EXTENSION

AGRICULTURE

Integrated Pest Management Guide:

Adopting Brassica Cover Crops on Vegetable Farms in the Northeast

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Overview

Cover cropping has numerous benefits for soil health, water quality, and nutrient efficiency on-farm. Cover crops hold soil in place and build soil aggregation and stability. Better soil aggregation increases soil aeration, and increases infiltration, which in turn prevents nutrient runoff and soil erosion. Often the vigorous growth of cover crops can outcompete weeds. While many farmers are familiar with the benefits of cover cropping, there can be many challenges to adoption.

As an example, brassica crops, an important part of diversified vegetable farms in the northeast, can create "green bridges" for diseases and pests to spread when brassicas are grown most of the year. Brassica cash crop may include rutabaga, cabbage, cauliflower, kale, broccoli, Brussels sprouts, collards, and mustard greens. Brassica cover crops have become increasingly popular because of their numerous benefits. Common, brassica cover crops include mustard, tillage radish, canola, and turnip. Many farmers are concerned that adoption of brassica cover crops might bring disease and pests that would impact their subsequent brassica cash crops. Traditionally, rotation and winterkill can help reduce the spread. Brassica cover crops have many unique benefits and contain glucosinolates, which can serve as biofumigants for pests and suppress weeds, and farmers may be missing out on these benefits. More research is needed to understand the risk/reward of integrating brassica cover crops into diverse vegetable crop farms in the northeast.

This factsheet provides a brief overview of brassica cover crops for vegetable systems and how to reduce pest and disease concerns with a robust integrated pest management (IPM) program.

Selecting Cover Crop Varieties

Species choice, timing, and limited tillage can reduce weeds, pest, and disease infestations. Cover crops can suppress weeds by outcompeting them or by changing the canopy cover and altering the soil surface temperature, making the environment less suitable for many weeds. Cover crops can also encourage the growth of microbial life that protects against disease, and some cover crops are biofumigants.

In turn, this can reduce pesticide use and minimize our reliance on them, reducing both pesticide exposure and costs. Cover cropping works best in combination with other practices such as no-till, diverse rotations, and integrated cropping systems.

Winter Canola, Alburgh, VT

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Cover Crop Type Selection

Different cover crops provide different advantages:

Grasses increase soil organic matter and structure, scavenge leftover nitrogen from the previous cash crop and release it for use in the next crop during decomposition, prevent erosion, and can be used as a forage. Grasses grow relatively quickly, and include oats, barley, rye, wheat, buckwheat, annual ryegrass, and sorghum-Sudangrass.

Legumes fix nitrogen, increase soil organic matter and structure, prevent erosion, and can be used as a forage. Legumes grow slower than grasses, and include clovers, cowpeas, field peas, alfalfa, and hairy vetch.

Brassicas suppress weeds and pests, reduce soil compaction, scavenge nutrients from the previous cash crop, and prevent erosion. It can also serve as an important pollinator crop. Brassicas include mustards, rapeseeds like canola, forage turnip, and forage radish.

Seeding rates will depend on the seeding method and cover crop species. Broadcast seeding will require higher seed rates per acre compared to seeding with a grain drill.

Some common cover crops (= winter kills)*

Benefits of Brassica Cover Crops

Despite concerns about disease carryover from brassica cover crops to cash crops, brassicas have numerous unique benefits:

- Radish and turnips have large taproots that can break up compacted soil and break through the plow pan better than the roots of cereal cover crops, Some radish can extend up to 6 feet down the soil profile!
- Deep rooting also helps reduce soil erosion.
- Brassicas produce a relatively large amount of biomass in a short window, and cover the ground rapidly and effectively. This is excellent for scavenging excess nutrients after cash crop harvest: brassicas can take up 30-50 lbs per acre of nitrogen.
- Lots of biomass: some brassica cover crops can produce up to 8,000 lbs of biomass per acre (SARE 2007), which can help to suppress weeds and build up soil organic matter.
- Some brassica cover crops have been bred to produce high levels of glucosinolates, which are chemicals that inhibit weed growth, insects, nematodes, and some pathogens. Glucosinolates are released into the soil once the cover crop is incorporated into the soil.
- The glucosinolates have been shown to be effective for preventing the following common vegetable diseases: Aphanomyces root rot, cucurbit scab (*Cladosporium cucumerinum),* Fusarium dry rot (*Fusarium sambucinum*), take-all root rot (*Gaeumannomyces graminis*), Phytophthora root rot, Pythium root rot, Rhizoctonia solani, southern blight (*Sclerotiumrolfsii*), white mold (*Sclerotinia),* Verticillium wilt, and other soilborne diseases (Brown and Morra, 2005; Larkin, 2013; Larkin et al., 2011).
- Glucosinolates have also been shown to reduce pests: wireworms, common fruit fly, housefly, black vine weevil eggs, white-fringed weevil larvae, symphilids, and nematodes (Brown and Morra, 2005).
- Brassicas can double as a high-quality forage (but are highly digestible and should not make up more than 30% of an animal's dry matter intake).
- Brassicas can also serve as an important crop for bees and other pollinators.

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Vegetables harvested in late summer can easily be followed by a brassica cover crop, giving the cover crop enough time to generate a large amount of biomass and preventing weed growth before it is terminated by cold winter temperatures. Forage radish leaves a light residue on the ground, which makes for easy no-till planting of vegetable cash crops in the spring. To get the maximum biomass, fall seeded brassica cover crops should be established as early as July. Most brassicas will be terminated when temperatures drop to 23° F for multiple nights. Mowing and incorporating the cover crop biomass will increase the effectiveness of biofumigants. Glucosinolates are released when the plant's cells are broken down and can serve as a natural pesticide.

Some common brassica cover crops include:

Tillage Radish (*Raphanus sativus)* also called forage radish, Daikon radish, and Japanese radish, can be grazed or harvested for human consumption. Known for their deep taproot, they are excellent nitrogen scavengers, and produce as much as 3,700 lbs/acre below ground, and 8,000 lbs/acre above ground biomass. The deep taproot also drills into the soil and breaks up compacted soil layers. They are excellent for weed suppression, but must be established early in the Northeast since they winterkill quickly when temperatures begin to drop below freezing. Planting an early spring cash crop can take advantage of the nitrogen scavenged by the tillage radish.

Tillage Radish, Alburgh, VT

Seeding rates: drill 6 to 8 lbs/acre, ½ - 1 in. deep, or broadcast 10 to 12 lbs/acre. To achieve larger and deeper tillage radish roots plant in early August.

Canola and Rapeseed are most often harvested for seed to produce oil and protein rich seedmeal fed to livestock, however they also can be grown as a cover crop. Winter canola (species *B. rapa*) is planted in late summer providing leafy growth for soil coverage and produces tall stocks the following spring/summer. Besides biennial rapeseeds like winter canola, there are annual rapeseeds (*B. napus*) that can be grown as cover crops planted in the early spring or late summer. Canola has lower concentrations of glucosinolates than other rapeseeds. Rapeseed is also better than canola at reducing nematodes and weeds.

Seeding rates: drill 5 to 10 lbs/ac less than ¾ inch deep or broadcast 8 to 14 lbs/ac.

Winter canola, Alburgh, VT

Mustards include many species and many have been bred to produce high levels of glucosinolates. Like rapeseeds, they can grow 5-6 feet tall. They are terminated by temperatures around 25º F and are best as a spring or late summer cover crop. Terminate mustard at the flowering stage by mowing and then quickly incorporate the mustard into the top 5-10 inches of the soil using a rototiller or disc. Adequate soil moisture is needed to help break down the mustard's glucosinolates and activate its biofumigant properties. To improve results, many farmers roll/pack the field , cover with a tarp, or use irrigation to create a better seal over the incorporated mustard. Wait at least 14 days before planting your cash crop to avoid crop injury, or longer if soil temperature is less than 50º F.

High glucosinolate mustard (HGM), Alburgh, VT

Seedings rates: drill 5 to 12 lbs/acre, ¼–1 inch deep or broadcast 10 to 25 lbs/acre.

Turnips have an edible root and can be forages by livestock and include several species. Like radishes, their deep taproot can help break soil compaction. Some turnip bulb lengths are rounder and do not go as deep into the soil profile, like purple top turnips, and this will depend on the variety you select. Similar to radishes, they terminate as temperatures dip below freezing.

Seeding rates: drill 4 to 8 lbs/acre, about ½ to 1 in. deep or broadcast 10 to 12 lbs/acre, after the average temperature is below 80° F.

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Purple top turnip, Alburgh, VT

Cover Crop Mixes often consist of a brassica combined with a legumes or small grain to achieve multiple cover crop goals. The seeding rate needs to be adjusted since brassicas are very competitive. The table to the right shows example mixes and seeding rates recommended by the USDA Natural Resource Conservation Service (NRCS) in VT. You can see that brassica seeding rates are very low. For example, if you wanted the benefits of a nitrogen-fixing legume, a winter grain, and a brassica, you could use Mix 5, and only should use 4 lbs/acre (broadcast) or 2 lbs/acre (drilled) of the brassica.

Mix		Min Seeding Rate (lb/ac)		Seeding Depth (inches)	Primary Purpose		
		Broadcast	Drilled		Erosion Control	Nitrogen Fixation	Nutrient Scavenging
1	Ryegrass (annual or perennial)	20	15	1/4 - 1/2	x		x
	Brassica (radish, canola, turnip, rapeseed)	4	3				
2	Winter small grain	85	60	1/2	x		x
	Brassica (radish, canola, turnip, rapeseed)	4	3				
3	Spring small grain	85	60	1/2	x		x
	Brassica (radish, canola, turnip, rapeseed)	4	3				
4	Spring small grain	85	60	3/4	x		x
	Mustard	4	3				
5	Winter small grain	60	40	1/2	x	x	x
	Red clover	6	5				
	Brassica (radish, canola, turnip, rapeseed)	4	2				
6	Ryegrass (annual or perennial)	15	12	1/4 - 1/2	x	x	
	Red clover	8	6				
7	Winter small grain	70	56	1 - 1-1/2	x	x	
	Hairy vetch	20	15				
8	Winter small grain	85	60	1/2	x	x	
	Clover (red, ladino, berseem, crimson, etc.)	8	6				
9	Winter small grain	70	56	1	x	x	
	Austrian winter pea	60	40				

Adapted from "Vermont NRCS Cover Crop Specifications Guide Sheet (340)"

Pest and Disease Challenges

Brassicas may need additional monitoring to prevent pest and disease outbreaks if a brassica cash crop is to follow a brassica cover crop, as they share pests and disease species. Many farmers have steered away from brassica cover crops despite the numerous benefits out of fear of pest transfer.

A field trial at UVM Extension at two sites looked at the risk of disease and pest transfer between fall brassica cover crops and a broccoli cash crop, from 2019-2020 and 2020-2021. Cover crop treatments included HGM (high glucosinolate mustard), radish, a mix of oats, peas, and radish, a mix of oats, peas, and HGM, and control plots with no brassicas seeded. Sites were located in Alburgh and South Burlington, Vermont, and plots were scouted for common pests and disease.

Brassica cover crop pest & disease trial at Borderview Research Farm, Alburgh, VT

When Alternaria leaf spot and downy mildew were present, they were present in the fall, and not the following summer, broccoli cash crop. At one site in Fall 2019, Alternaria leaf spot was significantly greater in the HGM plots ($p=0.0183$) compared to the other cover crop treatments. In Fall 2019 at both sites, the oats/peas/HGM treatment had significantly more downy mildew than the control and oats/peas ($p= 0.0054$, $p= 0.0008$). In Fall 2020 at the Alburgh site, downy mildew was significantly higher in the HGM plots than other treatments and control except for the oat/pea/radish mix ($p= 0.0026$).

Flea beetles infested all plots, especially when they were hatching. In Fall 2020 at the Alburgh site, there were significantly more flea beetles scouted in the HGM plots than the control, oat/peas/radish mix, and oat/peas mix ($p= 0.0017$). All other season and site combinations were similar across all treatments. Other arthropods scouted included imported cabbage worms, cabbage loopers, diamondback moth caterpillars, swede midges, and cabbage aphids, and there was no apparent carryover from the cover crop to the cash crop. In the 2020 subsequent broccoli crop, there were more diamondback moth caterpillars on the oats/peas/HGM mix compared to the oat/peas/radish and HGM plots at the South Burlington site ($p = 0.0068$). In fall 2019 at the Alburgh site, there were more swede midges in the radish plots ($p = 0.0002$). This trial indicates there was no disease impact on the broccoli cash crop, though it should be considered that summer weather was warm and dry in both years of the

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study. These results also indicate that the HGM cover crop was more susceptible to disease.

Integrated Pest Management, or IPM, is a management process that is intended to prevent economically harmful damage from pests and diseases while also reducing environmental harm, risk to humans, and cost of chemicals by minimizing the need for pesticides. An IPM plan can include enhancing soil health with cover crops, reduced tillage or no-till, making conditions unwelcoming for pests, biological control, and regular scouting to monitor what is happening on your farm. An IPM plan should begin with prevention and monitoring. Prevention includes practices like buying certified or treated seeds and removing plant diseased matter when you see it. Scouting your crops weekly is recommended, for both brassica cash crops and cover crops.

To scout your plants, walk through fields and rows in a random crisscross shaped like a "W", and select random plants. This will help you get a representative view of your field. Examine both sides of the leaves and high and low parts of the stem.

There are several steps you can take before resorting to pesticides. Cultural practices that can help to manage diseases include; proper crop rotation, incorporating crop residues right after harvest, adequate crop spacing to maximize airflow, and proper nutrient management. Ensure there is sufficient soil drainage and circulation at the base of the plants. Row cover can prevent new insect infestations, and irrigating early in the day can speed up drying of foliage. Planting a summer crop later, if possible, can also decrease the risk of disease. Timing can also be arranged to miss a breeding cycle of insects. If an infestation occurs in a brassica cover crop, consider not following with another brassica in the next rotation, but any crop that hosts different pests and disease.

Biological control is another option: releasing non-invasive beneficial insects/natural enemies like ladybugs can control pests. For example, *Trichogramma* wasps can help control European corn borer populations and can be purchased as cards or eggs at an insectary or online.

Pesticides may become necessary if the infestation is severe. Some common cutoffs for switching to pesticides are: when more than 10% of plants have cabbage aphids, more than 20% of plants have cabbage loopers, diamondback moths, or imported cabbage worms after heading, more than 5% of plants have cross-striped cabbageworms, or when flea beetles have caused more than 10% leaf damage on 50% of plants or more. More information and recommended pesticides by pest species can be found in the *New England Vegetable Management Guide* at: https://nevegetable.org/crops/insect-control-3. More information on chemical disease control can be found at: https://nevegetable.org/crops/disease-control-3.

Cabbage aphids, 1.6–2.6 mm

Common Pests

Aphids suck fluids from the plant tissue which can result in stunted growth and wilting. In outdoor settings, natural enemies include lady beetles, green lacewings, and parasitic wasps. Aphids lay eggs that overwinter and hatch in the spring, develop, and then continue to lay eggs throughout the season. Cabbage aphids (*Brevicoryne brassicae*) specifically target brassicas.

Tarnished plant bugs also suck fluids from plant stems, leaves, buds, and fruit with piercing-sucking mouthparts, and cause render crops unmarketable. They overwinter as adults in leaf debris, emerge when the weather is warm, and eggs hatch in about a week. Several lifecycles occur in New England through the summer. They feed on most vegetable plants, and are not brassica specific. **Grasshoppers** chew on plant material, and if they cause enough damage to plants, they decrease yields and seed development. Their lifecycle takes a full year, with eggs being laid during late summer and hatching in mid-late spring. Tilling may damage eggs and prevent them from hatching, which makes preventing large scale infestations especially important in no-till systems.

Flea Beetle, Crucifer, adult. 2.2mm

Flea beetles chew small holes through leaves, speckling a leaf with a "shotgun" type pattern. Heavy feeding causes leaves to die off and can reduce yields and even kill entire plants. If the plant does not die, vegetables can be considered unmarketable if the damage is excessive. This mostly impacts leafy vegetables. Flea beetles hibernate through the winter in the soil or dead leaves in an adult form, then begin to feed when temperatures reach 50° F, laying eggs around May at the base of plants. Larvae hatch within two weeks and while they feed on roots, they don't cause noticeable damage in comparison to the adult beetle. They can go through multiple generations in one season. Releasing nematodes as biological control, pesticides, row covers, and watering when flea beetles are active helps to reduce flea beetle populations.

Flea Beetle, Striped, adult. 2-2.4mm

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Cabbage root maggot larvae feed on root systems and enjoy brassica root crops in particular. They can completely eat the root system and kill the entire plant. Sign of cabbage root maggots include yellowing and purpling of leaves and wilting despite adequate sun and water. Pupae are long and brown and the maggots are white and legless. The maggots hibernate as pupae near the roots of a fall crop, and adults emerge in the spring, laying eggs at the base of a new plant. To prevent damage, crop rotation and planting after the spring flight of the adult flies are key. Cabbage maggots usually have their first generation flight around 400-500 GDDs in the spring.

Swede midges are small brown flies that only cause damage to crops when they are larvae. The larvae break down plant cells walls with a secretion, then feed on the leaves. Brassicas are most susceptible and swede midges are more likely to render the plants unmarketable than to kill the whole plant. The pupae overwinter in the soil and can spread from the previous fall crop and in wind currents. Adults emerge around mid-May in New England and produce several generations until early October. Their full life cycle is only 1-3 weeks, and larvae begin as translucent, 3-4 mm in length, and slowly turn yellowish. Crop rotations, clean transplants of seedlings, and insect netting to keep the adult flies out can reduce swede midge damage and populations.

Cabbageworms may refer to the imported cabbageworm (*Pieris rapae*), the diamondback moth caterpillar *(Plutella xylostella*), the cabbage looper (*Trichoplusia ni*), and the cabbage moth caterpillar (*Mamestra brassicae*). These are all moths that lay eggs on the underside of the leaves of brassicas and lettuce, and the larvae hatch 2-3 weeks later. While the larvae, or cabbage worms, feed on brassica leaves, the adult moths do not. Multiple generations occur throughout the growing season. Covering brassica and leafy crops with row cover before the appearance of white moths in the late spring can help prevent the moths from laying their eggs there. *Trichogramma spp.* parasitic wasps are also natural predators of the cabbageworm eggs.

Left: Swede midge damage

Imported Cabbageworm, partly grown and full grown caterpillars on cabbage, 3.2–30.1 mm

Diamondback Moth caterpillar, 1.7–11.2 mm

Cabbage Looper, 0.2 to 0.5 mm

Right: Common beneficials: lacewing, ladybeetle (adult, larvae, pupa, from upper left, clockwise), parasitic wasp. Photo credits: Hobby farms, University of Minnesota, Public news service.

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Common Diseases

Alternaria Leaf Spot (*Alternaria* spp.)

Symptoms-Yellow, dark brown to black circular leaf spots with target-like, concentric rings. Centers may fall out, giving the leaf spots a shot-hole appearance. Individual spots coalesce into large necrotic areas and leaf drop can occur. Disease can spread by wind and rain, and favored by high relative humidity and temperatures ranging from 52-88°F.

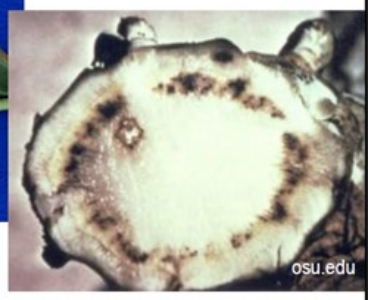
Concentric rings with papery centers on leaf

Spots coalesced into large necrotic area

Black Rot (*Xanthomonas campestris pv. campestris*)

Symptoms-Yellowing at the leaf margin, which expands into the characteristic "V"-shaped lesion at any growth stage. The bacterium enters the plant through the hydathode (water pore) on the margin of the leaf; insect feeding, hail, or mechanical injury. The pathogen is seedborne. The bacterial infection often becomes systemic, entering the veins of the plant and spreading into the head. Blackening of the vascular tissue is typical in severe infections.

"V"-shaped lesion progressing from leaf margin



Blackened vascular tissue of the stem

Black Leg, Stem Canker (*Leptosphaeria maculans*)

Symptoms-Oval, sunken, light brown cankers, often with a black/purple margin, near the base of the stem. Cankers enlarge until the stem is girdled and the plant wilts and dies. Severely infected plants are stunted. Damping-off can occur if plants are infected at the seedling stage. Inconspicuous, circular, light brown to grayish spots form on leaves. The spots soon become well defined and develop ash-gray centers with large number of scattered minute black bodies (pycnidia). The presence of pycnidia distinguishes blackleg from other crucifer diseases.

Black leg girdling of stem

Fungal pycnidia on leaf spots and on broccoli stem (top right)

Downy Mildew (*Hyaloperonospora parasitica)*

Symptoms-Sunken, angular greenish-yellow to light-brown lesions with fuzzy gray sporulation on the leaf undersides. The disease moves through the plant systemically, resulting in dark leaf petioles and dark streaks in broccoli heads. On mature cabbage and cauliflower, the infection may occur as dark sunken spots. The pathogen can survive in soils and plant debris; is spread by wind, rain and possibly by seed. Disease development is optimal at 50-60°F in humid conditions.

Pathogen sporulation on leaf underside

Close-up of fuzzy sporulation

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Powdery Mildew *(Erysiphe cruciferarum)*

Symptoms-White talcum-like growth on both leaf surfaces, starting as circular patches and expanding to cover the leaf. Leaves become pale green to yellow or tan, or if severely infected, curl and die. The plant is rarely killed, but growth can be stunted or defoliated. Low relative humidity with cool temperatures, water stress, and the availability of a thin film of moisture in which spores can germinate favor the disease. Spores easily spread by wind.

White talcum-like growth may appear on both leaf surfaces.

Sclerotinia White Mold (*Sclerotinia* sp.)

Symptoms-Prominent white, cottony growth covering infected plant parts. Survival structures, known as sclerotia, which are about the size of mustard seeds, black, and resemble mouse droppings, develop on diseased tissue. Infected stems have a bleached, light gray, desiccated appearance. Initial lesions are small, circular, water-soaked and light green but rapidly increase in size. Affected tissues dry, turn brown, and may be covered with a white, cottony mycelium.

Copious white, cottony growth on infected plant parts. Often black sclerotia, resembling mouse droppings, are visible (below).

Club Root (*Plasmodiophora brassicae*)

Symptoms-Struggling/stunted plants with deformed/galled roots. Crops with fibrous roots such as cabbage and broccoli produce club-like, spindle-shaped swellings on individual roots. Low soil pH of less than 6.5 and wet conditions favor this disease. Swimming spores move in water to infect plant roots. Resting spores can survive many years in the soil

Clubbed roots of kale (above) and rutabaga (right).

Additional Considerations:

Alternaria leaf spot (*Alternaria brassicae* and *A. brassicicola*) is seedborne and appears as black spots on the leaf and stem, which grow into bull's eye or target shaped lesions with a yellow rim. The necrotic lesions break easily and leaves will fall off the plant. Besides spreading in seeds, the disease can be spread from last season's plant debris. Wind and insects can spread Alternaria between plants in the summer.

White mold spreads by wind and insects carrying spores. The resting bodies of the fungus, sclerotia, can overwinter in the soil and remain viable for over 5 years. Moist conditions, high humidity, and warm temperatures encourage spore survival and growth. Seedlings may rot or become stunted, leading to poor establishment and lower yields. Alternative hosts include many broadleaf crops and weeds, so good weed control and proper rotations are key to its management.

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Final Notes on Disease and Pest Prevention

A four-year crop rotation away from host crops is the best defense for preventing disease. You can also avoid planting early if conditions are too wet, avoid excessive watering, and avoid planting in waterlogged soils. Ensuring good airflow at the base of the plants and spacing plants further apart can help prevent disease transfer. Buying certified tested seeds also reduces the risk of introducing seedborne pathogens like black leg, Alternaria leaf spot, black rot, and downy mildew. Buying seed treated with steam or fungicides also reduces the risk of introduction. In 2019, the University of Vermont Plant Diagnostic clinic ran a seed treatment assessment on tillage radish and Mighty Mustard (HGM) seed. Seeds were pre-treated with 1% Sodium hypochlorite for 5 minutes before rinsing and drying. As the seeds germinated, there were no seedborne diseases of *A lternaria brassica* or *A l-ternaria brassicola.* Some Alternaria spp. was present but was secondary and not seedborne. Simple seed treatments can assure that you are not introducing new pathogens.

Another important and simple way to prevent the spread of pathogens is to collect and discard the infected leaves and stems. Keep this plant material separate and do not add it to compost. Take note and discard infected plant material as part of a regular scouting program.
If an outbreak continues to spread, fungicides may be necessary. There are foliar fungicides available for the above pathogens, including copper sprays that are acceptable for organic farms. Pest pressure can also be reduced by preventing bare ground in the spring and fall, using row cover, timing cover crop planting to ensure canopy closure, interseeding, and selecting cover crops that winterkill based on spring planting times.

Resources

For more information on cover cropping see our website at: https://www.uvm.edu/extension/nwcrops

For help choosing the best cover crop for you:

Cover Crops for Vegetable Growers: The Cornell University Cover Crop Decision Tool helps you quickly narrow the choices of cover crop for your situation. http://covercrop.org/mobiledecisiontool

Managing Cover Crops Profitably 3rd Edition, 2007. SARE. Available in print or free online. https://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version

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