

Southern New England Vegetable Growers Meeting Series

Virtual Spinach Field Day: Questions & Answers

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The Spinach Downy Mildew (DM) Pathogen

We lost a whole crop of high tunnel spinach early this winter to DM. Is it likely to have come from the seed, the soil, or is it wind-borne? The pathogen biology is complicated and some of these questions are difficult to answer with certainty. Spinach downy mildew produces two spore forms— asexual sporangia that are spread by wind or splashed rain and oospores that form from sexual recombination and can last for long periods of time in soil or on or in seed. Where spinach is grown continuously in CA and AZ, sporangia can blow from older infected plantings to newer plantings (a scenario called a “green bridge”) and are often responsible for starting and spreading disease. Here in the Northeast, spinach production is more patchy in both space and time and spread from crop to crop and farm to farm via sporangia is likely less important, unless you have infected volunteer spinach popping up in tunnels and fields serving as a bridge between crops. Other potential sources of inoculum for commercial growers are infected material from the CA coming in via the grocery stores, compost/cull piles with infected residues, or infected spinach in home gardens.

Oospores have been found infesting spinach seed, but scientists have not been able to demonstrate in controlled trials that these oospores actually germinate and cause disease—but they could be doing so in the field. Oospores have not been found in the soil/crop residue in the Northeast but there has not been an extensive search for them. In order for oospores to form, two mating types of the pathogen need to come together on the same leaf, and since we have a relatively low incidence of the disease here, it is fairly unlikely that we have both mating types present in the same place at the same time. This is similar to the situation with the late blight pathogen, *Phytophthora infestans*, where the pathogen does not survive from season to season in the Northeast, because we currently do not have both mating types present and so no oospores are formed. Scientists don’t know how important oospores present in the soil or seed are in the disease cycle, but this is a very active research area.

How nervous should we be to put spinach in this tunnel again next year? Sporangia spread from volunteer spinach or continuous spinach production are the most likely way for this pathogen to survive and cause disease again next year, so be sure to have a spinach free period around your farm if you had DM last year. It has not been shown that the pathogen is producing oospores that can survive in the soil, so soil-borne inoculum is not currently believed to be a main source of infections. We see outbreaks of DM occur sporadically, on different farms or in different tunnels each year, not in the same tunnel year after year.

Could other chenopods serve as green bridges, or is spinach the only crop this variety of DM effects? Other *Chenopodium* crops and weeds are not hosts for spinach DM; the pathogen is very

specific to spinach. Jim's lab has tried inoculating a wide range of *Chenopodium* hosts with the spinach DM pathogen and have not been able to get the disease to develop.

Which DM races are generally showing up in the Northeast? So far 33 isolates have been collected in the Northeast from 2016-2020. Of those that Jim's lab has evaluated, 5 were **race 12**, 2 were **race 14**, and 11 were one of 6 **novel strains**—those that haven't been designated as a particular race because they are not widespread enough to get an official race #. Samples have come from all New England states plus NY and MD.

Determining the race of a given DM sample by doing the bioassay takes a long time. Are scientists working on developing a more efficient method to identify DM races? Jim's lab and others are sequencing spinach DM races for comparison to identify genetic markers associated with races. This would be like using a genetic fingerprint to determine the race and would be faster because you wouldn't need to grow out plants and inoculate them and wait for the disease to develop or not. The result would be attainable within 1-2 days. It hasn't yet been demonstrated so may not be possible, but it is a project that is in progress.

How cold-tolerant is the spinach downy mildew pathogen? Is there a difference in cold tolerance between mycelia and sporangia? How long can the pathogen survive at low winter temperatures?

The spinach downy mildew pathogen is very tolerant of cold temperatures. In fact, strains of the pathogen are typically stored as frozen infected leaves. Although viability of the spores diminishes over time in the freezer, the pathogen can often stay viable for 1-2 years and possibly longer in the freezer.

Spinach Downy Mildew Management

Are there organic fungicides that are effective against spinach DM?

No OMRI-approved fungicides have been found to be effective, given that crops need to have virtually no DM in order to be marketable. Many of these fungicides are copper formulations and leave a residue on the crop, which also renders the crop unmarketable.

What conventional fungicide options are there?

Many fungicides are very effective against downy mildew on spinach in conventional production, including Revus, Reason, Ranman, Ridomil Gold, Quadris, Orondis, and Aliette. This list is not a complete one. Typically, these are applied weekly and the chemistries or types are changed week-to-week to avoid fungicide resistance development in the pathogen. For a complete list of labeled fungicides see the [spinach disease section of the New England Vegetable Management Guide](#).

Is it useful to find out which race we had one season before selecting resistant varieties with that race in mind the following season, or is it unlikely that races will be consistent year to year? We only grow spinach in the cold months and there are at least 2 months when there is no spinach alive on the farm.

First, it is useful to find out the race in order to contribute to this growing body of knowledge about spinach DM in this region. So if you have spinach DM on your farm, reach out to us and we will help you get a sample sent to Jim to have the race determined. This way we can continue to help all growers make the best choices about resistant varieties. That being said, we do not see the same race year after year in the same field or tunnel, especially if you have a gap in spinach production on and around your farm. Each new outbreak seems to be unique. In the Northeast, so far we have

seen races 12, 14, 15, and novel strains. But, it is important to not base your variety choices solely based on those race #s; for example, we saw DM this year on the variety ‘Auroch’, which is resistant to races 12, 14, and 15. We recommended finding varieties with resistance to races 1-17, or as close to that as possible, and planting several different varieties with different resistance profiles so that you cover any “gaps” that may be present in a particular variety.

Do you have a list of varieties and their DM resistance? Who are the seed suppliers?

There are so many spinach varieties out there and variety availability changes so frequently that it’s difficult to compile a master list. The most reliable place to look for DM resistance information is the seed producer’s website. The producer and DM resistance of the varieties included in this year’s UMass trials are below.

Variety	Producer	DM Resistance
Corvus	BASF	1-17
Dracus	BASF	1-17
Nimbus	BASF	1-17
Sculptur	BASF	1-17
Patton	Bejo	1-15, 17
Responder	Bejo	1-12, 14-16
Crosstrek	Enza	1-17
Colusa	Pop Vriend	1-17
Nevada	Pop Vriend	1-17
Dallas	Pop Vriend	1-17
Laredo	Pop Vriend	1-17
Sunangel	Rijk Zwaan	1-9, (10), 11-17
Bandicoot	Rijk Zwaan	1-16, (17)
Kodiak	Rijk Zwaan	1-17
Platypus	Rijk Zwaan	1-15, 17
Viroflay	University of Arkansas	none
Kolibri	Rijk Zwaan	
Auroch	Rijk Zwaan	

Are there any organic varieties that have wide spinach DM resistance?

Many of the varieties being discussed are not available as certified organic seed. It may be worth discussing with your certifier—you can sometimes grow non-organic seed if there is a good reason, and avoiding a major disease may qualify. Some of the varieties we are testing are available from local seed distributors like Johnny's and may be organically grown, but most likely they are not. Open-pollinated varieties that Johnny’s grows e.g. ‘Equinox’, an improved Bloomsdale type, are grown organically but do not have any DM resistance.

Is transplanted spinach more or less susceptible to DM than direct-seeded?

Plants are susceptible regardless of their age, growth stage, production method, or overall health. We see DM on cotyledons of direct-seeded crops if disease starts early and conditions are favorable. Cool, humid, and low-light conditions favor disease development.

General Spinach Production

What type of weed control is being used in conventional production?

Ro-Neet and Spin-Aid are two herbicides used in CA in conventional production systems pre-plant or when plants are young—Spin-Aid is not registered in MA. For organic systems, growers will use a stale seed bed technique in which they repeatedly irrigate beds to germinate the weed and then cultivate to kill the weeds. This reduces the seed bank in the soil. I imagine that not many weeds reach maturity and go to seed in these high intensity systems, so the seedbank would get smaller and smaller over time.

Does winter spinach have a longer growing season if we keep it indoors using raised beds/high tunnels with proper temperature control & watering? Definitely. Seeding spinach into a high tunnel or caterpillar tunnel in September-October allows you to harvest through the winter. In MA, adding or row covers is not necessary (and can be expensive), but the added warmth may speed up crop growth slightly. If spinach freezes, wait for it to thaw before touching the plants to avoid damaging the plants. Freezing damage can occur as tip burn or wilting. Further north, you may need to experiment with heat and covers during cold spells. Making slightly raised beds can help with stand establishment and avoid some of the issues with “wet feet” that spinach can be susceptible to. Proper watering is important as well, since spinach is picky about being too wet or too dry. We use moisture sensors and irrigate whenever they soil moisture is 30 centibars or higher.

What is the effect of priming spinach seed? Priming, or soaking then drying, the seed before sowing, can speed up the germination process. Priming can also help improve germination under stressful conditions, e.g. heat—often when we are seeding spinach in tunnels in the fall it can be very hot for spinach germination. Faster germination may help get a better stand since damping-off pathogens would have less time to act on the seed if it is actively growing. We are planning some priming studies for next year, so stay tuned!