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Low Tunnels for Field Cut Flower Production

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Cut flower production in Utah can be limited by cold winters, late-spring freezes, daily temperature fluctuations, canyon winds, and intense sunlight. For growers who lack the space to construct a high tunnel, low tunnels can advance, extend, and improve seasonal production. Temperature increases from low tunnels during winter and spring can increase emergence and yield compared to unprotected beds, but require venting to avoid heat damage. During summer, low tunnels easily transition into shade structures that provide cooling and protection from the sun. This fact sheet describes a simple and cost-effective low tunnel design with metal-conduit hoops that are tall enough to cover the plant canopy; anchored to the ground with rebar; and fitted with fabric row cover, plastic, or shade cloth. We also share guidelines for using low tunnels to optimize cut flower production and present temperature management information.

Advance Cool-Season Annuals in Spring

Cool-season cut flowers benefit from starting the season as soon as the ground can be worked in the spring, but can be limited by high temperatures in early summer. Examples include:

- Anemone
- Campanula
- Delphinium
- Lisianthus
- Ranunculus
- Snapdragon
- Stock
- Sweet peas

Low tunnels can protect against spring freezes when planting early by increasing air and soil temperature (Figure 1). Common frost fabric options include AG-19 (0.5 oz/yd^2) or AG-50 (1.5 oz/yd^2), with the thicker option providing more temperature protection and strength against winter winds, but less light transmission. Plastic covers are typically 4- to 6-mil thick greenhouse grade plastic. AG-19 and 4-mil plastic are more often used in spring, while AG-50 and 6-mil plastic are more common in winter. Source fabrics and plastics that are UV-treated to last for one or more seasons. As temperatures warm in the spring, venting the low tunnels is important. We recommend venting when weather conditions will be sunny for 3+ hours and the outside air temperature is above 60°F. Venting is achieved by lifting and clipping the sides of fabric or plastic to the frame. This prevents overheating and excessive humidity that can damage blooms, cause stem curvature, and increase pest and disease pressure.

Figure 1. *Low tunnels covered with fabric (left half) or plastic (right half).*

Although low tunnels typically require additional labor for venting, and working underneath the tunnels can slow field operations, the increases in flower emergence and marketable yield can be substantial (Table 1). This improved crop performance resulted from more moderate temperatures, as well as protection from snow, rain, and wind that can decrease stem length and bloom quality.

Table 1. *Effect of a fabric (AG-50) low tunnel on emergence and marketable yield (stems per emerged plant) of anemone and ranunculus cut flowers grown in North Logan, UT from 2020-21.*

Cut flower	Planting Date	No low tunnel	With low tunnel	Difference
		Emergence (% of tubers that overwintered)		
Anemone	November 2020	69%	97%	+28%
Ranunculus	November 2020	58%	91%	+33%
		Yield (marketable stems per plant)		
Anemone	November 2020	1.7	4.6	+2.9
	March 2021	2.2	4.0	+1.8
Ranunculus	November 2020	0.9	2.1	+1.2
	March 2021	1.3	1.9	+0.6

Summer Crops and Shading

As spring turns to summer and temperatures increase, many cut flowers benefit from shading. Frost fabric or plastic is replaced with 30%, UV-treated shade cloth (using frost fabric for shade is not recommended). Anemones, campanula, celosia, dahlias, delphinium, lisianthus, ranunculus, snapdragons, stock, and sweet peas are examples of cut flowers that benefit. Shade can increase the number of stems per plant and the length of the stems. For cut flowers that require support, the low tunnel hoops can also be used to attach plastic trellising (Figure 2). In the case of taller cut flowers, such as dahlias, the low tunnel frames may be extended to give the flowers extra space to grow and avoid contact between the blooms and structure.

Figure 2. A low tunnel converted for summer snapdragon production with shade cloth and horizontal trellising.

Connecting 2’ lengths of metal conduit to the bottoms of the existing low tunnel hoops with couplers can extend clearance to nearly 6’ (Figure 3). As summer turns to fall and the threat of frost returns, the shade cloth can be replaced with frost fabric to avoid light freezes at night.

Figure 3. *Extended low tunnels for shaded dahlia production. Note the set screw coupling increasing the tunnel height and snap clamp securing the shade cloth.*

Overwintering and perennials

Tender species, such as anemones and ranunculus, can be planted in the fall with low tunnels to insulate over the winter and protect from subfreezing soil temperatures. Low tunnels also present a season-advancement opportunity for cool-season perennials, such as peonies. By mid to late winter, fabric low tunnels can be installed to increase temperature and advance the bloom of established peonies. We installed AG-19 fabric tunnels in mid-February and advanced bloom by at least one week. Using soil heat mats or heat cables with low tunnels provides additional warming and can advance harvest by an extra 7-10 days (Figure 4). Tunnel frames can be left in place for multiple years, with frost fabric or plastic added and removed when necessary. Peonies are particularly susceptible to bloom damage from excessive heat and humidity, so peony low tunnels need to be carefully vented (Figure 5). Remove low tunnels in late spring, before plant growth is in contact with the covers, as this causes stem curvature and burn.

Figure 4. *Advancing field-grown peonies with low tunnels.* Left foreground: *growth without cover,* left background: *advanced growth with low tunnels,* right: *additional growth from low tunnels plus soil heating.*

Figure 5. *'Coral Charm' peony buds. Browned buds that burned in a low tunnel are shown with healthy, pink buds that are ready to sell.*

Site Selection & Preparation

Consider soil, sun, and wind when determining the site and direction of your low tunnel. Prioritize areas with healthy, well-drained soils that are not shaded in early spring, can be reached in inclement conditions, and have water access outside of the main growing season (Figure 6). Conduct a soil test to determine suitability for cut flower production and fertility needs. A routine soil test is recommended in new planting areas or where soil testing has not occurred in 1-2 years. This will also determine fertilizer or compost application rates (Stock et al., 2020). USU's analytical laboratory performs soil tests with pricing and testing information available on their website.

After a site has been determined, most operations benefit from orienting low tunnels in an east-west direction. This allows for an efficient transition to summer shading, as shade cloth only needs to be attached on the south side and top of the tunnel, saving on fabric costs and allowing for easier, unobstructed harvests (Drost and Maughan, 2018). For areas prone to strong winds, however, orienting the long side of a low tunnel parallel with wind direction should be prioritized to reduce damage. If this results in tunnels oriented north-south, attach shade cloth to the west side and top of the tunnel (Drost and Maughan, 2018). Prior to installing the tunnel, complete all site preparation including tillage, soil raking, and installations of drip irrigation and plastic mulch.

Figure 6*. Soil prepared prior to low tunnel installation.*

Construction

To construct a low tunnel, a hoop bender, mallet, screwdriver, and scissors are needed. Hoop benders can be purchased from an agriculture supply store and are designed to bend conduit into hoops to a specific width depending on bed size (3' or 4' wide beds most common). Hoops for 3' wide beds will be 4.5' tall at the center and hoops for 4’ wide beds will be 4’ tall at the center. Table 2 provides a list of materials to construct a 20’ low tunnel, but low tunnels can be constructed to any length to meet production needs. The following are steps for constructing a 20’ low tunnel, which can be accomplished by one person:

1. Use a hoop bender to bend the metal conduit pipe into hoops. You will need one hoop on each end of the tunnel and an interior hoop every 10’ of bed length. For example, a 20’ bed requires 3 hoops (2 end walls and 1 interior hoop).
2. Slide hoop-to-purlin cross connectors onto end hoops and screw into place at the top of the arches. Snap cross fittings onto the top of the arch for the center hoop(s).
3. Rebar anchors the bottom of the hoops to the ground. Each hoop requires two pieces of rebar, one on either side. Pound rebar 18” into the ground with a mallet to leave 6” exposed above the soil.
4. Insert hoops onto the rebar.
5. Connect the crossbars (unbent conduit pipe) to each other with set-screw couplings; one crossbar is needed per 10’ of bed length. To attach the crossbars to the hoops, screw the cross bars to the end hoops with the hoop-to-purlin cross connectors. Snap the crossbar into the center hoop with the snap cross fitting*.
6. Once the frame is constructed and stable, cut the fabric, plastic, or shade cloth. Lengths include the length of the low tunnel plus 5’ of material on each end of the tunnel for sufficient room to reach to the ground. Attach to the frame with clips about every 3’ and secure to the ground with garden staples.

*Alternatively, a ¼” steel rod can be used for the crossbar (Figure 3). With this method, drill a hole at the top of each hoop and feed the crossbar through for a snug fit. This avoids the need for cross connectors and screw couplings.

Table 2. *Materials for one, 20’ long low tunnel on a 3’ or 4’ wide bed.*

Material	Function	Quantity	Cost (USD)
10’ conduit pipe, ½” diameter	Frame hoops and crossbars	5	$27
Set-screw coupling, ½” diameter, 5-pack	Connect crossbars to each other	1	$2
Snap cross fitting, ½” diameter	Connect crossbars to interior hoops	1	$3
Hoop to purlin cross connector, ½” diameter	Connect crossbars to end wall hoops	2	$6
24” pre-cut rebar, ¼’’ diameter	Secure frame to ground	6	$18
Frost fabric, plastic, or shade cloth, 10’x50’	Cover	1	$21-70
Snap clamps, ½” diameter, 10-pack	Secure cover to frame*	1	$7
Garden staples, 20-pack	Additional wind security	1	$8
		Total:	$92-141

*Binder clips are less costly than snap clamps, but tend to rip frost fabric in windy conditions.

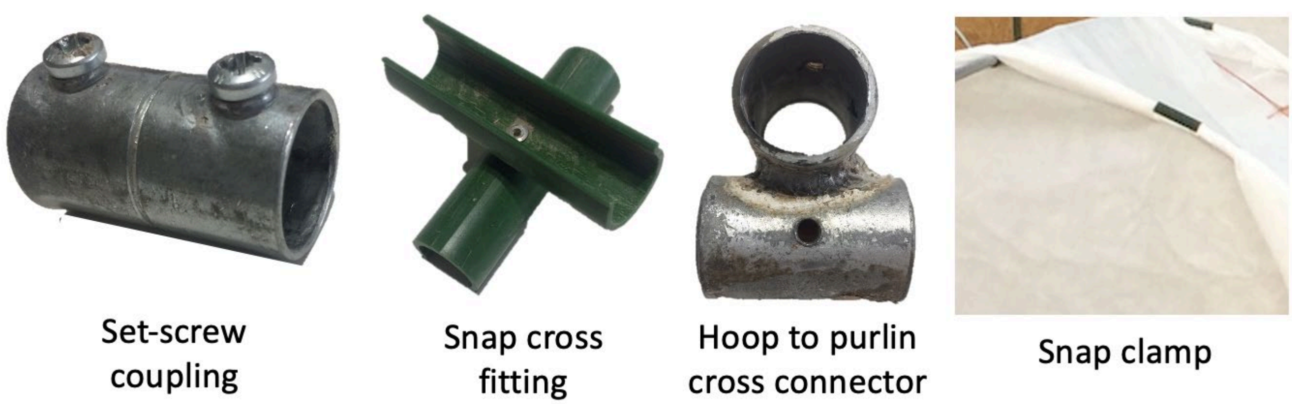

Figure 7. *Photos of some of the key pieces used to construct a low tunnel: set-screw coupling, snap cross fitting, hoop to purlin cross connector, and snap clamp.*

USU Trials on low tunnel use in winter

Trial 1: Testing low tunnel cover types with mulch for soil temperature insulation and warming

During the winter of 2019-20, hourly soil temperatures were recorded at a 2" depth under low tunnel and mulched conditions at the Utah Agriculture Experiment Station Greenville Research Farm in North Logan, UT (USDA Hardiness Zone 5b) to understand levels of insulation that are needed to protect tender bulbs planted at a 2" depth. 4" of straw mulch and low tunnels with different winter covers – fabric (AG-50), plastic (6-mil), and fabric plus plastic – were compared (Figure 8). Mulch alone prevented the soil from freezing around the bulbs, with the low tunnels minimally increasing soil temperature through mid-December. By January, the low tunnels began heating the soil, while soil without low tunnels did not heat. In February, tunnels with plastic and fabric warmed the soil the most (by 3°F), while tunnels with fabric alone warmed the soil the least (about 1°F) and mulched soils without low tunnels remained cool.

The take home: Use mulch in late fall through early winter to protect tender bulbs from freezing soils. Install low tunnels as early as January to begin soil warming and advance emergence. Though earlier installation of tunnels may not help warm the soil, it keeps loose mulch in place in windy sites. All low tunnel covers warmed the soil by late winter. The use of plastic required additional venting, but was less likely to tear than fabric in extreme wind. Using only AG-50 fabric provided an ideal tradeoff with heating, humidity, and labor needs for venting. Removing mulch no later than early March further advances soil warming and ensures emerging plants receive enough light.

Trial 2: Testing fabric low tunnels without mulch on soil and air temperature warming

Air and soil temperatures under low tunnels with AG-50 fabric were compared to outside conditions the following winter. The goal was to track the natural temperatures in the field and determine whether low tunnels alone (i.e. without mulch) could protect tender bulbs. The average monthly temperatures for each hour of the day are shown for December through March in Figure 9. Overall, the daily air temperature was 5°F warmer in the low tunnel than outside, but strongly fluctuated from day to night. During the day, the tunnels heated the air up to 21°F warmer than outside conditions. However, the nighttime lows were nearly the same and well below freezing each month.

Soil temperature fluctuates less than air temperature, becoming neither as warm nor as cold as air. Soils without low tunnels froze by December and remained so until March. Under low tunnels, the soil underwent daily freeze/thaw cycles in December and January, but remained unfrozen from February onward. On average, soils under low tunnels were 6°F warmer than unprotected soils across winter months, the greatest temperature lift was 15°F during the hottest part of the day (3 PM), and the least temperature lift was 1°F during the coldest part of the day (sunrise, 8 AM).

The take home: Low tunnels alone cannot maintain freeze-free conditions over winter. Optimize wintertime low tunnel use by targeting cool-season species that are advanced with warmer soil temperatures and can withstand overnight frosts by early spring. Crops from bulbs, tubers, or perennial crowns, all of which respond to warmer soil temperatures in the early season, are strong candidates for wintertime low tunnel use.

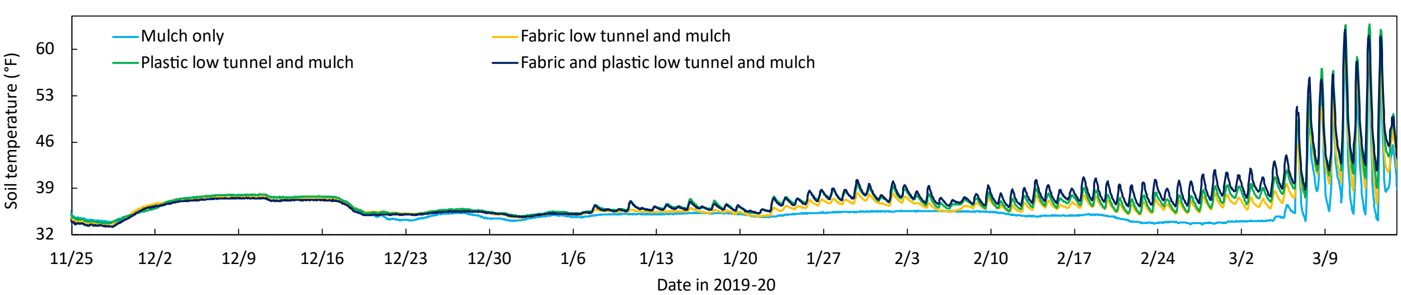

Figure 8. *The average hourly soil temperature at a 2" depth from late November through mid-March in a field in North Logan, UT. The soils were insulated with only mulch (blue line) or with mulch plus different low tunnel coverings: AG-50 fabric (yellow line), 6-mil plastic (green line), and AG-50 fabric + 6-mil plastic (black line). Mulch was removed on March 6.*

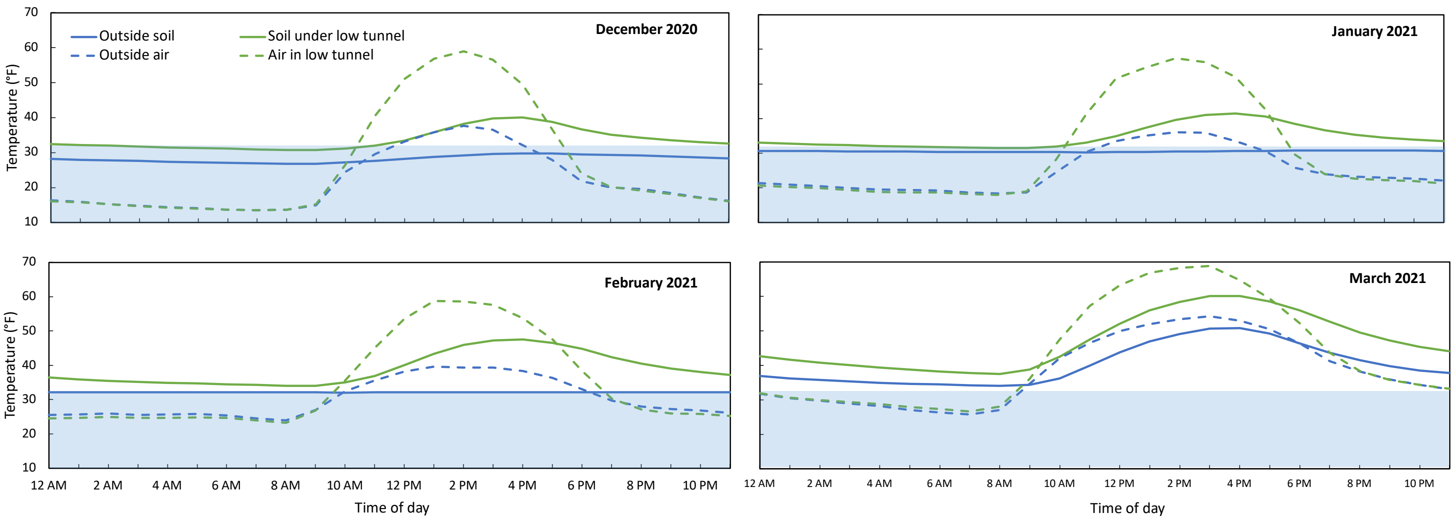

***Figure 9**. Soil at a 2" depth (solid lines) and air at a 10" height (dashed lines) in a fabric low tunnel (green lines) and unprotected field (blue lines) at the Utah Agricultural Experiment Station - Greenville Research Farm in North Logan, UT. The average temperature is shown by hour of the day for December 2020, January 2021, February 2021, and March 2021. The shaded blue background denotes temperatures below freezing and white denotes temperatures above freezing.*

Conclusions

Low tunnels are a low-cost, protected cultivation method that can aid cut flower production by providing frost protection in the spring and fall, shade in summer, and soil insulation and warming in winter.

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Disclaimers

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