Getting Started with Low Tunnels in the School Garden: Step by Step

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Anyone who has built a garden knows that getting started can seem daunting, but once the plot is established, the rest can be straightforward. This document outlines how to construct a garden, prepare the soil, and assemble low tunnel structures. For anyone with a school garden already in place, this last section will be most useful.

Choosing the Site

There are a number of resources that provide comprehensive information of siting a garden, such as the website School Garden Wizard, but here are some questions you should consider with winter growing in mind:

1. **How much sun does the site get?**
   When the sun is lower in the winter, buildings and trees can shade an area that seems bright in the summer. If you can, notice the site at different times on a sunny day in December to make sure it gets direct sunlight for at least five hours. Some spots that are bright in the summer could be completely shaded when the sun is lower in the winter.
2. **How will the site be impacted by snow removal?**
   If the garden is located near a parking lot, make sure that groundskeepers don't need to pile snow in the site in the winter.
3. **How will you access the site in the winter?**
   In snowy months like January, you likely won't need to access the tunnel more than once or twice, but you'll want to consider snow removal if it is necessary to get to the garden.
4. **Will you have access to water for irrigating?**
   This is less of a concern in the winter than the summer, but carrying buckets of water out to a site can be an inconvenience.
5. **Is the site especially wet or the location of standing water?**
   Growing on soil that is poorly drained can harm plant roots, and the garden may be too muddy to use early in the spring. Standing water can also introduce concerns about foodborne illness. If you are limited to wet areas, a raised bed can mitigate this problem somewhat.

Preparing a Garden

Many resources exist on garden construction, so what follows is a brief guide to getting started.

1. **Decide whether you want to build a raised bed.**
   Raised beds offer many benefits. They can improve drainage, neatly define where the garden is located, and potentially prevent students from stepping on plants. In the short term, a raised bed will likely involve additional work, since you will need to construct the frame and acquire additional soil. The frame is typically made of a wood material that is unlikely to rot (Fig. 1). Many gardeners are wary of using treated wood because of the chemicals it contains. Cedar is a great choice for the frame because it is slow to decompose, but it is also expensive. More information on choosing materials is available from the University of Maryland Extension here.[1]

   

   Fig. 1. A raised bed being used in an elementary school garden in New London.

   Additional loam may also be needed, which might be available elsewhere on the property, from a landscaper, or at a home center as bagged topsoil. Local landscapers are sometimes willing to donate these supplies.

2. **Till your site**.
   If you are starting a garden where grass or sod currently exist, you'll want to break up that sod and remove or incorporate it. Walk behind rototillers are commonly available for rent, and nearby farmers are often willing to till school gardens if the site can be accessed by a tractor and is large enough. Be aware that agricultural tractor tires may damage lawns and turf.

[1] See "Materials for Building Raised Beds" from University of Maryland Extension. http://extension.umd.edu/hgic/learn/materials-building-raised-beds

3. **Test the soil for plant nutrients and pH.**
   In order for your plants to succeed, they need access to sufficient nutrients. It is possible for nutrients to be present in the soil, yet plants are unable to access them because the soil pH is not within an acceptable range. Testing nutrient concentrations and pH (the soil's acidity or alkalinity) can be done in the classroom, where it can make a great lesson for certain grade levels. Alternatively, UNH Cooperative Extension can test these parameters with a one cup soil sample for about $20.[2] When taking a soil sample, you want the material you send for testing to be representative of the whole garden. Therefore, it is recommended that you use a shovel or trowel to collect slices of garden that contain soil found from the surface to six inches in depth. You can take samples from roughly six parts of the garden, mix them together in a bucket, and submit a portion of that for analysis, typically one cup. More information on submitting soil samples is available from UNH Cooperative Extension.[3]

   The results you receive will tell you the levels of several soil nutrients in your garden and recommend materials to apply. The Cooperative Extension Education Center can help you interpret the report and determine how to proceed, but let's walk through an example test report here.

   Below, you'll see the first part of a report, which contains the test results. We see that the soil pH, which describes how acidic or basic the soil is, was 6.30, and the concentrations of calcium, magnesium, potassium, phosphorus, and lead are listed in parts per million (Fig. 2). Mehlich 3 refers to the test method used to extract nutrients from the soil, and it is noted because different test methods can yield different results. Finally, the organic matter percentage is listed. Organic matter refers to formerly living material mixed into the soil, which will supply nutrients and provide other benefits as it decomposes.

[2] UNH Cooperative Extension Soil Testing Information. https://extension.unh.edu/programs/soil-testing-services

[3] "Best Practices for Submitting Your Soil Sample" from UNH Cooperative Extension. https://extension.unh.edu/blog/best-practices-submitting-your-soil-sample

Test Data

pH - Soil	6.30			**Optimum Range**
Calcium, Mehlich 3 (Ca)	1103.90	(ppm)	M	800 - 1200
Magnesium, Mehlich 3 (Mg)	285.00	(ppm)	H	60 - 120
Potassium, Mehlich 3 (K)	276.00	(ppm)	M	170 - 280
Phosphorus, Mehlich 3 (P)	119.00	(ppm)	H	30 - 50
Lead, Mehlich 3 (Pb)	2.31	(ppm)	VL	
Org. Matter, LOI-360 (OM)	6.57	(%)		

Optimum Range Key

VL - Very Low L - Low M - Medium H - High VH - Very High

Lead Screening Results

Generally, it is considered safe to use garden produce grown on soils with UNH soil test lead values of less than 180 ppm (This is equivalent to the US EPA total lead level of 400 ppm using their testing procedure). The lead level in your soil sample is 2, and is in the **Very Low** range. Based on your results:

- No special precautions are necessary

Fig. 2. The nutrient concentrations provided by a sample soil test.

The next section of the report (below) summarizes what should be added to produce healthy crops. First, because the pH falls within the target range of 6.0 and 6.5 for most vegetable crops, it does not need to be adjusted. It should be noted that certain plants, such as blueberries, have very different pH needs, but this range is fine for all the vegetables that might be wintered over. To make the soil more acidic (decrease pH), sulfur can be applied, and to make the garden more basic (increase pH), limestone can be added. pH change takes some time, so such amending is typically done in the fall.

Next, we see that three pounds of nitrogen and three pounds of potassium will be needed per 1000 square feet this growing season, but Extension predicts that one pound of nitrogen per thousand square feet will be provided by the existing soil as organic matter decomposes. Therefore, recommendations for conventional fertilizer and organic products follow (Fig. 3). These are based on commonly available materials, such as 10-10-10 fertilizer and soybean meal, but other fertilizer sources can be used. You can calculate how much to apply by using the percentages of nitrogen, phosphorus, and potassium listed on the fertilizer bag or contacting the Extension Education Center.

Vegetable Garden (Target pH Range: 6.0 - 6.5)

Lime: No Lime or Sulfur required at this time.

Nutrient Recommendations			
	Nitrogen	**Phosphorus**	**Potassium**
Nutrients Required (per 1,000 sq. ft.)	3 lbs	0 lbs	3 lbs
Credits:			
from organic matter	1 lbs	-	-
Apply the equivalent of (per 1,000 sq. ft.)	2 lbs	0 lbs	3 lbs

Conventional Fertilizer Recommendations

We recommend that you uniformly broadcast 7.5 lbs per 1,000 sq. ft. of 10-0-10.

A second application of fertilizer (12 lbs per 1,000 sq. ft. of 10-0-10) 3-4 weeks after planting or transplanting should be side dressed or applied by banding six inches from the growing plants and if possible, lightly incorporated into the soil

This will result in a total application of 19.5 lbs per 1,000 sq. ft. of 10-0-10

OR

Organic Fertilizer Recommendations

An equivalent organic source for 2 lbs of Nitrogen is 33 lbs of soybean meal, OR 15 lbs of dried blood.

An equivalent organic source for 3 lbs of Potassium is 14 lbs of sul-po-mag (0-0-22).

Composted manure is an excellent source of all three nutrients, but should not be used as the sole source on a long term basis.

Manure will provide approximately 1 lb of Nitrogen for every 800 lbs applied per 1000 sq. ft. Manures and composts are excellent sources of nutrients, but should not be used as the sole source on A long term basis. Please see the fact sheet Using manures and composts in the home garden.

Fig. 3. Fertilizer recommendations provided by a sample soil test.

Low Tunnel Construction

There are three common low tunnel hoop materials that differ in both snow-holding capacity and cost.

1. Wire Hoops
   Thick 9-gauge wire can be used to support plastic or horticultural fabrics such as reemay, a white fabric that is somewhat permeable to air movement but increases crop temperature moderately (Fig. 4). These structures are typically around three feet wide and just over a foot high, and they are unable to withstand any significant snow load. They are useful in extending the growing season into October and November or for planting crops early in the spring.

Fig. 4. A spool of heavy wire to be used to create wire hoops for tunnels. These are useful for keeping plants slightly warmer in the spring and fall, but they do not hold up under snow. They are fairly inexpensive.

Pre-cut wire hoops are available from a number of companies for around a dollar per hoop ($86.96/100 from Growers Supply and $108/100 from Johnny's Selected Seeds). A 50 foot spool of 9-gauge wire can also be purchased from home improvement stores for around $11. This can be cut to make 12 hoops with a pair of wire cutters. Spacing recommendations vary, depending in part on the crop the hoops will protect. Wet horticultural fabric may become heavy and sag, which could damage plants in extreme cases, but hoops can typically be spaced three feet apart. Covering materials will be addressed in a next section, but when considering the costs of hoops alone, wire hoop tunnels cost around $0.22 per square foot.

2. PVC Hoops

   PVC hoops can be a good choice because they are inexpensive, easy to store, and can withstand some snow load (Fig. 5). Half inch PVC pipe costs around $2.50 for a ten foot length, and it can be bent by hand into a hoop shape. To retain that shape and stay in place, the ends of the pipe can be pushed into the ground, but this is often inadequate, especially over the winter when the soil will be freezing and thawing. Instead, the pipe can be set onto one or two foot long pieces of metal rebar or similar stakes that are hammered into the ground at least six inches. When the hoops are installed, they should cover the exposed rebar completely. Rebar may pose a safety risk for children when the tunnel is not assembled because it is sharp and often rusty.

Fig. 5. A PVC low tunnel at the University of New Hampshire with the covering removed. PVC hoops can hold up to some snow, but they are more fragile than those made of metal electrical conduit. Because PVC is flexible, no tools are required to bend them and they can be stored easily.

A ten foot length of PVC can be installed to form a tunnel roughly five feet wide and a little over three feet high. Hoops should be spaced no more than four feet apart. Like wire tunnels, the covering must be removed to access the crop inside. Because the PVC bends so easily, it can withstand some snow load, but collapse will occur if too much snow builds up on the sides. This can be avoided by shoveling the tunnel out following large storms. There are also cases in which PVC will fuse with greenhouse plastic when they are directly in contact, but this is uncommon.

3. Electrical Conduit (EMT) Hoops

   Ten foot segments of half inch steel electrical conduit cost about $15 each, and fashioning them into hoops requires a specialized tool. Johnny's Selected Seeds sells benders that will produce hoops six feet wide, four feet wide, and three feet wide for about $60, and the conduit benders used by electricians, available at most home stores for about $40, can do a similar job if the pipe is bent in several spots (Fig. 6). Hoops can be pressed firmly into the ground and spaced about four feet apart to withstand any amount of snow without being crushed. Snow weight may cause some the hoops to fall over if the ground is especially wet, however. This can be avoided by setting them into rebar, as described in the last section, or by setting stakes into the ground on the ends of the structure and tying twine between the stakes and the bows (Fig. 7).

Fig. 6. An electrical conduit bender, which can be used to create metal hoops from ten foot lengths of conduit. Metal hoops are very strong, but they do need to be secured enough to prevent them from falling over. They may also be more costly than PVC hoops because of the need to purchase a bending tool.

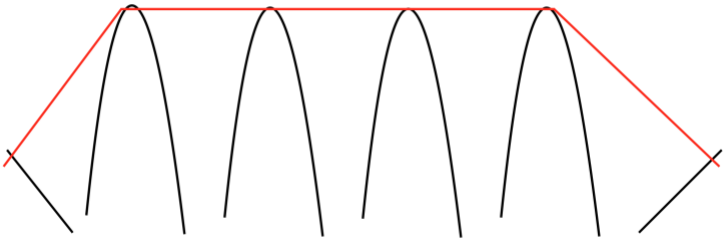

Fig. 7. To prevent bows from falling over, twine can be tied between the bows and stakes set into the soil on the ends. Twine is shown in red.

Covering the Low Tunnel

There are two basic options for covering tunnels: horticultural fabrics and polyethylene greenhouse plastic.

1. Horticultural Fabrics
   Horticultural fabrics are white in color but allow for some light transmission while buffering temperature changes (Fig. 7). These products are very useful in the spring and fall when night frosts might damage crops but the light intensity during the day would cause plastic tunnels to get too warm. Horticultural fabrics differ in thickness, which determine their ideal uses. For example, the Agribon product family, available from

Johnny's Selected Seeds, includes a light material designed for insect exclusion, a slightly heavier option for seasonal frost protection, and an even heavier product for covering plants over the winter. The tradeoff is that as fabric thickness increases, the amount of light reaching the crop decreases.

Fig. 7. A PVC low tunnel covered with horticultural fabric, which provides light frost protection.

2. Greenhouse Plastics
   Greenhouse plastics differs from the clear plastic sold for construction in that they are resistant to degradation by ultraviolet (UV) radiation from the sun. Standard plastic can be used to cover low tunnels for as much as a year, but it will slowly turn brown with light exposure. It can be a challenge to find greenhouse plastic in small enough sheets, since most greenhouses are much wider than low tunnels. Farms and nurseries with plastic greenhouses need to change their greenhouse film about every five years, and they might be willing to donate some old plastic that would be adequate for season extension. Otherwise, there are some options to purchase 10' wide plastic, such as 100' x 10' for $92 from Johnny's Selected Seeds.

Putting It All Together

Horticultural fabric or greenhouse plastic can be attached to the structure in a number of ways, but perhaps the easiest is to to simply secure them at the bottom with a generous number of sandbags or rocks (Fig. 8). It is common to apply horticultural fabric in early fall and then, as the days get colder, add a layer of plastic on top of that or use two layers of plastic for even better heat retention (Fig. 9). While the tunnel will not need to be accessed too frequently in the winter,

this can sometimes be improved by placing a tarp zipper at the top so that the sides don't need to be shoveled completely.

Fig. 8. Sandbags holding the plastic cover on a PVC low tunnel.

Fig. 9. A PVC low tunnel covered with a layer of Agribon horticultural fabric followed by polyethylene plastic to enhance heat retention. Typically, the fabric is installed in September or October, and the plastic is added around October as temperatures get colder. Then, the plastic can be removed first in the spring.

Summary

Once your garden is established, you'll want to choose the type of hoops and covering material that are best for your application. The hoop and covering options are summarized in the tables below.

Low Tunnel Hoop Type	Materials	Cost per Square Foot	Structural Integrity
Wire Hoop	Wire or precut hoops 5’ wide plastic or row cover Sandbags	$0.25*	Good for spring or fall, but not under snow
PVC Hoop Low	10’ PVC sections 1-2’ rebar 10’ wide row cover 10’ wide plastic Sandbags	$0.61*	Hoops can bend under heavy snow
Electrical Conduit Hoop Low	10’ electrical conduit pipe Electrical conduit bender 10’ wide row cover 10’ wide plastic Sandbags	$1.39*	Hoops can support heavy snow

*These include the cost per square foot of one layer of plastic and row cover, but they do not consider the minimum quantities that may need to be purchased. They also do not include tools, which factor especially into electrical conduit tunnels.

Material	Approximate Cost per Square Foot	Considerations
Horticultural Fabric	$0.10*	Protects from light frosts in the spring and fall
Polyethylene Plastic	$0.10*	Traps additional heat in the winter, but may cause the tunnel to get too warm in spring and early fall

*For plastic in particular, it may be difficult to purchase only the quantity needed. Therefore, you may have to buy extra material, which would increase costs.