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## Flue Gases Can Wreak Havoc on Horticultural Crops

Flue gases are best described as an unseen enemy that can compromise yield and plant quality in a few short hours. Often a small hole in the flue pipe or small holes in the heat exchanger can cause these colorless odorless gases to leak out into the growing area. In some cases a missing flue cap can allow flue gases to be blown back down the flue pipe into the growing area below resulting in significant injury to sensitive crops.

Several years ago an experienced grower lost his tomato crop when sulfur dioxide laden flue gases blew down his uncapped flue pipe into the greenhouse. This grower lost his entire crop due to a missing flue cap and a sudden downdraft during a spring thunderstorm. Sulfur dioxide is injurious to most crops when plants are exposed at 0.48 ppm for 4 hours or 0.28 ppm for 24 hours (Thomas, 1961)

Ethylene is the most subtle, but perhaps the most injurious of the flue gases. Ethylene can pass through the smallest of holes on the flue pipe or through holes in the heat exchangers into the growing area.



Sulfur dioxide injury is characterized by interveinal necrosis in tomatoes. (Photos by Thomas G. Ford)



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Unvented propane heaters that are sometimes touted as vent-less heaters often produce ethylene as a byproduct of combustion leaving this growth regulating substance behind as a stark reminder of its presence.

Tomatoes are often one of the most sensitive crops to ethylene and the downward bending of the stems (epinastic growth) is typically the first symptom noticed by a discerning grower. In some cases the grower may misidentify the causal agent which leads them to incorrectly employ an array of crop protectant chemistries to avert crop loss. Tomatoes exposed to 1 ppm of ethylene for 3 hours or to 0.1 ppm for 24 hours will display symptoms of epinasty.

As greenhouses are fired up across the world please carefully inspect your furnaces and flu pipes immediately. Low concentrations of flue gases can impact crop yield and plant growth so consider the following steps for a successful cropping year:

- Make sure that your flue pipe extends a few feet above the roof line of your greenhouse.
- Ensure that a cap is used on the flue pipe to prevent flue gases from being blown down the pipe and into the greenhouse.
- Inspect the heat exchanger for cracks and holes that can lead to flue gas leakage into the greenhouse.
- Ensure that exhaust/ventilation fans are not running when the furnace is in operation since they could potentially suck flue gases into the greenhouse.
- Make sure that you have a fresh air inlet in place to provide enough oxygen for proper combustion. Generally, a minimum of one square inch per 2000 btu of heat output is required.



Downward bending of tomato stems is described as epinasty. This grower installed an unvented gas furnace in a new greenhouse. Its prompt replacement eliminated the ethylene issue resulting in normal yields. (Photo by Thomas G. Ford)



The flue pipe extends over the roof line by several feet and has a cap in place to prevent flue gases from being blown down the pipe into the greenhouse. (Photo by Thomas G. Ford)



Even the temporary use of unvented heaters on a cold night can create cropping problems in greenhouses and high tunnels. (Photo by Thomas G. Ford)

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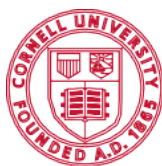
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