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Low Tunnels

A Low-Cost Protected Cultivation Option

Tiffany Maughan, ***Brent Black***, and ***Dan Drost***

Short growing seasons and early spring frosts can limit some fruit and vegetable production in the Intermountain West. For early spring crops, such as strawberry and asparagus, a frost event can significantly reduce yields. For most high-value fruit and vegetable crops, providing protection from frost is often justified.

Protected cultivation has also been used to extend the growing season earlier in the spring and later in the fall. This is particularly beneficial when selling local produce directly to the consumer such as at farmers markets, roadside stands or CSA. In these markets, out of season produce often commands a price premium high enough to justify the additional cost of protected cultivation.

One method of protection is a low tunnel. A low tunnel is a structure built just high enough to cover the canopy of the plant. Thin, clear plastic, usually 4 ml or less, is supported by wire or pipe frames to resemble a tunnel (Image 1). Low tunnels used alone can increase the air temperature around the plants by 5 to 15 °F or more on a sunny day. However, nighttime temperature increase is minimal. Low tunnels can also be used in combination with a high tunnel, a greenhouse-like structure covered with UV-stable plastic and large enough to walk in (Image 2). When low tunnels are used with a high tunnel, nighttime air temperature under the low tunnel can be 3 to 5 °F higher than the high tunnel air temperature and 5 to 7 °F higher than the outside air temperature (Wien et al., 2006; Maughan, 2013) (Figure 1).

Daytime temperature increase can be significantly more than during the night. As a result, ventilation is critical when using a low tunnel. Even when outside air temperatures are relatively low, on a sunny day air temperature under the low tunnel can easily be high enough to cause damage to the plants under them.

Image 1. Low tunnel over raised strawberry bed.

Image 2. Low tunnels within a high tunnel being ventilated by lifting low tunnel plastic

Depending on the design, low tunnel ventilation can either be done by lifting one or both sides of the tunnel up or by completely removing it (Image 2). For field production, perforated plastic can be used to minimize the need to ventilate. Keeping a thermometer under the low tunnel is recommended for determining ventilation needs.

Construction

Low tunnels can either be used alone or combined with a high tunnel. Depending on the intended use, the design will vary. Below are instructions for two low tunnel types: pinned tunnel, and free floating. The pinned tunnel is designed to withstand wind (can be used alone) and the free floating is designed to be used within a high tunnel and should not be used without a structure providing protection from the wind and UV light.

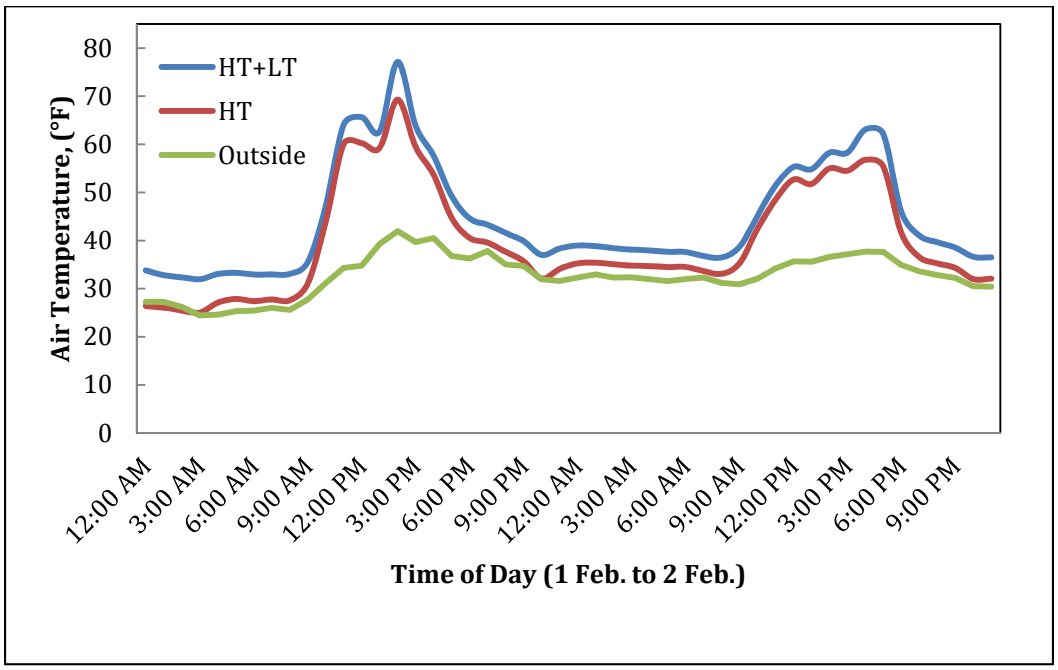

Figure 1. Air temperature outside, in a high tunnel (HT), and under a low tunnel within a high tunnel (HT+LT) over a typical 48 hour period in the late winter.

Pinned Low Tunnel

To build a pinned low tunnel you will need a post pounder, bolt cutters, and a measuring tape. Table 1 provides a list of materials for a 90′ low tunnel, which can be constructed with a 100′ roll of plastic. However, these tunnels can be constructed to any length to meet production needs. The material list should be used as a reference for determining the amount of material needed for individual systems.

Table 1. Materials needed to construct a pinned low tunnel. Quantities are presented for constructing tunnels 90' in length. Perforated or slitted plastic can be used to minimize the need for ventilation.

Material	Quantity
Smooth galvanized steel trellis wire (#10 gauge)	100 ft
1 mil clear UV-stabilized plastic (6′ wide)	100 ft
Sandbags (grocery sack filled with sand)	12
T-posts to secure tunnel ends (5′)	2
2’ long wooden garden stakes (1x2″ size)	2
Fencing staples	2

The following description will assist you in constructing the low tunnel. Low tunnels can be used over a raised bed, or simply over a flat row. One person can place the tunnel supports, but laying and securing the plastic usually requires two people.

1. Using bolt cutters, cut the#10 gauge smooth galvanized steel trellis wire into 6′ lengths. Pre-cut wire is also available, usually in bundles of 100.
2. Five feet from each end of the row or raised bed, insert a T-post at a 60° angle, the post will anchor the plastic.
3. Starting approximately 5′ in from the T-post, lay out a 6′ wire arch every 10′ and end 5′ from the second T-post.
4. Push the wire arches 8″ to 12″ into the soil at the base of each side of the bed as per Diagram 1.
5. Pound a wooden support 6″ to 8″ into the ground under each end arch to provide rigidity and to ensure it will stay parallel to the ground. Using a fencing staple, secure the wire to the top of the wooden support.

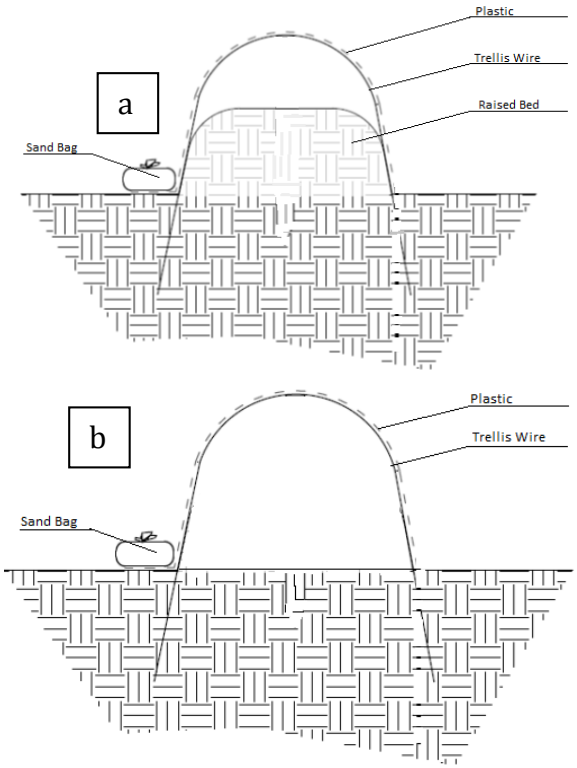

Diagram1. End view of a pinned low tunnel (a) with raised bed, (b) no raised bed. Note the additional space for plants in the no raised bed option. Sand bag is for pinning the plastic down, and still allowing removal for easy ventilation.

6. Roll out plastic from one end to the other, leaving an extra 5′ to tie off with at the end. Before cutting the plastic, tie the end to the T-post. It is important to get a very secure tie. One way is to wrap the plastic around the post several times and then, using the bailing twine, tie the plastic to itself, similar to Image 3.

Image 3. Pinned low tunnel plastic tie off after wrapping around T-post.

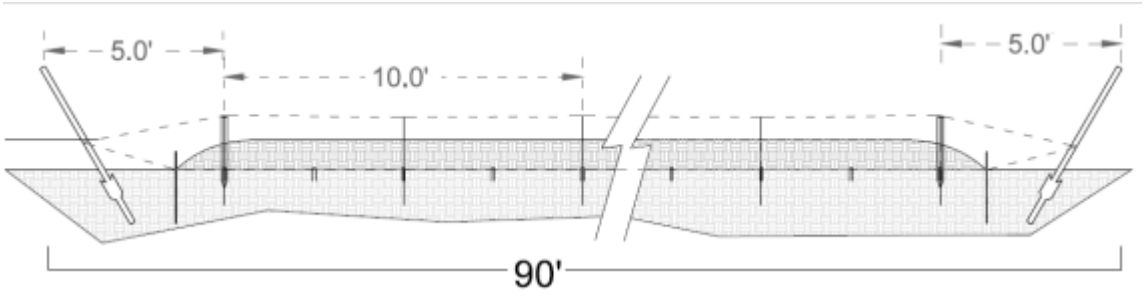

Diagram 2. Side view of pinned low tunnel.

7. - Cut plastic, leaving at least 5′ of plastic at the other end to tie off to the T-post. Pull the plastic tight across the wire arches, making sure the plastic has not twisted. Tie the end to the T-post, pulling the plastic as tight as possible. Keeping tension on the plastic from one end to the other will help the tunnel withstand wind.
8. Push additional wire arches into soil between the wire arches under the plastic. Resulting in every other wire arch being above the plastic (Image 4).

Image 4. Wire arches above and below the low tunnel plastic.

9. In areas prone to strong winds, the sides of the plastic need to be secured. On the windward side, bury the edge of the plastic with soil. This helps keep plastic in place during windy conditions.
10. On the other side of the low tunnel, either cover with soil or place sand bags every 10′. Use extra bags to hold down the tunnel ends near the T-post and the first arch. Bags can be removed, and the plastic lifted on that side to allow for ventilation on sunny days. Both sides can be buried with soil if the plastic is perforated (Image 5).

Image 5. Perforated plastic cover over a low tunnel with both sides of the plastic buried.

Free-floating Low Tunnel

To construct a free-floating low tunnel you will need a conduit bender, a sledgehammer, scissors, and a measuring tape. Table 2 provides a list of materials for a 90’ low tunnel.

Table 2. Materials needed to construct a free-floating low tunnel, intended for use inside a high tunnel. Quantities are presented for constructing tunnels 90’ in length.

Material	Quantity
½″ diameter conduit pipe (10′ lengths)	10
¼″ diameter pre-cut rebar (24″ length	20
2 mil clear non-UV-stabilized plastic (10′ wide)	100 ft
Bailing twine	300 ft
2″ binder clips	20

The following description will assist you in constructing the low tunnel. This low tunnel can be constructed by one person and fits well inside a high tunnel. Instructions are for a 40″ tall low tunnel to cover strawberry, tomato, or pepper. For lower-growing crops, such as spinach or lettuce, a 20″ low tunnel would be sufficient. These instructions can be modified to reduce the overall height of the low tunnel.

1. Bend each 10’ conduit length at 40″ and 80″, resulting in a square arch.
2. OPTIONAL: Weld washers onto each 24″ rebar, 6″ from the end. This will help stop the conduit support from being pressed into the soil.
3. Starting at the end of the bed, use a hammer to pound the rebar 18″ into the soil, leaving 6″ above ground. Rebar should be placed close to the base of the raised bed. Directly across from the first rebar, pound a second length into the soil at the opposite base of the bed, checking to make sure it is the right distance apart for the conduit arch to slide over both rebar ends.
4. Repeat step three every 10′.
5. Place conduit arches over each rebar pair.
6. Tie off bailing twine on one end arch and run along top of arches, looping around each arch. Run three bailing twine lines: one on each corner and one in the middle (Image 6). These act as supports for the low tunnel plastic.

Image 6. Low tunnel plastic suspended by three lines of bailing twine strung between tunnel arches.

7. Unroll plastic and lay across top of arches and twine, leaving 5′ extra at each end to drape down to ground.
8. Secure plastic to top of arches using binder clips (Image 7).

Image 7. Binder clip securing plastic to conduit frame.

Research

Low tunnel within a high tunnel: Low tunnels within a high tunnel add an additional increase of air temperature. Figure 1 shows air temperature on typical late winter day. During the night, air temperature under the low tunnel stays about 5 °F warmer than outside air and 3 °F warmer than the high tunnel. This additional temperature increase may be the difference between frost protection and frost damage.

Low tunnels have been evaluated in Utah on several crops; both when used with a high tunnel and when used in the open field. Table 3 shows how low tunnels in high tunnels impact the performance of strawberry, spinach, and beans. In most cases, the use of a low tunnel within a high tunnel improves yield, positively affects seedling performance, and may further extend the harvest season.

Table 4 illustrates the effect of low tunnels used outside. Lower productivity in strawberry was due to early flowering and subsequent frost damage to those blooms. Higher yields were noted with early asparagus but tunnels did not increase total asparagus productivity. Peppers grown under low tunnels established quickly, grew rapidly and this translated into higher yields later in the season.

Table 3. Effect of low tunnel (LT) in a high tunnel (HT) compared to high tunnel only for strawberry, spinach and bean production.

	Strawberry Yield (lbs./plant)	Fall Spinach Yield (oz./plant)	Winter Spinach Yield (oz./plant)	Bean (Final % Emergence)	Bean (Days to 50% Emergence)
High Tunnel Only	1.51	0.71	1.12	67.6	23.7
HT+LT	1.92	0.92	1.77	73.5	18.7
Difference	0.41	0.21	0.65	5.8	-5.0

Table 4. Effect on yield of low tunnel compared to open field grown plants.

	Strawberry (lbs./plant)	Early Asparagus (lbs./A)	Total Asparagus (lbs./A)	Red Peppers (lbs./A)
Open Field	0.26	1550	3365	18,700
Low Tunnel	0.18	1785	3195	24,000
Difference	-0.18	235	-170	5,300

Conclusion

Low tunnels can be an effective method of frost protection, both inside a high tunnel and in field production. Although low tunnels increase production costs, if frost protection is achieved, their use may be warranted. Usefulness of low tunnels varies by crop and system.

References

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