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72. Lower heating costs with underbench heat. Bartok, J. W., Jr. Greenhouse Management and Production 30(8):35-36. 2010.

Lower heating costs with underbench heat

By John W. Bartok Jr.

Maintaining optimum root temperature results in increased growth and reduced production time for many plants. It also affects the microclimate of the plants by eliminating temperature stratification and lowering humidity in the plant zone.

An underbench heating system can reduce fuel costs 10 percent or more. Air temperature in the greenhouse can be 5 to 10 degrees lower than the growing medium temperature and still achieve excellent growth. This lower air temperature means that the heat loss between the inside of the greenhouse and outside will be less.

Uniform temperature in the root zone is difficult to achieve with unit heaters that circulate heat over the top of the crop or a boiler that pumps water through fin radiation along the sidewalls. Distributing the heat under the benches warms the growing medium first before it rises to heat the air. For most crops, the medium temperature is more critical to good growth than the air temperature.

Amount of heat needed

Research at Rutgers University has shown that 15 to 20 Btu per square foot of bench area provides adequate heat to the root zone without drying out the medium or damaging tender roots. In northern climates, this amount of heat provides about 25 percent of the total greenhouse heat needed on the coldest night. During spring and fall, underbench heat may provide all the heat that is needed.

Root zone heating system components include a hot water heat source, distribution piping, radiation and a control system.

Hot water source

If a boiler system is heating the greenhouse, it can probably be modified to deliver the 100°F-120°F water needed for root zone heat. The existing boiler capacity should be adequate as the heat is just being redirected from fin or pipe radiation to the root zone area.

If the greenhouse has a condensing boiler, one in which the boiler can operate safely with a return water temperature of less than 140°F, then the high limit switch is set to the highest temperature water that is desired in the root zone piping. If a boiler is to be used for both high temperature (180°F) and root zone heat, then a bypass loop and mixing valve are necessary to achieve the low temperature water.

Most existing greenhouse boilers are the non-condensing type and require the above bypass loop and mixing valve to keep the water temperature in the boiler above 140°F. A three-way valve is commonly used to mix the return water from the root zone with the hot water in the boiler to achieve the desired root zone water temperature.

For providing root zone heat to a hoop house or small bench area, a domestic hot water heater does an excellent job. These heaters fired by gas, oil or electricity are available in capacities of 30,000 to 40,000 Btu per hour and can heat up to 2,000 square feet of bench area. Multiple heaters or larger commercial water heaters and instantaneous water heaters have also been used with good success.

Piping

Distribution pipe that is used to carry hot water from the water heater or boiler to the root zone system needs to be selected carefully. For the bypass loop and piping near the boiler, use metal pipe, either copper or iron. If the water temperature distributed in the root zone is less than 130°F, then PVC pipe is a good choice. Support the pipe to prevent sagging. Insulate the high temperature and large diameter pipes to save energy.

The distribution system should be designed so that the pipe loops are as short as possible to reduce friction losses and heat loss. Using a three-pipe, reverse return system provides the same temperature water to all the loops.

The system can be zoned so that individual benches or greenhouse areas can be heated to a different temperature. Each zone requires a separate circulating pump and piping.

Uniform temperatures

There are several systems that are used to provide the heat in the bench area. A common system uses a small diameter aluminum pipe with two fins (e.g., Alcoa Aluminum Fin, BioTherm Duo Fin or Delta Fin). This pipe provides about 70 Btu of heat per linear foot at 120°F water temperature. Under a 6-foot wide bench using two loops (four runs) of fin pipe are usually required to provide uniform temperatures. The fin pipe is usually suspended from the bench frame about 18 inches beneath the bench top.

An alternative system is to use bare steel pipe. At a water temperature of 120°F, a 1½-inch bare steel pipe gives off about 50 Btu per linear foot. The disadvantage is that the large diameter steel pipe has a greater volume of water that exceeds the temperature once the thermostat is satisfied and the circulating pump shuts off.

Some growers have attached PEX (cross-linked polyethylene) tubing to the underside of wire mesh benches. Besides being resistant to abrasion and chemicals, PEX stops oxygen diffusion which can cause corrosion in boilers, tanks and plumbing. The heat transfer from the PEX pipe is lower so more loops are required.

Circulating pump

A circulating pump is needed to move the heated water through the radiation pipe. In a system with multiple zones, either one pump per zone or a single larger pump with zone valves can be used. Size the pump to the number of loops and the friction loss in the piping. Being a closed system there is no head loss due to elevation in the pipes.

The sensor that controls the circulating pump and the flow of warm water to the root zone radiation should be placed in a representative pot or flat in the middle of one of the benches. The simplest control is a thermostat with a remote sensor bulb. The root zone system can also be connected as the primary heat zone to many controllers and computers.

Operating hints

Attaching an 18-inch skirt to the sides of the bench can trap the heat under the bench and provides a more uniform temperature. Weed barrier mat or plastic sheeting works well as a skirt.

To reduce the chimney effect from losing the heat under the bench, keep the benches full of plants. Lay a weed barrier mat on the bench top before placing the pots down or cover any sections where plants have been removed with plastic sheeting.

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