Keep your Greenhouse Cool with these Equipment Maintenance Tips

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Introduction

Keeping greenhouses cool during the summer can be a real challenge. The large amount of solar radiation received during warm days increases greenhouse temperatures to levels that are often unsuitable for profitable plant production. Those warm temperatures aren't particularly welcomed by greenhouse workers either. Besides warm temperatures, high humidity levels often add to the challenge of maintaining optimum growing conditions.

Growers can use a range of control strategies to reduce temperatures and humidity levels, including increasing air exchange (ventilation), reducing incoming radiation (glazing materials and shading), using air conditioning (evaporative cooling) and producing plants that are tolerant of higher temperatures. This article discusses the equipment used to maintain optimum greenhouse growing conditions during the warmer months and provides suggested proper maintenance tips.

Ventilation equipment

Mechanically ventilated greenhouses require louvered inlet openings, exhaust fans, controls and electricity to operate the fans. In a naturally ventilated greenhouse, the same maintenance issues apply, except this type of ventilation system does not use exhaust fans.

Louvered inlet openings are often controlled by an electric motor or other type of actuator attached to a chain or push rod. Window-type openings are often adjusted using a rack-and-pinion system operated by a motor attached to a low-speed gear box. The motors and other types of actuators, gear boxes and rack-and-pinion systems require periodic lubrication. Consult the owner's manual or contact the manufacturer to make sure the correct type of lubricant is used. In some cases adjustments of limit switches (e.g., to stop the motor/actuator when the ventilation window is fully opened or closed) need to be made.

While checking the operation of these system components, it is recommended to also check the overall performance. The openings should perform as intended (e.g., do they open and close completely, do they open and close as directed by the control system, are all components aligned properly?).
Ventilation fans can be direct-driven, gear-driven, or belt-driven, indicating how the (electric) motor is attached to the fan blades. In addition, these

motors can be single-speed, multiple-speed, or variable-speed, each type increasing the level of performance choices.

Servicing fan motors is typically done by a licensed electrician or service technician. Other adjustments, including making sure the drive belt is not worn and is properly aligned and has enough tension, cleaning and checking the alignment of the fan blades and checking the proper installation of protective guards, are often done by growers themselves and can significantly improve the operation and safety of the ventilation fans.

While an electrician is on hand to check the fan motors, consider having him do an inspection of the entire electrical system. Conducting periodic inspections can reveal any electrical code issues that may need to be addressed as well as reduce the risk of electrical shortages that may cause work interruptions or worse, that may result in personal and/or property damages.

Checking and adjusting control systems can be as simple as adjusting the setting on a thermostat or much more complicated in the case of a computer control system. Computer control systems typically include a mixture of high (115 volts of alternating current and higher) and low voltage (typically less than 24 volts) components and wiring. System adjustments can be made through the software that allows for user interaction. However, it is recommended that servicing the electrical parts of the control system be done by a service technician or a knowledgeable electrician.

Ventilation operation

Greenhouse ventilation systems are designed to provide sufficient air exchange and appropriate air distribution throughout the structure. The exhaust fans determine the air exchange rate, while air distribution is most influenced by the ventilation inlets. In some greenhouses, additional circulation fans provide air distribution by moving air within the greenhouse, but without providing any exchange with the outside air.

In an otherwise tight greenhouse, exhaust fans create a small vacuum (negative pressure) that causes air to enter the greenhouse through the ventilation inlets. This vacuum is called the static pressure difference and links the fan and inlet performance. There are three primary features to check when evaluating a mechanical ventilation system:

1. static pressure difference
2. fan capacity
3. effectiveness of the inlet opening.

Static pressure

Static pressure difference is the driving force for air movement in a ventilation system. Air moves from areas with a higher static pressure to areas with a lower static pressure. Air enters or leaves a greenhouse because the interior static pressure is different from the outside static pressure.

Static pressure differences can be measured with a manometer that indicates pressure changes displayed by a colored fluid level. In

greenhouses, the static pressure difference between the ventilated space and outside is measured in inches of water. By maintaining a relatively constant static pressure difference between the inside and outside air, the speed of the air entering through the ventilation inlet will also be relatively constant. This inlet speed is important to ensure proper mixing of the incoming outside air with the greenhouse air.

In mechanically ventilated systems, the static pressure difference should be maintained at approximately 0.05 inches of water with an acceptable operating range of 0.03 to 0.13 inches. Interestingly, few greenhouses monitor the static pressure difference.

Care must be taken in positioning the tubes connected to the manometer measuring ports. Be sure they are not exposed to moving air, which would result in the measurement of “velocity” pressure. A manometer should be permanently installed to provide an indication of the static pressure difference. This can be accomplished using an inexpensive inclined manometer or a manometer with an electronic control capacity for inlet opening positioning.

Ventilation fans

Greenhouse ventilation fans are typically selected for their operating performance at 0.10 to 0.125 inches of water pressure to account for exhaust fan design and inlet restrictions. Even higher operating performances are desirable when insect screening is installed, especially when screens with small opening sizes are used (e.g., to exclude small insects such as thrips). Note that dirty fan blades can significantly reduce the efficiency of exhaust fans.

The fan capacity (cubic feet per minute) can be determined by multiplying the average exhaust air speed (feet per minute) by the area of the fan face (square feet). The average exhaust air speed can be determined using a vane anemometer. A representative number of readings are taken across the outlet opening as close to the outlet as safely possible. These numbers are averaged to determine the average exhaust air speed.

Another way to determine fan capacity is by measuring the fan blade rotational speed in revolutions per minute (rpm). Note that the amount of air a fan moves is directly proportional to its rotational speed.
Fan blade rpm and rated air flow capacity are often listed on the housing nameplate or can be obtained from the manufacturer. For belt-driven fans, motor rotational speed will typically not equal blade rpm.

Fan rpm can quickly indicate if belts are loose or worn or if the supply voltage is too low. Inadequate wiring can lead to substantial voltage drops, causing fans to run at a lower rpm.

Fan rotational speeds can also be measured using a strobe light or tachometer. Tachometers that are pressed against the center of the fan shaft should be used carefully so

that no personal or equipment damage occurs if the tachometer shaft slips off the fan shaft.

The effectiveness of the inlet opening is characterized by the inlet air speed that should be quite high, 700 to 1,000 feet per minute (fpm), in order to ensure proper mixing with the greenhouse air. Air speeds across inlet openings are not uniform. The air speed will be zero at the edges of the inlet and typically increases to its maximum near the middle of the inlet opening. A small-head vane anemometer or a hot-wire anemometer can be used to measure air speed across the opening of the inlet to determine the maximum air speed reading.

Glazing materials

Maintenance of glazing materials typically consists of patching tears, fixing cracks and replacing broken panes. These measures typically do not greatly impact the cooling efficiency of the greenhouse, but there is an opportunity to do so when replacing weatherized covering materials, particularly film products.

Not only is it important to select glazing material that is able to withstand degradation due mainly to ultraviolet radiation, but film materials are available that contain additives that reduce the amount of heat radiation entering the greenhouse (IR films). Selecting these films diminish the challenge of keeping the greenhouse cool. These films also reduce the heat loss to the outside environment at night and during the colder months of the year.

Shading products

Spray-on shade. Spray-on shading compounds are relatively easy to apply and require minimal attention once they're used. Over time, weather conditions may affect their thickness and thus the level of shading provided, so a periodic examination of the shading's effectiveness is recommended. Additional shading compound can be applied as needed. Once applied, spray-on compounds are typically not removed until late in the fall when light levels begin to diminish.

Shade curtains. Movable shade curtains are preferred when more control over the outside light levels is needed. Most movable curtains are installed on the inside of the greenhouse. Outside curtains are often kept in place throughout the summer growing season. Movable curtains are pushed and pulled over or suspended from guide wires. The push-pull action is accomplished by a rack-and-pinion system or by rolling up or unrolling a wire pulley system.

These mechanical systems require some maintenance, although their light-weight construction combined with proper installation and specially designed curtain materials often result in many years of trouble-free operation. Movable shade curtains are operated with electrical motors attached to gear boxes. These items require periodic lubrication and the limit switches on the motors may need to be adjusted from time-to-time to make sure the motor turns off when a curtain is fully opened or closed.

Evaporative cooling
Evaporative cooling systems can be divided into two categories: pad and fan and fog systems.

Pad-and-fan systems
Maintenance of the pads includes checking for air and water leaks, checking for and removing blockages in the plumbing, inspecting the condition of the pad material and replacing it when necessary, preventing algae buildup by covering/shading all exposed plumbing components and by running the pads dry at night, and making sure there is adequate bleed-off to prevent salt buildup on the pads.

The pad-and-fan system requires sufficient makeup water to replenish the water evaporated into the incoming air, and a reliable pump capable of providing sufficient water to keep the pads wet during operation.

Since evaporative cooling pads are typically not used during the colder months, proper care should be taken to store exposed system components as not to allow cold weather to impact their operating condition. Evaporative cooling pad systems should be checked carefully at the start of each cooling season. For fan maintenance, see the section above on ventilation fans.

Fog systems
A fog system consists of a high pressure pump that pumps highly purified water through a distribution system and small nozzles placed strategically throughout the greenhouse. The high pressure ensures that the nozzles deliver a fine mist so that the plant foliage does not become wet during system operation. The fine mist that is produced reduces the risk of diseases. A fog system requires careful installation in order to ensure reliable operation.

The three main areas requiring maintenance are the pump, nozzles and water purification system. It is recommended that manufacturer guidelines be followed for proper and timely maintenance procedures. Since all system components are installed inside the greenhouse, any time there is a need for additional cooling the fog system can be used to reduce the greenhouse temperature below a level attainable with regular ventilation.

Safety considerations
As is the case for all equipment used in a greenhouse, carefully review the owner's manuals and operating instructions before attempting to repair and/or service any of this equipment. Adhere to all code and construction requirements and guidelines and consider hiring a reputable service company that has expertise in servicing the type of equipment installed in your facility.

While it may seem less expensive to repair and maintain equipment yourself, mistakes can be very costly, especially with larger pieces of equipment. Maintenance errors can potentially increase the risk of damage to your facilities and harm to yourself and fellow greenhouse personnel.

Picture 1. Fully opened side wall ventilation window in a mechanically ventilated greenhouse.

Picture 2. Exhaust fan shown from inside the greenhouse with the louvers removed.

Picture 3. Mechanically ventilated greenhouse with an external shade curtain.

Picture 4. Drive motor and gear box for a vertically operated side wall ventilation window.

Picture 5. Partially opened side wall ventilation window showing an externally installed insect screen on the right and an internally installed evaporative cooling pad on the left.