PART 2

Postproduction of bedding plants:
A FOCUS ON ETHYLENE

SOME BEDDING PLANT SPECIES CAN BENEFIT FROM THE ETHYLENE INHIBITOR 1-MCP. ETHYLENE SENSITIVITY VARIES WITH PLANT GENETICS, HEALTH, NUTRITION AND ENVIRONMENT.

By Polyxeni (Cheni) Filios and William B. Miller

In part one of this postproduction series, we explored the potential detrimental effects of ethylene exposure on bedding plants. In this part we will take an in-depth look at the effects of ethylene on 20 bedding plant species and the benefits of protecting plants with the ethylene inhibitor 1-methylcyclopropene (1-MCP).

The sensitivity to exogenous ethylene and efficacy of a sprayable formulation of 1-MCP (AFxRD-038, 3.8 percent w/w active 1-MCP; AgroFresh Inc. Springhouse, Pa.) of 73 commercially available cultivars from 20 species of annual bedding plants was investigated. This sprayable formulation of 1-MCP is not currently labeled for use on ornamental plants and is restricted to fruit crops apples, pears, kiwifruit, walnuts, tomatoes and peppers (Harvista) and field crops corn, soybean, cotton, sunflower, wheat and rice (Invinsa). Previous experiments have shown that bedding plants treated with comparable rates of sprayable and gaseous 1-MCP show no difference when exposed to 1-ppm ethylene overnight (data not shown).

Experimental Design

Plants were grown from seed or vegetative cuttings, transplanted into 4-inch pots and were pinched to encourage compact growth without the use of plant growth regulators (PGRs). Plants were grown following standard growing practices (e.g. water and fertility) in a glass greenhouse at 68° F and ambient light at Cornell University in Ithaca, N.Y.

Plants were cleaned to remove older flowers and leaves approximately one week prior to ethylene experiments, ensuring only young flowers were present when experiments started. Plants were selected at market stage with enough foliage to cover the growing media in the container and a minimum of six open flowers.

The 1-MCP was applied to runoff (about 2 quarts per 100 square feet) with a hand pump sprayer at a rate of 0 or 25 ppm and allowed to dry. After 1-MCP treatment, species of plants prone to expressing senescence as flower and bud abscission were sleeved. In genera not prone to flower abscission, plants were not sleeved before ethylene treatment.

Plants were then moved into an ethylene-free growth chamber at 70° F and placed into 0.4-cubed-meter plexiglass boxes with two small fans mounted inside, and boxes were sealed. Air flowing through boxes was either clean air or air containing 1-ppm ethylene. Air flow was set at 10 liters/minute, giving approximately 1.5 air changes per hour. Plants were treated with ethylene for 18 hours in darkness. Immediately after treatment, plants were assessed

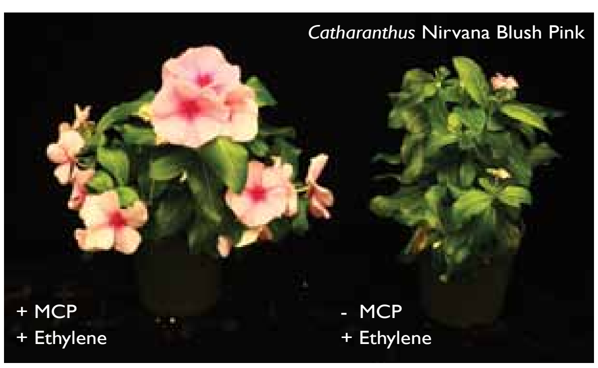

Figure 1. Complete permanent ethylene damage resulting in flower abscission and transient epinasty symptom (right) and complete protection by 1-MCP (left)

Table 1. Summary of the effects of 25-ppm 1-MCP treatment followed by exposure to 1-ppm ethylene for 18 hours on bedding plants.

Chart	Effect of ethylene	Effect of 1-MCP
Angelonia angustifolia	4 - complete permanent damage	complete protection
Begonia x benariensis	4 - complete permanent damage	complete protection
Bidens ferulifolia	1 - no response	n/a
Calibrachoa x hybrida	3 - partial permanent damage	complete protection
Catharanthus rosea	2 - transient symptoms / 4 - complete permanent damage	complete protection
Cleome hassleriana	4 - complete permanent damage	complete protection
Cuphea ramosissima	2 - transient symptoms / 4 - complete permanent damage	partial protection
Diascia barberae	4 - complete permanent damage	complete protection
Heliotropium arborescens	1 - no response	n/a
Impatiens walleriana	2 - transient symptoms / 4 - complete permanent damage	complete protection
Impatiens x hawkeri	2 - transient symptoms / 4 - complete permanent damage	complete protection
Lantana camara	4 - complete permanent damage	complete protection
Lobelia erinus	4 - complete permanent damage	complete protection
Osteospermum ecklonis	1 - no response	n/a
Pelargonium peltatum	4 - complete permanent damage	partial protection
Pelargonium x hortorum Interspecific	4 - complete permanent damage	partial protection
Pelargonium x hortorum Zonal	4 - complete permanent damage	partial protection
Petunia hybrida	4 - complete permanent damage	complete protection
Scaevola aemula	1 - no response	n/a
Solenostemon scutellarioides	2 - transient symptoms / 4 - complete permanent damage	complete protection
Verbena x hyrbida	3 - partial permanent damage	complete protection

Effect of ethylene	Effect of 1-MCP
1 - no response	n/a
2 - transient symptoms	partial protection
3 - partial permanent damage	complete protection
4 - complete permanent damage	

for senescence symptoms including flower abscission, wilting or discoloration, bud abscission, bud abortion and leaf epinasty.

Experiment Results

There were four groups of ethylene sensitivity: 1) no response to ethylene 2) transient ethylene symptoms 3) partial permanent damage and 4) complete permanent damage (Table 1).

Bidens ferulifolia, *Heliotropium arborescens*, *Osteospermum ecklonis* and *Scaevola aemula* proved to be very resistant to ethylene and showed no response to exposure in these treatments.

Leaf epinasty (downward bending of turgid leaves) is considered a transient symptom of ethylene damage because when plants are removed to an ethylene-free environment they will recover and leaves will return to upright position. Epinasty was seen in *Solenostemon scutellarioides*, *Catharanthus rosea*, *Cuphea ramosissima*, *Impatiens x hawkeri* and *I. walleriana*.

Plants exhibiting permanent ethylene damage manifested symptoms of premature flower senescence such as wilting, abscission and bud blast. The majority of ethylene-sensitive plants showed greater than 75 percent of flowers senescing after ethylene treatment (Table 1), the only exceptions to this were *Calibrachoa x hybrida* and *Vebena hybrida*, which exhibited approximately 50 percent flower senescence.

Species showing permanent ethylene damage were split into two groups, those that were completely protected by 1-MCP and those in which 1-MCP provided incomplete protection. Plants that were completely protected by 1-MCP showed no signs of premature senescence when exposed to ethylene, while plants exposed to ethylene without 1-MCP pre-treatment resulted in large losses of flowers and flower buds. *Angelonia angustifolia*, *Begonia x benariensis*, *Calibrachoa x hybrida*, *Catharanthus rosea* (Figure 1), *Cleome hassleriana*, *Diascia barberae*, *Impatiens x hawkeri* (Figure 2), *I. walleriana* (Figure 3), *Lantana camara*, *Lobelia erinus*, *Petunia hybrida* and *Vebena hybrida* are among those which 1-MCP provided complete protection from ethylene damage.

1-MCP provided incomplete protection in *Cuphea ramosissima*, *P. peltatum*, *Pelargonium x hortorum* (Figure 4) interspecific and zonal hybrids, resulting in 1-MCP preventing senescence of approximately 50 percent floral parts when in the presence of ethylene. The majority of plants exhibited ethylene damage as flower and bud abscission and only a few showed symptoms of floral wilting and remaining intact on the plant (*Lobelia*, *Calibrachoa* and *Petunia*).

Notable differences in ethylene sensitivity were seen not only between plants of different genera but also within a genus at the species, series and cultivar level. Geraniums exposed to ethylene (without 1-MCP protection) showed an average flower abscission of 90 percent across two series 'Caliente'

Table 2. *Begonia x benariensis* 'Whopper' series flower senescence (%) following exposure to 1 μl•liter^{-1} ethylene for 18 hours in darkness. Plants were not pretreated with 1-MCP.

Cultivar	Flower senescence (%)
Red Bronze	70
Rose Bronze	63
Red Green	63
Rose Green	**48**

Figure 2. Complete permanent ethylene damage resulting in flower abscission and transient epinasty symptom (right) and complete protection by 1-MCP (left)

Figure 3. Complete permanent ethylene damage resulting in flower abscission and transient epinasty symptom (right) and complete protection by 1-MCP (left)

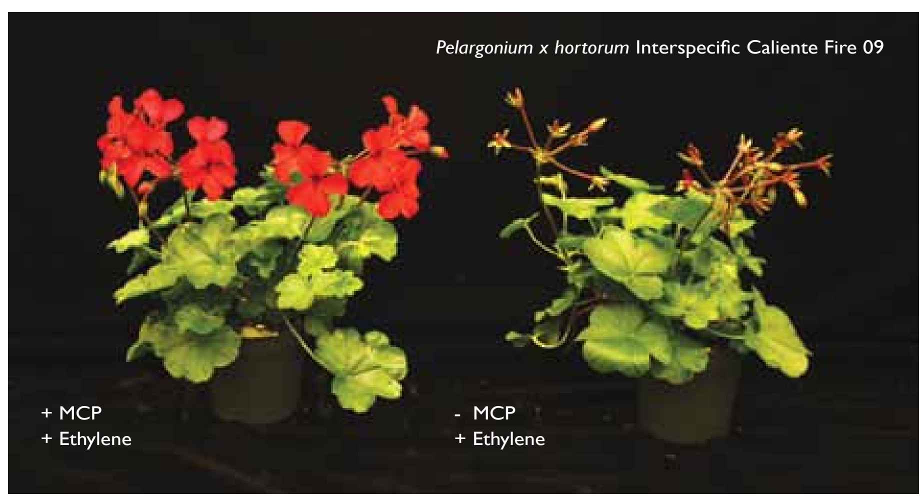

Figure 4. Complete permanent ethylene damage resulting in flower abscission (right) and partial protection by 1-MCP (left)

and 'Pinto Premium' while *P. peltatum* 'Contessa Sybil' was significantly less sensitive to ethylene with only 38 percent flower abscission. *Impatiens walleriana* series 'Tumbler' ranged in flower abscission from 68 to 98 percent while 'Accent Premium' series ranged from 83 to 100 percent abscission. *Begonia x benariensis* 'Whopper Rose Green' was the least sensitive to ethylene exposure showing 48 percent abscission whereas 'Red Bronze', 'Rose Bronze' and 'Red Green' abscissed 63 to 70 percent of flowers (Table 2).

Conclusion

Ethylene sensitivity is affected not only by genetics but also plant health, nutrition and environmental conditions. Exposure to stress will increase ethylene sensitivity and can increase internal production of ethylene. Genetic differences in ethylene sensitivity are likely to be greatest between genus and species of plants, but differences can even exist within a series. This is not unexpected, as most bedding plants are not specifically selected for ethylene resistance. It is recommended for growers to monitor crops that they suspect to be ethylene sensitive for senescence symptoms during postproduction shipping and handling. Other cultivars of a species may be less susceptible to ethylene and could be suitable for production.

EthylBloc (Floralife Inc., Walterboro, S.C.) and Ethylene Buster (Crysal Americas, Miami, Fla.) are currently the only commercially available 1-MCP products registered for use on ornamental plants. These gaseous 1-MCP products are available in multiple formats for use in contained environments such as trucks, storage rooms, coolers and individual boxes. Our work shows 1-MCP is effective in protecting plants from external and internal ethylene for approximately four days after application. Crops that are susceptible to ethylene and could potentially be exposed to ethylene in shipping and handling would benefit from postproduction 1-MCP treatment before they are loaded into shipping boxes, carts or trucks.

A sprayable formula allows for 1-MCP application immediately before packing and shipping; it is effective and rainfast within minutes of application and growers can target ethylene susceptible crops rather than needed to treat entire shipping containers. We are hopeful that this sprayable 1-MCP technology will be registered and available for use on ornamental flower crops soon. Additional figures for this article can be seen online at www.gpnmag.com. g

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