

Funding Generations of Progress  
Through Research and Scholarships

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## BACKGROUND

Ethylene ( $C_2H_4$ ) is an odorless, colorless gas that is produced by both biological (i.e. plants) and non-biological sources. It is a plant hormone, which means that it is produced by plants and affects growth and development even at very low concentrations. Ethylene plays a role in seed germination, adventitious rooting, fruit ripening, leaf shedding, leaf yellowing and flower death (i.e. senescence). The most common source of ethylene contamination in the greenhouse is malfunctioning heating units. Incomplete combustion of organic fuels can result in the production of carbon monoxide, ethylene and other byproducts. Because it is a gas, ethylene can easily move throughout the greenhouse. Ethylene from heaters,  $CO_2$  burners, or any combustion engines can accumulate to damaging (i.e. biologically active) concentrations in greenhouses, especially in tight structures and during the winter months when there is little ventilation (Jones and Ling, 2012).

The best way that growers can determine if they have ethylene contamination in their greenhouse is to know which plants are sensitive to ethylene and carefully monitor them for symptoms of damage. Symptoms of ethylene damage include accelerated flower wilting or leaf yellowing, shedding of leaves or petals, abnormal or stunted growth, and leaf epinasty. Indicator plants can be used in the production greenhouse to help identify symptoms of ethylene contamination before other plants are damaged. An indicator plant should be one that is very sensitive to ethylene so that symptoms are observed at low concentrations of ethylene and after very little exposure time. Tomatoes are often used as indicator plants, because when they are exposed to ethylene they exhibit downward curvature of the leaf petiole, which is referred to as epinasty. Tomatoes are very sensitive to ethylene and the symptoms of epinasty are very clearly observed.



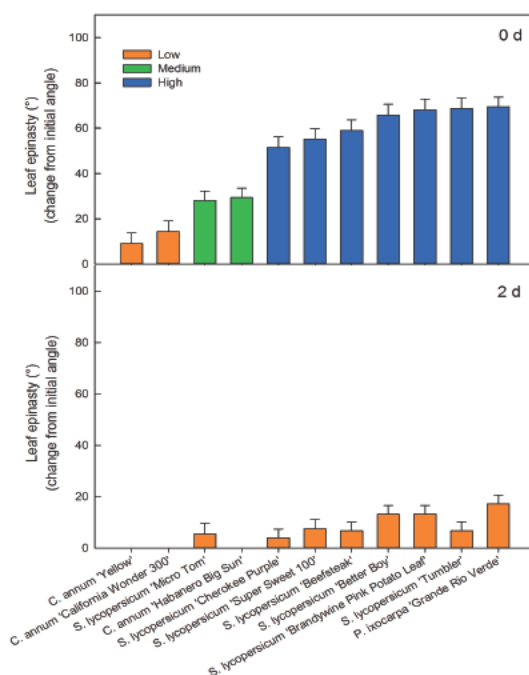
*Figure 1. Tomatoes are a good indicator plant because they exhibit epinasty (downward bending of the leaves) when exposed to ethylene (plant on the right). They can be placed in the greenhouse near heaters and other equipment that might produce ethylene in the greenhouse.*

## MATERIALS & METHODS

Forty different plants from the family Solanaceae (Table 1; Edelman and Jones, 2014) were grown from seed in the OARDC greenhouses in Wooster, OH. Plants at different developmental stages were enclosed in chambers and treated with 0 or 10 ppm ethylene gas (in the dark at 23° C). Plants were removed from the chambers after treatment with the various concentrations of ethylene for 24 hours. Initial leaf angles were measured for each plant before treatment. Leaf angles were measured at 0 (immediately upon removal from the ethylene), 1, 2, 5 and 7 days after treatment to determine the degree of leaf epinasty and time to recovery. The degree of leaf epinastic curvature was obtained by measuring the angle between the stem and the top of the petiole for the bottom six leaves from each plant. Ethylene sensitivity classifications were as follows: no response = 0° change from initial leaf angle; low = 1 to 20°; medium = 21 to 40°; high = greater than 40°.

## RESULTS

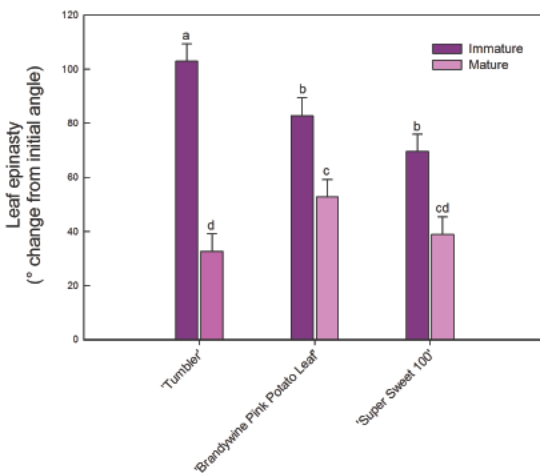
Previous experiments (Edelman et al., 2014) identified tomatoes as one of the most ethylene sensitive bedding plants. Tomatoes exhibit very visual symptoms of leaf curvature or epinasty when exposed to low concentrations of ethylene. This experiment was conducted to determine how ethylene sensitivity and symptoms varied within the family Solanaceae. One of the objectives was to identify the best plants to use as indicator plants to detect ethylene contamination in the commercial greenhouse. Nicotiana species, petunias, calibrachos, and eggplants showed symptoms of flower damage (i.e. shedding or wilting), but did not show signs of leaf epinasty (Edelman and Jones, 2014). Tomato, pepper, and tomatillo plants exhibited leaf epinasty, which varied in severity following exposure to 10 ppm ethylene (Figure 2).



**Figure 2. Leaf epinasty in mature plants at 0 days (top) and 2 days (bottom) after removal from 10 ppm ethylene.**

The peppers (*Capsicum annum*) ‘Yellow Bell’ and ‘California Wonder 300’ were less sensitive to ethylene and epinastic curvature was below 20° degrees at 0 days (immediately after removal from 10 ppm ethylene). *C. annum* ‘Habanero Big Sun’ was more sensitive and receive a medium rating. All of the tomatoes were considered to have high ethylene sensitivity, with epinastic curvature greater than 40°, except for ‘Micro Tom’. The tomatillo (*Physalis ixocarpa*) ‘Grande Rio Verde’ exhibited epinasty that was similar to the most sensitive tomatoes. The leaves started to recover and leaf angles returned to within 10° of the original angles in all the plants by 2 days after the treatment (Figure 2). The plants evaluated in figure 1 were all mature plants that had 4 or more flowers. This stage was used in these evaluations so that symptoms of flower damage could also be assessed following ethylene treatment and these results can be found in Edelman and Jones, 2014.

Vegetable transplants are often sold before they are flowering, so we compared ethylene sensitivity in mature tomato plants and immature plants that were not flowering. In all three varieties the epinastic curvature was higher in the immature plants, indicating that the younger plants were more sensitive to ethylene (Figure 3).



**Figure 3. Effect of plant age or maturity on ethylene sensitivity. Leaf epinasty was determined at 0 days in mature flowering plants that were 8 to 9 weeks old and immature plants that had no flowers and were 4 to 5 weeks old. Bars represent the average change in the leaf angle and error bars represent the SE. Bars with different letters are significantly different.**

## CONCLUSIONS

Once ornamental plants lose their flowers due to abscission (i.e. shedding) or senescence (i.e. wilting) they are no longer marketable. While most will reflower, this takes time. Symptoms of epinasty can be observed very early, while concentrations of ethylene are low. Once the ethylene is removed, even very extreme curvature returns to normal growth within a few days. Tomatoes are the best plants to use as indicators of ethylene contamination because the plants are very sensitive to ethylene, the symptoms of epinasty are very easy to

observe in a crowded greenhouse, and plants will easily recover from the symptoms once ethylene is removed. Common cultivars like 'Brandy Wine' and 'Better Boy' show easily observable symptoms at low concentrations of ethylene and very severe symptoms at 10 ppm. Young plants are more sensitive than mature plants, so indicator plants should be replaced with younger plants before they flower.

### **IMPACT TO THE INDUSTRY**

Ethylene contamination in the production greenhouse can cause devastating crop damage if it goes undiagnosed. The use of ethylene indicator plants is a very easy way for growers to identify when they have ethylene contamination in the greenhouse. Symptoms of epinasty on tomatoes should be observed while concentrations of ethylene are still low and damage to other plants can be prevented.

### **PUBLICATIONS**

Edelman N.F, Kaufman B.A. and M.L. Jones (2014) Comparative evaluation of seedling hypocotyl elongation and mature plant assays for determining ethylene sensitivity in bedding plants. HortScience 49:472-480.

Edelman N.F, and M.L. Jones (2014) Evaluating ethylene sensitivity within the family Solanaceae at different developmental stages. 49:628-636.

Jones M.L. and P. Ling (2012) Preventing ethylene damage in the production greenhouse. Greenhouse Management 31 (11; Nov) 45-49.

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