

## Sensitivity of potted ornamental peppers to ethylene<sup>(1)</sup>

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### ABSTRACT

Many environmental factors affect the post-production shelf life of potted ornamental plants. Exposure to ethylene can reduce the quality of many species, inducing flower, fruit and leaf abscission and senescence. The present study identified ethylene-resistant pepper genotypes during post-production shelf life testing. Potted plants of eleven pepper cultivars were transferred to a 90-L sealed container when they had 30% of ripe fruits and treated with 10  $\mu\text{L L}^{-1}$  of ethylene for 48 hours. Number of leaves and fruits were counted at the beginning of ethylene exposure and after 48, 96 and 144 hours. The experimental design was completely randomized, with five replicates of individual pots. The cultivars showed varied rates of foliar and fruit abscission. 'Peloteira' showed higher resistance to ethylene, with foliar abscission of 19%, after 144 hours. For fruit abscission, the cultivars 'Peloteira', 'Jalapeño', 'Stromboli ornamental', 'Malagueta' and 'Rocoto Vermelha' presented a lower percentage of leaf drop, varying between 9 and 34%, after 144 hours of exposure to ethylene. This study showed that ornamental peppers have high genetic diversity regarding ethylene sensitivity.

**Keywords:** *Capsicum*, growth regulator, leaf and fruit abscission, ornamental plant.

### RESUMO

#### Sensibilidade ao etileno em pimenta em vaso

Muitos fatores ambientais afetam a fase de pós-produção das plantas ornamentais. A exposição ao etileno é um dos fatores mais importantes que afetam a qualidade de muitas plantas ornamentais em vaso. O trabalho teve como objetivo identificar genótipos de pimenta resistentes ao etileno na fase de pós-produção das pimentas de vaso. Onze cultivares de pimentas foram utilizadas, quando as plantas apresentaram 30% dos frutos maduros, foram transferidas para um recipiente hermético de 90 L e tratados com etileno à 10  $\mu\text{L L}^{-1}$  por 48 horas, em seguida, mantidas à temperatura ambiente para posterior análise dos efeitos do etileno. Foram feitas contagens do número de folhas e frutos no tempo zero, 48, 96 e 144 horas após o tratamento com etileno. O delineamento experimental utilizado foi inteiramente casualizado, com cinco repetições. As cultivares apresentaram taxas variadas de abscisão foliar e de frutos. O cultivar 'Peloteira' apresentou maior resistência ao etileno, com abscisão foliar de 19%, após 144 horas. Para característica abscisão dos frutos, os cultivares 'Peloteira', 'Jalapeño', 'Stromboli ornamental', 'Malagueta' e 'Rocoto vermelha' apresentaram menor porcentagem de abscisão, variando entre 9 e 34%, após 144 horas de exposição ao etileno.

**Palavras-chave:** *Capsicum*, regulador de crescimento, abscisão de folhas e frutos, plantas ornamentais.

## 1. INTRODUCTION

Peppers are an important part of Brazilian plant biodiversity with a large number of varieties that differ in type, color, size, and flavor (PEREIRA and RODRIGUES, 2005; NASCIMENTO et al., 2012). Pepper fruits usually have a spicy taste, although there are also sweet peppers with low heat index (PICKERSGILL, 1997). Peppers can be consumed fresh, boiled or dehydrated, at an immature or mature stage, or in the form of sauces and jams (FINGER and PEREIRA, 2016). Recently, the use of peppers as potted ornamental plants with fruit that can also be consumed has increased, becoming another way to increase the financial return to farmers (FINGER et al., 2012; RÊGO and RÊGO, 2016).

The search for new ornamental products has increased over the past years (SCHOELLHORN, 2009). In particular, the demand for ornamental peppers has grown both domestically and internationally (FINGER et al., 2015). Sales of decorative peppers in Brazil are still limited to free markets and some supermarkets, but the situation is changing, and more consumers are able to buy peppers in flower shops (RÊGO and RÊGO, 2016). The many colors of the fruits, which attractively contrast with the foliage (MELO et al., 2014), and the durability, cost benefit and easy handling of the plants add value to ornamental peppers (JUNQUEIRA and PEETZ, 2014).

During post-production phase the plants are exposed to many environmental stresses during shipping and sales, where the plants are subjected to low light, high

DOI: <http://dx.doi.org/10.14295/oh.v24i4.1458>

<sup>(1)</sup>Received in 29/08/2018 and accepted in 20/09/2018

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temperatures and mechanical injuries (HOYER, 1996). Such stressful conditions increase ethylene synthesis and action (MAYAK et al., 2004; SIDDIKEE et al., 2011). When plants are exposed to ethylene, sensitive flowers and leaves will abscise or senesce (WOLTERING, 1996). The negative effects of ethylene on sensitive varieties are one of the main factors limiting the commercialization of ornamental peppers (SEGATTO et al., 2013).

Therefore, the objectives of this work were to evaluate the sensitivity of eleven potted pepper cultivars to the effect of ethylene under simulated shipping or marketing.

## 2. MATERIAL AND METHODS

### Conducting the experiment

Ten commercial cultivars of *Capsicum*: 'Pérola negra' and 'Jalapeño' (*Capsicum annuum*); 'Malagueta', 'Tabasco', 'Stromboli ornamental', and 'Pirâmide ornamental' (*Capsicum frutescens*); 'Rocoto vermelha' (*Capsicum pubescens*); 'Dedo de moça' (*Capsicum baccatum*), 'Bode vermelha' and 'Biquinho vermelha' (*Capsicum chinense*), and one *Solanum*: 'Peloteira' (*Solanum pseudocapsicum*) were grown in a greenhouse.

Seeds were sown in 200 cell polystyrene trays containing commercial substrate. When the seedlings had four pairs of leaves, one single plantlet was transplanted into a 700 ml pot number 13 (10 cm in height, 9 cm in basal diameter and 12 cm in diameter).

### Ethylene treatment

When plants reached the stage of 30% of full ripe mature fruits, plants were evaluated for sensitivity to ethylene according to Segatto et al. (2013). Pots were placed in 90-liter sealed chambers in the dark simulating stress conditions during transport or storage, and then exposed to 10  $\mu\text{L L}^{-1}$  of ethylene for 48 hours.

Plant quality and longevity were determined after the ethylene treatment, when the pots were transferred to a room simulating the interior conditions of stores, supermarkets and homes of the final consumers at  $25 \pm 1$  °C, 8-10  $\mu\text{mol s}^{-1} \text{m}^{-2}$  of white fluorescent light, and RH 60-65% and watered when necessary. Percentages of leaf (LA) and fruit abscission (FA) were recorded every two days.

### Statistical analysis

The experimental design was completely randomized, with five replicates. The quantitative data were submitted to analysis of variance, with averages grouping by the Skott-Knott criterion at 1% probability. Statistical analyzes were performed through the Genes computational program (CRUZ, 2013).

## 3. RESULTS AND DISCUSSION

Significant differences ( $p < 0.01$ ) occurred among the pepper cultivars for leaf and fruit abscission (data not shown), which means that there is genetic variability among the tested cultivars studied that can be exploited in pepper breeding programs.

After 48 hours untreated control plants showed variable rates of foliar abscission among the cultivars. The genotypes were grouped into three distinct classes according to the Skott-Knott criteria. 'Peloteira' (*Solanum pseudocapsicum*) and 'Malagueta' (*C. frutescens*) had the lowest leaf abscission, 6 and 17%, respectively, after 48 exposure to ethylene (Table 1). The cultivars 'Pérola negra' (*C. annuum*), 'Jalapeño' (*C. annuum*) and 'Biquinho vermelha' (*C. chinense*) showed the highest percentage of foliar abscission, 69, 65 and 98%, respectively, after 48 hours exposure to ethylene (Table 1) (Figure 1).

**Table 1.** Percent leaf abscission (LA) and fruit abscission (FA) for eleven pepper cultivars after 48, 96 and 144 hours exposure to ethylene.

Cultivars	48 hours		96 hours		144 hours	
	LA	FA	LA	FA	LA	FA
Pirâmide ornamental	42 b	55 a	49 b	60 a	67 b	62 a
Pérola negra	69 a	33 a	84 a	36 b	93 a	49 a
Dedo de moça	53 b	31 a	77 a	43 a	94 a	49 a
Bode vermelha	39 b	38 a	54 b	56 a	61 b	58 a
Peloteira	6 c	6 b	11 c	8 b	19 c	9 b
Jalapeño	65 a	2 b	79 a	24 b	91 a	31 b
Biquinho vermelha	98 a	46 a	100 a	62 a	100 a	63 a
Tabasco	31 b	67 a	71 a	73 a	74 b	74 a
Stromboli ornamental	49 b	11 b	78 a	20 b	91 a	26 b
Malagueta	17 c	18 b	72 a	33 b	84 a	35 b
Rocoto vermelha	39 b	15 b	88 a	15 b	93 a	36 b

Means with the same letter in the column do not differ significantly by the Scott-Knott test at 1% probability



**Figure 1.** Effect of ethylene on: A1 - 'Pérola Negra' (*C. annuum*), A2 - 'Jalapeño' (*C. annuum*) and A3 - 'Biquinho Vermelha' (*C. chinense*) cultivars. A - before treatment with ethylene; B - 48 hours after exposure to ethylene.

Remaining cultivars had intermediate rates of foliar abscission. Similarly, Lima et al. (2017), evaluating two cultivars of *C. annuum*, reported that cultivar 'MG 302' showed intermediate sensitivity to ethylene, while 'Calypso' showed complete leaf abscission when exposed to ethylene. Segatto et al. (2013), evaluating four *C. annuum* ornamental peppers genotypes, reported that ethylene also elicited a severe leaf abscission in plants of the 'Calypso' cultivar after being exposed to  $10 \mu\text{L L}^{-1}$  of ethylene for 48 hours. This demonstrates genetic variability within the same species as has been discussed by Serek et al. (2006).

According to Rêgo et al. (2015), in developing new cultivars, it is important to select genotypes that have specific characteristics, such as rapid growth, adequate architecture for commercialization, resistance to aging and extended post-production shelf life. Hybridization between contrasting genotypes produces extremely

heterogeneous progeny, which may result in the production of cultivars with higher tolerance to ethylene (OLSEN et al., 2015).

Leaf abscission increased at 96 and 144 hours after the exposure to ethylene. The cultivars were grouped in three distinct classes; 'Peloteira' had the lowest sensitivity to ethylene, with foliar abscission of 11 and 19%, respectively, over time (Table 1) (Figure 2).

On the other hand, the exposure of 'Biquinho Vermelha' to  $10 \mu\text{L L}^{-1}$  of ethylene induced the abscission of 100% of leaves at 96 and 144 hours (Figure 3). The remaining cultivars had intermediate foliar abscission. Nascimento et al. (2015) evaluated two genotypes of peppers and two simple hybrids, showing different ethylene sensitivity levels, where the '76 x BP' and 'DR x BP' hybrids presented lower sensitivity to ethylene, less than 50% foliar abscission, 144 hours after exposure to ethylene.





**Figure 2.** Effect of ethylene on 'Peloteira' cultivar (*S. pseudocapsicum*). A - before treatment with ethylene; B - 144 hours after exposure to ethylene.



**Figure 3.** Appearance of the 'Biquinho Vermelha' pepper cultivar (*C. chinense*). A - before treatment with ethylene, B - after treatment with ethylene for 144 hours.

The sensitivity of ornamental plants to ethylene is generally established at family level, but there can be marked differences between species and cultivars (SEREK et al., 2006; CORDEIRO et al., 2011). Santos et al. (2013) found variation for resistance to ethylene in a segregating population ( $F_2$ ) of ornamental pepper *C. annuum* ranging from genotypes that were totally sensitive to ethylene to others that were resistant. Commercially, cut stems of peppers with a high degree of sensitivity to ethylene for foliar abscission, but resistant to fruit abscission, would be important in the making of bouquets, as an alternative form of commercialization of ornamental peppers. On cut

stems, growers often have to manually remove the foliage to improve the presentation of the fruit and ethylene could be used to make this laborious process easier.

Regarding fruit abscission, the cultivars were divided into two distinct groups at 48, 96 and 144 h. The cultivars 'Peloteira', 'Jalapeño', 'Stromboli ornamental', 'Malagueta' and 'Rocoto' exhibited lower fruit abscission (Table 1). The other cultivars presented more than 30% of abscission of the fruits, making it unviable to commercialize as ornamental plants. The efficacy of ethylene on the abscission of the pepper fruit depends on the exposure period, concentration, temperature, and

stage of development and sensitivity of species or varieties (Finger et al., 2015). Brown (1997) adds that the different intensities of fruit abscission in response to ethylene may be related to the increase of ethylene.

Physiological responses to the presence of ethylene in fruits and ornamental plants require that the organs have receptors to allow binding of ethylene molecules (SEREK et al., 2006). In cultivars of ornamental peppers sensitive to ethylene, the application of ethylene action inhibitors, silver ion or 1-methylcyclopropene, prolong shelf-life (FINGER et al., 2017; LIMA et al., 2017) by binding to the receptors, making them a useful option to maintain the plant quality during transport and marketing to the final consumer. Therefore, the use of inhibitors of ethylene synthesis or action should be tested to increase the post-harvest life of the peppers.







#### 4. CONCLUSIONS

Ethylene sensitivity is an important factor that affects the commercialization of peppers, since the harmful effects caused by ethylene decrease the quality and the shelf life of ornamental plants (FINGER et al., 2012). The incorporation of resistance genes into new cultivars will improve the longevity of ornamental plants (FINGER et al., 2015). This study showed that ornamental peppers have high genetic diversity regarding ethylene sensitivity. Breeding programs aimed at reducing the response to ethylene can be developed by crossing among resistant genotypes.

#### ACKNOWLEDGMENTS

The authors are grateful for the financial support by CNPq (National Council for Scientific and Technological Development) and CAPES (Coordination for the Improvement of Higher Education Personnel).

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