

**Air Pollution Damage on Greenhouse Vegetables** David Trinklein

There are several phytotoxic gases that can be produced by heating systems used for greenhouse climate control. This especially is true when the heater or furnace is not maintained properly. Closed greenhouses (and high tunnels) have the ability to retain these gases with plant damage as the end result. This article is written to inform greenhouse vegetable growers of pollutant gases that can become problematic, how they are produced, and measures that can be taken to prevent their occurrence.

The three most problematic and potentially damaging pollutant gases in greenhouse vegetable production include ethylene, sulfur dioxide and oxides of nitrogen. All of these gases potentially are part of the fumes generated in the combustion chamber of heating systems that employ propane, natural gas, fuel oil, coal or wood as a fuel source. Of the three, ethylene is by far the most common and holds the greatest potential for plant damage and yield reduction.

Ironically, ethylene is a growth hormone naturally produced by plants in minute amounts during their growth and development. It often is referred to as the “ripening” hormone and is responsible for, among other things, regulating the ripening of fruit. For example, tomatoes destined for shipment over long distances usually are picked green (breaker stage). Upon receipt of the fruits hundreds or even thousands of miles away, they are exposed

to ethylene gas. As a result, they soon turn red and soften. Please note I did not use the term “ripen”, for the latter (to the author) implies the development of flavor.

Ethylene levels high enough to cause plant damage in greenhouses or heated high tunnels most often result from the incomplete combustion of fuel by defective heating equipment. Typical symptoms of ethylene exposure include epinastic growth (downward curling of the leaves and petioles) followed by general stunting of growth. Other symptoms of exposure to high levels of ethylene include the abscission of flower buds petals or leaves; water-soaked appearance of older leaves; chlorosis; and wilting of flowers.

Unfortunately, tomato, our primary greenhouse crop is one of the most sensitive plants to this pollutant. Couple this fact along with the other environmental conditions present in a closed greenhouse or high tunnel (high temperature and relatively humidity), and it is not surprising to see severe ethylene damage on tomato.

The second pollutant of concern, sulfur dioxide, is produced when a fuel such as coal is burned. Many sources of coal contain sulfur as an adulterant. Upon combustion (oxidation) sulfur dioxide is produced. Symptoms of sulfur dioxide damage include chlorotic “stippling” of the leaves at lower levels and interveinal leaf necrosis at high levels. Tomato fruit damage?

Finally, the air that we breathe is comprised primarily of nitrogen gas (about 80%). High temperature combustion (oxidation) holds the possibility that oxides of nitrogen (e.g. nitric oxide) will be produced. When this happens in a greenhouse heater with faulty heat exchange tubes, the oxides of nitrogen are accidentally introduced into the greenhouse. Symptoms similar to those caused by sulfur dioxide at higher levels often result. At lower levels, the leaves may simply appear darker or have downward curving leaf margins, or both.

Prevention is the best cure for air pollution problems in the greenhouse or heated high tunnel. In order to allow for complete combustion of fossil fuels, adequate oxygen is required. As a general rule, one square inch of free area (an unobstructed opening to the outside) should be provided for each 2000 Btu of heater rating. Heating systems should be cleaned on a yearly basis and checked for possible leaks in the heat exchange tubes. Exhaust pipes should be checked to make sure bird or wasp nests that would restrict air flow are not present. Finally, become familiar with the symptoms of ethylene damage and monitor plants closely. In most cases, ethylene damage is reversible, but only if the source of the pollutant is eliminated.

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# Review Items from Recent Food Safety Trainings

James Quinn

## Attendance

There were five trainings held around Missouri this off-season, in which Amish and Mennonite growers attended. While they started slow, they ended with brisk attendance.

In November, a training in Jamesport had about a dozen and in Kirksville ½ a dozen. A training at Morgan County Seeds in December pulled in 25. On March 13th 20 attended a training in Buffalo. Lastly, on March 19th 50 attended in Rich Hill. These were all the full day trainings where a certificate is received\*.

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\* To comply with the FSMA or GAPs, one individual per farm needs this certificate by January 2020. A farm can be exempt from FSMA, then this training certificate isn't needed.

## Claiming an Exemption from FSMA\*

- If sales of fresh produce is below \$25,000 (as an average of the past three years) then a grower is exempt from documenting compliance of FSMA. One still needs to follow food safety practices. Records showing the sales for fresh produce of the prior three years need to be available, if a FSMA inspector requests to see them.

- If all of a farm's fresh produce is sold direct to customers, e.g. at a farmers market, roadside stand or direct delivered to a grocery store, then the farm is exempt, for up to \$500,000 in sales. One still needs to follow food safety practices.
- The problem for many wholesale growers is that if some of their fresh produce is sold to a distributor, they lose the above exemption. They can still qualify for an exemption if more than 50% of their sales is direct to customers. This must be documented with records and be available if requested by a FSMA inspector (contact your local extension specialist if you'd like a copy of this form).
- Can some sales through produce auctions be considered direct? Yes, if it is direct to a grocery store, restaurant, roadside market, or farmers market vendor. However, the produce auction grower would need to keep all lot tickets and sort those into direct sales and those not (e.g. to distributors). They would also need to place their farm name and business address on each lot ticket (a mailing label would be sufficient). The contact information for all direct customers would also need to be retained and updated annually, corresponding to the buyer numbers for the lot tickets.
- The above two bullet points have led some auction growers to comment- "It might be easier to comply with FSMA than to document and receive a qualified exemption".

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\* Some of the specifics have been simplified in this section. Full details can be found at: [https://www.ksre.k-state.edu/foodsafety/produce/fsma/docs/Coverage\\_Worksheet.pdf](https://www.ksre.k-state.edu/foodsafety/produce/fsma/docs/Coverage_Worksheet.pdf)

## Water testing\*

The required water tests for FSMA compliance leave some groaning, as they are different, and more stringent than for GAPs. That said, NO water tests are required for compliance with FSMA until January 2024. By then, (if not long before) the GAPs versus FSMA differences should be resolved.

Want to get a jump start? Most important is to have some water source on your farm verified as potable. A simple potable water result from a well is relatively inexpensive, \$10 to \$20 from the county health department. Getting a well to test potable may be as simple as a gallon of bleach. One grower reported their well didn't pass on the first test in 2016. A gallon of bleach was used and the 2nd test passed. That well passed again in 2017, with no additional bleach required.

The FSMA water testing requires 4 potable water tests for a well. Some details need to be worked out on this prior to the compliance date of 2024 (for very small growers), but starting now to document a well as potable for a farm would be a good idea.

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\* Some of the specifics have been simplified in this section. Full details can be found at: [https://www.ksre.k-state.edu/foodsafety/produce/fsma/docs/water\\_decision\\_tree.pdf](https://www.ksre.k-state.edu/foodsafety/produce/fsma/docs/water_decision_tree.pdf)

## Reopening of the Plant Diagnostic Clinic 2018

Josephine Mgbechi-Ezeri



Hurray! The Plant Diagnostic Clinic is back again. The clinic was established to provide answers to plant health problems faced by the citizens of Missouri. The mission of the clinic is to provide accurate, timely answers and management recommendation that reflects research-based results and an integrated pest management (IPM) philosophy. Besides answering plant disease problems, the clinic also handles samples submitted for identification of weeds, mushroom, insects or arachnids. Starting January 8th, Josephine Mgbechi-Ezeri will serve as the new clinic Director. Josephine's role is to coordinate the daily operations of the laboratory, provide diagnostic services to clients and disease management training to the agricultural stakeholders in Missouri. When necessary, the clinic can utilize the expertise of University of Missouri State Extension Specialists and faculty in the Division of Plant Sciences who specialize in Agronomy, Entomology, Horticulture or Plant Pathology to ensure accurate and effective diagnosis and reporting. We welcome samples from government agencies, growers, industries and homeowners throughout the state.

*Please visit the Plant Diagnostic Clinic website for:*

- Information on how to collect and ship a sample
- Submission forms (types of samples accepted)
- Plant Disease Identification
- Turfgrass Disease Identification
- Insect / Arachnid Identification
- Plant / Weed Identification (to include mushrooms)
- Clinic hours for dropping off a sample
- Fees associated with services

### **Contact information:**

University of Missouri–Plant Diagnostic Clinic  
28 Mumford Hall  
Columbia, MO 65211

**Phone:** 573-882-3019

**Email:** [plantclinic@missouri.edu](mailto:plantclinic@missouri.edu)

**Web:** <http://plantclinic.missouri.edu/>

## Minimum Required Records for FSMA

Growers will have the opportunity to modify their farm operations so that fewer records will be required by FSMA. While many records are suggested, relatively few must be provided. More detail will be provided on this in the future, and was discussed at the training, but below is a short example.

Streamlined Produce Auction Farm: Grows all produce at the farm business address. Always applies manure or compost to any field used for fresh produce the previous calendar year. One well is verified as being potable; all water used for spraying, post-harvest washing, sanitizing, and hand washing is used from this source. No irrigation water comes in contact with any fresh produce harvested. (A pond is used for irrigation, but only through drip tape under plastic) Only family members are used for harvesting or post harvest handling and they are trained annually in April. Any fresh produce that is washed is with a single pass. Equipment used for picking and handling fresh produce (e.g. washing) is sanitized on a regular basis, as needed. New cardboard boxes are used for any fresh produce covered by FSMA.

### *The following records would be required:*

- Farm business name and address.
- FSMA trained individual- name, date trained and location (one's certificate will provide this).
- Worker training- worker names, date trained (April xx) and supervisor conducting the training.
- Annual water test for well documenting it is potable.
- Annual inspection of the well and all pipes associated with the water distributed from it.
- Date and method of sanitizing all harvest containers or post-harvest handling equipment.

# Saying farewell to two Lincoln University colleagues

Two state specialists are moving on to jobs in other states. Both have been frequent contributors to the Missouri Produce Growers Bulletin.

**Jaime Pinero** moved to Missouri in April 2010. He initially worked with both insect and disease issues of vegetables and berries, until Zelalem Mersha joined Lincoln University. Since then Jaime's work has focused on insect pests and he's been doing innovative work such as a pest mass trapping, most notably of cucumber and Japanese beetles. So maybe it's not surprising he'll be doing similar work with apple, pear, cherry, in Massachusetts. As of April 1, 2018, Jaime will be joining the University of Massachusetts (located in Amherst), as an Associate Professor, Tree Fruit Entomology/ IPM.



**Zelalem Mersha** joined Lincoln University in November 2012. His work has focused on diseases of vegetables and berries. He was helpful when bacterial canker of tomatoes flared up in 2013 and has been working the Melcast system for watermelons and cantaloupes, and more recently with lettuce drop disease. Zelalem will be doing similar work as an Assistant Professor, Plant Pathology / Agricultural Research at Virginia State University, located in Petersburg, Virginia. We'll miss them both and wish them well in their new positions.



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