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Growing Peppers in Short-Season, High-Altitude Idaho Gardens

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Introduction

PEPPERS ARE CHALLENGING TO GROW if you garden or farm at high elevations (above 4,000 ft) or in United States Department of Agriculture Hardiness Zone 5 or lower. Cool climates in such locales tend to experience late-spring frosts, cool summer night temperatures, and short growing seasons. Peppers are a tender, warm-season crop that reach optimal growth where weather conditions are warmer and growing seasons longer than those found in high-elevation places in Idaho. In spite of the zone's suboptimal climate conditions, it is possible to grow high-quality peppers in high-altitude locales. This publication outlines the principles of optimizing growing conditions that allow for successful pepper performance at high altitudes.

Providing the Ideal Site for Pepper Production

To grow peppers successfully, identify an appropriate site on your property with adequate sunlight and good-quality soil. Given an ideal environment, peppers grow quickly and take advantage of the warm growing conditions within the short production season available.

Sunlight and Temperature

Peppers require plenty of sunlight to produce quality fruit. Provide pepper plants with a minimum of 6 hours—more is better—of direct sunlight if you want to produce a large quantity of high-quality fruit. While current research states that a minimum of 6 hours of daily sunlight is needed, the pepper plant will grow more daily and thus develop faster with 8 or more hours of direct sunlight during ambient temperatures between 70°F and 80°F. Extra

summer sunlight can help to counter some of the effects of suboptimal temperatures and a shortened season. Idaho offers many spring and summer days with plenty of direct sunlight hours, but daytime temperatures can be suboptimal for plant growth depending on the weather. Cooler temperatures delay growth, flowering, and fruit development. Inadequate sunlight hours reduce both fruit size and the total amount of peppers produced. An indicator of inadequate sunlight is tall, leggy (meaning stems are elongated from trying to get more light) plants, with little or no fruit set. In this case, select a different location.

Proper spacing within the row or bed is also important for plants to prevent competition for sunlight. Plants should be placed 18 inches apart in a row. It can be beneficial to provide more than 18 inches between each plant, but if you are restricted on space or have a high-intensity planting strategy then this may not be an option. The extra spacing allows plants to become bushier, receive more sunlight, and ultimately be more productive. The walkways between rows should be no less than 36 inches wide measured from the center of each row. This gives you adequate room to pull weeds, pinch the tops of pepper plant branches, harvest fruit, and prevent the plants from competing for nutrients and sunlight. If growing peppers in a high-intensity production strategy, decrease row spacing to 24 inches, but be aware that crowding, legginess, and accessibility issues may develop or occur.

YOU ARE A SHORT-SEASON, HIGH-ALTITUDE GARDENER IF

- You live in Idaho at an elevation above 4,500 ft, **OR**
- Your USDA hardiness zone is 4 or lower, **OR**
- You have a frost-free growing season of 110 days or less

Soil

To optimize pepper growth within a short season, provide the best overall soil health possible. As with adequate sunlight, a productive, fertile soil is critical for rapid development. An ideal soil for peppers is a well-drained, light-textured soil that allows for a quick spring warm-up, adequate levels of fertility, and well-composted organic matter. While it is difficult to change most characteristics of the soil in your garden, you can improve drainage and increase fertility by adding organic matter. Most high-altitude garden soils in Idaho are low in organic matter (with an average content of less than 3%), have little naturally occurring biological activity, and overall have low fertility. Improvement to the health and texture of native soils can be accomplished by adding organic matter to the soil. Pepper plants are moderate-to-heavy users of the major nutrients: nitrogen, phosphorus, and potassium. Soil testing should be done every 3–5 years prior to planting to determine appropriate additions of compost and fertilizer. Apply 1–3 inches of compost to the soil of a pepper-growing area annually and work it into the soil to a depth of 6 inches.

There may be cases when your existing garden soil cannot be improved sufficiently to create adequate growing conditions for peppers. In this situation, the installation of raised beds is the best approach. Fill them with soil components that provide good drainage, high organic matter content, a light texture, good anchorage, sufficient soil depth, and adequate nutrient content. Many nurseries already offer a planter bed mix that provides these qualities. Most planter bed mixes are composed of finely chipped bark, perlite, peat moss, sand, and compost. Some planter bed mixes lack a full complement of nutrients or will have varying nutrient levels from batch to batch. Conducting a soil test is essential to identify if nutrient deficiencies are present in a planter bed mix.

Wind

Springtime in Idaho is known for extended weeks of high winds that batter and damage young transplants. While peppers normally produce sturdier plants than tomatoes, plants are quite brittle and can be damaged during a windstorm. Good wind protection should not interfere with the plant receiving sunlight. Examples of wind protection include planting near (but not right next to) fences, homes, and/or hedges, or creating artificial windbreaks made of landscape fabric, shade cloth, or other sturdy, pliable materials.

Starting Transplants Indoors

Transplanting peppers provides growing advantages for locations with short growing seasons. Pepper plants should be started indoors or in a climate-controlled greenhouse, grown to the appropriate size, and then transplanted outside. The practice of direct sowing peppers into the ground is not recommended for short-season gardens, because plants lack adequate time to reach harvest. Transplanting peppers provides a full stand of plants in the garden and a competitive edge against spring weeds.

Start pepper seeds using a seedling heat mat with the soil temperature set to 70°F–72°F. Pepper seedlings take a longer time to grow and develop to an appropriate size for transplanting as compared to tomatoes. Depending on pepper variety, germination to emergence takes about 6–10 days. If starting peppers in germination trays, plan on transplanting them into larger individual containers at about 21–26 days from germination. Overall, the time frame from planting pepper seeds to transplanting into the garden is about 7–11 weeks.

Once your transplants reach appropriate size—generally 6–8 inches tall—harden them off before planting them in the garden. Hardening plants allows them to adapt to cold nighttime ambient temperatures, intense sunlight, and windy conditions. Acclimate transplants by placing them outside and allowing them to experience full sunlight, windy conditions, and nighttime temperatures no lower than 50°F. Chilling injury

to the plant can occur at and below 50°F. The acclimatization process helps minimize sunburn or windburn when the plants are moved permanently outdoors. Exposure to outside conditions should initially be just a few hours a day, but over the two-week hardening period, the time outside should be extended until plants are left out all day. Bring plants back indoors if night temperatures below 50°F are predicted. Low-temperature acclimatization helps slow excessive top growth and creates sturdier plants.

An Idaho Master Gardeners' List of Pepper Varieties That Perform Well in High Elevations

Sweet Peppers

Ace
Better Belle
California Wonder
Gypsy (Cubanelle)
North Star Hybrid
Yellow Cheese
Super Bell
Sweet Banana
Yankee Bell

Hot Peppers

Hungarian Wax
Anaheim Chili
Big Jim
Super Chili

Choosing Short-Season Varieties

There are many different pepper varieties available, but few of them are locally adapted to high-elevation regions. Short-season varieties should be chosen for optimal production. One strategy for variety selection

is to choose those with the shortest possible “days to harvest” number printed on the package. A second strategy is to visit with experienced gardeners in your neighborhood to determine which varieties they successfully grow.

Personal taste preference and intended usage are also important considerations when choosing a variety. For salad use, sweet peppers are usually preferred, while one of the hot pepper cultivars may be preferred for sauces, salsas, and processing. The mildest of the hot peppers are Anaheim, Cubanelle, banana, poblano, and ancho. Medium heat selections include jalapeño, hot wax, chipotle, and serrano peppers. For intense heat, grow cayenne, Bahamian, habañero, pequin, or ghost peppers (but use these with caution).

Season Extension Techniques for Peppers

High-elevation sites in Idaho tend to have large diurnal temperature variations, meaning daytime temperatures can be relatively high but nighttime temperatures are cool (for example, 95°F during the day, 55°F or less after dusk). This limits what we call a heat unit (a measure of the temperature needed to produce a mature crop). Peppers that are consistently exposed to suboptimal growing conditions, even though it may get hot during the day, will grow poorly. Given these conditions, peppers benefit from the application of “season extension” techniques.

Season extension refers to any technique that protects plants from early and late-season frost events, but it also applies to any methodology that increases both daytime and especially nighttime temperatures. In the latter case, we may actually shorten the time needed to mature a crop rather than actually extend the number of frost-free days. But the results are the same—successful maturation usually requires much warmer conditions and longer growing seasons than supplied naturally.

Examples of season extension techniques include simply planting a crop against a south-facing masonry wall or growing them in a climate-controlled greenhouse. Here are a few choices for artificially enhancing the pepper-growing environment:

Low-Input Season Extension Techniques

Selection of a warm microclimate. Better production conditions can be created if you plant peppers on a south-facing slope, against the foundation of a south-facing wall, or on the south side of a fence (especially a masonry wall that can hold some heat at night). Sometimes these microclimates may become too hot on a summer day, triggering blossom abortion, so it’s critical to research which site on your property is the best for growing peppers.

Water tubes. Often known by the trade name Wall O’ Water, these devices are made from welded plastic with chambers that hold water. During the day the sun heats the water; at night the stored heat radiates to the plants, which helps protect the peppers from frost and warms them through the early part of the season. Venting by spreading open the top may be required to ensure plants do not get exposed to excessively high temperatures on warm sunny days.

Plastic mulch. Covering the soil surface with black plastic mulch helps warm soil temperatures and helps increase transplant root growth. Mulches also aid in weed management and, when used with other season extension technologies, significantly increase plant growth, earliness of fruiting, and total yield. Make sure the plastic is securely fastened to the ground to avoid wind damage (Figure 1).



Figure 1. Pepper plant growing in plastic mulch-covered bed. Courtesy of Rebekah D. Wallace, University of Georgia, Bugwood.org.

Aqua Dome Plant Protector. Similar to water tubes, these hard-plastic covers provide the temperature-retaining benefits of a layer of water and two layers of hard plastic. Venting to prevent heat buildup is essential when using these devices.

Cloches. A cloche is a name for a bell-shaped glass dome. In practical application, use any glass or plastic device of appropriate size to cover and protect pepper plants. Care must be taken in using this technique. On sunny days, overheating is a serious problem even if it's a cool day, because they must be opened or removed to prevent heat damage.

Grow it Now Plant Protectors. Similar to a cloche, these plant covers are made from a heavy-duty polyethylene sheeting. They provide some frost protection and can be opened on the top for ventilation on warm days.

Row covers. Cover entire rows of plants with fabric material, either placed over hoops or directly on the plants. The advantage of using row covers is that you can leave them in place for an extended time, thereby increasing temperatures around the plants until consistent summer warmth arrives.

Medium-Input Season Extension Techniques

Raised beds. Soil in raised beds warms up faster in the spring than soil in traditional flat gardens. When combined with other season extension techniques (like plastic mulch or plant covers), raised beds can help produce a mature crop of peppers.

Hot beds. These are commonly created by combining raised beds with shallowly buried electric heating cables to increase soil temperatures. These devices are most useful when combined with row cover, low tunnels, or high tunnels.

Cold frames. Constructed as either a permanent or temporary structure, cold frames provide conditions like those created by a more extensive greenhouse structure except they lack an artificial heat source. As with cloches, cold frames must be opened on warm days and should be designed with this procedure in mind.

Low tunnels. Low tunnels are constructed by placing clear plastic over metal or plastic hoops.

These structures may cover a significant portion of your garden. They are often too short to walk under, will need to be vented, and may make garden maintenance activities more difficult. However, they provide very good season extension capabilities when managed properly.

High-Input Season Extension Techniques

High tunnels. High tunnels are structures with features that help the home gardener overcome some of the challenges of high-altitude gardening. Although they do not have artificial temperature controls, they can be built either as permanent or portable structures, are tall enough to comfortably work under, and can extend over a significant portion of the garden—covering more than just the peppers. Remember, however, that daily temperature management is critical for high tunnels to function properly.

Greenhouse. Greenhouses can be large or small. Due to their climate control capabilities, they can be used to produce crops such as peppers for much of the year. The high cost of heating the structure during the coldest months of the winter is significant, thus winter production may not be practical.

Additional Growing Tips

Provide consistent irrigation. Avoid moisture content fluctuations in the garden soil such as drought-stressing or overwatering. Peppers are shallow rooted and are easily affected if drought conditions occur, making them prone to fruit-quality degradation.

Practice good weed-control practices such as hand weeding and using mulches to control weeds and prevent competition that will slow plant growth, reduce productivity, and negatively affect fruit quality.

At the time of first blossoming, a side dressing of a complete fertilizer may help ensure plants have sufficient nutrients to optimally develop fruit. The application amount of this side dressing will vary dependent upon soil nutrient content, which can be determined by a soil test.

Pest and Disease Problems in Short-Season Climates

There are only a few pest and disease issues of peppers in the high-elevation locales of Idaho. The following pests and diseases appear often enough to require monitoring and management:

Insect Pests

Aphids. Aphids will often congregate on and damage the new growth of pepper plants. During a severe infestation, foliage may become yellow and wilted, eventually falling from the plant.

Control: Spray infested plants with a hard stream of water and knock the aphids from the plants. Beneficial insects are critical to long-term control of aphids, so avoid using a broad-spectrum insecticide that will kill these predators.

Spider Mites. Damage from spider mites first appears as a bronzing of the leaves accompanied by webbing on the underneath surface. Affected leaves eventually turn yellow and fall from the plant.

Control: Employ overhead irrigation in the garden, a practice that discourages proliferation of spider mites. If infestations become severe, spray the foliage with a hard stream of water, with special attention to the underside of the leaves. As with aphids, beneficial insects are important for long-term control and should be protected.

Diseases and Environmental Issues

Verticillium wilt. This fungal disease is soil-borne, meaning it lives in the soil, infects roots, and moves into the stems where it blocks the vascular tissues, thereby reducing the plant's ability to take up water. Early symptoms of infection include foliage wilting on warm, dry days. This progresses into continuous wilting, accompanied by necrotic leaf margins, and eventually the death of individual stems. If severe, this disease will completely kill infected plants. Once this disease is in a garden, it will likely be a recurring problem due to persistence in the soil.



Figure 2. Peppers with phytophthora infection.



Figure 3. Peppers with phytophthora infection. Note the dark discoloration that starts from the roots moving up.



Figure 4. Sunburn of pepper plants.

Control: Select pepper varieties that have known tolerance or resistance to *verticillium*. Utilize a crop-rotation program in the garden, although this may have limited effectiveness due to the mixing and possible inoculation of the soil throughout the garden. For any single spot in the garden, plant unrelated crops for at least two years between pepper crops. Related crops that should not be in the pepper rotation include potatoes, tomatoes, and eggplants. If symptoms of unexplained wilting (not due to drought) and leaf scorch are found in the garden, dig up and remove the infected plant(s) from the garden and dispose of them to reduce soil inoculation and spread to other plants. Do not compost infected plants, as the pathogens can survive in the compost pile and cause future disease problems.

Phytophthora capsici. This pathogen infects roots, stems, fruit, or leaves (Figures 2 and 3). The infection usually starts in the roots (*phytophthora* root rot), but eventually exhibits visible stem blight that slowly spreads up the plant. The blackened, creeping infection is quite indicative of *phytophthora* blight.

Control: Same treatment as when managing *verticillium* wilt. Select pepper varieties that have known tolerance or resistance to the *phytophthora* pathogen.

Sunburn. Prolonged direct sunlight combined with hot air temperatures can cause heat damage to the sun-exposed skin of the fruit. Sunburn shows up initially as soft, discolored areas on the fruit. The damaged skin becomes sunken and dies, and, as the defect progresses, the discolored spots become an entry point for diseases to enter the fruit and cause it to rot (Figure 4).

Control: Provide optimal growth conditions (adequate and consistent water, fertility, and pest management) to keep leaves healthy so the fruit remains shaded in its own leaves. Pinching encourages branching during the growth stages so plants become bushy and produce more leaves, thereby providing more shade for the fruit. Employ irrigation practices that prevent plants from being water stressed and supply plants with sufficient

nutrients to maintain healthy growth. If sunburn is a consistent problem, use shade cloth with a 30% filtration rating to reduce heat damage during the hotter parts of the day. Additionally, avoid planting peppers next to a south-facing wall that reflects extra heat onto the peppers.

Blossom-End Rot. The typical symptoms of blossom-end rot is black, hard, leathery skin on the bottom end of the fruit. Calcium deficiency is the underlying cause of this physiological disease, normally triggered by irregular watering. Unfortunately, adding calcium to the soil will not resolve the issue once it has started.

Control: Proper water management, which ensures adequate calcium uptake by the roots, is the best defense against blossom-end rot. Never let plants deplete soil water to the point that they wilt, especially during the hottest days of summer.

Harvest and Utilization

Sweet peppers can be harvested at any point after the fruit becomes large enough to eat. However, the sweetest fruits are those that reach their mature color. Many orange, yellow, and red sweet peppers require an additional 14–21 days to develop their full color when compared to a common green bell pepper. A short growing season can impair this color change, thus season extension methods are recommended to help the fruit develop their full color potential. Hot peppers should be fully mature at the time of harvest. If hot peppers are to be dry stored, they may be left on the plant to be partially dried before removal; or, later in the season, you can pull up the plants and dry them in a protected shed or garage.

Harvest the fruit by cutting the stems rather than pulling the fruit from the plants. Pepper plants have brittle stems and branches and pulling fruit off the plant often results in stem breakage, thereby reducing production or killing branches.

Freshly harvested peppers have a short shelf-life. Peppers are best utilized within several days of harvest. For longer storage, place fruits in the crisper

of a refrigerator. However, fruits will suffer cold injury if held at a temperature below 45°F for an extended time. For long-term storage, keep fruit in moist conditions at temperatures between 45°F and 50°F.

Processed peppers can be successfully stored for long periods of time. Process peppers by drying, freezing, or canning. Peppers can be sun-dried or dried in a dehydrator. If sun-dried, prevent fruits from being exposed to rainfall during the drying period. Freeze peppers with or without blanching. Can peppers using only a pressure-cooking process. Determine cooking specifications using an up-to-date, reputable source.

Further Reading

- Bush, M. R., M. D. Heitstuman, and L. Powers-Hammond. 2016. *Vegetables: Growing Peppers in Home Gardens*. Washington State University Extension, FS220E. 8 p. <http://pubs.extension.wsu.edu/vegetables-growing-peppers-in-home-gardens-home-garden-series>.
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