



Colorado MASTER GARDENER

Plant Growth Factors: Temperature no. 7.712

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Thought Questions:

- Why did I have so much winter injury on my trees and shrubs? While it was dry and windy, temperatures were not extremely cold.
- My arborvitae are bleached tan from the winter. Will they green-up with spring temperatures?
- With the rather hot summer, will the apple and peach crop be as sweet as normal?



Temperature Considerations

Temperature factors that figure into plant growth include the following:

- Maximum daily temperature.
- Minimum daily temperature.
- Difference between day and night temperatures.
- Average daytime temperature.
- Average nighttime temperature.

Microclimates

The microclimate of a garden plays a primary role in actual garden temperatures. In mountain communities, changes in elevation, air drainage, exposure, and thermal heat mass (surrounding rocks) will make some gardens significantly warmer or cooler than the temperatures recorded for the area. In mountain communities, it is important to know where the local weather station is located so gardeners can factor in the difference in their location to forecast temperatures.

Examples of factors to consider include the following:

Elevation – A 300 foot rise in elevation accounts for approximately 1 degree F drop in temperature.

Drainage – At night, cool air drains to low spots. Valley floors may be over 10 degrees F cooler than surrounding gardens on hillsides above the valley floor. That is why fruit orchards are typically located on the benches rather than the valley floor.

Exposure – Southern exposures absorb more solar radiation than northern exposures. In mountain communities, northern exposures will have shorter growing seasons. In mountain communities, gardeners often place warm season plants, like tomatoes, on the south side of buildings to capture more heat.

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Putting Knowledge to Work

Based on local topography, buildings, fences and plantings, garden areas may be protected from or exposed to cold and drying winds. They may also be exposed to or protected from warm and drying winds.

Thermal heat mass (surrounding rocks) – In many Colorado communities, the surrounding rock formations can form heat sinks creating wonderful gardening spots for local gardeners. Nestled in among the mountains, some gardeners have growing seasons several weeks longer than neighbors only a half mile away.

In cooler locations, a rock mulch may give some frost protection and increased temperatures for enhanced crop growth. In warmer locations, a rock mulch can significantly increase summer temperatures and water requirements of landscape plants.

In Phoenix, Arizona, the urban heat island (with all their rock mulch instead of grass and trees) has significantly raised day and night temperatures. The upward convection of heat has become so strong that summer storms are going around the city and not raining on the urban heat island.

Impact of Heat on Crop Growth

Temperature affects the growth and productivity of plants, depending on whether the plant is a warm season or cool season crop.

Photosynthesis – Within limits, rates of photosynthesis and respiration both rise with increasing temperatures. As temperatures reach the upper growing limits for the crop, the rate of food used by respiration may exceed the rate at which food is manufactured by photosynthesis. For tomatoes, growth peaks at 96 degrees F.

Temperature influence on growth

Seeds of cool season crops germinate at 40 to 80 degrees F. Warm season crops germinate at 50 to 90 degrees F. In the spring, cool soil temperatures are a limiting factor for plant growth. Mid-summer, hot soil temperatures may prohibit seed germination. See Table 1.

Examples of temperature influence on flowering:

- Tomatoes
 - Pollen does not develop if night temperatures are below 55 degrees F.
 - Blossoms drop if daytime temperatures rise above 95 degrees F before 10 a.m.
 - Tomatoes grown in cool climates will have softer fruit with bland flavors.
- Spinach (a cool season, short day crop) flowers in warm weather with long days.
- Christmas cacti and poinsettias flower in response to cool temperatures and short days.

Examples of temperature influence on crop quality:

- High temperatures increase respiration rates, reducing sugar content of produce. Fruits and vegetables grown in heat will be less sweet.
- In heat, crop yields reduce while water demand goes up.
- In hot weather, flower colors fade and flowers have a shorter life.

Heat Zone Map

A new concept in plant selection is **heat zone mapping**, a measurement of the typical summer heat accumulation. It will help identify geographic areas that have adequate heat accumulation to mature various crops.

The American Horticultural Society's Heat Zone Map can be viewed online at: www.ahs.org/publications/heat_zone_map.htm.

Heat zones can be sorted by zip codes. To look up a heat zone by zip code, go on-line at www.ahs.org/publications/heat_zone_finder.htm

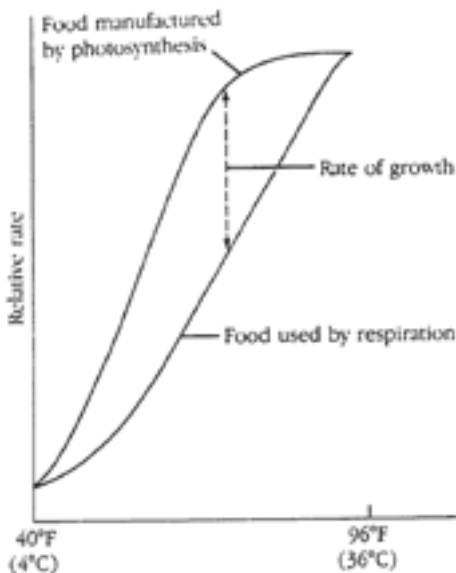


Figure 1. Generally, rates of photosynthesis and respiration increase as temperatures increase.

Table 1. Temperature differences in warm season tomatoes and cool season cole crops.

| Temperature for | Cool Season: broccoli, cabbage, and cauliflower | Warm Season: tomatoes, peppers, squash, and melons |
|------------------------|--|--|
| Germination | 40°-90°, 80° optimum | 50°-100°, 80° optimum |
| Growth | Daytime <ul style="list-style-type: none"> • 65°-80° preferred • 40° minimum Nighttime <ul style="list-style-type: none"> • >32°, tender transplants • >mid-20s°, established plants | Daytime <ul style="list-style-type: none"> • 86° optimum • 60° minimum • A week below 55° will stunt plant, reducing yields Nighttime <ul style="list-style-type: none"> • >32° |
| Flowering | Temperature extremes lead to bolting and buttoning. | <ul style="list-style-type: none"> • Nighttime <55°, non-viable pollen (use blossom set hormones) • Daytime >95° by 10 a.m., blossoms abort |
| Soil | Cool <ul style="list-style-type: none"> • Use organic mulch to cool soil. • Since seeds germinate best in warm soils, use transplants for spring planting, and direct seeding for mid-summer plantings (fall harvest). | Warm <ul style="list-style-type: none"> • Use black plastic mulch to warm soil, increasing yields and earliness of crop. |

It should be recognized that in mountain communities, minor changes in elevation and exposure (for example south slopes versus north slopes) make significant differences in heat accumulation. A heat zone for a community's zip code may not reflect the actual growing conditions in any specific garden.

Impact of Cold Temperatures

Hardiness Zone Map

Hardiness zone maps indicate the average annual minimum temperature expected for geographic areas. While this is a factor in plant selection, it is only one of many factors influencing plant hardiness.

The USDA Hardiness Zone Map was revised in 2003. Primary changes in the new map include the addition of four new zones in the sub-tropical area and the elimination of areas A and B for zones. Zones are based on a 10 degrees F difference in average annual minimum temperature.

On the 2003 Hardiness zone map, most of the Colorado Front Range falls into Zone 5 with cool mountain areas in Zone 4. Warmer locations in the Denver Metro, Fort Collins, El Paso and Pueblo Counties fall in Zone 6. Warmer areas of western, southwestern and southeastern Colorado are in Zone 6.

Hardiness zone maps can be viewed online at www.ahs.org/publications/usda_hardiness_zone_map.htm.

The new map was based on temperature data from 1987 to 2001 and does not reflect normal low (30 year base) or record low (all time low based on available records) used in weather reporting. On the new map, some areas of the nation are in a zone higher than previous maps due to a warmer than normal weather period from 1987 to 2001 or due to growth in the urban heat island. When talking about the Hardiness Zones Map, it may be important to clarify if the gardener is referring to an old version or the 2003 version.

Average Annual Minimum Temperature

Zone 4 -20° to -30°

Zone 5 -10° to -20°

Zone 6 0° to -10°

Plant Hardiness

Hardiness refers to a plant's tolerance to cold temperatures. Low temperature is only one of many factors influencing plant hardiness (ability to tolerate cold temperatures). Key hardiness factors include the following:

- photoperiod,
- genetics (source of plant material),
- low temperature,
- recent temperature pattern,
- rapid temperature changes,
- moisture,
- wind exposure,
- sun exposure, and
- carbohydrate reserve.

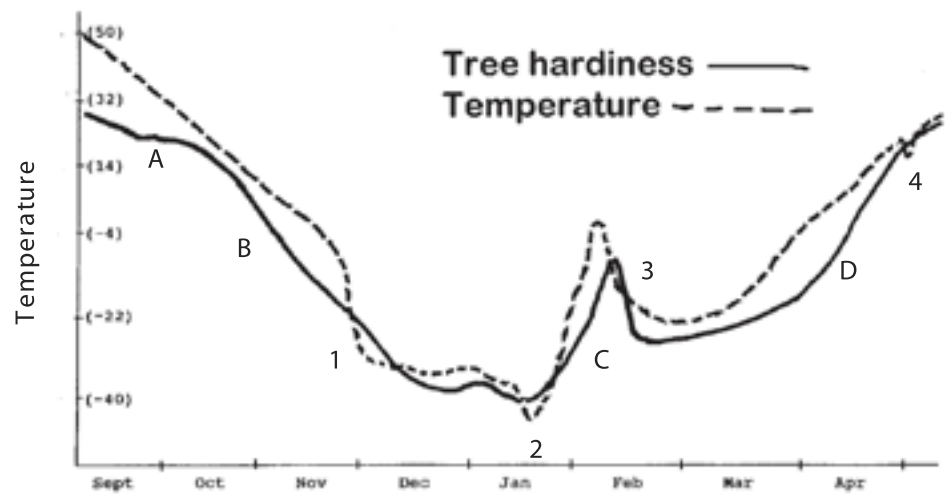


Figure 2. Impact of temperature change on the hardiness of trees.

Hardiness changes through the winter period.

- A. Increased cold hardiness induced by short days.
- B. Increased cold hardiness induced by low temperatures.
- C. Dehardening due to abnormally warm temperatures.
- D. Normal spring dehardening.
 - 1. Injury due to inadequate fall hardening from rapid drop in temperature.
 - 2. Injury at temperatures lower than hardening capability.
 - 3. Injury due to rise and fall of midwinter temperatures.
 - 4. Injury due to spring freeze.

Examples of Winter Injury

Bud kill and dieback – from spring and fall frosts.

Root temperature injury – Roots have limited tolerance to sub-freezing temperatures. Roots have limited protection from soil, mulch, and snow. Under extreme cold, roots may be killed by the lack of snow cover or mulch. Street trees are at high risk for root kill in extreme, long-term cold.

Soil heaving pushes out plants, breaking roots. Protect with snow cover or mulch.

Trunk Injury

Sunscald – caused by heating of bark on sunny winter days followed by a rapid temperature drop, rupturing membranes as cells freeze.

Frost crack – vertical split on tree trunk caused by rapid drop in bark temperature.

Frost shake – separation of wood along one or more growth rings, typically between phloem (inner bark) and xylem (wood), caused by sudden rise in bark temperature.

Winter Injury on Evergreens

Winter drought – water transpires from needles and can't be replaced from frozen soils. It is more severe on growing tips and the windy side of trees.

Sunscald – winter sun warms needles, followed by rapid temperature drop rupturing cell membranes. It is typically on southwest side, side of reflected heat, or with sudden shade.

Photo-oxidization of chlorophyll – foliage bleaches during cold sunny days. Needles may green-up again in spring.

Tissue kill – tissues killed when temperatures drop below hardiness levels.

Rest Period

An accumulation of cool units controls the flowering period of temperate-zone woody plants. The winter rest period (hours below 45 degrees F) required to break bud dormancy includes:

| | | | |
|---------------|----------------|----------------|----------------|
| Apricot | 100-400 hours | Pear | 200-1500 hours |
| Apple | 250-1700 hours | Plum, European | 900-1700 hours |
| Cherry, sour | 600-1400 hours | Plum, Japanese | 300-1200 hours |
| Cherry, sweet | 500-1300 hours | Walnut | 400-1500 hours |
| Peach | 800-1200 hours | | |

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