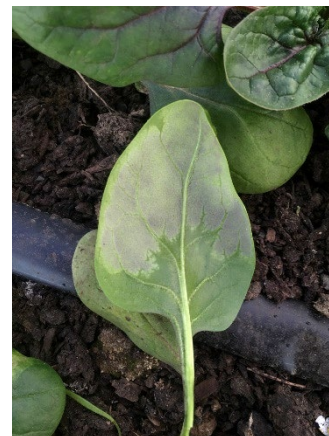


Evaluation of spinach downy mildew-resistant cultivars for New England winter high tunnel production, 2020-2021

A recording of our Virtual Winter Spinach Field Day, which includes preliminary data from this trial, is available to view [here](#).

Background: Spinach downy mildew (DM), caused by the fungal-like pathogen *Peronospora farinosa*, has emerged in New England as an important disease of fall and spring field spinach and winter high tunnel spinach over the last several years. It produces characteristic fuzzy gray sporulation on the undersides of spinach leaves. This disease is sporadic and does not appear every year on every farm. Part of the reason for the sporadic pattern of incidence is that there are now 19 strains—called “races”—of the pathogen, as well as novel races that don’t match any of the 19 numbered races. Spinach varieties have resistance to different sets of spinach DM races, so whether or not a disease outbreak occurs depends on the spinach varieties, DM races, and environmental conditions on a farm at a certain time. There are conventional fungicides that can effectively control spinach DM (including Revus, Reason, Ranman, Ridomil Gold, Quadris, Orondis, and Aliette—for a complete list, see the [spinach disease section of the New England Vegetable Management Guide](#)), but there are currently no effective OMRI-listed fungicides, so resistant varieties are a crucial management tool for certified-organic growers and still an important tool for conventional growers since they can help to delay development of fungicide resistance.



Spinach downy mildew sporulation on the underside of a spinach leaf.

Downy mildews are very host-specific pathogens—spinach DM only causes disease on spinach and is different from the downy mildews that cause disease on cucurbits, basil, and other crops.

Spinach breeders are constantly developing new spinach varieties with new resistance packages to manage DM, but most new varieties are targeted to large-scale growers in CA and AZ, where most of the country’s spinach is grown and where DM can lead to total crop losses. The downy mildew pathogen has quickly evolved to overcome resistance bred into spinach varieties, so spinach varieties available from seed producers change quickly, and while New England seed distributors aim to provide varieties with the best possible disease resistance, there is also incentive to carry varieties that will be available for a long time despite not having full DM resistance. Over the last 3 years, the UMass Extension Vegetable Program has conducted spinach variety trials aimed at identifying varieties with resistance to as many DM races as possible and that perform well in a New England winter high tunnel environment.

Results of the previous spinach variety trials can be found here: [2018-19 Spinach Variety Trial](#) and [2019-20 Spinach Variety Trial](#).

Methods: 18 spinach varieties were trialed in 2020. This group was comprised of fast-growing varieties with complete or near-complete DM resistance recommended by seed producers, varieties commonly grown by winter spinach producers, and 1 variety with no DM resistance (Viroflay). See Table 1 for the

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varieties trialed in 2020 and their DM resistance.

[Click here for photos of each variety throughout the growing season.](#)

The high tunnel was prepared by disking the soil, irrigating to allow a flush of weeds to germinate, then spreading fertilizer based on soil test results (20# N/A in the form of blood meal). The tunnel was then disked again to incorporate the fertilizer and kill the flush of weeds. All spinach varieties were seeded by hand on October 13, 2020. Plots were organized in randomized complete blocks, in 4' wide beds. Plots were 2' long, with 5 rows of spinach per plot, seeded at a rate of 3,000,000 seeds/A (550 seeds/plot)—a rate commonly used by large-scale spinach growers in California and Arizona. Seeds were sown at a ½" depth.



Trial tunnel on December 8, 2020, just prior to the first harvest.

For the duration of the trial, circulating fans remained on, exhaust fans remained off, and roll-up sides were programmed to open at 50°F and close at 40°F. The tunnel was coldest on January 30, when the air temperature reached 7.8°F and the soil temperature 2" beneath the surface reached 31.6°F. The tunnel was irrigated with overhead sprinklers as needed to maintain soil moisture at 30-60 centibars according to Watermark soil moisture sensors soil moisture sensor reading and was hand-weeded once after all spinach had germinated. Soil nitrate was measured monthly throughout the course of the trial. Soil nitrate levels began at 103 ppm on November 23 and steadily declined to 29 ppm by February 16. The recommended threshold at which to add N is 30 ppm, but the trial was almost complete when that threshold was reached, so no N was added.

Germination and post-emergence damping off were rated twice—both 1 week and 2 weeks after seeding. Beginning 3 weeks after seeding, plot vigor

Variety	Seed Producer	Downy Mildew Resistance	# of Harvests	Days to 1 st harvest
Corvus	BASF	1-17	3	94
Dracus	BASF	1-17	3	94
Nembus	BASF	1-17	3	94
Sculptur	BASF	1-17	3	94
Patton	Bejo	1-15, 17	3	70
Responder	Bejo	1-12, 14-16	3	70
Crosstrek	Enza Zaden	1-17	3	70
Colusa	Pop Vriend	1-17	3	70
Nevada	Pop Vriend	1-17	3	94
Dallas	Pop Vriend	1-17	3	70
Laredo	Pop Vriend	1-17	2	94
Sunangel	Rijk Zwaan	1-9, (10), 11-17	4	70
Bandicoot	Rijk Zwaan	1-16, (17)	3	70
Kodiak	Rijk Zwaan	1-17	3	70
Platypus	Rijk Zwaan	1-15, 17	3	70
Kolibri	Rijk Zwaan	1-9, 12-15, 17	3	94
Auroch	Rijk Zwaan	1-12, 14-16	3	70
Viroflay	Univ. of AR	none	3	94

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was rated weekly, taking into account stand, plant size, and after the initial harvest, regrowth quality. Each variety was harvested as it sized up, resulting in 6 harvest dates, the earliest being December 22 and the latest being March 30. Plots were harvested by hand; plants were clear-cut just above the growing tip.

Results: Platypus and Viroflay had significantly lower germination rates than all other varieties in the trial (<15% germination). When Platypus and Viroflay were excluded from the dataset, there were no significant differences between germination rates of the remaining 16 varieties. Platypus and Viroflay were excluded from the dataset for the vigor and yield analyses.

Figure 1 shows vigor ratings from immediately before the first harvest on December 22. Average vigor, calculated across the entire season, showed a similar pattern to the December 22 vigor ratings. Crosstrek and Dallas were the most vigorous varieties on December 22, followed by Patton, and those 3 varieties along with Sculptur were also the most vigorous varieties when averaged over the full season.

Some notes about some varieties that stood out:

Dallas also had the highest yield (just above 0.9 lbs/ft²), significantly higher than about half of the varieties trialed. **Crosstrek** and **Nembus** also had high yields, around 0.8 lbs/ft².

Auroch and **Bandicoot** had the lowest yields, both less than 0.5 lbs/ft², and, along with Bandicoot, had consistently low vigor ratings. Both Auroch and Bandicoot had high rates of post-emergence damping off, which contributed to both the low vigor ratings and low yields.

Dallas description: a dark-green variety that was fairly flat when small but became more upright after it was harvested for the first time.

Crosstrek description: produced dense, fairly upright plants, with slightly curly leaves. Crosstrek had even regrowth that didn't show the cuts from the previous harvest(s). **Patton** and **Responder** had similar appearances to Crosstrek, and Patton had notably very even growth. Both Patton and Responder had numerically lower but not significantly lower vigor and yield.

Nembus was among the highest yielding varieties, but had middle-range plot vigor. It was an average-looking variety with a medium growth height.

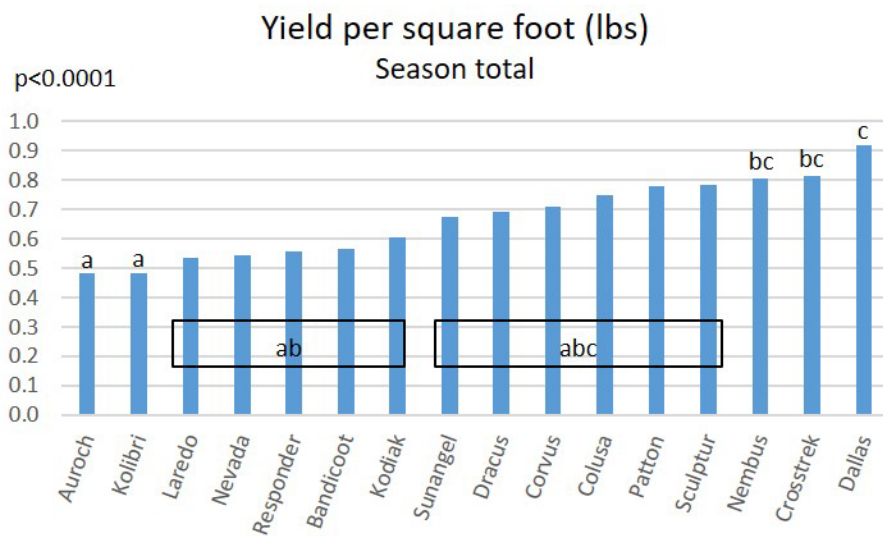
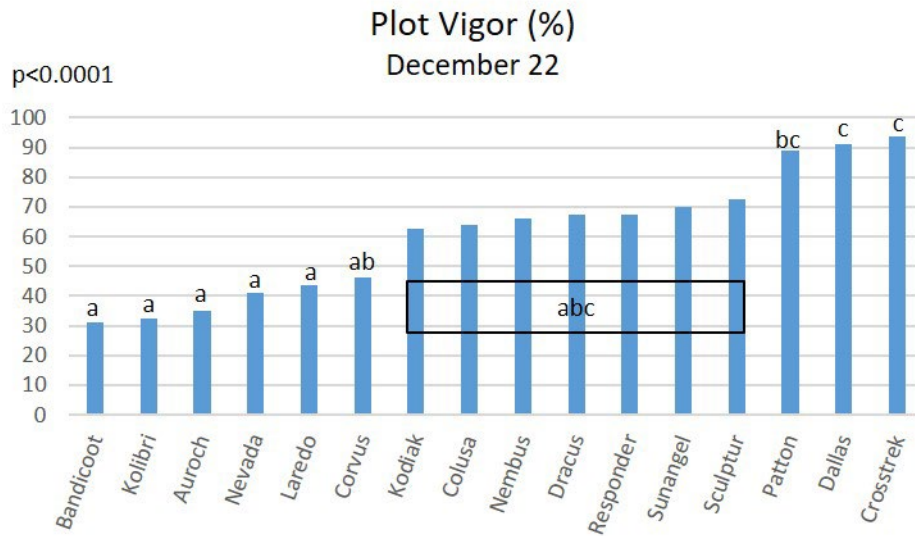
Sculptur had a high seasonal vigor rating, but a middle-range yield.

All varieties were harvested 3 times between December 22 and March 30, with the exception of Laredo, which was harvested only 2 times, and Sunangel, which was harvested 4 times. Despite being harvested 4 times, Sunangel had middle-range vigor and yield.

Conclusions: Overall, most of the varieties grew similarly well in terms of germination, vigor, and yield and would be good choices for winter tunnel production in the Northeast. Two varieties, Dallas and Crosstrek, stood out as having significantly higher vigor and yield and have resistance to races 1-17 and would be excellent choices for winter growing. Some of these varieties may not appear in seed catalogs but seed reps may be able to special order unlisted varieties from producers, especially if smaller-scale growers collaborate to meet minimum order requirements. Ask your seed rep, and if you cannot locate the

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variety you want, please get in touch with us and we may be able to help you track the variety down or find other growers interested in ordering the same variety.



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