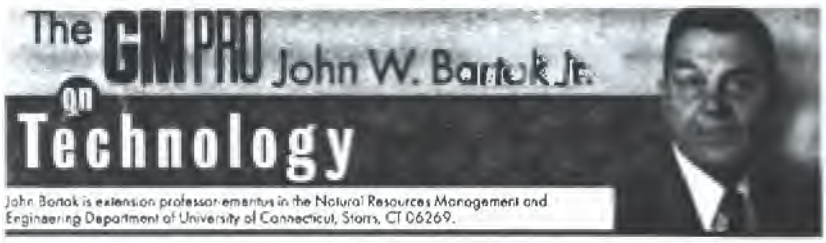

Root-zone heating can save energy by reducing needs

With fuel costs rising rapidly, root-zone heating is becoming popular to save energy. Supplying heat under a crop reduces its needs by allowing the air temperature to be maintained 5°F-15°F cooler. It also maintains a more uniform heat pattern than can be obtained with perimeter or unit air heaters.

Root-zone heat can be provided in the floor or under the crop on benches.

Root zone basics

The basic floor system consists of pipe embedded in a layer of sand or concrete. Warm water, pumped through the pipes, conducts the heat to the plants placed on the floor. The sand or concrete distributes the heat evenly across the floor surface.

In the bench system, aluminum fin pipes or bare steel pipes placed under the bench radiate heat up to the root zone. Another system uses rubber tubing or mats placed on the bench top under the plants.

Depending on climate, a root-zone heating system will provide 25-75 percent of the total heat needs of a greenhouse. The remaining heat need is usually made up with perimeter radiation or air heaters. Research has shown that about 15-35 Btu per hour per square foot of floor or hench can be obtained from a root-zone heating system.

To get good service from root-zone systems, they have to be installed correctly. Cutting corners usually doesn't pay, Here are a few installation techniques that may help.

Heat source

For heating areas less than 3,000 square feet, a low-cost, domestic hot water heater is usually the best choice. These are available in natural gas, propane and electric models in sizes to about 45,000 Btu per hour. Commercial water heaters with output to 300,000 Btu per hour can be used for larger areas.

Select a heater with a glass-lined tank. Gas-fired models frequently require only a plastic flue pipe rather than a metal or masonry chimney. The installation is simple in that besides the water heater all that is needed is an expansion tank, air eliminator, PTR valve, circulating pump and remote bulb thermostat. The thermostat on the water heater is usually set at 100°F to 110°F and

the circulator thermostat placed in the growing medium of a representative container is set at the desired soil temperature.

Hot water from an existing or new boiler can also be used. One or more circulators and tempering valves are needed to feed the root-zone heat.

Because the return water from the root zone is cool, a non-condensing boiler should not be used. Water less than 135°F can cause condensation that is highly acidic and can damage the boiler.

A tempering valve that protects the boiler can be installed to warm the return water. A better option is to have a condensing boiler that uses the heat from the flue gases to warm the return water.

Another installation technique that works well is to install a heat exchanger between the boiler and the root-zone heat. A heat exchanger isolates the boiler water from the root-zone tubing water. A circulating pump moves the hot boiler water on one side of the heat exchanger and a second pump passes the water through the other side.

Heat exchangers are used if the root-zone tubing is filled with a glycol solution in a greenhouse that is shut down during cold weather. It is also common in a system that has been installed to deal with the problem of oxygen diffusion when the tubing does not have an oxygen barrier.

Heat distribution

Oxygen diffusion can corrode heating systems. Dissolved oxygen molecules are present in all fresh water. These molecules can attack ferrous components in the heating system causing rust.

Plastic or rubber tubing without a diffusion barrier will allow oxygen to enter the water and sludge and rust to accumulate causing a restriction in flow. Use a material such as PEX, a cross-linked polyethylene tubing that has an oxygen diffusion barrier. PEX tubing is available in sizes from 3/8 to 2 inches and in roll lengths up to 1,000 feet. Typical size for floor systems is 1/2 inch for loops up to 200 feet and 'A inch for loops up to 400 feet. Tube spacing is usually 9 to 12 inches on center. If non-oxygen diffusion barrier tubing is used and water flows through the boiler, be sure that all the pipe and fittings are copper or brass. Also add a water treatment that balances the pH and removes the free oxygen from the water.

Some growers have installed low-cost, Schedule 80 polyethylene ¦ in sand floors with good results, With a glass-lined hot-water heater and no ferrous components, life expectancy has been good.

EPDM rubber tubing is common for on-bench heating and low-out put fin or bare steel pipe used under benches. These systems provide uniform heat if the bench is kept full of plants or a weed barrier mat is placed on the benches to spread out the heat.

A gap in the plant canopy creates a chimney effect, allowing heat to escape, and can make control of the temperature difficult. Skirts placed around the sides of benches can be used to reduce heat escaping from under benches.

Circulating pumps

The circulating pump is the heart of the root-zone system. Centrifugal pumps create a good flow without using much energy. High pressure is not needed as the system is closed and the water is not lifted very high. Inline pumps are the most common. A wet rotor circulator, which has the advantages of no seals and low cost, could also be used. Place a shut-off valve and a union on both sides of the pump so that it can be serviced or replaced easily.

When sizing the pump, remember that the flow should be about n feet per minute fine 1/2 or 3/4-inch. This keeps the temperature difference between the supply and return ends of the loop to between 5°F and 10°F. The head or pressure loss is determined by the number and length of loops in the system and the tubing size. The pump is best located near the expansion tank to reduce pressure differences.

Controlling the system

A remote bulb thermostat is the most common control used for a root-zone heat system. Placed in a pot or flat, the thermostat senses soil temperature and activates the circulating pump when heat is needed. When the water is supplied by a boiler, controls that modulate water temperature or a variable-speed pump may be used.

Root-zone heat makes sense as it provides a uniform temperature under all the plants. It is difficult to get the ideal root temperature of 70E-75°F required by most plants for optimum growth with an air heat system.