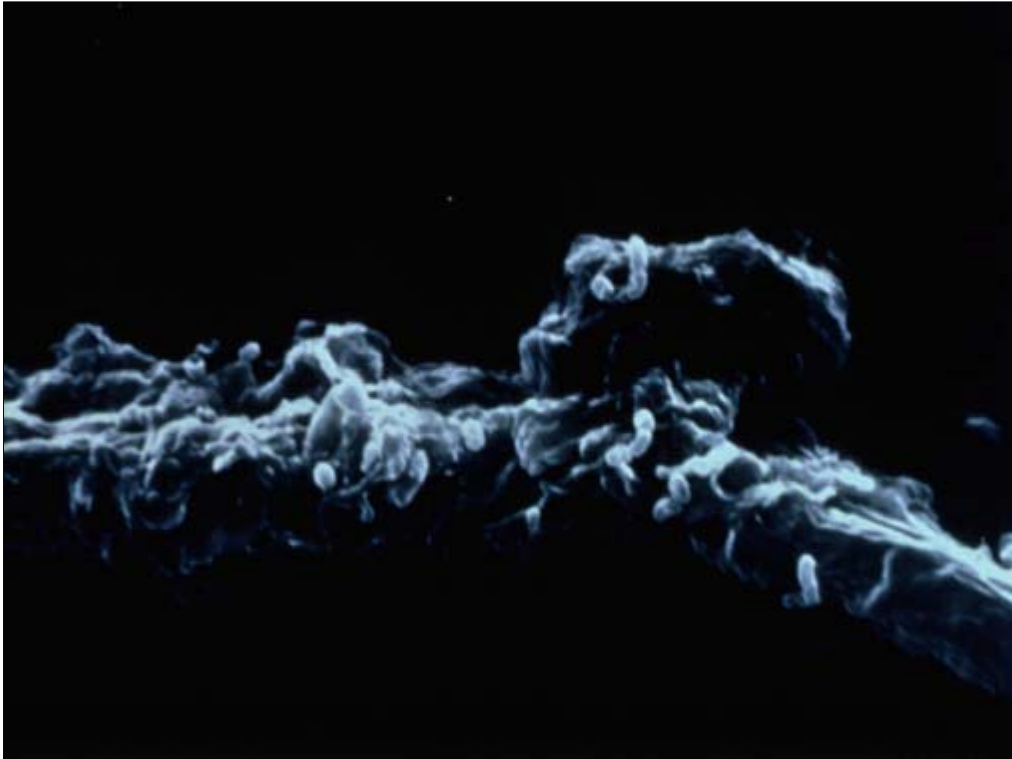
**Is there anything else I need to know about cover crops?**

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

## Farming the Soil

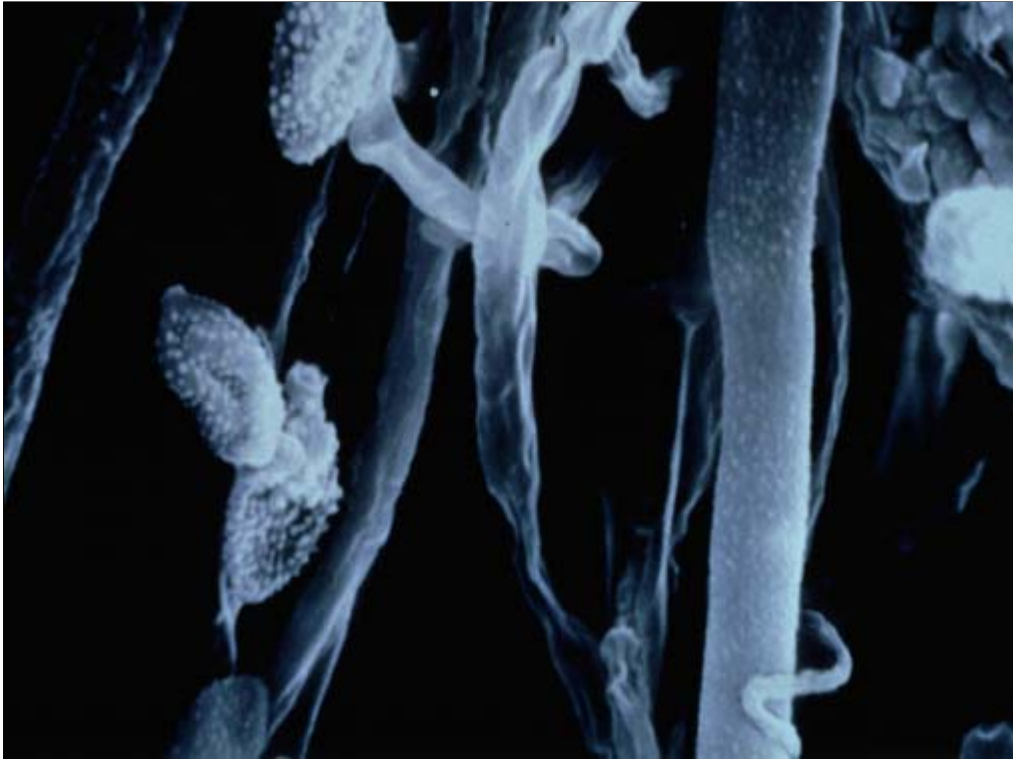
**Bacteria**  
**Fungi**  
**Nematodes**  
**Earthworms**

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



*Bacteria on cover crop residue.*

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



*Fungal hyphae.*



*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 CO<sub>2</sub>. More cover cropping results in increased soil carbon material, which feeds the herds of nematodes, which in turn fertilize the crop with their wastes.





*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.

## **Cover Crops offer long-term benefits.**

With fast-paced California farming it is sometimes difficult to think of long-term effects. If used on a regular three-year cycle, the cost of the cover crop should be spread over all three years because the contribution to better soil structure and beneficial biological processes will last that long.



*Tomatoes.*

Because of the real yield increases following a cover crop, many tomato farmers, like those in the West Side Biologically Integrated Farming Systems project, are searching for ways to include cover crops in their rotations.



*Celery in Ventura County.*

Cover crops have not been used much in conjunction with late-spring planted crops such as melons. But these opportunities should be explored and evaluated.



*Peppers.*

There is also a great deal of interest in using cover crops to smother weeds and in using cover crop residue on top of the bed of transplanted crops.





*Lettuce in Ventura County.*

When dealing with high-value row crops, any practice that improves yield or quality even slightly, or reduces disease, is of great value.



*Cotton.*

No matter what kind of crops you grow, there is a time when including a cover crop in your rotation can give you a net return. By experimenting with several cover crops in different parts of your rotation, you will gain experience in improving the soil and production of your farming operation.



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