much different from that of seeds developing on control plants (Table 3). However, an increase in seed yield of more than 30% over that of the control was obtained by the GA₃-50 ppm treatment (Table 3) which could have important economic consequences for the seed grower.

Large inflorescences produced seeds with a thousand weight 13% greater than small inflorescences (Table 3). The GA₃-50 ppm treatment brought about 80% of large umbels as compared with 60% in the nontreated plants (Table 2). In many species, positive correlations have been found between thousand weight and seed vigor (3, 6). Thus, GA₃ application might possibly result in seeds of improved quality, but no information on this matter is available.

Higher concentrations of a single GA₃ treatment were almost as effective as the 50 ppm treatment. However, the growing seedstalks developed crooked shapes and tended to lodge. It is therefore recommended that higher concentrations be avoided with 'Grano' onion, although with other cultivars different concentrations might prove optimal. It seems that with 'Grano', one of the most popular cultivars in "short-day" zones, a single application of GA₃ at 50 ppm could greatly increase uniformity in flowering and in height of seedstalks and also improve seed yield and seed quality.

**Literature Cited**


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**Rust Mite Damage Increases Uptake and Effectiveness of an Abscission-accelerating Chemical on ‘Valencia’ Oranges**¹

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Additional index words. Citrus sinensis, Phyllocoptruta oleivora

Abstract. ‘Valencia’ oranges (*Citrus sinensis* (L.) Osbeck) damaged with rust mite (*Phyllocoptrutta oleivora* Ashmead) responded to the abscission-accelerating chemical glyoxal dioxime (ethanedial dioxime) with greater ethylene production and greater reduction in bonding force than undamaged fruit. More than 90% of the ¹⁴C-glyoxal dioxime taken up by the rind was absorbed during the first 24 hrs. Absorption of ¹⁴C-glyoxal dioxime by rind tissue of mite-damaged fruit was more rapid than that of undamaged fruit. The differences in uptake of ¹⁴C-glyoxal dioxime due to mite damage were greatest on the first day after treatment, which was also the time of maximum ethylene production in response to glyoxal dioxime. The increased uptake in mite-damaged fruit is partially responsible for the increased effectiveness of glyoxal dioxime. It is likely that mite-damaged fruit are more permeable to many agricultural chemicals than undamaged fruit.

The citrus rust mite, (*Phyllocoptrutta oleivora*) is one of the most serious pests of citrus fruits. Light feeding on citrus fruit by rust mites causes little damage, but heavy feeding may lead to browning, lignification, and death of the affected epidermal cells (7). Mite-damaged fruit tend to be smaller, have higher transpiration rates, and have lower bonding strength than undamaged fruit (2). If heavy feeding occurs on young fruit which have not expanded completely, growth stresses will cause development of cracks in the epidermis and formation of a would periderm (1). When damage occurs after the fruit have reached full size, epidermal cell lignification and death occur, but the cuticle is not broken (1, 7).

Most abscission-accelerating compounds used on citrus fruit cause damage to the rind tissue, which results in ethylene

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production and triggers the abscission process (3, 4). The altered morphology of the rind from rust mite feeding injury could alter the uptake of and response of abscission-accelerating compounds. In this study, the effects of mite damage on uptake and the effectiveness of the abscission chemical glyoxal dioxime were examined.

Materials and Methods

'Valencia' oranges from a 15-year-old commercial grove near Apopka, Florida, were used for the experiments. Most mite-damaged fruit in this grove displayed symptoms of spring and summer mite infestation; rough texture and browning (Fig. 1). A few fruit showed browning with smooth texture characteristic of late damage, i.e., occurring after the fruit have reached full size. No distinction was made among the fruit on the basis of time of mite damage.

For ethylene determinations in the field, fruit were tagged and rated visually on degree of mite damage, taking into account the density of damage and the proportion of the fruit surface affected. The fruit were dipped in water or an aqueous commercial formulation of 150 ppm glyoxal dioxime (Pik-Off). Internal ethylene samples were obtained from beneath the point of stem attachment 1, 2, 3, and 6 days after treatment. Each fruit was sampled only once to avoid ethylene production stimulated by puncture. Ethylene concentrations in the samples were measured at ambient temperature (23°C) with a Perkin-Elmer 990 gas chromatograph equipped with a glass column containing Poropak T. The results were recorded on a Hewlett-Packard Integrator, model 3380A, using an external standard. Six days after treatment, the force required to remove the fruit from the tree was measured using an Amatek pull-force meter, Hunter Spring Division, Hatfield, PA 19440. The experiment was performed twice during May 1978, using a total of 125 fruit.

Fruit to be used for 14C-glyoxal-dioxime uptake experiments were harvested, washed, and held overnight at room temperature. An area of the rind with a uniform degree of mite damage was chosen near the equatorial center of each fruit. These areas were measured for degree of mite damage and treated with radiolabeled glyoxal dioxime. Since the browning and loss of pigment in the mite-damaged areas of the fruit result in an increase in reflectance of light at 580 nm by the rind (5), the reflectance value was used to rate the degree of mite damage. The reflectance at 580 nm of the selected areas of the rind was measured with a Ratiospect (Agricultural Specialty Co.). Typical values included 0.29 for undamaged fruit, 0.33 for light damage, 0.35 for medium damage, and 0.38 for heavy damage. The selected area was outlined with a 1- x 3-cm rubber stamp.

The fruit stems were recut and placed in water-filled Aquapiks (Syndicate Sales, Inc.) to prevent excessive water loss during the 6-day incubation period. 14C-glyoxal dioxime was applied to the fruit rind within the prescribed area, using 25 μl of solution containing about 8,000 cpm per fruit. Non-radioactive glyoxal dioxime (commercial formulation) had been added to the solution to make a 150-ppm concentration. The fruit were incubated in growth chambers at 50% humidity, 27°C days and 16°C nights. Fruit were removed at intervals and the treated area washed first with a water-soaked cotton swab, then with a second swab soaked in acetone. The use of chloroform, a better solvent for citrus wax, for the second wash had no effect on the amount of radioactive material removed by the swab. The treated rind area was cut from the fruit and frozen.

The cotton swabs and rind samples were oxidized in a Packard Sample Oxidizer, model 306, in which the 14CO2 was collected in Carbosorb (Packard). The radioactivity was determined in a Packard liquid scintillation counter, model 3320. The uptake experiment was repeated in toto 3 times during May 1978, with about 120 fruit used for each experiment. Curves were fitted to the data by regression techniques.

Results

The effect of mite damage on response to the abscission agent glyoxal dioxime was tested on 'Valencia' oranges in the field. The internal atmospheres of fruit with medium or heavy mite damage contained more than twice as much ethylene as undamaged fruit on the first day after treatment with glyoxal dioxime (Fig. 2). Significantly greater concentrations of internal ethylene remained in mite-damaged fruit on the second day, but by the third day there were no significant differences.

Fruit which were dipped in water instead of glyoxal dioxime contained very little ethylene (between 0 and 0.2 ppm); there was no significant difference in ethylene concentrations between undamaged and mite-damaged fruit.

![Fig. 1. A 'Valencia' orange showing rough texture, and browning characteristic of spring and summer mite damage.](image1)

![Fig. 2. The effect of various degrees of mite damage on internal ethylene in glyoxal-dioxime-treated (150 ppm) 'Valencia' oranges in the field.](image2)
Table 1. Fruit removal force (kg) of untreated and glyoxal-dioxime-treated 'Valencia' oranges exhibiting various degrees of mite damage.

<table>
<thead>
<tr>
<th>Mite damage</th>
<th>Untreated</th>
<th>150 ppm glyoxal dioxime</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>7.2 a²</td>
<td>5.6 a</td>
</tr>
<tr>
<td>Light</td>
<td>9.0 a</td>
<td>3.8 ab</td>
</tr>
<tr>
<td>Medium</td>
<td>9.4 a</td>
<td>1.8 b</td>
</tr>
<tr>
<td>Heavy</td>
<td>8.2 a</td>
<td>3.4 b</td>
</tr>
</tbody>
</table>

²Mean separation by Duncan's multiple range test, 5% level.

The degree of fruit loosening, measured as the force required to detach the fruit from the stem, was determined on the sixth day after treatment. The fruit removal force (FRF) was not significantly different between undamaged and mite-damaged fruit which were dipped in water (Table 1). However, the size of the control group (49 fruit) may have been too small to discern slight differences. Allen (2) found that bonding force was negatively correlated with degree of rust-mite damage with a sample of 524 mature 'Valencia' fruit. When treated with glyoxal dioxime, medium and heavily mite-damaged fruit had significantly lower bonding force than undamaged fruit.

Citrus rind tissue absorbed 14C-glyoxal dioxime very rapidly. The average rate of uptake for all fruit is shown in Fig. 3. Most of the labeled material absorbed by the rind tissue was taken up during the first 24 hr after treatment. The rate of uptake was dependent on the degree of mite damage, as measured by the Ratiospect instrument (Fig. 4). The differences in uptake between undamaged and mite-damaged fruit were greatest on the first day after application of the radioactive material.

The amount of labeled material recovered from the treated area was affected by the degree of mite damage. On any day during the incubation period, the amount of recovered radioactive material increased as the degree of mite damage increased (Fig. 5). The recovery of labeled material decreased as the incubation period progressed (Fig. 5). Radioactive material may have been removed from the surface of the fruit by contact with other fruit or with the holding trays, or from the tissue by translocation away from the area of application.

Discussion

Both uptake and responsiveness to the abscission-accelerating chemical glyoxal dioxime were altered in mite-damaged fruit when compared with undamaged fruit. Because ethylene is the hormonal initiator of the abscission process, conditions which
lead to increased ethylene production also lead to decreased FRF (3). In these experiments, the combination of chemical wounding by glyoxal dioxime and mite damage led to greater ethylene production and lower FRF than chemical wounding alone. The higher concentration of ethylene in glyoxal dioxime-treated, mite-damaged fruit may have been due to greater concentration of glyoxal dioxime in the tissue due to more rapid uptake or delayed breakdown, or to greater responsiveness of the ethylene synthesizing system in mite-damaged tissues. The largest difference in uptake between undamaged and mite-damaged fruit occurred on the first day of the incubation period. This coincided with the time of maximum ethylene production by the fruit in response to glyoxal dioxime. The more rapid rate of uptake of the abscission-accelerating agent by mite-damaged fruit may be responsible for the increased concentration of ethylene and the decrease in bonding force of the fruit.

The increased rate of uptake of glyoxal dioxime by mite-damaged fruit can be explained by the altered morphology of the rind. Most of the mite-damaged fruit used in the experiments had been damaged early in the season. Albrigo and McCoy (1) showed that the rough texture characteristic of early mite damage was due to cracking of the epidermis and cuticle during fruit growth following the mite infestation. Assuming that the cuticle is not completely permeable to glyoxal dioxime, the chemical would be able to move more quickly into the tissue through the cracks than through an intact cuticle. The presence of lignified cells in the epidermis might also alter the absorption of applied chemicals.

Ismail (6) showed that rust mite-damaged 'Pineapple' oranges responded to ethylene, ethephon, and cycloheximide with a greater reduction in FRF than undamaged fruit. They also found that mite-damaged fruit lost fresh weight twice as quickly after harvesting as undamaged fruit, indicating a difference in rind permeability.

Since glyoxal dioxime is taken up more rapidly by mite-damaged fruit than by undamaged fruit, the same may be true of other agricultural chemicals. In the case of abscission compounds, this could result in disproportionate loosening of mite-damaged fruit. The effect of mite damage should be considered when determining the type and concentration of agricultural chemicals for use on citrus fruits.

Literature Cited


Effect of Light and Nitrogen and Potassium Levels on Growth and Light Compensation Point of Ficus benjamina L.1

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Additional index words. nutrition, compensation point, shade, carbohydrate

Abstract. The effects of 2 light levels, (full sun and 47% shade) 3 nitrogen and 3 potassium levels (672, 2018, and 3362 kg/ha yr1) on light compensation point, shoot and root growth, canopy distribution and leaf tissue nutrient content of Ficus benjamina were determined. The 47% shade treatment during 7 months of production significantly decreased light compensation point levels. N level slightly affected compensation point and K level had no effect. Higher N levels increased shoot growth, while K levels played a dominant role in root development. Light level interacted with both of these effects. N level was positively correlated to percent of the plant canopy contained in the upper half of the plant and this in turn closely was correlated with plant light compensation point.

The concept of acclimatization or plant preconditioning developed from research demonstrating that sun-grown plants could develop lower light compensation points when grown for a time under low light intensities. Acclimatization was first accomplished by holding plants in shaded areas after normal production time, but prior to shipping (6, 11, 12), however, acclimatization procedures now have been incorporated into production schemes. Higher quality areca palms were produced under 40% shade than in full sun (16). Similarly, Dracaena marginata produced under 40 or 80% shade were better quality plants and showed less leaf drop under interior conditions of 150 ft-c (1.6 klx) than plants produced under full sun. Increasing shade at low fertilizer levels gave the best leaf color and did not adversely affect plant height or indoor performance of this dracaena, according to Conover and Poole (7). They also found that height, grade, and foliage color of Ficus benjamina improved

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2Professor and Associate Professor, respectively.

3From MS Thesis submitted to the University of Florida.

4Atomic Absorption Spectrophotometer purchased from a grant by the Fred C. Gloeckner Foundation.