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INHIBITION OF ALTERNARIA ROT OF TOMATOES AND BELL PEPPERS BY POSTHARVEST TREATMENT WITH CGA-64251 OR IMAZALIL[1,2]

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Abstract. **Dipping tomatoes** (Lycopersicon esculentum **Mill.) and bell peppers** (Capsicum annuum **L.) for 10 seconds in an aqueous solution of 50 to 250 μg a.i./ml of CGA-64251 or imazalil inhibited development of rot by** Alternaria alternata **(Fr.) Keissler. Residues of imazalil were less than 1 μg/g in tomatoes analyzed after treatment in 100 or 250 μg/ml of imazalil.**

Development of alternaria rot during marketing of Florida produce in the Greater New York Market from 1974-77 caused 1.2 and 1.3% retail and 1.4 and 1.2% consumer losses in prepackaged and loose-packaged tomatoes, respectively (2). These figures represent 20-35% of the total retail and 18-24% of the total consumer losses determined in this survey. A similar study in the same area from 1971-73 showed the alternaria rot caused 0.26% wholesale and 0.26% retail losses in loose-packaged bell peppers (1). These figures represent 6.4% of the total wholesale and 8.2% of the total retail disease losses determined in this survey. However, losses in Florida peppers are often much higher in export markets (4) with 1.9% wholesale and 16.2% retail losses due to alternaria rot in peppers shipped to Europe (3).

Imazalil has been reported (5) to control alternaria rot of tomatoes. Our preliminary tests showed that the experimental chemical, CGA-64251, inhibited the *in vitro* growth of *A. alternata*. We compared imazalil and CGA-64251 for controlling alternaria rot of both tomatoes and peppers and determined residues for tomatoes treated with imazalil.

Materials and Methods

The following experimental fungicides were tested *in vitro* at 1, 10, and 100 μg a.i./ml of potato-dextrose agar (PDA): 1-[2-(2,4-dichlorophenyl)-4-ethyl-1,3-dioxolan-2-ylmethyl]-1H-1,2,4-triazole (CGA-64251) (Ciba-Geigy, Greensboro, NC 27409) and 1-[2-(2,4-dichlorophenyl)-2-(2-propenyloxy)ethyl]-1H-imidazole (imazalil) (Janssen Pharmaceutica, B-2340 Beerse, Belgium and Decco Pennwalt, Monrovia, CA 91016). A 7-mm disk with spore-mycelial growth of *A. alternata* from a 1- to 2-week-old culture on PDA was placed in the center of a petri plate containing PDA with or without fungicide. Four duplicate plates were run for each treatment, and the entire test was repeated at another time. The plates were incubated at 25°C for 7 days, and then the average diameter of growth was measured.

Large, commercially waxed, non-ethylene-treated, mature-green 'Flora-Dade' tomatoes and medium-sized, mature-green 'California Wonder' bell peppers were purchased at intervals from Dec. 1979 to Apr. 1980, from local sources in Dade County, Florida. Fruits were sorted into 8 lots of 20-25 fruit with similar size, appearance, and freedom from decay and injury. Fruit surfaces were then disinfested by washing them with 70% ethanol. Fruits were inoculated by inserting a small amount of sporulating mycelial growth from a PDA culture of *A. alternata* into a small pocket (about 2 mm wide) just beneath the skin. Each fruit was inoculated at two sites on opposite sides along the equator to double the data obtained per fruit.

Within 2 hr of inoculation, tomatoes and peppers were dipped for 10 seconds in an aqueous solution of 0-250 μg a.i./ml of CGA-64251 or imazalil, drained of excess liquid, placed in a plastic tray, and covered loosely with a polyethylene bag to maintain humidity. The fruits were stored for 2 weeks at 5°C to induce chilling injury and allow fungal growth and then transferred to 13°C for 1-2 weeks to allow lesions to develop. The roughly elliptically shaped lesions were measured as the area of an ellipse with the vertical measurement as the major axis and the horizontal as the minor axis. Data were then converted to show the percent inhibition of lesion development due to fungicidal action.

Imazalil residues on mature-green tomatoes treated for 10 seconds in 100 or 250 μg a.i./ml of imazalil were determined. Three tomatoes were selected at random from a treated lot and analyzed separately for imazalil residue. Analyses were run within 2 hr of treatment, after 3 days of simulated transit at 13°C, and after ripening to the red stage at 21°C. A fruit for analysis was homogenized, and a representative portion (20 g) of the homogenate was shaken for 1 hr with 20 ml of benzene. The sample was then centrifuged, and the benzene phase analyzed for imazalil by gas chromatography at 260°C. The instrument was equipped with a ^{63}Ni linearized electron capture detector and a glass column (4-mm I.D. x 25 cm) packed with 20% OV-17 on

[1]Mention of a fungicide, trademark, proprietary product, or vendor does not constitute a guarantee or warranty by the U.S. Department of Agriculture nor does it imply registration under FIFRA.

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80-100 mesh 'Gas-Chrom Q'. Argon-methane (95:5) at a flow rate of 60 ml/min was the carrier gas.

Results and Discussion

Imazalil and CGA-64251 inhibited similarly the growth of *A. alternata* in agar plates at the concentrations tested (Table 1). Both compounds inhibited completely the growth of the fungus at 100 μg/ml. CGA-64251 was significantly more effective than imazalil for controlling alternaria rot of tomatoes at 10 and 50 μg/ml (Table 2). However, less than 50% inhibition was obtained at 10 μg/ml, a level of inhibition too low for practical control purposes. Imazalil and CGA-64251 inhibited alternaria rot development by over 90% at 50 μg/ml or higher, and control was similar with both compounds at 100 or 250 μg/ml. On bell peppers, CGA-64251 inhibited alternaria rot development by over 95% at 50 μg/ml, whereas imazalil inhibited development by less than 50% at 50 μg/ml (Table 3). As on tomatoes, both compounds at 100 or 250 μg/ml inhibited alternaria rot development by over 95%.

Residues of imazalil were less than 1 μg/g when analyzed within 2 hr of treatment of tomatoes at either 100 or 250 μg/ml (Table 4). Residues were lowest on tomatoes treated with imazalil at 100 μg/ml. Residues tended to decrease during transit and ripening. Additional analyses are needed to determine residue changes during overseas marketing of both tomatoes and peppers treated with either imazalil or CGA-64251.

Table 1. Comparison of imazalil and CGA-64251 for controlling growth of *Alternaria alternata* in potato-dextrose agar plates held for 7 days at 25°C.

Fungicide (μg/ml)	% inhibition of growth[z]	
	Imazalil	CGA-64251
0	0 a	0 a
1	76 b	72 b
10	95 c	95 c
100	100 d	100 d

[z]Each figure is based on 2 replications. In each replicate, each concentration of fungicide was tested on 4 duplicate plates. Mean separation is by Duncan's multiple range test, 5% level.

Table 2. Comparison of imazalil and CGA-64251 for controlling growth of alternaria rot of tomatoes.

Fungicide (μg/ml)	% inhibition of lesion development[z]			
	Test I		Test II	
	Imazalil	CGA-64251	Imazalil	CGA-64251
0	0.0 a	0.0 a	0.0 a	0.0 a
1	7.0 ab	12.6 ab	—	—
10	19.6 b	33.3 c	—	—
50	—	—	93.7 b	98.5 c
100	97.5 d	97.9 d	97.4 bc	99.3 c
250	—	—	99.3 c	99.4 c

[z]Each figure is based on 2 replications. Each replicate consisted of 20-25 mature-green tomatoes, and each fruit was inoculated at 2 sites. Mean separation for all data in each test is by Duncan's multiple range test, 5% level.

Table 3. Comparison of imazalil and CGA-64251 for controlling alternaria rot of bell peppers.

Fungicide (μg/ml)	% inhibition[z]	
	Imazalil	CGA-64251
0	0.0 a	0.0 a
50	41.8 b	96.7 c
100	95.3 c	99.1 c
250	96.4 c	99.6 c

[z]Each figure is based on 2 replications. Each replicate consisted of 25 mature-green bell peppers, each inoculated at 2 sites. Mean separation is by Duncan's multiple range test, 5% level.

Table 4. Residues of imazalil in mature-green tomatoes after treatment, simulated transit at 13°C for 72 hr, and ripening at 21°C.[z]

Time after treatment (hr)	Imazalil residue (μg/g)	
	Imazalil dip concn	
	100 μg/ml	250 μg/ml
2	0.330 ± 0.031	0.546 ± 0.068
72	0.253 ± 0.022	0.428 ± 0.040
312	0.095 ± 0.022	0.176 ± 0.050

[z]Each figure, which is followed by the standard deviation, represents the mean of duplicate samples of 3 whole tomatoes extracted and analyzed separately.

The data reported here suggest that both imazalil and CGA-64251 should be evaluated further as a means of reducing losses due to alternaria rot of tomatoes during domestic and overseas marketing. At the present time, neither compound has been approved by the EPA for use on tomatoes or peppers.

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