tions and was essentially eliminated in treatments where ethephon was applied first (11).

Plants from blocks 1 and 2 were preferred by all participating growers. They were described as being darker green in color, containing aborted floral structures, and adventitious roots on the stems (Fig. 1). All growers reported plants were more uniform, contained fewer crown-set fruits and resumed growth faster after transplanting than clipped plants from block 4. Tomato yields from 3 hand harvests for the 3 trials in Ohio were not adversely affected by treatment as shown in Table 4.

All spray mixtures effectively controlled stem length (Table 5). Stem and root wt were greatest for plants sprayed with the highest concn of ethephon. Results from these studies indicate that both ethephon and SADH can be combined with maneb and applied in 1 operation.

**Literature Cited**


10. Wilson (16) reports that Release enhances ethylene production in mature 'Valencia' fruit 3 to 5 days after application. There is no information on the ethylene response of mature fruit to Pik-Off and DS-27914 treatments.


**The Effect of Four Abscission Chemicals on Orange Fruit and Leaf Ethylene Production**

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**Abstract.** Four abscission materials were evaluated to determine their effects on ethylene production and abscission of fruit and leaves of orange (*Citrus sinensis* (L.) Osbeck cvs. Hamlin and Valencia): 5-chloro-3-methyl-4-nitro-1H-pyrazole, glyoxal dioxime, cycloheximide, chlorothalonil.

All chemicals enhanced internal fruit ethylene levels and subsequent fruit loosening. However, the magnitude and timing of the fruit ethylene response varied with each chemical and correlated with fruit loosening and subsequent retightening. The pattern of ethylene production may indicate the optimal fruit harvest period and the degree of leaf abscission for each chemical.

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3Mention of a trademark name or a proprietary product does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products that also may be suitable.
mended concn of each abscission-inducing chemical in 15.14 to 37.85 liters of water. (The amount sprayed was determined by the size of the tree.) All applications were made with a hand gun with 0.1% Triton X-100 as a surfactant. Each treatment was replicated 3 times, and 10 fruits per treatment were collected daily off the branches at 10 AM for ethylene determinations. Branch tests were run with 'Valencia' oranges taken from trees containing 20 to 30 fruit per branch. Twenty branches were used for each treatment and were randomized on different trees with 4 treatments per tree. Each branch was sprayed with 500 ml of chemical. Forty fruit per treatment were collected daily for ethylene assay. Internal fruit ethylene was sampled by removing a 3-ml sample from under the albedo of the fruit with a 23 gauge, 2.5 cm (1 inch) needle attached to a hypodermic syringe. Ethylene was determined according to the method described by Rasmussen and Cooper (14). Daily fruit removal force (FRF) determinations were also made using previously outlined methods (2).

We also measured ethylene production from treated 'Valencia' leaves: 5 undamaged leaves per treatment were incubated for 24 hr in sealed flasks at 25°C, and then leaf ethylene determinations were made by gas chromatography (14). Each experiment was replicated 3 times. Plastic ground covers were placed under the treated trees. Total leaf drop counts were made 5 days after treatment.

Results and Discussion

The internal ethylene levels in 'Hamlin' fruit varied with the 4 chemicals, as did the time of peak ethylene production (Fig. 1). Ethylene production in fruit treated with Release at 125 ppm and Pik-Off at 300 ppm peaked 3 days after application, although the internal ethylene level was much higher with the Release treatment. Acti-Aid application at 10 ppm caused ethylene production to peak in 4 days, whereas DS-27914 (5 ppm CHI + 100 ppm chlorothalonil) application shifted the peak ethylene production to 5 days. The level of ethylene produced in 'Hamlin' fruit with DS-27914 was similar to the level produced in fruit treated with 10 ppm Acti-Aid alone. Branch and field tests (10, 11) have shown that chlorothalonil at rates up to 5,000 ppm had no effect on citrus abscission, but enhanced Acti-Aid-induced fruit abscission. In this study, chlorothalonil treatments also had no effect on fruit ethylene production.

In the 'Valencia' branch test, we determined the correlation between timing of ethylene production (Fig. 2a) and fruit loosening (Fig. 2b). Ethylene production peaked after 5 days, and maximum loosening occurred 5 to 6 days after DS-27914 (20 ppm CHI + 1,000 ppm chlorothalonil) application. Seven days after treatment with all chemicals, ethylene production had declined from peak levels, and fruit retightening had begun. Pik-Off-treated fruit had near
control fruit ethylene levels at this time, and fruit from the Pik-Off treatments had retightened more than with the other chemicals. The sharp decrease and subsequent increase in FRF with Pik-Off treatments may explain the variable fruit abscission responses in larger field tests (10, 11). The sharp peak in ethylene production and short period of maximum fruit loosening of Pik-Off could result from either its biological instability or from its short half-life in light, although no studies have been published on this subject.

The results presented in this paper confirm that fruit ethylene enhancement is part of the abscission response with CHI (3, 4, 8, 14) and Release (17), as well as with Pik-Off and DS-27914. The correlations found in this study suggest a cause and effect relation between timing of ethylene production and fruit loosening.

Leaf abscission responses were also related to patterns of ethylene production (Fig. 3). Pik-Off at 300 ppm and Release at 150 ppm induced rapid, short-term ethylene production in treated 'Valencia' leaves. Acti-Aid at 15 ppm and DS-27914 (10 ppm CHI and 500 ppm chlorothalonil) caused leaf ethylene production over an extended period, although DS-27914 treatment resulted in lower ethylene levels. Lower rates of Release, Acti-Aid, and DS-27914 were used in this study because less of these chemicals were needed to obtain optimum fruit loosening in the early part of the 'Valencia' harvest. The numbers in parentheses in Fig. 3 are leaves abscised per tree 5 days after treatment and amounted to less than 12% of the total leaves. The plastic ground cover was mistakenly not placed under the Pik-Off-treated trees, so exact counts could not be taken. However, visual estimates of leaf drop under the Pic-Off trees were similar to the other treatments.

Previous studies demonstrated that the CHI-treated orange trees abscised more leaves than untreated trees (2, 3). In these tests, application of CHI resulted in increased leaf ethylene production (6), but the greatest ethylene enhancement was in the leaf petiole and abscission zone (5). Wilson reported that Release treatment also caused elevated leaf ethylene levels (17). The role of fruit abscission chemical-induced leaf ethylene production in the fruit-loosening response was not determined in this study. Cooper and Henry (9) reported that concn of CHI of 25 ppm or more, applied to leaves, caused a reduction in the FRF of fruit comparable to that obtained with treated fruit alone. The best response with CHI was obtained when both fruit and leaves were treated. Thus, abscission chemical enhancement of leaf ethylene production may play an important role in fruit loosening.

Literature Cited