Fall and Winter Hoophouses ©Pam Dawling 2021

Twin Oaks Community, Central Virginia (zone 7a).
Author of *Sustainable Market Farming* and *The Year-Round Hoophouse*.
SustainableMarketFarming.com facebook.com/SustainableMarketFarming

- Overview of the hoophouse in fall and winter
- Winter-kill temperatures of cold-hardy crops
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- Rotations, schedules and maps
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Winter Kill Temperatures of Winter-Hardy Vegetables 2021 revision

Unless otherwise stated, these are killing temperatures of crops *outdoors without any rowcover*. All greens do a lot better with protection against cold drying winds. Note that repeated cold temperatures can kill crops that can survive a single dip to a low temperature, and that cold winds, or cold wet weather can destroy plants quicker than simple cold. Crops get more damage when the weather switches suddenly from warm to cold. If the temperature drops 5 or more Fahrenheit degrees (about 3 C degrees) from recent temperatures, there can be cold damage. The forecaster in Raleigh, NC says it needs 3 hours at the critical temperature to do damage. Your experience with your soils, microclimates, and rain levels may lead you to use different temperatures in your planning.

35°F (2°C): Basil.

32°F (0°C): Bush beans, cauliflower curds, corn, cowpeas, cucumbers, eggplant, limas, melons, okra, some pak choy, peanuts, peppers, vines of potatoes, squash and sweet potato, tomatoes.

27°F (-3°C): Many cabbage varieties, *Sugarloaf* chicory (takes only light frosts).

25°F (-4°C): Some cabbage, chervil, Belgian Witloof chicory roots for chicons, and hearts, Chinese Napa cabbage (*Blues*), dill (*Fernleaf*), some fava beans (*Windsor*), annual fennel, some mustards (*Red Giant*, *Southern Curled*) and Asian greens (*Maruba Santoh, mizuna*, most *pak choy, Tokyo Bekana*), onion scallions (some are much more hardy), radicchio, rhubarb stems and leaves.

22°F (-6°C): Some arugula (some varieties are hardier), *Bright Lights* chard, endive (Escarole may be a little more frost-hardy than Frisée), large leaves of lettuce (protected hearts and small plants will survive colder temperatures).

20°F (-7°C): Some beets (*Bulls Blood, Chioggia*,), broccoli heads (maybe OK to 15°F (-9.5°C)), some Brussels sprouts, some cabbages (the insides may still be good even if the outer leaves are damaged), some cauliflower varieties, celeriac, celtuce (stem lettuce), some collards (*Georgia Cabbage Collards*, variegated collards), some head lettuce, some mustards/Asian greens (*Tendergreen*, *Tyfon Holland* greens), flat leaf parsley, radicchio (both Treviso and Chioggia), radishes (*Cherry Belle*), most turnips (*Noir d'Hiver* is the most cold-tolerant variety).

Large oat plants will get serious cold damage. Oats seedlings die at 17°F (-8°C)

Canadian (spring) field peas are hardy to 10-20°F (-12 to -7°C).

15°F (-9.5°C): Some beets (*Albina Verduna, Lutz Winterkeeper*), beet leaves, some broccoli and cauliflower leaves, some cabbage (*Kaitlin, Tribute*), covered celery (*Ventura*), red chard, cilantro, fava beans (*Aquadulce Claudia*), *Red Russian* and *White Russian* kales, kohlrabi, some lettuce, especially medium-sized plants with 4-10 leaves (*Marvel of Four Seasons, Olga, Rouge d'hiver, Tango, Winter Density*), curly leaf parsley, rutabagas (*American Purple Top Yellow, Laurentian*), broad leaf sorrel, most covered turnips, winter cress.

12°F (-11°C): Some beets (*Cylindra,*), some broccoli perhaps, some Brussels sprouts, some cabbage (*January King*, Savoy types), carrots (*Danvers, Oxheart*), most collards, some fava beans (mostly cover crop varieties), garlic tops if fairly large, *Koji* greens, most fall or summer varieties of leeks (*Lincoln, King Richard*), large tops of potato onions, covered rutabagas, some turnips (*Purple Top).*

10°F (-12°C): Covered beets, *Purple Sprouting* broccoli for spring harvest, a few cabbages (*Deadon*), chard (green chard is hardier than multi-colored types), some collards (*Morris Heading* can survive at least one night at 10°F), *Belle Isle* upland cress, some endive (*Perfect, President*), young *Bronze fennel*, *Blue Ridge* kale, probably *Komatsuna*, some leeks (*American Flag (Broad London), Jaune du Poiteau*), some covered lettuce (*Pirat, Red Salad Bowl, Salad Bowl, Sylvesta, Winter Marvel*), *Chinese Thick-Stem Mustard* may survive down to 6°F (-14°C), covered winter radish (Daikon, *China Rose, Shunkyo Semi-Long* survive

10°F/-12°C), *Senposai* leaves (the core of the plant may survive 8°F/-13°C), large leaves of savoyed spinach (more hardy than smooth-leafed varieties), *Tatsoi, Yukina Savoy*.
Oats cover crop of a medium size die around 10°F (-12°C**)**. Large oat plants will die completely at 6**°**F (-17**°**C) or even milder.
5°F (-15°C): Garlic tops even if small, some kale (*Winterbor, Westland Winter*), some leeks (*Bulgarian Giant, Laura*), some bulb onions, potato onions and other multiplier onions, smaller leaves of savoy spinach and broad leaf sorrel. Many of the Even' Star Ice Bred greens varieties and the *Ice-Bred White Egg turnip* are hardy down to 6°F (-14°C), a few unprotected lettuces if small (*Winter Marvel, Tango, North Pole, Green Forest*).
0°F (-18°C): Chives, some collards (*Blue Max, Winner, McCormack's Green Glaze*), corn salad (mâche), garlic, horseradish, Jerusalem artichokes, Even' Star *Ice-Bred Smooth Leaf* kale, a few leeks (*Alaska, Durabel, Tadorna*); some bulb onions, yellow potato onions, some onion scallions, (*Evergreen Winter Hardy White, White Lisbon*), parsnips (probably even colder), salad burnet, salsify (?), some spinach (*Bloomsdale Savoy, Long Standing Bloomsdale, Olympia*). *Walla Walla* onions sown in late summer are said to be hardy down to -10°F (-23°C), but I don't trust below 0°F (-18°C)
Crimson clover is hardy down to 0°F (-18°C) or perhaps as cold as **-10°F (-23°C)**
-5°F (-19°C): Leaves of overwintering varieties of cauliflower, *Vates* kale survives although some leaves may be too damaged to use. *Lacinato Rainbow Mix* kale may survive this temperature.
-10°F (-23°C) Austrian Winter Field Peas and Crimson clover (used as cover crops).
-15°F (-26°C) Hairy vetch cover crop – some say down to -30°F (-34°C)
-20°F (-29°C) Dutch White clover cover crops – or even -30°F (-34°C)
-30°F to -40°F (-34°C to -40°C): Narrow leaf sorrel, Claytonia and some cabbage are said to be hardy in zone 3. I have no personal experience of this.
-40°F (-40°C) Winter wheat and winter rye (cover crops).

Hoophouse Notes

In a double-layer hoophouse (8F/5C warmer than outside on winter nights) **plants can survive 14F/8C colder** than they can outside, without extra rowcover; **with thick rowcover** (1.25oz Typar/Xavan) at least **21F/12C colder** than outside without.
For example, salad greens in our hoophouse in zone 7a survive nights with outdoor lows of 14°F (-10°C). Russian kales, lettuce, mizuna, senposai, spinach, tatsoi, turnips, Yukina Savoy survived a *hoophouse* temperature of 10.4°F (-12°C) without rowcover, -2.2°F (-19°C) with. *Bright Lights* chard got frozen leaf stems. Outdoor temperatures fell to -12**°**F (-24**°**C)!
Lettuce varieties for a solar-heated winter greenhouse or hoophouse in zone 7a: (hardiest are in bold) ***Buckley,*** *Ezrilla,* ***Green Forest****, Green Star, Hampton, Hyper Red Rumpled Wave, Lollo Rossa, Marvel of Four Seasons, Merlot, New Red Fire, North Pole, Oscarde, Outredgeous, Pirat, Red Cross, Red Sails, Red Salad Bowl,* ***Red Tinged Winter, Revolution, Rouge d'Hiver,*** *Salad Bowl, Sylvesta,* ***Tango,*** *Winter Marvel, Winter Wonderland*.
Cold-tolerant early spring lettuces include *Buckley, Crawford, Green Forest, Hampton, Merlot, New Red Fire, Revolution, Simpson Elite, Susan's Red Bibb* and *Swordleaf*.

Salad Crops

- **Lettuce heads** may survive an occasional dip to 10°F (–12°C) with inner rowcover
- **Particularly cold-hardy for outdoors**: Brune d'Hiver, **Buckley,** Ezrilla, **Green Forest, Hampton,** Lollo Rossa, Merlot, North Pole, **Red Tinged Winter, Revolution,** Rouge d'Hiver, **Tango, Winter Marvel**
- **For a frost-free unheated winter greenhouse in zone 7a:** Buckley, Ezrilla, Green Forest, Green Star, Hampton, Hyper Red Rumple Waved, Marvel of Four Seasons, Merlot, New Red Fire, North Pole, Pirat, Red Cross, Red Sails, Red Salad Bowl, Red Tinged Winter, Revolution, Rouge d'Hiver, Salad Bowl, Sylvesta, Tango, Winter Marvel, Winter Wonderland.
- **Baby lettuce mix, Small-leaf lettuces:** High Mowing's Multileafs, Johnny's Salanovas, Tango, Oscarde, Panisse.
- Many **cooking greens** can be used as salad crops while plants are small.

Fall and Winter Hoophouse Crops

- **Leafy cooking greens:** Spinach, Napus kales (Russians, Siberian), Swiss chard, Asian greens: senposai, Napa cabbage, Tokyo Bekana, Muruba Santoh, pak choy, tatsoi, Yukina Savoy, Thick-Stem Mustard, Mizuna, frilly mustards Ruby Streaks, Golden Frills, Scarlet Frills, Red Rain,.
- **Roots:** Turnips and their greens, carrots, beets, radishes,
- **Onions**: scallions, bulbing onions, garlic scallions
- **Peas and beans**; dwarf snap peas, fava beans
- **Bare-root transplants:**
  - In October we sow "filler" greens and lettuce to use in the hoophouse during the winter
  - In November we sow bulbing onions to plant outdoors 3/1
  - Jan 24 we sow kale, collards, spinach to plant outdoors in March

Fall Hoophouse Planting

- Early September: We clear and add compost to one of the beds, broadfork and rake, and sow sprouted spinach seed, radishes, scallions, Bulls Blood beet greens and tatsoi.
- Sept 15 and Sept 24: We make outdoor sowings of crops to later transplant into the hoophouse at 2–4 weeks old.
    - Sept 15: about ten varieties of hardy leaf lettuce and romaines, pak choy, Chinese cabbage, Yukina Savoy, Tokyo Bekana, Maruba Santoh, chard.
    - Sept 24: another ten varieties of lettuce, Red and White Russian kales, Senposai, more Yukina Savoy, mizuna, frilly mustards and arugula.
- At the end of September, we prepare one more bed. We transplant Tokyo Bekana and Maruba Santoh at 2 weeks old, Chinese cabbage, pak choy and Yukina Savoy at 3 weeks.
- Early October, we sow more radishes and some "filler" greens, (spinach, lettuce and Asian greens) to fill gaps later. We try hard to keep all the space occupied, mostly using lettuce and spinach.
- By mid-October we prepare another bed and transplant lettuce and chard, and sow our first turnips
- Late October we sow more filler greens, baby lettuce mix, radishes and our second spinach, turnips and chard
- In the fourth week of October, we clear and prepare more beds and transplant the Senposai, mizuna, ffrilly mustards, the 2nd lettuce, kale, arugula and Yukina Savoy at 4 weeks old.
- Nov 10 we sow more turnips, mizuna, frills. Arugula, filler lettuce and spinach, and our first bulb onions for field transplanting in early March.
- Nov 11-20 we sow scallions, tatsoi, radishes, more bulb onion starts.
- From Nov 20 we keep a fully planted hoophouse. As each crop finishes up, we immediately replace it with another.
- During December we use the "Filler" greens to replace casualties and harvested heads of Chinese cabbage, Pak choy, Yukina Savoy.

Follow-on Winter Hoophouse Crops

A sequence of different crops occupying the same space over time.

- Nov 17: We follow our 1st radishes with 3rd scallions
- Dec 23: 1st baby brassica salad mix with 5th radishes
- Dec 31: Some of our 1st spinach with our 2nd baby lettuce mix
- Jan 15: Our 1st tatsoi with our 4th spinach
- Jan 16: Our Tokyo Bekana with spinach for planting outdoors
- Jan 24: Our pak choy & Chinese cabbage with kale & collards for outdoors
- Feb 1: Our 2nd radishes with our 2nd baby brassica salad mix
- Feb 1: Our 1st Yukina Savoy with our 3rd mizuna/frilly mustards
- Feb 1: Some of our 1st turnips with our 3rd baby lettuce mix
- Feb 1: More of our 1st spinach with dwarf snap peas

Winter Hoophouse Harvest Dates

- October: beet greens, radishes, spinach, tatsoi.
- From November onwards: As October plus arugula, brassica salad mix, chard, lettuce leaves, mizuna, frilly mustards and scallions.
- From December: As November plus kale, senposai, turnips, and Yukina Savoy.
- From January: As December
- During December: whole plants of Tokyo Bekana, Maruba Santoh.
- During January: heads of Chinese cabbage, pak choy.
- Having the heading crops in December and January gets us through the slow-growth period.
- Most loose-leaf crops last until mid-March or later.

Persephone days and winter hoophouse crops

- When the daylight length is **below 10 hours**, little growth happens.
- The dates depend on your latitude. At our 38°N, it's Nov 20–Jan 20
- The slow growth is modified by the time to cool the soil.
- In practice, the dates of slowest growth for us are Dec 15–Feb 15. The same length of time, delayed 25 days.
- To harvest in mid-winter, we plan to grow a good supply of mature crops before this period. They will provide *most* of our harvests.

- For most of the winter, our hoophouse plants *are* actively growing, not merely being stored for harvest (as happens in colder climate zones and outdoors.
- Having some big Asian greens to harvest during the Persephone days allows the "leaf-harvest" crops to rest.

To keep nitrate levels as low as possible:

- ✓ Grow varieties best suited for winter;
- ✓ Avoid animal fertilizers; use organic compost.
- ✓ Ensure soil has sufficient P, K, Mg and Mo
- ✓ Water enough but not excessively;
- ✓ Provide fresh air as soon as temperatures reach 68°F (20°C), so that carbon dioxide levels are high enough;
- ✓ Harvest after at least four (preferably six) hours of bright sunlight in winter;
- ✓ Avoid harvesting on very overcast days;
- ✓ Avoid over-mature crops and discard the outer leaves. Harvest crops a little under-mature, rather than over-mature;
- ✓ Refrigerate immediately after harvest, store harvested greens at temperatures close to freezing;
- ✓ Use crops soon after harvest;
- ✓ Mix your salads; don't just eat spinach.

Hoophouse Succession Planting

Crop		Planting Dates	Harvest Dates	Notes
Chard	#1	transplanted Oct 15	Dec 11–April 9	
	#2	sown Oct 26	March 6–April 9	
Lettuce mix	#1	sown Oct 24	Dec 11–Feb 21	
	#2	sown Feb 1	March 20–April 20	3 cuts if we're lucky
Lettuce heads		until October	November to February	Harvest leaves from the mature plants
			Dec 6–March 31	Cut the heads
Mizuna	#1	transplanted Oct 24	Nov 1–Jan 25	
	#2	sown Nov 10	Jan 27–March 6	
Onions (bulbing)	#1	sown Nov 10		Transplanted outdoors as early as possible in March
	#2	sown Nov 22		
	#3 backup	sown Dec 6		
Radish	#1	sown Sept 6	Oct 1–Nov 15	
	#2	sown Oct 22	Nov 25–Jan 29	
	#3	sown Nov 27	Feb 12–March 13	
	#4	sown Dec 27	March 2–April 1	
	#5	sown Jan 27	April 2–April 15	
Scallions	#1	sown Sept 6	Dec 25–March 20	
	#2	sown Nov 13	March 19–May 15	Following radish #1
Spinach	#1	sown Sept 6	Oct 30–April 9	Sprouted seeds sown
	#2	sown Oct 24	Nov 20–May 7	
	#3	sown Nov 10	All these later sowings are harvested until May 7	We keep planting to fill gaps and pulling up finished plants
	#4	sown Dec 27		
	#5	sown Jan 17		
	#6	sown Jan 24	Until mid-May	To transplant outdoors in February
Tatsoi	#1	sown Sept 7	Oct 30–Dec 28	
	#2	sown Nov 15	Feb 15–Feb 28	
Turnips	#1	sown Oct 15	Dec 4–Feb 20	
	#2	sown Nov 10	Feb 25–March 10	Thinnings Jan 11
	#3	sown Dec 10	March 5–March 20	Only worthwhile if thinned promptly and eaten small. Greens are a very sweet and beautiful hoophouse crop
Yukina Savoy	#1	transplanted Oct 10	Dec 30–Jan 22	
	#2	sown Oct 24	until Jan 29	Only one week extra

Resources - General

- ATTRA attra.ncat.org/ *Season Extension Techniques for Market Farmers,* etc.
- SARE www.sare.org/ A searchable database of research findings. *See Season Extension Topic Room*
- articles.extension.org/organic_production and eorganic.info Reliable publications, webinars, videos, trainings and support.
- *Growing Small Farms*: growingsmallfarms.ces.ncsu.edu/ Farmer Resources.
- Jean-Paul Courtens, Roxbury Farm https://www.roxburyfarm.com/roxbury-agriculture-institute-at-philia-farm *Whole farm Approach; Biodynamic Practices; Harvest Manual; Crop Manual; More Info for Farmers: Soil Fertility Practices; 100 Member CSA plans: CSA Share List, Greenhouse Plan, Field Plan.*
- Johnnyseeds.com. Growers' Library, Winter Growing Guide https://www.johnnyseeds.com/growers-library/vegetables/winter-growing-guide-high-tunnel-scheduling.html. The first two of 9 sections in the guide.
- https://weatherspark.com/ Weather records for your area. Fun!
- Soil temperatures www.greencastonline.com/tools/soil-temperature

Resources - Hoophouses

- University of Minnesota *Deep Winter Greenhouse* extension.umn.edu/growing-systems/deep-winter-greenhouses
- U of MN *High Tunnel Production Manual* www.extension.umn.edu/garden/fruit-vegetable/#high-tunnel
- U of MN *Cold-Climate Greenhouse Resource* cura.umn.edu/publications/catalog/cap-186
- *The Northlands Winter Greenhouse Manual*, Carol Ford & Chuck Waibe mosesorganic.net/product/northlands-winter-greenhouse-manual-the/
- HighTunnels.org: hightunnels.org/category/for-growers/growing-in-high-tunnels/ or hightunnels.org/for-growers/
- Penn State *High Tunnel Production Manual*, William Lamont, $25 extension.psu.edu/high-tunnel-manual
- *High Tunnels: Using Low Cost Technology to Increase Yields, Improve Quality, and Extend the Growing Season* by Ted Blomgren, Tracy Frisch and Steve Moore. University of Vermont Center for Sustainable Agriculture. https://www.sare.org/resources/high-tunnels/
- *High Tunnel Winter Cropping Systems*, Lewis Jett, SARE. Slideshow and audio. https://northeast.sare.org/resources/high-tunnel-winter-cropping-systems/
- *Greenhouse and Hoophouse Grower's Handbook – Organic Vegetable Production Using Protected Culture,* Andrew Mefferd, Chelsea Green

Resources - books

- *The Market Gardener,* Jean-Martin Fortier, New Society Publishers
- *The Complete Know and Grow Vegetables,* J K A Bleasdale, P J Salter et al.
- *Knott's Handbook for Vegetable Growers,* Maynard and Hochmuth extension.missouri.edu/sare/documents/KnottsHandbook2012.pdf
- *The Organic Farmer's Business Handbook,* Richard Wiswall, Chelsea Green
- *Sustainable Vegetable Production from Start-up to Market,* Vern Grubinger, host31.spidergraphics.com/nra/doc/fair%20use%20web%20pdfs/nraes-104_web.pdf NRAES
- *The New Organic Grower* and *The Winter Harvest Manual*, Eliot Coleman,
- *Crop Planning for Organic Vegetable Growers,* Daniel Brisebois and Frédéric Thériault (Canadian Organic Growers www.cog.ca)
- *The Chinese Greenhouse: Design and Build a Low-Cost, Passive Solar Greenhouse,* Dan Chiras, New Society Publishers. Solar-heated, earth-sheltered, well-insulated, plastic-glazed structures, making it possible to grow warm weather crops in winter.

Resources – Asian Greens

- *Grow Your Own Chinese Vegetables*, Geri Harrington, 1984, Garden Way Publishing. Includes the names for these crops in different cultures.
- *Growing Unusual Vegetables*, Simon Hickmott, 2006, Eco-Logic books, UK.
- *Oriental Vegetables: The Complete Guide for the Garden and Kitchen*, Joy Larkham, revised edition 2008, Kodansha, USA
- *Asian Vegetables,* Sally Cunningham, Chelsea Green
- *The Chinese Kitchen Garden*, Wendy Kiang-Spray, 2017, Workman Publishing
- Kitazawa Seeds kitazawaseed.com/ & Evergreen Seeds have the most choices.

- ❑ Evergreen's helpful clickable list. evergreenseeds.com/asveglis.html
- ❑ Fedco Seeds fedcoseeds.com/ and Johnny's johnnyseeds.com/ have a good range.
- ❑ Wild Garden Seed has many interesting home-bred varieties. Search under Mustard. wildgardenseed.com
- ❑ ATTRA *Cole Crops and Other Brassicas: Organic Production* attra.ncat.org/attra-pub/summaries/summary.php?pub=27

Resources – My Slideshows www.slideshare.net/ Search for Pam Dawling. You'll find:

- ❑ *Cold-hardy Winter Vegetables*
- ❑ *Cover Crops for Vegetable Growers*
- ❑ *Crop Planning for Sustainable Vegetable Production*
- ❑ *Crop Rotations for Vegetables and Cover Crops*
- ❑ *Diversify your Vegetable Crops*
- ❑ *Fall and Winter Hoophouse*
- ❑ *Fall Vegetable Production*
- ❑ *Feeding the Soil*
- ❑ *Growing Great Garlic*
- ❑ *Growing Sweet Potatoes from Start to Finish*
- ❑ *Hoophouse Production of Cool Season Crops*
- ❑ *Lettuce Year Round*
- ❑ *Many Crops, Many Plantings, to Maximize High Tunnel Efficiency*
- ❑ *Producing Asian Greens*
- ❑ *Production of Late Fall, Winter and Early Spring Vegetable Crops*
- ❑ *Season Extension*
- ❑ *Sequential Planting of Cool Season Crops in a High Tunnel*
- ❑ *Spring and Summer Hoophouses*
- ❑ *Storage Vegetables*
- ❑ *Succession Planting for Continuous Vegetable Harvests*
- ❑ *Sustainable Farming Practices.*
- ❑ *The Seed Garden*
- ❑ *Year Round Vegetable Production*
- ❑ *Year Round Hoophouse Vegetables*