e-GRO Edible Alert


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Get off to a good start: optimizing leafy green and herb seedling culture

The key to a productive harvest starts with healthy and uniform seedlings (Figure 1). Poor choices or cultural practices in propagation can lead to underperforming seedlings, setting your production schedule behind or wasting valuable grow space. This article is intended to help you optimize your leafy green and herb seedling production so you can make the best choices for your individual operation.

Figure 1. Healthy lettuce seedlings with 3-4 expanded leaves, ready to transplant into a hydroponic system. Image: Nathan Eylands, Cornell University

Seed Choice

Whether the seed you choose to sow came from your storage or a seed purveyor, it must be viable. Seed deteriorates over time and must be handled and stored properly to retain its viability. Leafy green and herb seeds fall under the category of medium-lived, orthodox seed. That means in favorable storage conditions (i.e., open air, room temperature), these seeds would remain viable for periods of two or three years though germination percentage can decrease over time. However, if stored at low humidity and low temperature, storage life would be considerably longer. This can easily be attained by storing seeds in airtight containers, like a mason jar, in a household refrigerator. When ordering from a seed supplier, be sure they are a reputable business before you buy. Not all seed producers are equal.

Seeds can often be found either naked (i.e. no added coating) or pelleted. Pelleted seeds are coated with an inert clay-like material to create a uniform shape for mechanical seeders (Figure 2). However, pelleted seed is also easier to manually handle and is often preferred. Fungicides and beneficial microbes can be added to the pelletized coating and can help prevent damping-off of seedlings. In the production of pelleted seed, the manufacturer may prime the seed (i.e. begin initial stages of germination to encourage quicker and more uniform germination), this can reduce the storage life.

Figure 2. Pelleted seed is easer to use than naked seed with mechanical seeders such as this small vacuum seeder. Image: Nathan Eylands, Cornell University

Figure 3. Lettuce seedlings grown in stone wool, note some algal growth on the surface is common until the plant canopy closes in. Image: Neil Mattson, Cornell University

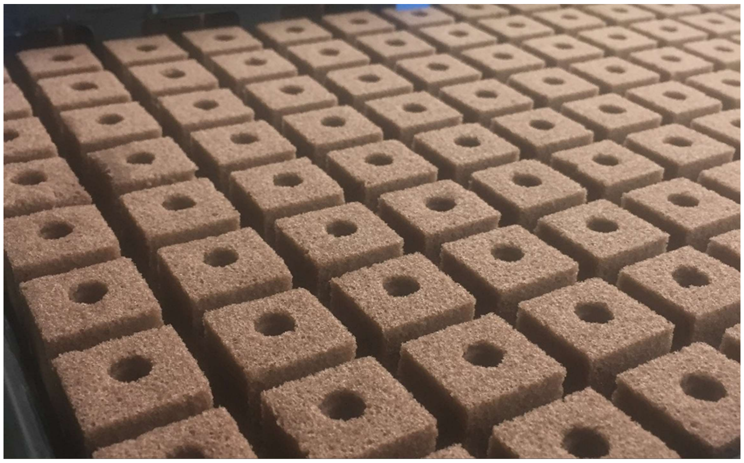

Figure 4. Phenolic foam (Oasis) is a common substrate for hydroponic leafy greens and herb seedlings. Image: Nathan Eylands, Cornell University

To ensure consistent germination the recommendation is to use up well-stored naked seed within a year and pelleted seed within 6 months. If you are concerned about the viability of your seed, conduct a seed germination test before planting. For production, you will need to sow some extra seed to account for those that don't germinate, however some growers will also sow an added margin of seed (perhaps 10-20% above accounting for germination percentage) this is so they can select the largest, most uniform seedlings for transplanting.

Substrate

Hydroponic germination substrates are numerous, but the most common are stone wool (i.e., rockwool) (Figure 3) and phenolic foam (i.e., Oasis) (Figure 4) and to a lesser extent, chemically bound organic media of coco-coir or peat moss. The main parameters of all substrate media are particle size, shape, and porosity. These components are crucial in determining how well a particular medium retains water and nutritional elements and simultaneously leaves room for oxygen within the matrix. Stone wool and phenolic foam are generally inert and have a neutral pH making them ideal as propagating media. Stone wool and organic media tend to hold more water than phenolic foam requiring less frequent irrigation.

Moisture Management

Once a system is put together, the hard part of managing an irrigation schedule starts. To begin, it is wise to condition your substrate media (i.e. leach salts, and adjust pH and add initial nutrients). This can be done by soaking stone wool or oasis in a mild nutrient solution or in the case or organic media, if a starter fertilizer charge has already been incorporated, add water until the substrate just begins to exhibit water leaching from the bottom. Seeds should be sown into the media and subsequently misted to help them imbibe water. Although the storage tissues of a seed (perisperm, endosperm, and cotyledons) contain enough energy to be used by the embryo through germination, it is recommended to start fertilizing your irrigation solution right away (Figure 5).

Figure 5. Impact of seedling fertilization on subsequent growth. Lettuce plants on the left received fertilization during the seedling stage, while the plants on the right did not receive fertilizer at seedling stage and are markedly delayed in their growth. Image: Neil Mattson, Cornell University

Your solution should be pH adjusted to 5.5-6.0, and have an electrical conductivity of about one-half to three-quarters of what you will feed mature plants (ex: if mature plants get a complete nutrient solution with 150 ppm nitrogen and an EC of 1.8 mS/cm; seedlings should get a nutrient solution of 75-125 ppm N or EC of 0.9-1.35 mS/cm). Seedling trays can be overhead watered or sub-irrigated. It is good practice to allow your seedling media to have a dry down period between irrigations. A dry down of 30% is usually a good starting point. Since stone wool holds more water, this is harder to achieve on a daily schedule.

Figure 6. Damping off of lettuce seedlings from proliferation of root disease due to an excessively wet root-zone. Image: Masaki Kurosaki, Cornell University

Therefore, it is recommended that very humid environments (i.e., Southeastern United States) lean towards the phenolic foam while dry environments (i.e., Southwestern United States) opt for stone wool. (Or simply be prepared to adjust your irrigation frequency depending on the season). Seedlings can germinate poorly if the substrate is overly saturated due to poor oxygen supply. Saturated conditions can also promote damping off diseases (seedlings death to rotting of stem and root tissues at or below the soil surface) (Figure 6).

Environment

The environment in which your leafy green and herb seedlings grow is critical towards the goal of optimization. Whether your seedlings are in an open environment in the greenhouse or in a meticulously controlled environment like a growth chamber, a recipe of conditions must be followed.

Temperature should be between 60 and 75 °F depending on species (Table 1). Temperatures that are too low will result in stunted growth while temperature too warm will diminish the germination rate.

Crop	Optimal Germination Temperature (°F)
Basil[1]	77
Lettuce[2]	60-71
Spinach[3]	68
Kale[4]	59-68

Table 1. Optimal germination temperature for four species based on scientific literature. Be sure to consult your seed supplier for cultivar specific germination requirements.

Check with your seed supplier about the optimum germination temperature for your cultivars. Electric heating mats are advised in the case of low temperatures. Be aware that heating mats can get too warm and dry the root zone out too quickly and therefore a thermostat control is recommended.

Relative humidity for germinating seeds should be kept as high as possible (100% is optimal). This is a good level for the first two days. This high level is easily attained in a growth chamber (Figure 7), but not as easily in open air. Intermittent misting systems work very well as do humidity domes. A good trick to keep relative humidity high is to cover seeds and media with a small layer of vermiculite or wet newspaper to trap moisture near the seed. However, as soon as the radicle emerges (often after 1 day for lettuce or 2-4 days for other leafy greens) any coverings such as newspaper should be removed (as described below the seedlings will need light to ensure they don't excessive stretch). After radicle emergence, the relative humidity should be reduced within the range of 50-70%. The lower end of this range will reduce the risk of fungal pathogens.

Light is not required in high amounts to induce germination. Low light intensity of

Figure 7. A germination room is used to deliver high humidity, temperature-controlled conditions for optimal germination. Shown here is the germination room at a large potted herb grower. Image: Neil Mattson, Cornell University

Figure 8. Lettuce seedlings that are excessively stretched due to low light during germination (note long internodes and poor leaf expansion). Sowing multiple seeds per cell exacerbated the situation by providing more competition for light. Image: Neil Mattson, Cornell University

50 $\mu mol \cdot m^{-2} \cdot s^{-1}$ is good for germination (to avoid early stretch). This low light can be supplied for 24 $h \cdot d^{-1}$ (4.3 $mol \cdot m^{-2} \cdot d^{-1}$). In terms of light quality, perception of red light in the embryo enhances germination of some lettuce cultivars (far-red radiation can inhibit)[5]. Sunlight and most artificial lights contain an abundance of red light. After two days of germination, light intensity should be increased to achieve a daily light integral (DLI) of a minimum of 12 $mol \cdot m^{-2} \cdot d^{-1}$. Plants use light most efficiently at limited intensities, therefore a good combination of intensity and photoperiod to reach this DLI is 200 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for 16 $h \cdot d^{-1}$ with broad spectrum LED lights. Increasing DLI up to about 20 $mol \cdot m^{-2} \cdot d^{-1}$ can lead to more robust seedlings (short internodes, good leaf development) that are ready to transplant earlier. Too little or too much light during the seedling stage can result in lower yields at time of harvest[6]. A common problem is not providing enough light causing seedlings to stretch and become “leggy” (Figure 8). Seedlings are the easiest stage to add light due to high plant density. Do not be stingy on the light!

CO_2 supplementation can be beneficial but is not necessary at the seedling stage. Ambient CO_2 level (~400 ppm) is sufficient, however, if you do wish to supplement your seedlings with CO_2, (up to about 800-1000 ppm) be prepared to increase your light intensity and rearing temperature in order to gain the full benefits of additional CO_2.

Airflow is often overlooked. Sufficient airflow will increase photosynthesis and transpiration by drying out the boundary layer at the leaf surface. Too much or too little airflow will slow seedling growth. A recommended uniform airflow applied to the seedling canopy is 10 $ft \cdot s^{-1}$ (0.3 $m \cdot s^{-1}$)

Timing of Transplant

When to transplant seedlings to their finishing location is most often determined by production schedules and spacing of the finishing location. Nonetheless, there is such a thing as too early and too late to transplant. When seedlings are transplanted too young, they may have a hard time acclimating to the environmental conditions that come with their finishing site (i.e., higher light intensity, higher fertilizer concentration). This can slow down their growth rate and waste valuable grow space. If transplanted too early the small seedlings can lead to excessive unused space between each plant (i.e. lots of wasted space in the hydroponic system). Seedlings that are transplanted too late start to crowd one another. This leads to competitive stretching as plant leaves compete for more light. Neighboring plants also tangle together which leads to leaf damage when workers attempt to separate the thin leaves. Lettuce and leafy greens are typically transplanted when the have 3-4 expanded leaves (and roots visible at the bottom of the substrate). Most leafy green and herb seedlings should be ready for transplant between 10 and 14 days after seeding if grown under optimum conditions. Some seedlings under suboptimum environments may take as long as 3-4 weeks.

Every grow facility possesses its own unique opportunities. Using the tips provided in this article is not a silver bullet but should help you consistently plan to have healthy and uniform seedlings on schedule every time you transplant.

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