Growth Regulator Effects on Ethylene Production from Calamondin Flowers

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Abstract. Ethylene production by senescing calamondin (Citrus madurensis Lour.), at rates as high as 15 ml/g fresh weight-hour did not necessarily induce abscission. Moreover, combinations of gibberellic acid (GA), calcium dihydrophosphate and 6-benzylamino purine (BA), which are known to increase fruit set, did not significantly decrease ethylene production. Abscission of calamondin fruitlets and increases in fruit set appear to be independent of ethylene production.

Low concentrations of GA and 2,4-dichlorophenoxyacetic acid (2, 4-D) increase fruit set or delay abscission of navel orange (20) and other citrus cultivars (10, 11, 18, 21). Combinations of GA with BA and calcium dihydrophosphate increased fruit set of navel orange in some years (20), and GA+BA as a coating agent (19). In addition, GA and 2, 4-D stimulate ethylene production in plant tissues (3, 8, 13, 15). Greater amounts of ethylene (g/fresh wt hr) were produced from younger fruit than from fruit at later stages of development in citrus (7, 9). Ethylene induced or accelerated abscission of mature citrus fruit (5, 6) but failed to cause similar responses in young citrus fruit (9). Ethylene has been associated, however, with premature flower abscission of apple and cherry (2). The objective of this study was to determine whether growth regulators that increase citrus fruit set do so by affecting ethylene production.

Calamondin is uniquely suited to flowering and fruit-set studies because it can be induced to flower at any time of the year by withholding water and nitrogen. Flowers also respond to growth regulators in a fashion similar to other citrus species (12), thus providing a convenient test plant for fruit set studies.

Three-year-old calamondin plants were transferred from the nursery to 20 cm plastic pots containing sand: pine bark: peat (1:1:1 v/v) plus macro- and micronutrients. Plants were fertilized biweekly with approximately 12 g per 3.8 liters of 20N:8.6P:16.6K water-soluble fertilizer and micronutrients. Plants were induced to flower after about a month-long period of acclimation to greenhouse growing conditions.

Ethylene determinations were made at various flower developmental stages. Flowers were collected and placed into one of four groups: 1) closed flowers that would open in 24 to 48 hr; 2) opening flowers with a visible stigma and free but not recurved petals; 3) senescing flowers with brownish, recurved petals, water-soaked flaccid stamens, and a yellow-green ovary; and 4) fruitlets without flower parts persisting. Flowers were collected from each of 3 trees for each developmental stage. Flowers and fruitlets were clipped with 1.0 to 2.0 mm of the pedicel attached and put into 19.8 ml glass vials. A serum rubber stopper was used to seal the open end of the vial. Ethylene levels were determined following 2- and 6-hr incubation periods at 25°C. One ml gas samples were withdrawn from each container into a disposable plastic syringe and injected into a Hewlett-Packard 5710A gas chromatograph equipped with a flame ionization detector and a stainless steel, 1 x 6.35 mm ID column packed with activated alumina. Flow rate of nitrogen carrier gas was 75 ml/min and oven temperature was 100°C.

Five terminal leafy inflorescences per treatment, each borne on a different plant, were randomly selected and dipped for 10 sec into growth regulator solutions (see Table 1 for materials and concentrations). Growth regulators were dissolved in distilled water and 0.1% X-77 adjuvant. Flowers were allowed to dry before they were clipped from the plant and put into 19.8 ml shell-vials. Excised flowers were incubated for an hour in the dark at 25°C. Ethylene was collected at hourly intervals up to 8 hr after sealing the vial with a serum rubber stopper for an hour. A 1 ml gas sample was withdrawn from each vial as described previously; thereafter, vials were opened, flushed with air and reincubated in the dark at 25°C until the next hourly incubation.
Table 2. Ethylene production from excised calamondin flowers during varying stages of development.\(^2\)

<table>
<thead>
<tr>
<th>Development stage</th>
<th>Ethylene production (nl/g fresh wt/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed</td>
<td>trace (^b)</td>
</tr>
<tr>
<td>Opened</td>
<td>0.43b</td>
</tr>
<tr>
<td>Senescing</td>
<td>14.92a</td>
</tr>
<tr>
<td>Ovary only</td>
<td>0.22b</td>
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</tbody>
</table>

\(^2\)Calamondin flowers were collected April 1, 1980; 3 flowers of each developmental stage were collected from each of 3 trees. \(^\)Means separation by Duncan’s multiple range test, 5% level.

collection period. Ethylene level was determined as in the previous experiment. Experiments were performed at least twice.

Ethylene levels were greatest in senescing calamondin flowers (Table 2); however, these levels did not necessarily induce fruit abscission. Similar levels of ethylene have been observed from developing navel orange flowers (19), further supporting the use of calamondin as a fruit-set test species for citrus. Cooper (4) observed comparable ethylene production by various combinations did not significantly decrease ethylene production from calamondin flowers in either 1979 (data not shown) or 1980 (Table 1). Neither Promalin (GA\(_{4+7}\) + BA nor a GA + BA + 2, 4-D combination affected ethylene production (Table 1). In contrast, GA\(_{4+7}\) + BA did increase ethylene production and decreased fruit set of apple (8). Furthermore, incubation time had no significant effect on ethylene levels. These data indicate that increases in fruit set following growth regulator application (20) probably do not result from direct control of ethylene production. Similarly, Rahemi and Dennis (17) concluded that aminoethoxyvinylglycine (AVG) and ethephon increased initial fruit set in ‘McIntosh’ apple independently of ethylene action. Lewis et al. (14) and Ismail (9) observed a lack of abscission response to ethylene in young citrus fruit. This lack of response has been attributed to the developmental stage of the abscission process in beans (1). Effectiveness of GA, 2, 4-D, BA and BA + GA mixtures as fruit-setting agents for calamondin appear to be independent of ethylene levels.

Literature Cited