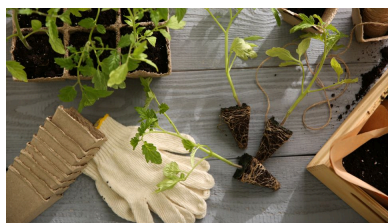


# Starting Vegetable Seeds Indoors: IV. Seedling Culture and Transplanting

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## Introduction

The period between seedling emergence and planting outdoors for the growing season is a time of rapid plant growth and development and is critical to long-term production success. In this last fact sheet in this series, we cover the main topics crucial to growing seedlings into quality, usable plants for outdoor production, including air circulation, temperature, light, water, fertilizer, indoor transplanting, hardening off, and transplanting outside.

## Air Circulation



Figure 1. Small Fan to

### Circulate Air

Proper air circulation in your growing space can deter the growth of fungi or other pathogens that can harm growing seedlings. Once roughly 50% of the seeds under the humidity dome have germinated, remove the dome. A small fan is a simple way to ensure good air circulation (Figure 1). Additionally, very light, intermittent, direct airflow on your seedlings can help them grow strong and resilient (Li et al., 2020). Having this more directed airflow on your seedlings one to several times a day for a short

duration (5 to 10 minutes or more) may be beneficial. Too much direct airflow can damage seedlings and likely increase the frequency of needed waterings.

## Temperature

Most vegetables prefer night temperatures between 60 °F to 65 °F. Day temperatures may run about 10 degrees higher. If temperatures are warmer than this, spindly plants can result. Cool-season vegetable crops (broccoli, cabbage, kale, spinach, etc.) prefer night temperatures around 55 °F and day temperatures hovering around 65 °F. With this in mind, remove or unplug any heat pads used during germination if temperatures are too warm.

## Light



Figure 2. A Simple Timer

### to Control Lighting

In most situations, natural light through a window is insufficient and will result in seedlings that are less healthy and weaker than those grown using supplemental lighting. Thus, if no supplemental lighting was used during germination, add lights after germination occurs. An actively growing seedling will benefit from 12–14+ hours of light each day. Use an inexpensive wall timer to give the necessary hours of lighting without manually turning the lights on and off each day (Figure 2). Expensive LEDs or lights marketed as “grow lights” are not necessary—fluorescent shop lights will work well. Hang the lights 2–3 inches above the growing plants, but be cautious of leaf scorching if the lights output high amounts of heat. If growing several flats of plants, multiple lights will likely be necessary. Move the light(s) up as seedlings continue to grow. For an in-depth discussion on light requirements and considerations, see the fact sheet “[Important](#)

Considerations for Providing Supplemental Light to Indoor Plants” from Iowa State University Extension.

## Water

As your seedlings grow more leaves, water will be lost into the air at a faster rate through transpiration. Always watch to ensure the soilless mix does not excessively dry out. A short period without sufficient water can kill young seedlings. On the other hand, do not keep your growing seedlings’ roots too wet, as this can deprive roots of oxygen. Notice the weight of a fully watered pot or tray—heft it in your hand. As the pot or tray’s weight gets significantly lighter, it is time to water. In addition to weight changes, look for the soil’s color to change from dark brown to nearly black when well-watered to light brown when dry. When potting soils get very dry, they shrink and retract from the edge of the pot. Allowing the growing media to moderately dry out between watering is advisable to avoid pests, pathogens, and other problems. However, do not let the seedling get so dry that it starts to wilt.

*Watch carefully; a short time without sufficient water can kill young seedlings.*

Sub-irrigation, or “bottom watering,” where you fill up a container with 1–2 inches of water to set your seedling packs or growing containers in, is a good option, as is overhead watering with a gentle stream of water. It is good practice to water from above periodically to prevent salt buildup in the containers that results from fertilizer salts and minerals naturally dissolved in the water. Regardless of the irrigation method, discard the drainage water and do not allow it to be re-absorbed into the container.

## Fertilizer

Soilless mixes used for seedling culture and potting soil generally do not have the nutrients necessary to sustain plant growth. However, some growing mixes do have a starter fertilizer added that will last a few weeks at most. Check the product label to understand what, if any, nutrients are present.

Fertilizer will be necessary when growing in soilless media of any kind (Figure 3). There are many suitable liquid or powdered water-soluble fertilizers available. If transplanting seedlings into a larger container, a slow-release, granular fertilizer can be a good option. Choose a fertilizer with macronutrients nitrogen, phosphorus, and potassium, and as many of the following micronutrients as possible: magnesium, boron, copper, iron, manganese, zinc, and molybdenum. When using a

liquid or water-soluble fertilizer, refer to the product label for mixing instructions for seedlings. If none are listed, a general recommendation is to dilute the normal recommended concentration by half and fertilize once a week. Overfertilizing can cause rapid succulent growth, which causes weak stems and makes the plants more attractive to pests and diseases. It is better to err on the side of being a little lean on fertilizer than excessive.



**Figure 3.** Water-Soluble Complete Fertilizer (left) and a Slow-Release Fertilizer (right)

## Indoor Transplanting



**Figure 4.** Pot up Seedlings When a Healthy Number of Roots Are Visible, but Before They Form Dense Mats  
Indoor transplanting or “potting up” means moving plants to a larger container. The number of times you will need to transplant will depend on the starting container, plant growth rate, and the length of time before you plant it out in the garden. Seedlings are ready to be potted up to a larger container when their leaves start overlapping with neighboring plants or when their roots become so dense in their current container that they form a thick mat at the

bottom. You can gently lift seedlings by their leaves from their container to check this (Figure 4).

When transplanting, take care to handle the seedlings gently to prevent damage. If transplanting from an open flat, use a pencil, knife, or similar instrument to dig up the seedlings and gently tease them apart—their roots may be intertwined, and some roots will be broken. Prepare the next container with moist soilless mix and create a hole for planting the seedling. Make it deep enough to plant the seedling at the same depth it grew in the open flat. It is often beneficial to handle the seedling by the leaves rather than the stem. Plant the seedling and gently firm the soilless mix around it, then water the seedling. If transplanting a seedling from a small cell pack into a larger pot, it is often easiest to use a pencil or other instrument and push the root ball from the bottom to dislodge the seedling from its current cell.

## Hardening Off



**Figure 5.** *Hardening Off*

### *Seedlings Before Transplanting Outside*

Indoor-grown seedlings are tender and unfit to grow immediately in harsh outdoor environments like those we experience in Utah. “Hardening off” refers to the process of acclimating your tender seedlings to the environment they will experience in your garden (Figure 5). This is done by incrementally exposing those seedlings to that outside environment, a crucial step in ensuring successful transplanting.

Hardening off can begin soon after seedling emergence but should minimally begin about two weeks before transplanting into your garden. Be careful not to expose your seedlings to freezing temperatures or temperatures below 45 °F to 50 °F for warm-season plants like tomatoes, peppers, squash, and melons. Excessively exposing your hardy and semi-hardy seedlings to temperatures below 40 °F can result in premature flowering. Initial outdoor exposure may be for just a short

period such as a few hours, with increasing outdoor time each day. Initial outside exposure should be in the shade, gradually increasing time in the sun until they tolerate full sun all day. Some leaves may yellow or turn dry and brown during this process, which is normal. The goal of hardening off is to allow time for the plants to grow new leaves and shoots under bright, dry outdoor conditions and not necessarily to preserve all the existing leaves and stems.

## Transplanting Outside

Different plant types, such as tender and hardy crops, should be transplanted outside at different times. Timing should have been estimated before starting any seeds. However, even with the best planning, sometimes the weather does not cooperate.

Carefully remove plants from their containers, leaving as much soilless mix as possible around the roots. It is best to push the root ball out from the bottom rather than pulling from the top. Dig a hole about twice as wide but only as deep as the soil mass around the roots so that transplants are at the same level they were in the container. Tomatoes can develop roots along the stem and may be planted deeper if desired. Water all plants immediately after planting to settle the soil around the root ball. Plants grown in peat pots can be planted without removing the pot, but remember to cut slits in the pot and cover the pot entirely with soil. Plants grown in peat pellets can be planted directly into the soil. If roots have formed a thick circular mat around the root ball, it is often beneficial to disrupt the roots by making several shallow, vertical cuts in the root ball with a knife or gently breaking up the roots with your hands.

If possible, transplant in the morning or on a cloudy day. Keep the root ball moist; this may require daily irrigation as new transplants require water more frequently until they are established. Be careful not to overwater. Soil should be kept damp but not perpetually soggy.

## Troubleshooting

### **Poor Germination**

Poor germination can be caused by several factors, including old or poor-quality seeds, incorrect temperatures (too hot or too cold for the crop), overwatering or underwatering (which can lead to seed rot or insufficient moisture for germination), and planting seeds too deep. To improve germination rates, use fresh, high-quality seeds with valid expiration dates, maintain the proper

temperature for each vegetable (using a heating mat for warm-season crops if needed), keep the soil evenly moist but not waterlogged, and plant seeds at the recommended depth (typically 2–3 times the diameter of the seed).

### **Thin-Stemmed, Weak Seedlings**



**Figure 6.** All Seedlings Were Started Together, But Seedlings on the Left Were Grown Under Insufficient Light

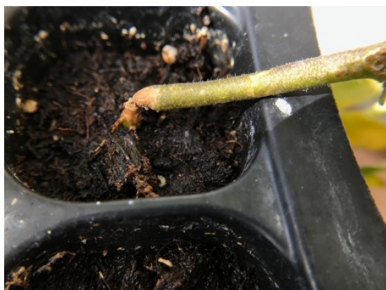
Poor light intensity is often the cause of tall, skinny plants that have difficulty staying upright. Consider adding supplemental lighting, and ensure it is within several inches (up to 6–12 inches) of the growing seedlings. Spacing plants so the leaves don't overlap, decreasing fertilizer, and lowering the temperature can also be helpful.

### **Leaning/Bending Seedlings**

Plants naturally lean or bend toward a light source, and this is usually due to insufficient or unidirectional light. Prevent this by adding more lights and rotating plants 180 degrees regularly.

### **Seedlings Stunted or Growing Slowly**

Common factors contributing to stunted or slow seedling growth include poor light (Figure 6), poor nutrition (fertilizer) availability, waterlogged soil, or cold temperatures.



**Figure 7.** Damping-Off

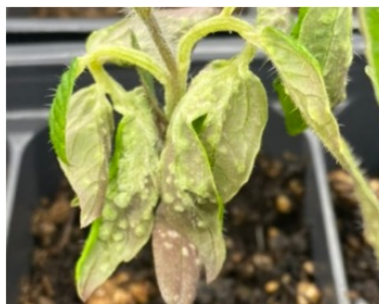
### **Seedlings Suddenly Fall Over and Die**

Seedlings falling over and dying is likely due to a condition called “damping-off,” caused by several fungal pathogens (Figure 7). Remove affected seedlings (along with

the soilless media they are growing in), and scout for any seedlings nearby that may also be infected. Use new, clean growing media (bagged soilless mixes are usually fine) and new or sanitized containers. Cool, moist conditions encourage the proliferation of the pathogen(s), so make sure to grow in the recommended temperature ranges, allow the soil to dry out between watering, and increase space between plants for air circulation. A small fan placed at plant level can help lower humidity and increase stem strength. For more information on damping-off, see the [USU Extension fact sheet “Damping-off.”](#)

### **Bumps Occurring on Stems and Leaves**

Edema (or oedema) can cause bumps on stems and leaves, which is a physiological condition when plants take up more water than they can transpire through their leaves (Figure 8). This causes internal cell pressure, which causes ruptures in plant cells. These look like little white to yellow bumps on leaves or stems and can turn darker over time. Edema is often seen in tomatoes and other solanaceous crops. Ensure temperatures are warm enough, air circulation is adequate, and that full spectrum light is sufficient. Decreasing fertilizer rates and allowing soil to dry out more will also help. For more information on edema, see “[Oedema \(Edema\)](#)” on the [USU Extension Integrated Pest Management website](#).



**Figure 8.** Edema on Tomato Seedlings

## ***Insect Pests***

There are several insects that can cause problems for young plants, but the most common in home transplant production are fungus gnats and whiteflies. Fungus gnats are small flies that thrive in high-moisture environments. Adults are primarily just a nuisance, but larvae can feed on roots and stems and cause extensive damage if not managed. The best long-term solution to manage fungus gnats is to ensure the soil dries out between waterings. Fungus gnats are not easily controlled by pesticides. Refer to the [USU Extension fact sheet "Fungus Gnats in the Home"](#) for more information.

Whiteflies are small, white, winged insects that feed on plant sap. They can cause stippled, yellowing leaves, up to entire leaf loss. Some biocontrol options are available, as well as insecticides. Consider discarding heavily infested plants. See the [USU Extension article "Whiteflies"](#) for more information.



**Figure 9.** *The Algal Layer Shown Is Not Directly Harming the Seedlings, But It Can Indicate Too Much Moisture and Lead to Other Complications*

### ***Plants Continually Wilting***

Plants that seem to be perpetually dry and wilted usually need to go into a larger pot. Gently ease the root ball from the current pot or cell pack for inspection. If there is a dense mat of roots, it's time for transplanting. Alternatively, if you are top watering and the soilless mix has gotten too dry, it may be that the water is not fully saturating the root ball. Bottom watering can help. Other factors that cause wilting include vascular wilt diseases that have not killed plants outright and excessively hot temperatures.

### ***White Crust on Soil Surfaces***

White crusty buildup is accumulation of salts and minerals primarily from the irrigation water. Most water sources in Utah are high in dissolved mineral content, and fertilizers add to this. Extensive bottom watering and overhead

watering without discarding the soil drainage are causes. Periodic overhead watering allows the water to flush through the soil, decreasing these salts.



**Figure 10.** *This Tomato Seedling Will Soon Shed Its Seed Coat as It Continues Growing*  
***Green Layer on Top of Soilless Mix***

This green layer is algae and is not directly harmful (Figure 9). However, it can increase the presence of disease pathogens that can cause damping-off or other issues. Ensure the soilless media dries out between waterings.

### ***Purple Color on Leaves***

A deep green to purple hue on leaves usually indicates a lack of phosphorus. Fertilize with a complete fertilizer to see if symptoms improve. Phosphorus deficiency can also be caused by cold, wet soil. Using a heat mat and allowing soil to dry out more will be helpful.

### ***Seed Coats Remaining On Seedling***

In most instances, the seed coat will shed off the emerging seedling as it grows. Sometimes this takes several days or more (Figure 10). It is usually not recommended to try and physically remove the seed coat, as this will most often result in damage to the young seedling.

## **Photos**

The authors provided all figure photos.

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