Greenhouse Cooling Without Fans

John W. Bartok, Jr.
Extension Agricultural Engineer

In an attempt to offset the increasing cost of operating fan ventilation systems, growers are installing alternate systems that provide cooling for at least part of the year.

New technology, such as roll-up sides and hinged roof panels, adapt well to poly-covered houses. Automated roof vents are now standard on most glass houses. A temperature near outdoor ambient can be achieved by combining fog with natural ventilation and shading. Greenhouse design can also contribute to better ventilation and cooler summer temperatures.

Natural ventilation systems operate on the principle that heat is removed by a pressure difference created by temperature and wind gradients. On sunny days, the air within the greenhouse becomes lighter as it is heated and rises to escape out the ridge vents. At the same time, cooler, heavier air enters the side vents. Adjustment of the vent openings regulates the ventilation rate. In Dutch glasshouses that only have roof vents, cool air enters and hot air exhausts through the same opening.

Wind-induced ventilation can be a significant factor in how much cooling is obtained. The greatest effect is when the sidewall is perpendicular to the wind direction. Research has shown that at speeds of over one mile per hour, there is more cooling from wind than from temperature gradient. That is why on calm, hot days, very high temperatures can occur in a greenhouse. To get good cooling, it is important that both ridge and sidewall vents be kept operational and in use.

To be effective, total vent area should be 15% to 25% of the floor area. Ridge vents should be capable of adjusting to a 60-degree angle with the roof to provide a large opening.

Remember that if exhaust fans are operated, uniform cooling will occur only if vents are adjusted to a vary narrow slot opening, otherwise the air for the fan will short circuit from the nearest vent.

Greenhouse design

Sawtooth style greenhouses are common in southern climates because of their natural ventilation capability. The sloped roof directs the heated air to the vent. Adjustment of the vertical roof section with either hinged panels or inflated tubes can give good control throughout the year.

Difficulties with ventilation in large, poly-covered, gutter-connected houses stems from the large distance between the sidewall and the center of the greenhouse. Most growers have found that fan ventilation is the only practical method of getting acceptable cooling and, even then, there may be a 10- to 15-degree difference between the intake and exhaust.

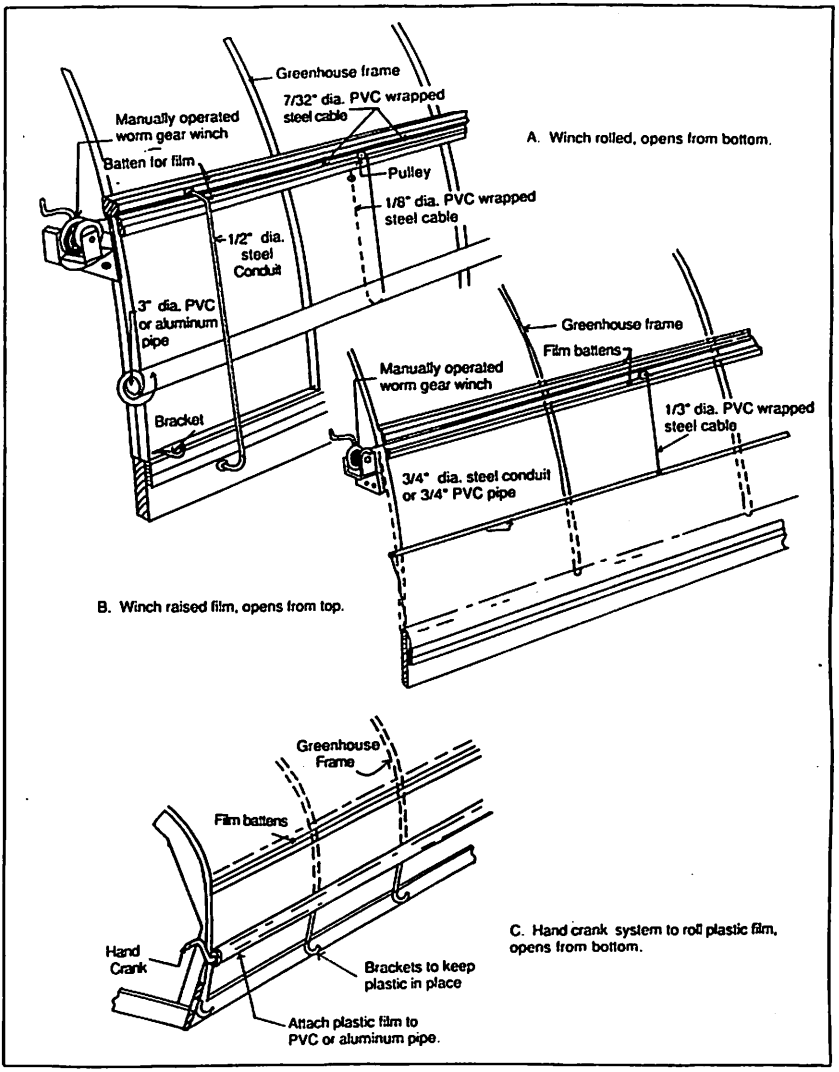
A recent development in design is the hinged roof panel. Roof bars are hinged at one gutter or at the ridge and opened with standard vent system hardware. Gearmotors or linear actuators provide the power to lift the roof section. There is concern with this system about damage to the frame in areas where gusty winds are common.

Another concept that growers are using is increasing the height of the gutter to create a larger volume of air. This raises the warmest air well above the plants. Today growers are building with a 12' to 14' gutter height. A disadvantage to this is that winter heating costs are increased due to the increased glazed surface and greater temperature gradient from floor to roof or insulating blanket.

Roll-up sides

Several options are available for hoophouses. One of the least expensive is the roll-up sidewall. This can be purchased as part of the greenhouse package or added at a later date. Many growers fabricate their own system. Most systems are manually operated but could be motorized with a small power winch.

Roll-up sides work best during the late spring, summer and early fall when outside air temperatures are mild. Ventilation area is controlled by the height of the opening. Guides



Manually operated ventilation walls: a) Winch rolled film, opens from bottom; b) Winch raised film, opens from top; and c) Hand-crank rolled plastic film, opens from bottom.

are installed to keep the detached sidewall plastic from blowing on windy days.

Inflated tubes are used by at least one manufacturer to provide a variable sidewall opening. Inflation fans keep the tubes rigid until cooling is needed. They are then deflated from the top down to vary the opening. This keeps the cool air off the plants.

Bedding plant growers in many sections of the country have had good success in houses less than 100' long with hinged or removable endwall panels. This works best in a location where natural breezes occur during the period when the greenhouse is in operation.

Fog

Fog can be used to advantage with all natural ventilation systems. Droplets less than 30 microns in size (about 1/10 the diameter of a human hair) are created using high pressure pumps and nozzles or spinning atomizers. The fog droplets created just float around until the water is evaporated. Uniform cooling occurs when the fog is injected throughout the growing area.

For each gallon of water evaporated, over 9,000 Btu of heat are absorbed. Ventilation air then carries this out of the greenhouse. Transpiration from plants and evaporation of moisture from soil surfaces also aids the process.

Clean water is the key to low maintenance fog systems. The water needs to be free of chemicals or particulate matter. Rainwater is commonly used along with double filtration.

Shade

The addition of shade cloth or shade compounds can also aid all of the above ventilation systems. Keeping the heat out of the growing area in the first place reduces the amount of ventilation that is needed. On a sunny summer day, a 30' by 100' greenhouse will capture about 3.2 million Btu of heat, equivalent to burning 32 gallons of fuel oil.

Natural ventilation systems are a low-tech way of cooling greenhouses. It is important that the system selected fits the style of greenhouse and the crops grown. The addition of fans to provide cooling during difficult periods will allow optimum growing conditions to be maintained.