From Forest Nursery Notes, Winter 2012

134. High tunnels. Kleinhenz, M. D. Greenhouse Management 31(7):66-69. 2011.

By Matthew D. Kleinhenz

HIGH tunnels

Consider these major factors when initiating high tunnel production

High tunnels are simple structures that help establish and maintain microclimates that benefit crops and growers. High tunnels are less sophisticated than automated greenhouses but they operate similarly.

The tunnels provide crops with optimal environments. High tunnel crops out-perform their open field-grown counterparts, which are subjected to numerous stresses. Greenhouses and high tunnels are easily distinguished in their design, components and basic management.

High tunnel components

High tunnels consist of a metal, wood or PVC frame; a polyethylene film roof (one or two layers) and usually a soil floor. High tunnels can also be constructed over impermeable or semi-permeable surfaces.

High tunnel frames are usually a gothic, arched/Quonset or V-peak shape. The shape is determined primarily by construction materials, the crops produced and the local climate. Gothic and V-peaked shape frames are preferred when heavy snow and/or ice loads are expected.

Bows are usually three to five parts with the spacing of intact bows determined by budget, tunnel width, crop and climate. Bows are usually placed every 4 to 6 feet apart.

Plastic films designed to cover high tunnels offer an increas-

Left photo: Tomatoes are the most popular main-season high tunnel vegetable crop. High tunnel users set transplants earlier than field growers and typically obtain multiple benefits from high tunnel microclimates. **Above photo:** Enclosing crops in a high tunnel can create favorable microclimates in a very cost efficient manner. **Right photo:** An increasing number of high tunnel users successfully produce cold-tolerant crops, including leafy vegetables, fall through winter. Photo by Ken Chamberlain, Ohio State University-OARDC

ing range of function with respect to durability, light transmission (including spectral filtering), heat penetration and retention and moisture collection resistance.

High tunnels are single or multi-bay structures. Most initial structures were permanently moored although portable high tunnels are increasingly popular since they aid with crop rotation and other practices. Moreover, high tunnels can be covered year-round or re-skinned and de-skinned annually in the spring and fall, respectively. Plastic film coverings last three years or more depending on the type and local climatic conditions.

Regardless of shape, internal high tunnel peak height tends to be at least 8 feet. The tunnels usually lack a permanent heating and cooling system. Temporary heat is added only when needed and cooling is rarely possible. Few are electrified.

High tunnels may or may not require a building permit. Moreover, they are rarely insurable or taxed (this varies with local ordinances) and even less rarely contain supplemental light. They are always large enough to walk and work in and may accommodate tractors or other equipment.

Single-bay high tunnels often possess a length:width ratio exceeding 2.5:1. A single bay measuring 96 feet long by 30 feet wide or similar-sized high tunnels are commonly used in many areas. The absence of an integrated, automated system for monitoring and controlling temperature, humidity and light levels and the near total reliance on manual ventilation, sunlight and soil tend to differentiate high tunnels from most greenhouses.

Managing production

High tunnel management must be timely and round-the-clock during some weather events and portions of the year. Although temperature-sensitive and hydraulic or motorized devices can open vents and sidewalls, most high tunnels are vented manually. Regardless, high tunnel temperature changes can be rapid and extreme. Moreover, since most high tunnels tend to lack ridge vents, during some conditions, high tunnel growers must choose between venting excess heat and shielding crops from wind and/or driving rain, the latter normally accomplished by closing side- and/or end-walls.

Strict reliance on sunlight slows high tunnel-based production and marketing in some areas fall through spring. The inability to cool aggressively can have similar effects at other times. These and other factors limit high tunnel use and their value to individual growers depending on their circumstances.

Tunnel applications

A majority of high tunnel users grow vegetables and also have open field production. However, an increasing number of growers have begun to use the tunnels exclusively and are expanding the variety of crops they produce in them.

High tunnel-only and high tunnel-greenhouse operations appear to be on the rise, along with the use of high tunnels to produce flowers, herbs, fruit and other crops. High tunnels are used in conventional and organic operations and they are increasing in popularity among urban and peri-urban growers. High tunnel production also appears to be equally suited to all major forms of marketing (e.g., direct, wholesale, etc.).

The most consistent effects of high tunnels on crops is their ability to increase temperatures, reduce wind exposure, shield against rainfall and flooding and shift pest and disease complexes. Marketable crops can be developed and held in high tunnels when conditions preclude open-field farming. High tunnels are especially popular as season

High tunnels protect crops against common natural threats, including wind and rain. This can improve crop yield and quality and extend production marketing windows.

extension tools in large tracts of the Midwest, Northeast, Mid-Atlantic and Northwest.

Compared to open-field production, experienced high tunnel users tend to report that using the structures allows them to increase: the yield and total productivity of individual parcels of ground; the efficiency and reliability of many cropping practices; and their market opportunities and profit potential.

Selecting a high tunnel

High tunnels are defined by their particular combination of type (year-round, three-season), degree of portability, size (especially width and single versus multi-bay), supply of electricity, and floor (soil, other). The combination selected depends on budget, crop, current and expected farm work load, and current and future production (volume) requirements. The structure (frame, plastic film covering, lumber and hardware) often comprises the majority of the material startup costs which can total approximately $3.50-$9.50 per square foot.

Key Points

1 High tunnels may or may not require a building permit. Moreover, they are rarely insurable or taxed (this varies with local ordinances).

2 The high tunnel structure often comprises the majority of the material startup costs, which can total approximately $3.50-$9.50 per square foot.

3 Siting a high tunnel strongly influences the success with which it is used, especially in organic production and if the soil covered by the high tunnel is both the floor and growing medium.

Selecting a site

Siting a high tunnel strongly influences the success with which it is used, especially in organic production and if the soil covered by the high tunnel is both the floor and growing medium (the most common scenario).

The ideal high tunnel site:

- Contains high quality soil.
- Is well-drained and graded and, possibly, tiled to divert water.
- Contains an adequate supply of quality irrigation water.
- Lacks potentially damaging contaminants.
- Is large enough to accommodate regular farming operations, including moving the high tunnel if needed.
- Allows ample sun exposure.
- Permits good air movement while offering protection from the most severe wind.
- Is close to labor, equipment and supplies.

Set up

The best compass orientation of rectangular high tunnels is debated often. Some consider sun exposure to be the key while others prefer to emphasize the direction of prevailing winds and its effects on ventilation and structural integrity. The debate is difficult to resolve.

Orienting the long axis of the structure north to south maximizes the total light

received annually but much of this light is received during the summer when light is not limiting to production. An east-west orientation maximizes winter-to-spring sunlight capture. And, it is often said that structures with their long axis parallel to prevailing winds are more effectively ventilated.

Growers tend to have more than one high tunnel and most recommend that adjacent high tunnels be spaced as far apart as they are wide. Siting and orientation are strongly influenced by local and farm-scale conditions.

High tunnels can be constructed entirely or primarily by users, some with little experience in building design and establishment. The frames (bows, some hardware) of many high tunnels are shipped as kits accompanied by an instruction manual. Other high tunnel setup guides are available. The most important assets in constructing a high tunnel may include "farmer engineering," common sense and experienced or qualified help.

With a well-prepared site and the required hardware, materials and tools, most single bay high tunnel frames can be constructed within one week. Skinning or attaching the plastic glazing can be more difficult to schedule. The wind should be minimal, temperatures should remain in the low- to mid-60s and adequate assistance must be available.

Uses

High tunnels offer an intermediate level of climate control for a fraction of the materials cost common in greenhouse production. Yet, high tunnel production carries financial risk and other challenges uncommon in greenhouse systems.

Modern greenhouse production tends to involve some type of hydroponic system while high tunnel production does not, although high tunnel systems can accommodate hydroponics. Evidence from commercial production and research suggests that:

- Varieties should be chosen specifically for high tunnel production.
- High tunnel soil, fertility and water management demand careful attention.
- Pest and disease complexes and the persistence or activity of beneficial insects and micro-organisms differ among open field, high tunnel and greenhouse systems. GM

Matthew D. Kleinhenz is associate professor, Ohio State University-Ohio Agricultural & Research Development Center, (330) 263-3810; kleinhenz.1@osu.edu.