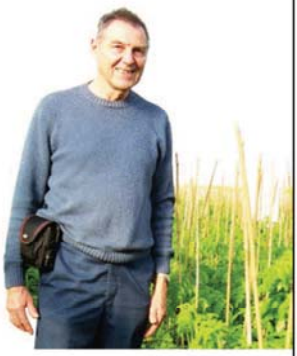
From Forest Nursery Notes, Winter 2012

133. Heat distribution options. Bartok, J. W., Jr. Greenhouse Management 31(8):51-53. 2011.



Heat distribution options

Heat is one of the several factors that control plant growth. Getting the heat from the furnace or boiler firebox where it is generated to the greenhouse so that each plant is uniformly warm is a challenge that faces the heating system designer. With many systems to choose from the decision can be difficult.

SMALL BUDGET SOLUTION

Furnaces. Furnaces are usually less expensive than boilers. They directly heat the air in the greenhouse. Distributing the heated air is largely dependent upon some means of air circulation. Systems include unit heaters, perforated polyethylene inflated tubes and horizontal air flow circulation.

Unit heaters. Unit heaters, either floor mounted or suspended from the greenhouse frame, have a fan or blower that moves the greenhouse air past the heat exchanger.

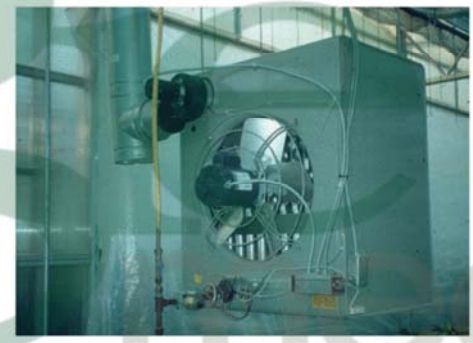
A single unit works well in a small free-standing greenhouse up to about 60 feet long. In larger greenhouses, either two heaters or some other means of moving the air is required.

By connecting a perforated polyethylene tube to the furnace, outlet heat can be moved and distributed over a larger area. This generally requires a blower rather than a fan to get the higher pressure needed to overcome the friction loss in the tubing.

Tube diameter, hole size and spacing are critical to get uniform distribution from the tubes. The tubes can be placed on the ground between rows of plants, located under benches or suspended above the crop.

Horizontal air flow. Horizontal air flow (HAF) utilizes circulating fans to create a horizontal pattern of air movement within the greenhouse. The system uses 12- to 20-inch diameter, 1/15th horsepower fans to move the air down one side of the greenhouse and back the other.

The fans, which operate continuously, mix the air from roof to floor and provide uniform temperatures throughout the growing space. The fans are usually located above head height and spaced from 40-50 feet apart down each side of the greenhouse.



Unit heaters along with horizontal air flow circulation provide uniform heat. This system is good for greenhouses closed during the winter as the system does not have to be drained.

The heat source can inject the air anywhere within the air stream. The air moves at 50-100 feet per minute. Fan cost is about $200 each installed.

Infrared systems. Infrared systems, properly installed, can transfer heat energy to crops without the necessity of air circulation. The system is usually located near the peak of the greenhouse so that it can radiate heat to the crop. Sizing the system should be done by the system supplier. Air circulation may be needed to get uniform heat on tall or dense crops.

Furnaces have the advantage that the greenhouse can be closed during the winter without having to drain a series of water pipes as is the case with a boiler system.

HAVE A QUESTION? You can write John at jbartok@rcn.com.

LARGE BUDGET SOLUTION

In larger greenhouses, hot water is a better medium of heat distribution than air. Hot water's advantages include energy saving temperature modulation for different seasons of the year, different water temperatures for air and root zone systems and more constant and uniform heat.

Providing different temperatures in adjacent bays or sections of the greenhouse is easier as circulating pumps controlled by separate thermostats supply heat as needed. Heat from water can be distributed by bare steel pipe, fin radiation, root zone heat or water to air unit heaters.

Bare steel pipe. Bare steel pipe is rarely used in U.S.-designed greenhouse heating systems. Its low heat output, large volume of water and space requirements are disadvantages. It has been replaced by fin pipe.

Fin pipe. Fin pipes with numerous thin plates radiate heat away from the pipe and increase heat output by five to 10 times. The diameter of pipe and size and number of plates determine the heat output. A 1¼-inch pipe with 38 4¼-inch square fins per foot has an output of about 1,200 Btu per hour per

Boilers can provide modulated water temperature for root zone heat during spring and fall greenhouse operation.

linear foot with 180°F water.

Fin pipe is best located along a greenhouse's perimeter walls. The walls behind the pipes should be insulated with an inch or two of board type insulation with an aluminum foil facing. Fin pipe can also be installed under gutters where it can be controlled manually to melt snow.

Low output fin pipe (two or five linear fins) with 100 to 200 Btu per hour per linear foot is a good choice for under bench heating. It is easy to install as sections are connected with rubber gasket couplings or high temperature rubber hose. Low output fin is also used overhead instead of bare steel pipe and for gutter heat.

Root zone heat. Root zone heat is popular as it warms the plant root zone rather than the greenhouse air. It can be installed on or under benches as above or in the floor.

Commercially available systems use EPDM rubber or cross-linked polyethylene (PEX) tubing either as single tubes or as multiple tubes attached to a web. The tubing is connected to plastic or copper headers. Hot water can be provided by a hot water heater or boiler.

Most growers who use this tubing operate with a water temperature of 100°F to provide a 75°F growing medium temperature. A remote bulb thermostat or sensor located in the growing medium controls the supply water circulating pump.

> "For each 1°F a thermostat is lowered, there is about a 3 percent fuel savings.

Water to air unit heaters. Water to air unit heaters convert hot water to hot air. Circulation within the greenhouse is by HAF fans. HAF fans are available in outputs from 12,000 to 700,000 Btu per hour.

Unit heaters are low cost and easy to install. Supply pipes should be insulated to reduce heat loss. Unit heaters work well as a supplement to root zone heat by providing the extra heat needed on cold nights.

Achieving uniform temperature throughout the greenhouse allows the thermostat to be set lower. For each 1°F that the thermostat is lowered, there is an approximate 3 percent savings in fuel. GM