Germination and establishment considerations for spinach and leafy greens

Several growers, from different parts of the Northeast, have reported problems with germination of spinach in high tunnels. The reports of problems with spinach germination come mostly from crops that are established in the fall for overwintering in high tunnels.

Spinach planted in unheated High Tunnels will establish in late fall as long as soils are not too cold, and survive the cooler winter temperatures, to resume growth in early spring when the lengthening days warm the high tunnels for harvest in early spring.

Spinach planted in heated High Tunnels can be established as long as soil temperatures are in the right range, and could produce a crop earlier in the winter.

In a typical situation where problems are reported, spinach is seeded in sequential plantings, on separate beds with separate seedings about one week apart. The spinach variety and seed lot are the same, the seeding equipment is the same, etc. and yet there can be marked differences in stand establishments between the different beds. What causes this poor performance of the same seed in some beds?

The Basics

Seed germination happens when seeds imbibe with water, which starts the germination process. Several enzymes are activated to start the physiological process of cell division and elongation, the conversion of starchy reserves into water soluble sugars, protein synthesis, etc.

Temperature

The process of seed germination is temperature dependent; generally speaking, germination is quicker at higher temperatures. Different plant species have a different range of temperatures for seed germination (cool weather crops germinate at lower temperatures, and warm weather crops germinate at higher temperatures….).

The trick in getting the best germination and stand establishment is finding the optimum temperature for seed germination. In any given seed lot, there will be variation in seed size, physiological age and maturity, and genetic variation – all of these are factors that contribute to variation in seedling vigor, temperature sensitivity, and speed of germination.

This variation among seeds in the same lot becomes a concern as the soil temperature gets farther away from the optimum temperature (too high or too low). As the soil temperature becomes less optimal, fewer seeds will germinate and fewer seedlings will establish themselves. There is an optimum temperature range for germination, with a minimum and a

maximum temperature. Germination will be good between minimum and maximum temperatures, but will become erratic beyond these limits (temperature too high or too low).

The optimum temperature range for spinach is 10 – 20 ^{0}C (50 – 68 ^{0}F). Germination above 68 ^{0}F or below 50 ^{0}F will be spotty. Optimum germination temperature will be 59 ^{0}F

For comparison, germination temperatures for some other crops are:

Crop	optimum ^{0}F	range
Claytonia	cool	
Spinach	**59**	**50 – 68**
Mache	59	50 – 60
Lettuce	68	
Swiss Chard	86 (day), 68 (night)	
Cress	86 (day), 68 (night)	
Mizuna		68 – 86
Kale		68 – 86
Claytonia	cool	
Radish	68	50 – 77

Seeding depth

Generally speaking, seeds should not be planted deeper than about twice their diameter. Smaller seeds should be planted shallower, larger seeds can be planted deeper. Planting too deep can prevent germination, resulting in poor stands.
Problems with planting too deep are easily diagnosed: the stand will be good where the seeder was introduced into the bed, and where the seeder was pulled out of the bed (shallower seeding).

Damping-off

Several soil borne fungi (*Fusarium, Pythium, Rhizoctonia*) can cause poor seedling performance, either during or shortly after germination. Often, seedlings will emerge, only to die shortly afterwards. In some cases, however, seedlings can be attacked and killed before emergence, leaving the impression that the seeds never germinated. Seed treatments with fungicides can help prevent problems with damping-off, but keeping germination temperatures and soil moisture in the optimum range should be able to prevent most of these diseases.

Trouble Shooting

In the case where spinach seed shows variable performance in successive plantings, environmental conditions are almost certainly at play. On the other hand, in cases where all plantings perform poorly, a simple germination test should be able to tell you if the seed itself is bad.

The temperature in high tunnels can build quickly on sunny days, and adequate ventilation is needed to prevent the soil from heating up too much. A soil temperature recorder will be helpful in tracking temperature fluctuations in the germination zone.

While dry and dormant spinach seed is quite resilient, the germinating seed is actually quite fragile. Temporary spikes in temperature can be quite damaging to the enzymes responsible for the physiological processes involved in germination, and can quickly lead to tissue damage, and even seedling death. The period where seedlings are most fragile is as they emerge from the seed, while still underground. A temporary spike in temperature can kill the seedlings at this time, but give the impression that the seed never germinated (because nothing came up…).

The optimum germination temperature range for spinach is quite a bit lower than that for lettuce, swiss chard, the various mustards or cabbages. Poor germination performance in spinach may be an indicator that the temperature spiked during a sensitive part of the germination process and affected the spinach seedlings. Other crops in the same tunnel (even other plantings of spinach in a different stage of development) may be less sensitive to high temperature damage, and may perform normally at the same time when a single planting of spinach is performing poorly.

Solutions

Keeping temperature and soil moisture in the proper range will help with germination of all crops, of course. Knowing what the optimum temperature range is, and measuring the soil temperature during germination will help determine if soil temperature is indeed the cause of the problem.

Shading of the beds, improved ventilation, thermostatic controls on louvers, and keeping an eye on the weather, etc. will help prevent temporary overheating of the beds.