P14119
Rochester Roots
Adaptable High Tunnel

Abstract

Rochester Roots, a non-profit in Rochester, NY, uses urban agriculture as a tool for social and educational programs. One such tool is a 960 sq. ft. high tunnel. The high tunnel, while functional, was dilapidated and not usable in the winter months. The goal of this project was to provide an upgraded design to the high tunnel that included the following features:

- Grow food year round
- Use adaptable panels
- Resistant to child vandalism
- Rain-water irrigation system
- Short change-over time
- Promote urban agricultural awareness

Maintaining Temperature

Requirements: For proper year-round plant growth, the soil temperature must be kept above 40° F through the winter growing season.

Solution Design Components:

▪Subterranean Heating: 600m of heating cables controlled by a thermostat will be snaked through the soil of the high tunnel at a depth of 2 feet to provide heat to the system.

▪Soil Insulation: Insulation will enclose the soil volume under the high tunnel to a depth of 4 feet to prevent heat loss out of the system.

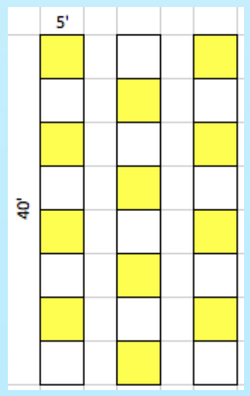
▪Insulated North Wall: Utilizing the fact that sunlight does not come from the North, reflective Mylar material and insulation is to be placed along the north wall to prevent heat loss and reflect light back into system.

Provide Adequate Lighting

Requirements: For proper year-round plant growth, adequate amounts of light must be supplemented during the winter growing season.

Solution Design Components:

- Supplemental Light: (12) 600 Watt metal halide luminaires in layout to right to supply adequate light.



Enclosed Garden

Requirements: The high tunnel requires hard side paneling to prevent child vandalism. The high tunnel must also be able to be quickly open/closed, and the panels must be multi-functional.

Solution Design Components:

- Polyethylene Roof: The roof will be covered with 6mm polyethylene plastic
- Acrylic Side Panels: 8mm Deglas acrylic will be used for all vertical walls. This was chosen for its high strength/durability, high insulation value, and transmissibility.
- Multi-functional Panels: Hinges will be secured to each panel that open and close the panels based on temperature. This ensures the high tunnel does not overheat and allows the panels to function similar to a cold frame.

Sustainable Watering System

Requirements: Provide 1” of water daily to soil beds in sustainable fashion.

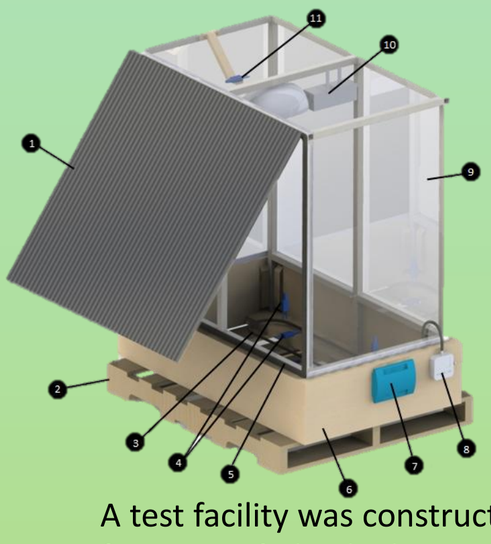
Solution Design Components:

▪Gutters**:** Gutters will be mounted along the 2 walls to collect rainwater

▪Water Storage: (2) 550 gallon tanks will store collected water

▪Distribution System: 1.5hp pump distributes water from storage tanks through drip line system onto soil beds.

Test Facility



Feature List:

1. 8mm Polycarbonate Panel
2. Pallet
3. Heating Coils
4. Subsurface Thermocouples
5. Steel Frame
6. Wood Soil Box
7. Data Logger
8. Thermostat
9. Polyethylene Soft Sheeting
10. Light
11. Air Thermocouple

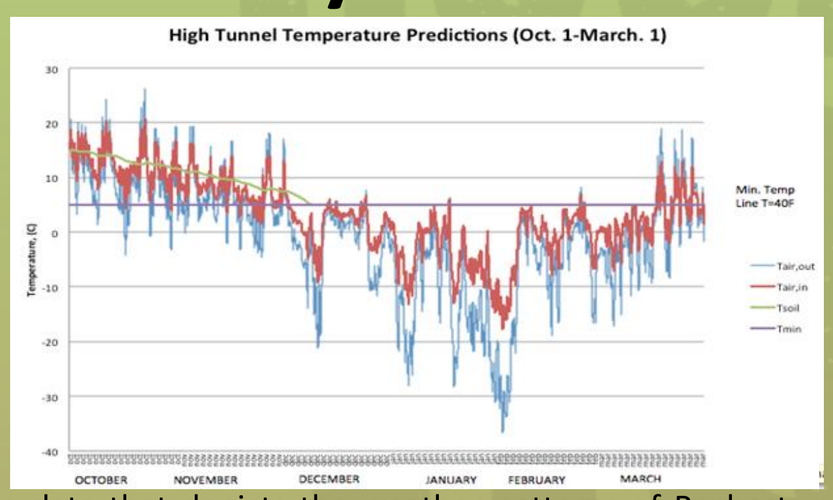
A test facility was constructed to test the feasibility of certain design features of the high tunnel. Notably, it was especially useful for choosing the final panel design as well as observing the thermal performance of the system.

Final Proposed Design

Added Features List:

1. 600W Metal Halide Lighting Luminaries
2. Low Tunnel Covers
3. Heating Coils
4. Soil Insulation
5. Deglas Acrylic Panels
6. 550 Gallon Water Tank
7. Gutters
8. Polyethylene Soft Cover

Thermodynamic Model



Using data that depicts the weather patterns of Rochester, NY for a typical Meteorological year, the concepts of heat transfer and thermodynamics were applied to create a thermodynamic model that allows us to predict the thermal behavior of the system and accurately estimate heating needs for the winter season.

Project Team

Dillon Jourde
Mechanical Engineer

Matt Pellegrini
Industrial Engineer

Kelsey McManus
Industrial Engineer

Chris Caradonna
Mechanical Engineer