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# Enhancement of Ornamental Pepper Ripening with Ethephon Sprays or Drenches

**Josh B. Henry[1], Ingram McCall[1], and Brian E. Whipker[1]**

[1] Department of Horticultural Science, North Carolina State University, Raleigh, NC 27606 U.S.A.

**Abstract**
Ethephon can be used to enhance fruit ripening in ornamental peppers. Previous work found ethephon sprays to be an effective method of ripening enhancement; however, ethephon sprays also led to significant fruit abscission and phytotoxicity to the foliage. This study compared the efficacy of ethephon drenches and sprays on an ornamental pepper cultivar. These plants received either a foliar spray or a drench of 75, 150, 300, or 600 mg·L$^{-1}$ ethephon. All plants treated with an ethephon drench and most sprays had more red peppers than the untreated control. Plants that received an ethephon drench of 75 or 150 mg·L$^{-1}$ had higher fruit set compared to untreated plants or sprayed plants. Drenched plants had lower phytotoxicity than sprayed plants or were asymptomatic. In this study, the optimal concentrations of 150 – 300 mg·L$^{-1}$ ethephon applied as a drench resulted in higher fruit set and ripening with lower incidence of phytotoxicity.
***Keywords: Capsicum annuum*, Ethylene, PGR.**

## 1. Introduction

Ornamental peppers (*Capsicum annuum*) are grown for the abundance of brightly colored fruit they produce upon maturation. The immature fruit are typically green, but over time ripen to vibrant yellows, reds, or a variety of other colors. Fruit ripening can be enhanced with applications of ethephon (2-Chloroethylphosphonic acid). Previous studies investigated the effect of ethephon sprays on fruit abscission [1] and ripening of edible peppers [2][3][4]. In these studies, ethephon increased fruit ripening but also caused greater fruit abscission when applied at higher concentrations [3]. Fruit abscission is sometimes beneficial for harvest of edible peppers [4], but is not desirable for ornamental pepper production. Additionally, phytotoxicity and leaf abscission may occur on pepper plants sprayed with ethephon [5], rendering the plants unmarketable.

Although ethephon is typically applied as a foliar spray, ethephon substrate drenches have been of recent interest for floriculture crop production [6]. There is potential to avoid the phytotoxicity symptoms associated with ethephon sprays by applying ethephon to the substrate instead of the foliage. Miller et. al [6] demonstrated that ethephon drenches successfully suppressed plant height without phytotoxicity symptoms developing on the foliage. Applying ethephon as a substrate drench may provide a safer alternative for ornamental pepper growers to enhance ripening and reduce production time. This study was conducted to compare the efficacy of ethephon drenches and sprays on ornamental peppers.

## 2. Materials and Methods

### 2.1 Plant Materials

'Tango Red' ornamental pepper seeds (Fred C. Gloeckner & Co., Inc., Harrison, NY), were sown on 6 April into 1204 flat inserts with cell dimensions of 5.7 x 3.8 x 5.4 cm and propagated in a glass greenhouse at 35°N latitude in Raleigh, NC. The seedlings were transplanted into 14-cm diameter pots (Dillen, Middlefield, OH) with dimensions of 14.0 x 11.4 x 11.1 cm and moved into a polyethylene covered greenhouse for the remainder of the experiment. The plants were fertilized at every irrigation with 13N–0.9P–10.8K mixed at 150 mg·L$^{-1}$ nitrogen.

### 2.2 Treatments and Design

The experiment was completely randomized with nine single plant replicates of each of the nine treatments. Pepper plants were treated on 3 August with either a spray or a drench of 75, 150, 300, or 600 mg·L$^{-1}$ ethephon (Collate; Fine Americas) when ≥75% of the peppers had reached mature size but were still green. Sprays were applied to the

foliage and fruit at a rate of 203.7 $mL \cdot m^{-2}$, and were sprayed to the point of slight runoff. Drenched plants had 88.7 mL of solution applied to the substrate of each pot.

The experiment was terminated 21 days after treatment on 24 August. Peppers were removed from the plants, and the number of green, blushing, red, and abscised peppers was totaled. A phytotoxicity rating was also conducted based on foliar phytotoxicity symptoms. The scale was 0 – 3 with 0 being no damage and 3 being high levels of damage. The highest level of damage consisted of severe chlorosis of the foliage, leaf abscission, and some purple spotting on the leaves. The peppers and remaining shoot tissue were then dried for at least 72 hours at 70°C and used to obtain the dry mass.

### 2.3 Statistical Analysis

Data for pepper coloration, abscission, dry mass, and foliar phytotoxicity were analyzed using SAS (version 9.4; SAS Institute, Cary, NC). Data were subjected to PROC GLM and the least squared means were separated by Tukey's honestly significant differences at $P \leq 0.05$.

## 3. Results and Discussion

### 3.1 Results

Whether a plant was treated with ethephon and the method by which ethephon was applied led to several differences compared to untreated plants. Sprays of 150 – 600 $mg \cdot L^{-1}$ ethephon led to significant levels of fruit abscission, but drenches did not (Table 1). Plants sprayed with 75, 150, and 600 $mg \cdot L^{-1}$ ethephon had more red peppers than untreated plants, while all drench concentrations resulted in higher numbers of red peppers (Table 1). All spray concentrations resulted in fewer green peppers than control plants; however, drenches of 75 – 300 $mg \cdot L^{-1}$ ethephon had similar numbers of green peppers as control plants (Table 1). Although sprays of 150 – 600 $mg \cdot L^{-1}$ ethephon led to significant levels of fruit abscission, all sprayed plants had similar numbers of total fruit as untreated plants (Table 1). Conversely, plants drenched with 150 – 300 $mg \cdot L^{-1}$ ethephon had significantly more peppers than control plants (Table 1).

Table 1. Mean number of peppers of each color from each ethephon treatment, as well as the number of abscised peppers.

| Application method | Ethephon concentration ($mg \cdot L^{-1}$) | Number of peppers | | | | |
|---|---|---|---|---|---|---|
| | | Total | Green | Blushing | Red | Abscised |
| Control | 0 | 38.1bc[1] | 15.1a | 7.7abc | 15.3b | 0.0d |
| Spray | 75 | 34.7c | 2.1b | 5.6bcd | 24.2a | 2.8bcd |
| | 150 | 36.4c | 0.9b | 4.4cd | 25.2a | 5.9a |
| | 300 | 30.4c | 0.3b | 4.4cd | 20.8ab | 4.9ab |
| | 600 | 31.0c | 0.1b | 2.4d | 25.2a | 3.2abc |
| Drench | 75 | 45.8ab | 13.7a | 9.6ab | 22.6a | 0.0d |
| | 150 | 47.4a | 11.4a | 9.9ab | 25.0a | 1.1cd |
| | 300 | 49.4a | 10.9a | 11.1a | 25.9a | 1.6cd |
| | 600 | 37.4bc | 4.6b | 7.2abc | 23.7a | 2.0cd |

[1] Lower case letters signify minimum significant differences within columns. Means with different letters were significantly different at $P \leq 0.05$.

The total quantity of pepper dry mass was also significantly affected by ethephon treatment. All plants that received an ethephon drench had similar total pepper dry mass to untreated plants (Fig. 1). All plants treated with a spray had lower pepper dry mass compared to untreated plants (Fig. 1). Plants that received a drench had phytotoxicity ratings that were not significantly greater than that of the asymptomatic control (Fig. 1). In fact, the majority (>50%) of

drenched plants were completely asymptomatic. The only symptoms that occurred on drenched plants included some chlorotic spotting on the foliage. The phytotoxicity rating increased with increasing spray concentrations, with uniformly high symptoms observed on all plants (Fig. 1). Phytotoxicity symptoms were present on all sprayed plants (Fig. 2).

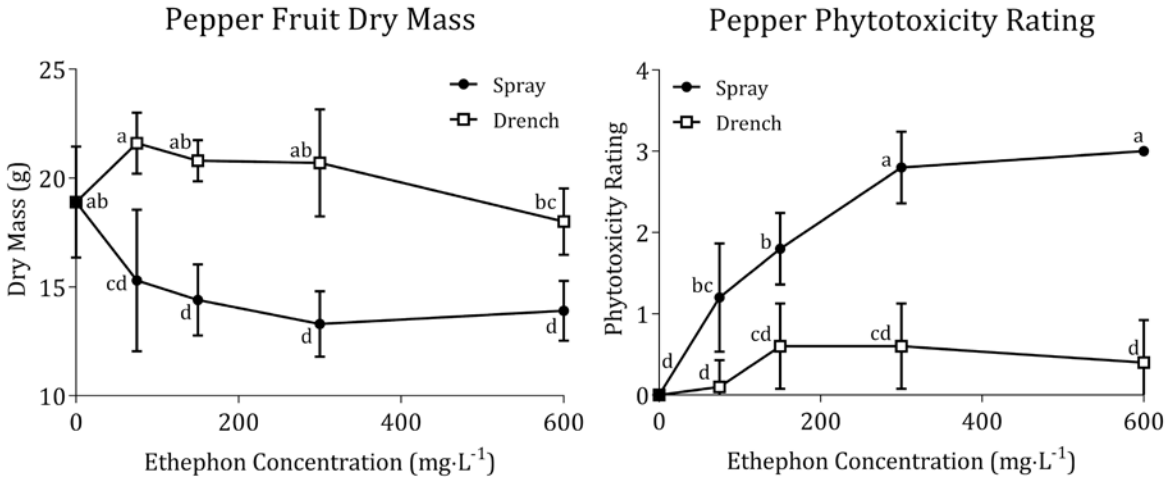


Figure 1. Pepper fruit dry mass (left) and phytotoxicity rating (right) with significant differences indicated among all treatments. Points with different lower case letters were significantly different at $P \leq 0.05$.

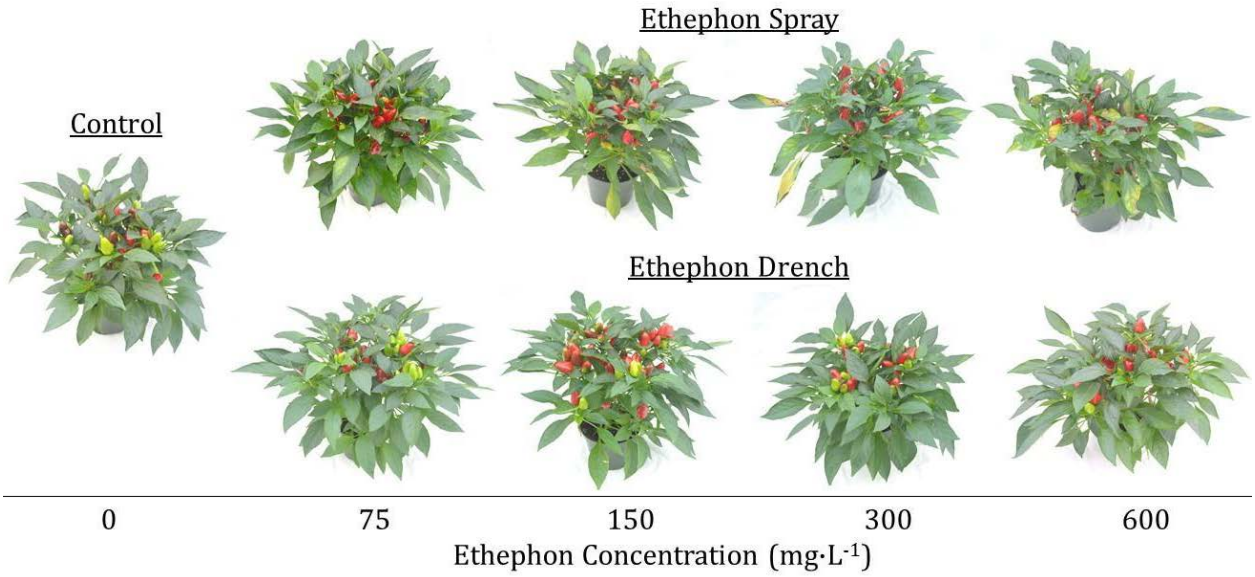


Figure 2. Representative pepper plants from each ethephon treatment compared with the untreated control plant. Phytotoxicity symptoms were observed on all sprayed plants.

## 3.2 Discussion

One of the most unexpected findings from this study was that moderate concentrations of ethephon applied as a drench appeared to enhance not only the number of red fruit, but also the total number of fruit compared to untreated plants. This indicates that ethephon drenches may stimulate fruit set. A benefit to consumers is that ornamental pepper plants drenched with ethephon may have more red fruit at the time of purchase, with additional green and blushing fruits to potentially extend the color for a greater period of time. The optimal ethephon drench concentrations determined from this study were 150 – 300 mg·L$^{-1}$. These concentrations did not result in significant fruit abscission or phytotoxicity to the foliage, and led to higher numbers of red peppers with increased overall fruit

set. This indicates that ethephon drenches can be successfully used by growers to produce ornamental peppers and may be a superior alternative to ethephon sprays.

Previous work investigating ethephon substrate drenches found some negative side effects of drenches. For instance, Miller et. al [6] found that ethephon drenches led to a delay of flowering in several bedding plant species. Ethephon drenches were also found to cause flower bud abortion and premature floral senescence in some species. None of these issues would be problematic for ornamental pepper production, as ethephon applications are made after anthesis. Additionally, because Miller et. al [6] did not observe any foliar phytotoxicity symptoms, and the symptoms observed on the drenched plants in our study were minimal, it may be concluded that ethephon drenches maintain many of the desired effects of an ethephon spray without the same magnitude of undesirable side effects.

## 4. Conclusions

Using ethephon enables ornamental pepper growers to reduce the total crop time by enhancing fruit ripening. Ethephon drenches resulted in the development of similar numbers of red peppers as ethephon sprays, without the severity of phytotoxicity and fruit abscission. Further studies should investigate drench application timing to optimize ethephon treatments and develop recommendations that may be applied to commercial production practices. There are currently no ethephon products registered for use in greenhouses as a drench. Therefore, these results should be considered experimental.

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