e-GRO Alert

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Seal the Leaks and Save the Heat: Managing Cold Air Infiltration in Winter Production

Cold air infiltration is an often overlooked but expensive source of heat loss and crop stress in heated greenhouses and covered retail spaces. This Alert outlines how to recognize infiltration problems and provides practical steps to reduce drafts, protect crops, and improve heating efficiency during the production and sales season.

Cold air infiltration through doors, vents, fan housings, and small gaps or cracks can create localized cold spots, increase fuel use, and cause chilling or freezing injury in floriculture crops. This alert highlights common sources of cold air infiltration and provides practical strategies to tighten structures, protect plants, and improve heating efficiency.

Figure 1. Plant loss due to cold air infiltration at an exhaust fan. Photo by: W. Garrett Owen, OSU.

Why Cold Air Infiltration Matters

In floriculture production, maintaining a relatively uniform air temperature around the crop is essential for consistent growth and high-quality plants. Even with properly sized heaters and working environmental controls, unwanted cold air infiltration can create pockets of low temperature that stress crops and reduce marketability or even result in plant loss (Fig. 1). Cold air entering through cracks and openings behaves differently than

Cold air entering through cracks and openings behaves differently than gradual heat loss through glazing. Infiltration can:

- Create localized "cold corridors" near doors, sidewalls, and vents where plants are repeatedly exposed to air several degrees colder than the setpoint.
- Increase the risk of chilling or freezing injury to foliage, buds, and flowers near leak points, especially on cold-sensitive species.
- Contribute to uneven development within a greenhouse bay or house, leading to non-uniform height, delayed flowering, or visible injury in specific rows or benches.
- Increase fuel use, since heaters must replace the warm air lost through leaks while also reheating incoming cold air.

Understanding where cold air is entering and how it moves across the crop is the first step toward reducing these risks and improving overall heating efficiency.

Where Cold Air Sneaks into the Greenhouse

Cold air infiltration rarely comes from a single, obvious source. Most greenhouses and supporting facilities (headhouses, offices, storage rooms, etc.) have a combination of small openings and less obvious problem areas that together create a significant "leak load." Common entry points include:

1. **Doors and Personnel Entries**
   - Gaps at the bottom of doors where thresholds are worn or uneven.
   - Loose or missing weather stripping around door frames.
   - Overhead or roll-up doors that do not fully seal at the sides, top, or between panels.
   - Doors that are frequently opened during loading, shipping, or retail hours (Fig. 2).
2. **Vents, Louvers, and Fan Housings**
   - Inlet vents that do not close tightly when ventilation is off.
   - Fan shutters that are warped, rusted, dirty, or held partially open by debris or ice.
   - Exhaust fans and pad inlets that allow cold outside air to "spill" along the floor or directly onto nearby benches when they cycle on and off.
3. **Glazing, End Walls, and Sidewalls**
   - Tears or loose areas in polyethylene film, especially near inflation tubes and edges.
   - Poorly sealed joints between glazing panels and framing members.
   - Gaps where end walls meet sidewalls, foundations, or gutter connections (Fig. 3).
   - Unsealed penetrations where utilities, control wires, or irrigation lines pass through the structure.

4. Under Benches and Along the Floor

- Gaps between the structure and the greenhouse foundation slab or soil surface.
- Open vents or drains that allow outside air to be pulled in when fans operate.

Plants located directly in the path of cold air entry points often show the earliest and most severe symptoms of chilling or freeze injury and damage. Recognizing these patterns can help pinpoint where leaks are located.

Recognizing Patterns of Cold Air Injury

Cold air infiltration often produces distinct spatial patterns of damage. Growers should watch for:

- Bands or strips of discolored (white) and necrotic (dead) foliage that align with a doorway, vent, or fan (Fig. 4).
- Leaf edge or margin necrosis, or bleached patches on crops closest to sidewalls or end walls.
- More severe injury on the windward side of the structure compared to the leeward side during cold, windy periods.
- Crops near leak points that develop more slowly, have delayed flowering, or show uneven bud development compared to plants in the center of the house (Fig. 5).

Symptoms can resemble nutrition problems, chemical injury, or disease. When injury is localized to plants near likely air entry points, infiltration should be considered as a possible cause. Pairing visual scouting with simple diagnostic tests, such as smoke sticks or handheld temperature sensors, helps confirm where cold air is entering.

Figure 2. Example of a high-traffic greenhouse door where outside cold air enters the growing space. Asparagus ferns are exhibiting chilling and freezing injury leading to overall plant death. Photo by: W. Garrett Owen, OSU.

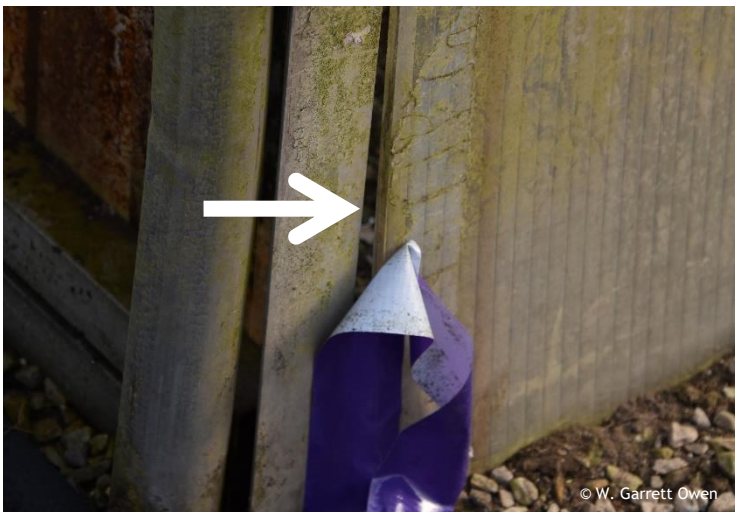

Figure 3. Example of a gap where the greenhouse end wall and sidewall meet. The gap allows cold air to infiltrate into the greenhouse environment. The gap was temporarily repaired with blue tap to prevent cold air infiltration. Photo by: W. Garrett Owen, OSU.

Figure 4. Petunia exhibiting discoloration (white) and necrotic (dead) foliage due to freezing injury. Hanging baskets placed at ground level near a high-traffic door. Photo by: W. Garrett Owen, OSU.

Finding Leaks: Simple Diagnostic Tools

Several low-cost approaches can help identify and visualize air infiltration:

- **Smoke sticks or foggers**: Non-toxic smoke sticks, incense, or portable foggers placed near suspected leak points reveal air movement patterns. Smoke drawn inward indicates negative pressure and infiltration at that location.
- **Handheld thermometers or IR thermometers**: Comparing air temperatures near sidewalls, doors, and vents with temperatures in the center of the house can highlight cold zones.
- **Thermal imaging cameras**: Thermal cameras or smartphone attachments can reveal cold surfaces, drafts, and temperature gradients that are difficult to visually notice (Fig. 6).
- **Visual inspections on windy days**: On cold, windy days, carefully inspect poly film, vents, and doors for visible movement, fluttering, or gaps that open and close with gusts.

Documenting these findings with photos and notes helps prioritize which leaks should be addressed first and provides a record for future maintenance.

Tightening the Structure Before the Heating Season

Addressing structural and sealing issues prior to the heating season pays dividends in fuel savings and crop quality. Key steps include:

1. **Inspect and Repair Glazing**
   - Replace torn or brittle polyethylene film and ensure proper inflation if a double layer is used.
   - Check inflation blowers, tubing, and connections to maintain consistent inflation pressure.
   - Seal gaps where glazing meets framing with appropriate tapes, caulks, or foam strips.
2. **Seal Doors and Personnel Entries**
   - Add or replace weather stripping around door frames and thresholds.
   - Install door sweeps to close gaps at the bottom of doors.
   - Adjust or repair hinges and latches so doors close fully and do not remain slightly open.
   - For high-traffic areas, consider vestibules, double doors, or plastic strip curtains to reduce the volume of cold air entering or reaching crops when doors are opened (Fig. 7).
3. **Maintain Vents, Louvers, and Fans**
   - Clean and lubricate hinges and pivot points so shutters close completely when fans are off.

Figure 5. Tomato plants located along the outer perimeter and at the end of the greenhouse near the double sliding doors are visibly smaller and less vigorous than plants in the interior rows, illustrating growth reduction associated with cold air infiltration. Photo by: W. Garrett Owen, OSU.

- Replace broken, bent, or missing louvers that prevent a tight seal.
- Add weather seals or gaskets around fan housings and inlet frames where appropriate.
- Verify that automated vents fully close at night and during cold events and adjust control settings as needed.

4. Seal joints and penetrations

- Caulk or foam gaps at wall and roof joints, along foundations, and around utility penetrations.
- Ensure that any unused vents, openings, or old penetrations are properly closed and sealed.

These improvements reduce infiltration, extend heater run intervals, and help maintain more uniform temperatures throughout the growing area.

Mitigation Strategies During the Season

Even in a well-sealed structure, day-to-day practices influence how much cold air enters and where it flows. During the season, growers can:

1. Manage Air Distribution

- Use horizontal air flow (HAF) or circulation fans to mix air and minimize temperature stratification.
- Aim circulation fans so that incoming air near doors or vents is mixed with warm air before it passes across sensitive crops.
- Avoid placing the most cold-sensitive crops directly in the path of known drafts, especially near end walls, doorways, and vents.

2. Adjust Crop Placement

- Place hardier crops or less sensitive
- species in locations more likely to experience temperature swings.
- Keep high-value or cold-sensitive containers away from obvious leak points and from floor-level drafts.

3. Use Interior Curtains or Temporary Barriers

- Nighttime thermal curtains or energy screens can help buffer crops from cold air movement when designed and operated correctly (Fig. 8).
- In some cases, temporary plastic sheeting can be used to create interior partitions that limit how far cold air travels from doors or shipping areas into production zones (Fig. 9).

4. Coordinate Labor and Traffic

- Minimize door opening frequency and duration during the coldest periods of the early morning or late afternoon and evening.
- Consolidate loading, unloading, and shipping activities into defined time windows when possible.
- Train staff to fully close doors and report any latches or seals that do not function properly.

These operational strategies complement structural improvements and help reduce cold stress on crops when conditions outside the greenhouse are most challenging.

Planning for Extreme Cold Events

Advanced planning for forecasted cold snaps or polar vortexes helps limit damage when outside temperatures drop and sustain well below normal winter conditions:

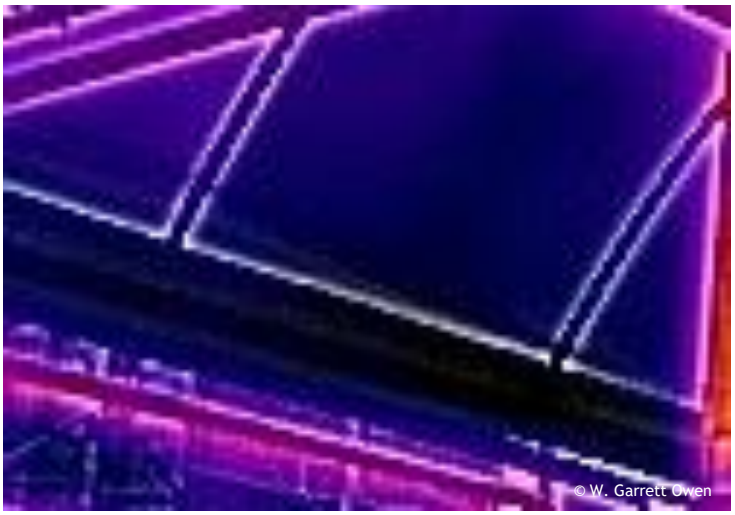

Figure 6. Thermal imaging camera used to check greenhouse gutters for leaks thereby allowing cold air to enter the greenhouse growing environment. Photo by: W. Garrett Owen, OSU.

Figure 7. Example of plastic strip curtains installed near a high-traffic door to reduce the volume of cold air reaching a poinsettia crop when the doors are opened. Photo by: W. Garrett Owen, OSU.

Figure 8. Example of a propagation greenhouse deploying thermal energy screens at night to retrain heat and to be more energy efficient. Also pictured is day-extension lighting. Photo by: W. Garrett Owen, OSU.

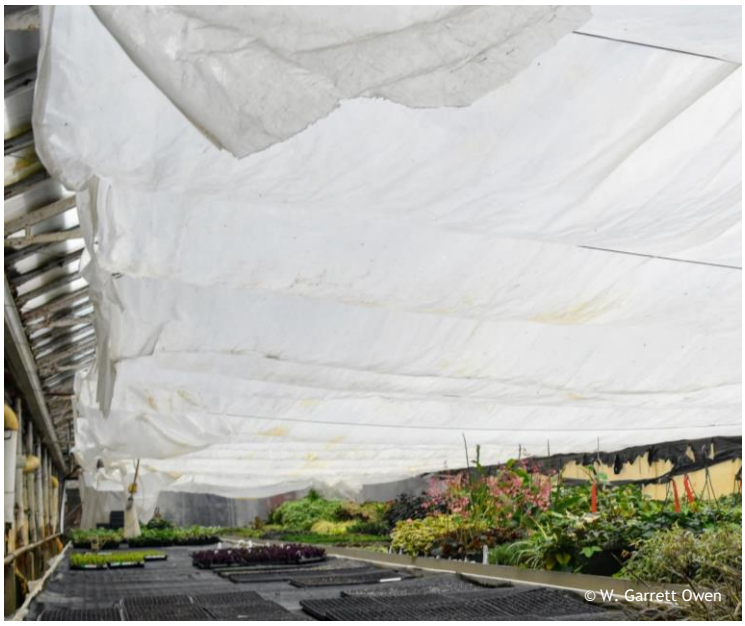

Figure 9. Example of temporary plastic sheeting used to create a barrier in a propagation greenhouse. The barrier keeps the heat air closer to the crops and prevents loss and cold air from contacting plant material. Photo by: W. Garrett Owen, OSU.

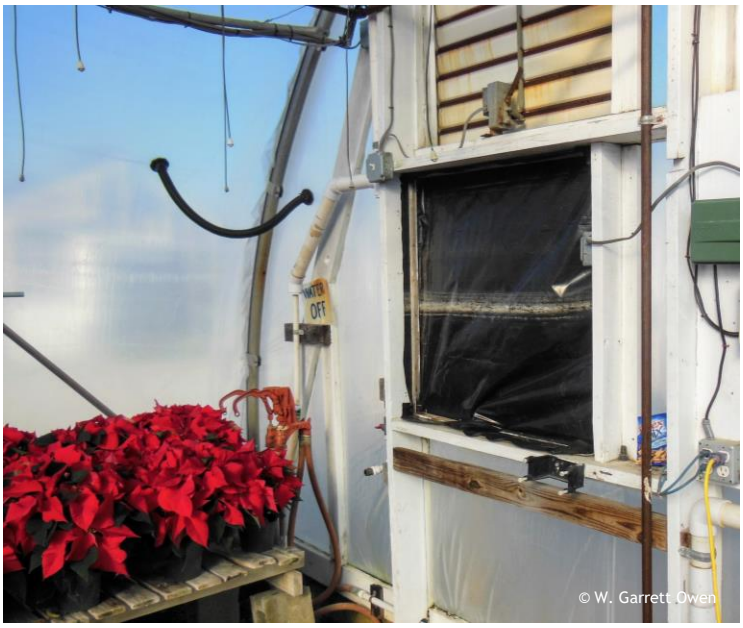

Figure 10. Example where exhaust fans were temporarily covered with plastic sheeting to prevent cold air infiltration prior to an extreme cold weather event. Photo by: W. Garrett Owen, OSU.

- Verify that environmental controls, alarms, and back-up systems are functioning correctly.
- Inspect heaters, fuel levels, and distribution systems several days before cold weather is expected.
- Double-check that all vents, louvers, and doors close properly and that known leaks are temporarily sealed (Fig. 10) if permanent repairs are not yet possible.
- Consider slightly increasing setpoint temperature before an extreme event to build some “thermal momentum” into the structure and crop.
- If possible, relocate the most sensitive crops away from known draft areas or into tighter houses for the duration of the event.

After a significant cold event, scout carefully for localized injury patterns, and use what you observe to guide further improvements to sealing and air distribution.

Overall, cold air infiltration is a silent but significant contributor to cold stress, chilling or freezing injury, and uneven crop development in greenhouse and nursery production. Small leaks around doors, vents, fan housings, and structural joints can create localized cold zones that reduce plant quality and increase fuel consumption.

By systematically identifying where cold air enters, tightening the structure before the heating season, and adjusting crop placement and air movement during the season, growers can reduce infiltration, protect crops, and improve heating efficiency. Regular scouting for injury patterns and periodic checks for new leaks help maintain a tight greenhouse envelope over time, supporting uniform, high-quality crops for greenhouse growers, nursery growers, and independent retail garden centers

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