Control of Alternaria Rot of Tomatoes by Postharvest Application of Imazalil

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ABSTRACT

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Dipping tomatoes (*Lycopersicon esculentum*) for 2 min in an aqueous solution of 0.01–0.1% a.i. imazalil inhibited development of rot by *Alternaria alternata*. Treatment could be delayed for 2 wk after inoculation and still significantly inhibit lesion development. Inhibition of lesion development was similarly effective in tomatoes dipped in 0.01% imazalil for 2 min or 0.1% imazalil for 10, 60, or 120 sec.

Alternaria alternata (Fr.) Keissler (= *A. tenuis* Auct.), the cause of Alternaria rot of tomatoes, is generally considered to be a weak pathogen requiring injured or weakened tissue in which to germinate and develop (4). Thus, the fungus tends to develop in tomatoes and other produce affected with sunscald, chilling injury, blossom-end rot, faulty blossom scars, and growth cracks (4,6,7). Treatments before and after harvest are needed to prevent the development of Alternaria rot, especially if the tomatoes have been exposed to chilling temperatures in the field or during harvesting and handling operations. To my knowledge, no fungicides have been approved for postharvest treatment of tomatoes to prevent or inhibit development of Alternaria rot. Fungicides are only approved for preharvest use on tomatoes. Chlorothalonil is labeled for control of Alternaria rot of tomatoes in California. Captafol can cause contact dermatitis in susceptible individuals and is, therefore, only used for tomatoes that are to be harvested mechanically. Imazalil, a new fungicide, inhibits growth of *A. citri* Ell. and Pierce (5), suggesting possible activity against *A. alternata*. This study compares the effectiveness of imazalil with some commercial fungicides and reports the successful control of *A. alternata* in tomatoes by postharvest application of imazalil.

This article reports the results of research only. Mention of a pesticide does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended.

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MATERIALS AND METHODS

Sample description and inoculation method. Large, commercially waxed mature-green Flora-Dade tomatoes were purchased from a local packinghouse in Dade County, Florida, and were used in all experiments except one in which large pink Seaside tomatoes were used because no other cultivars were available. Tomatoes were sorted into lots of fruit with similar size, appearance, and freedom from decay and injury. Fruit surfaces were then disinfested by washing them with 70% ethanol. Twenty tomatoes were used per treatment except in tests with Seaside tomatoes, where only 13 tomatoes were used per treatment. Fruits were inoculated by inserting a small amount of sporulating mycelial growth from a potato-dextrose agar (PDA) culture of *A. alternata* into a small pocket (about 2 mm wide) just beneath the skin. Each tomato was inoculated at two sites on opposite sides along the equator.

Fungicide tests. The following commercial fungicides were tested in vitro at 100 μg a.i./ml of PDA: 2,4,5,6-tetrachloroisophthalonitrile (chlorothalonil), *cis*-*N*-[(1,1′,2,2′-tetrachloroethyl)-thio]-4-cyclohexene-1,2-dicarboximide (captafol), and 1-[2-(2,4-dichlorophenyl)-2-(2-propenyloxy)ethyl]-1*H*-imidazole (im-

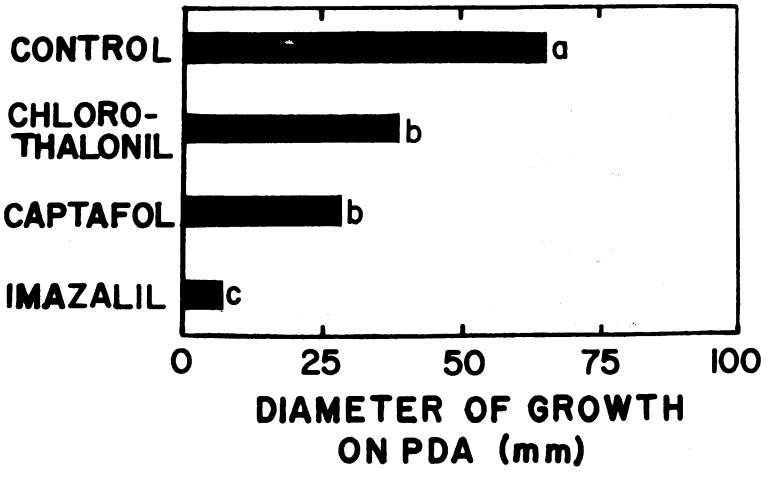

Fig. 1. Control of growth of *Alternaria alternata* by three fungicides (100 μg/ml potato-dextrose agar) in plates held for 7 days at 25 C. Mean separation by Duncan's multiple range test, 5% level.

azalil). A 7-mm disk of spore-mycelial growth of *A. alternata* from a 1- to 2-wk-old culture on PDA was placed in the center of a petri dish containing PDA with or without fungicide. Four duplicate dishes were run for each treatment, and the entire test was repeated at another time. Inoculated treatments were incubated at room temperture (21 C) for 7 days and then the average diameter of growth was measured.

Captafol, chlorothalonil, and imazalil were tested in vivo in 2-min dip-treatments at 0.1% concentration in tap water to control Alternaria rot of pink Seaside tomatoes. The tomatoes were treated within 2 hr of inoculation, drained of excess liquid, placed in a plastic tray, covered loosely with a polyethylene bag to maintain humidity, and held at 21 C for 10 days. The surface size of an Alternaria lesion was measured as the average of its width and height. The test was repeated twice during the 1978 season.

Imazalil was also tested in dip-treatments for various times and concentrations to control Alternaria rot of mature-green Flora-Dade tomatoes. Tomatoes were treated within 2 hr of inoculation or after various periods of delay, and then placed in a tray covered loosely with a polyethylene bag. Tomatoes were stored for 2 wk at 5 C to induce chilling injury and allow fungal growth and then transferred to 13 C for 1–2 wk to allow *A. alternata* to grow. Lesions were measured as described for Seaside tomatoes. The tests were repeated three times during the 1978 and 1979 seasons.

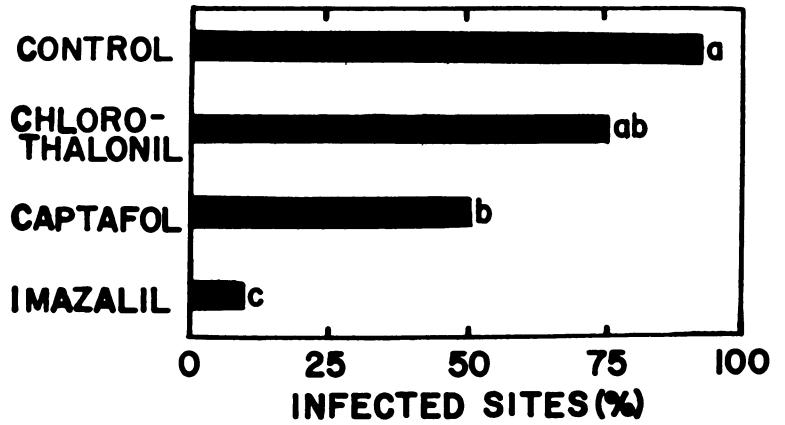

Fig. 2. Control of growth of *Alternaria alternata* in inoculated pink Seaside tomatoes dipped in 0.1% a.i. fungicide for 2 min, then held for 10 days at 21 C. Mean separation by Duncan's multiple range test, 5% level.

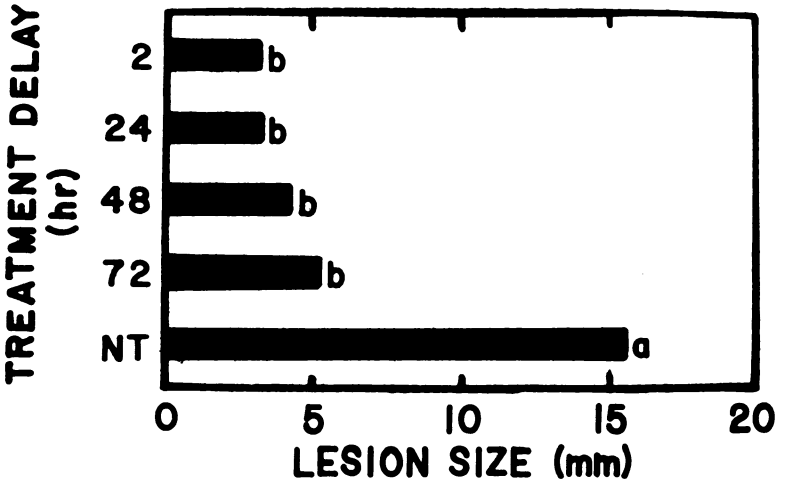

Fig. 3. Effect of treatment delay on development of Alternaria rot in inoculated mature-green Flora-Dade tomatoes. All tomatoes, except those not treated (NT), were dipped in 0.1% imazalil for 2 min. Mean separation by Duncan's multiple range test, 5% level.

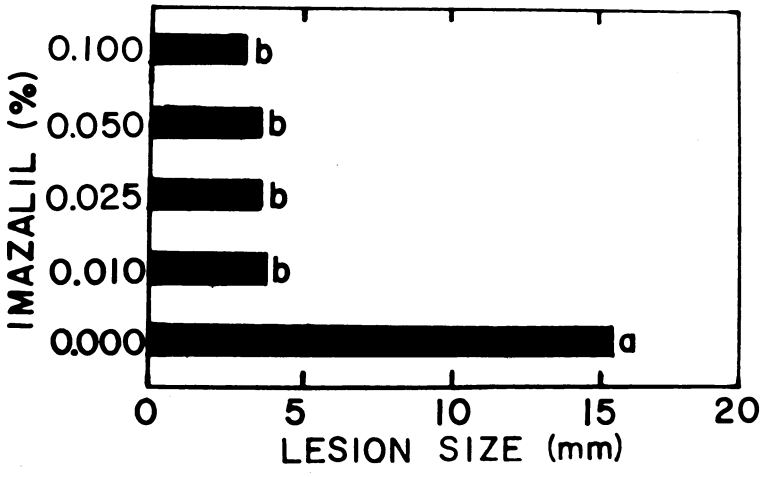

Fig. 4. Effect of concentration of imazalil in the dip tank on development of Alternaria rot in inoculated mature-green Flora-Dade tomatoes dipped for 2 min. Mean separation by Duncan's multiple range test, 5% level.

RESULTS

Comparison of fungicides. Imazalil inhibited growth of *A. alternata* in agar plates significantly more effectively than did either chlorothalonil or captafol when all were compared at 0.01% concentration (Fig. 1). Imazalil also controlled development of Alternaria rot in pink Seaside tomatoes significantly more effectively than either chlorothalonil or captafol (Fig. 2). Captafol and chlorothalonil did not differ significantly in either in vitro or in vivo control of *A. alternata*.

Effect of delayed treatment. Treatment of Flora-Dade tomatoes in 0.1% imazalil for 2 min could be delayed for 72 hr after inoculation and still markedly inhibit development of the lesion (Fig. 3). No significant differences could be detected in lesion sizes on tomatoes treated up to 72 hr after inoculation.

In a single experiment in which the imazalil treatment was delayed for 2 wk at 5 C after inoculation, lesions averaged 6.5 mm in diameter in control and 6.8 mm in treated tomatoes. After 2 wk at 21 C, lesions averaged 22.9 mm in control and 11.2 mm in treated tomatoes.

Effect of concentration. Imazalil significantly inhibited development of *Alternaria* lesions, even when inoculated Flora-Dade tomatoes were treated for 2 min in only 0.01% imazalil (Fig. 4). Lesion sizes were generally slightly, but not significantly, smaller in tomatoes dipped in 0.1% imazalil than in those dipped in 0.01% of the fungicide.

Effect of length of dip-treatment. *Alternaria* lesions developed to approxi-

mately the same size in tomatoes dipped for 10, 60, or 120 sec (Fig. 5). Generally, lesion sizes were slightly, but not significantly, smaller in tomatoes dipped for 120 sec.

DISCUSSION

Imazalil more effectively controlled *A. alternata* both in vitro and in vivo than did chlorothalonil and captafol. The relatively poor control obtained with chlorothalonil was surprising in view of its reported effectiveness for control of *A. alternata* infections in snap beans (1), papaya fruits (2), and Kadota figs (3). Preharvest sprays, rather than postharvest dips, with chlorothalonil were used to control Alternaria rot development during storage of papayas (2). Growers in Dade County, Florida, encountered a high incidence of *A. alternata* infection in fields of tomatoes injured by low temperature during January 1977. In these tests the successful postharvest use of imazalil to control *A. alternata* infections suggests that imazalil might also be an effective fungicide for tomatoes in the field after exposure to low temperatures (0–13 C, but especially around 5 C and below, where damage is produced more rapidly as a direct function of time and temperature [4]).

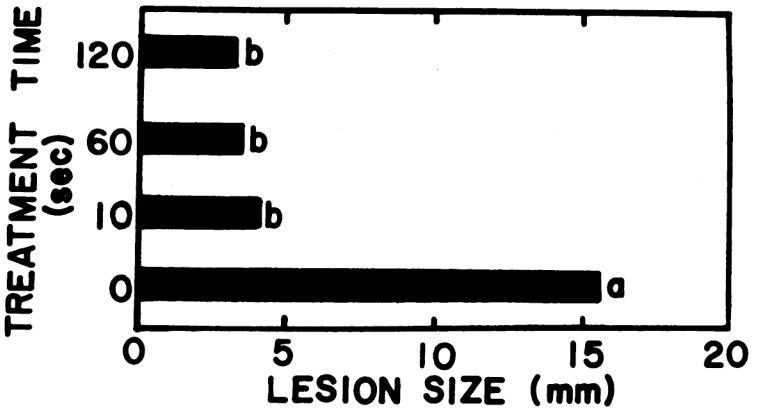

Fig. 5. Effect of treatment time in 0.1% imazalil on development of Alternaria rot in inoculated mature-green Flora-Dade tomatoes. Mean separation by Duncan's multiple range test, 5% level.

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