Unvented Heaters in Greenhouses

"When growing transplants in the greenhouse or high tunnel, be careful not to use unvented heaters. An unvented heater is one that is designed without a flue connection so that the heat and products of combustion are exhausted into the greenhouse. Unvented heaters can be fired with natural gas, propane or kerosene which all contain traces of sulfur. During combustion sulfur in the fuel is combined with oxygen to form sulfur dioxide. Levels as low as 0.5 part per million (ppm) can cause injury to some plants. Once the sulfur dioxide enters the plant through the stomates, it reacts with water to produce sulfuric acid that causes leaf burn, flecking and general chlorosis. Tomatoes and white petunias are very sensitive and will show signs in as little as one hour. Ethylene gas is another pollutant formed during combustion. Ethylene levels as low as 0.01 ppm can cause symptoms such as malformed leaves and flowers, stunted growth, bud abscission, epinasty and flower senescence."

http://extension.umass.edu/floriculture/fact-sheets/growing-vegetable-bedding-plants

GREENHOUSE GROWER, August 1986, pp. 74, 76

Unvented Heaters: False Economy?

By GARY HICKMAN, RICHARD EVANS, and MICHAEL REID

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Last winter a number of growers in California reported serious problems affecting greenhouse-grown foliage plants. In five different operations, there were severe crop losses from symptoms such as premature leaf fall (schefflera and cissus); leaf yellowing (tradescantia); leaf spotting (chlorophytum); downward bending of leaf stalks, known as epinasty (poinsettia and syngonium); and browning or partial death of leaves (dracaena, dieffenbachia, and syngonium). In all of these greenhouses, the operators had recently upgraded their heating systems. They had replaced standard vented gas heaters with direct-fired unvented heaters because of promised 20%-30% savings in energy costs.

Injury to greenhouse-grown plants resulting from malfunctioning heaters is not a new phenomenon. More than 100 years ago, greenhouse growers reported similar symptoms — yellowing or death of foliage, premature loss of leaves or flowers, and failure of flowers to open normally — when their greenhouses were polluted from leaks in gas lines.

Later, injury to plants caused by gas leaks led to the discovery that ethylene, a common component of the coal gas used at that time, is an important regulator of plant growth and development, even when present in minute quantities. As little as 5 parts per billion of ethylene in air can damage or kill sensitive plants.

Modern natural gas contains very low concentrations of ethylene, but ethylene produced during combustion is present in the exhaust of gas heaters. Although it is possible, in theory, to achieve complete combustion of fossil fuels, present combustion technology requires that provision be made to remove heater fumes the greenhouse.

The energy savings claimed for the "new" greenhouse heaters are achieved by eliminating the heat exchanger and exhaust flue normally used and venting all the products of combustion into the greenhouse. To determine whether unvented heaters were introducing ethylene into the greenhouse atmosphere, we measured the concentration of ethylene and other gases in the air of a greenhouse fitted with new unvented heaters.

The air was found to contain ethylene gas at a concentration of as much as 500 parts per billion. Because the ethylene was accompanied by other products of incomplete combustion, it is likely that the heaters were the source of the pollutants.

Damage to Plants
The levels of ethylene detected in that greenhouse certainly were high enough to account for the observed injury. A recent study in The Netherlands of the effects of fumes from gas burners for CO_2 enrichment showed that ethylene concentrations as low as 200 parts per billion adversely affect the bud and shoot development of chrysanthemum plants. Over the past 50 years, researchers have studied the effects of low concentrations of ethylene on many cultivated plants.

Other Potential Problems
Production of ethylene is not the only possible problem introduced by unvented heaters. Plants are also sensitive to oxides of nitrogen, which may be produced in high concentrations when oxygen and nitrogen combine in the heat of combustion of gas burners. This problem may be more pernicious, because often the only symptom exhibited by plants is reduced vigor.
Another product of incomplete combustion is carbon monoxide, a gas that is extremely toxic to humans. In some of the greenhouses using unvented heaters, workers complained of headaches, which may have been caused by elevated levels of carbon monoxide in the atmosphere.
Greenhouse growers have been advised for years to avoid the damage caused by products of combustion by installing vented heaters. The experience of the unlucky California growers is a timely warning to others who grow plants that may be sensitive to ethylene.
Resist the temptation to reduce fuel bills by installing unvented heaters in your greenhouses. Such heaters may continue to be a potential source of greenhouse plant damage and may cause problems for greenhouse workers as well.

Unvented gas heaters are not vented to the outside. Gases produced from combustion are released directly into the heated area. This type of gas heater is only recommended for temporary use in a greenhouse because many plants are very sensitive to the by-products.

http://www.littlegreenhouse.com/accessory/heater-compare.shtml

“Unvented Direct-Fired Heaters

- Discharges combustion products into the greenhouse, damaging crops and leading to serious discomfort, injury and/or death if not properly ventilated. These risks far outweigh any benefit that may be sought from CO2 being released in the combustion process.
- Direct fired units, often advertised as 100% efficient, are in fact 92% efficient at most. The latent heat of vaporization consumes Btu's to maintain water vapor in its gaseous state, reducing efficiency to roughly 92%. Then, you must provide fresh air to meet safe air requirements. The energy required to heat this air can bring the overall system efficiency below 80%. And, the colder it gets, the less efficient the system is. Refer to unit heater efficiency for additional details.
- Risk for increased condensation issues due to the water vapor produced from combustion. This vapor can condense within the greenhouse and cause mold and/or fungal diseases, as well as premature failure of metal objects (structures, conduit, wiring, etc).”

http://www.modine.com/v2portal/page/portal/modine/modineMarketsDefault/modine_com/markets/building_HVAC/level_4_content_004.htm#unvented

“However, an unvented heating system creates ethylene pollution and excess water vapor and condensation. This can lead to poor plant growth, unless a distribution tube is installed to dilute the flue gas and mix the air, thus, reducing the concentration of harmful gases like ethylene.”

http://www.ces.ncsu.edu/depts/hort/floriculture/hils/HIL530.pdf

- **“Unvented** gas heaters are generally not for indoor use because they can introduce harmful gases like carbon monoxide and reduce the amount of oxygen in the areas where they operate. For this reason, some states have banned the use of unvented as heaters indoors.”

http://www.homedepot.com/webapp/wcs/stores/servlet/ContentView?pn=Portable_Heaters&catalogId=10053&storeId=10051&langId=-1

"An unvented heater is one that is designed without a flue connection so that the heat and products of combustion are exhausted into the greenhouse. Dumping these flue gases into the greenhouse may improve the overall efficiency rating as compared to a conventional heater but the pollutants and added moisture from combustion may put your plants in jeopardy."

http://www.negreenhouseupdate.info/index.php/component/content/article/209-problems-with-using-unvented-greenhouse-heaters

- "Vent all fossil-fueled unit heaters to the outside in any enclosed greenhouse"

http://edis.ifas.ufl.edu/ae024