Southern Cover Crops
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Soil Biology: Cover Crops and Disease Suppression

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Fig. 1. No-till hairy vetch cover crops may reduce diseases caused by splash-dispersed pathogens such as anthracnose caused by *Colletotrichum orbiculare*. Photo Xin-Gin Zhou, Texas A&M University

Introduction

Cover crops provide several benefits to soil health such as improving soil structure, reducing the need for synthetic chemicals by decreasing weed biomass, increasing soil organic matter, contributing nutrients to the soil, retaining soil moisture, and decreasing soil erosion. In addition, the integration of cover crops into crop production often leads to soils that are suppressive to plant diseases (i.e. have less potential for disease development). Disease reductions may occur in fields where the cover crop is planted in the fall and tilled under in the spring as a green manure prior to planting the cash crop, as well as when the cover crop is killed and the residue is left on the soil surface as a mulch (Fig. 1).

Mechanisms of Disease Suppression

Mechanisms of cover crop-induced disease suppression are not yet fully understood. However, several common mechanisms are thought to be involved in the "general suppression" of soil-borne plant diseases. Disease may be suppressed due to an increase in the overall activity and diversity of the soil microbiota (microorganisms that inhabit the soil) that occurs with cover crop production. Greater microbial diversity and activity results in increased competition with plant pathogens for nutrients and release of more compounds that interfere with the ability of plant pathogens to grow and develop. Some cover crops impact plant pathogens directly by releasing fungitoxic compounds (compounds that are toxic and subsequently unfavorable to the growth of fungi). In addition to increasing competition with soil-borne plant pathogens, these changes may also impact diseases because decomposing organic matter may increase fungistasis. Fungistasis occurs when a soil-borne plant pathogen's growth and infection is inhibited, even under optimal soil conditions. Fungistasis results from the presence of volatile compounds and/or the reduction in organic carbon compounds and nutrients. One example of a cover crop that may trigger several of these impacts is mustard greens (*Brassica juncea*). Mustard greens contain high levels of glucosinulates, which are sulfur containing chemicals that have fungicidal and nematicidal properties. The glucosinulates in mustard greens induce high levels of biological activity (mostly antimicrobial) and successfully suppress the occurrence of *Rhizoctonia* on potatoes through the release of isothiocyanates into the soil. In addition to direct effects on plant pathogens, many cover crops impact plant pathogens indirectly by triggering the plants' host defense response (a plant's immune response that protects it from infection).

In addition to general suppression, cover crops may also induce specific suppression by enhancing individual beneficial organisms. An example of an organism that induces specific suppression is the fungus *Trichoderma harzianum*, which suppresses *Pythium*, *Fusarium* spp. and other soil-borne pathogens of beans, and many other vegetable crops. Suppression by *T. harzianum* is thought to be due to competition for nutrients. *Trichoderma* is able to colonize many cover crops including annual ryegrass (*Lolium multiflorum*), red clover (*Trifolium pretense*), hairy vetch (*Vicia villosa*), and winter wheat (*Triticum aestivum*). Its ability to survive at high populations and colonize a subsequent cash crop is related to the cover crop root mass, time of cover crop termination, and other factors. In one study, winter wheat and canola (*Brassica napus*) resulted in the best carry over of *Trichoderma*. Due to its ability to reduce some diseases, *T. harzianum* has been formulated into a commercial biocontrol product.

TABLE 1. Selected cover crops that have suppressed vegetable diseases.		
Cover Crop Amendment	**Disease Suppression**	**Comments**
Sudangrass (*Sorghum sudanense*)	Nematodes on many crops Bean root rot Verticillium wilt in potato	Suppression of nematodes is enhanced by the addition of poultry litter compost. (Sorghum spp. green manure has also reduced fungal diseases of lettuce and potato.)
Mustard (*Brassicaceae* spp.)	Root knot nematode Potato scab (*Streptomyces scabies*) Black scurf (*Rhizoctonia solani*) Verticillium wilt of tomato (*Verticillium dahlia*)	May reduce or increase *Fusarium oxysporum*. May suppress mycorrhizal populations in soil. Timely incorporation of the cover crop is important .
Hairy vetch (*Vicia villosa*)	Fusarium wilt of watermelon	Response is location dependent. Hairy vetch is a host of Root Knot Nematode (RKN) and therefore, not suitable for RKN infested areas. Use RKN resistant cv. Cahaba white.
Mixed forage species	Damping off tomatoes	Mix of tall fescue (*Festuca arundinacea*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pretense*), red clover and alfalfa (*Medicago sativa*) suppressed Pythium.
No-till cover crop mulches: Hairy vetch Hairy vetch + cereal rye (*Secale cereale*)	Black rot (*Didymella bryoniae*) Anthracnose (*Colletotrichum orbiculare*) Plectosporium blight (*P. tabicinum*) on pumpkin Septoria leaf spot of tomato (*Septoria lycopersici)* Early blight (*Alternaria tomatophila*)	Provides a layer of plant material between soil and fruit, which reduces soil splash. Edema of pumpkin also was reduced some years on a no-till cover crop. Black plastic mulch also reduced disease in some years.
Sunnhemp (*Crotolaria juncea*)	Root knot nematode	
Crimson clover (*Trifolium incarnatum*)	Fusarium wilt on watermelon	Location dependent effect.
Cereal rye or oats (*Avena sativa*)	Verticillium wilt in potato	Not a good cover crop prior to corn production because it can host *Fusarium graminearum*, *F. oxysporum* and *Pythium* spp.

Mycorrhizae (fungi that live in association with plant roots and benefit the plant by aiding in water and nutrient absorption) may suppress individual pathogens. Cover crops influence the quantity and composition of mycorrhizae in soils and on the subsequent cash crop (Fig. 2). Investigators have observed enhanced mycorrhizal populations in peach and tomato following a mycorrhizal cover crop. More recently, there was an increase in mycorrhizal colonization in watermelon grown after a hairy vetch or crimson clover (*Trifolium incarnatum)* cover crop. The cover crops improved mycorrhizal colonization of the watermelon roots and also reduced Fusarium wilt.

No-till and Disease Suppression

No-till cover crops provide many of the benefits just described and, additionally, provide a physical barrier that reduces the splash of soil and soil-borne pathogens onto foliage, stems, or fruit. The cover crop can also reduce the presence of free moisture on the plant because they reduce soil splash. Septoria leaf spot severity was reduced on tomatoes grown in a hairy vetch cover crop mulch due to reduced soil splash to the tomato leaves. Foliar and fruit rot diseases of pumpkin such as white fleck (caused by *Plectosporium tabacinum*) and black rot (caused by *Didymella bryoniae*) are often lower when the crop is grown on a no-till hairy vetch, cereal rye (*Secale cereale*), or hairy vetch plus cereal rye cover crop. The reduction may be due to the formation of a cover crop vegetative layer between the fruit and soil reducing soil splash and shortening the length of time the fruit remain wet throughout the day.

Cover Crop Management

Selection of a cover crop depends on many factors including its ability to suppress disease. In considering a cover crop for disease suppression, consider field history and what diseases have been observed in the past. In addition, consider future crops and their potential pathogens. Table 1 is a partial summary of specific cover crops that have successfully reduced diseases. Cautionary notes are also included.

Cover crops, even those commonly associated with disease suppression, can under some circumstances increase other diseases (Table 1). In addition, timely incorporation of a cover crop is very important because incorporation that occurs too close to planting the cash crop may increase pathogens such as *Pythium* spp. It is important to maximize biomass of the cover crop, however the cover crop must be incorporated to insure enough time to breakdown, usually several weeks, prior to planting. Like all plants, cover crops get diseases and therefore can host plant pathogens, increasing the population present on the subsequent cash crop. For example, hairy vetch is a host of root knot nematode. White clover (*Trifolium repens*) and buckwheat (*Fagopyrum esculentum*) cover crops increased bean root rot where *Fusarium, Pythium*, and *Rhizoctonia* were present. Though brassica cover crops suppress many diseases, there also are reports of an increase in *Fusarium* disease severity following brassica cover crop incorporation (Fig. 3). This increase may have resulted because a *Brassica* cover crop decreases the mycorrhizal colonization of the succeeding cash crop. For example, when tomato was planted after a mustard (*Allaria petiolata*) cover crop the tomato roots had lower mycorrhizal colonization than in the absence of the cover crop.

Fig. 2. Crimson clover and other legumes cover crops support mycorrhizae populations that may increase colonization of this beneficial organism on the following cash crop. Photo Kathryne Everts

Fig. 3. *Brassica* spp. Cover crops suppress several diseases but have contributed to increases in Fusarium wilt diseases in some cases. Photo Kathryne Everts

The use of cover crop mixtures, timely incorporation of the cover crop into the soil or selection of a different cover crop can minimize these problems.

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