A COMPARISON OF POSTHARVEST FUNGICIDES FOR DECAY CONTROL OF FLORIDA ORANGES

JOHN J. SMOOT AND C. F. MELVIN

Market Quality Research Division
U. S. Department of Agriculture
Orlando

ABSTRACT

During the 1968-1969 season, six fungicidal treatments were evaluated for control of decay of naturally infected freshly harvested 'Hamlin,' 'Pineapple,' and 'Valencia' oranges. The most effective material for reducing decay was Benlate at 0.05%. The other treatments in descending order of decay control were 5-aceto, 8-hydroxy quinoline sulphate (Geigy 20072) (0.5%); 2-aminobutane phosphate (2-AB) (1%); thiabendazole (TBZ) (0.1%); hot water (128°F—5 min.); and sodium orthophenylphenate (SOPP) (2%) + hexamine (1%). Rind breakdown (aging and pitting) was not increased appreciably by any treatment. No burning or other phytotoxic effects resulted.

In four tests with fruit commercially shipped to northern markets, TBZ was slightly more effective than SOPP + hexamine.

SOPP, TBZ, and hot water are approved by Food & Drug Administration for use on citrus fruits. The other materials are for experimental use only.

INTRODUCTION

In recent years many experimental fungicides have been evaluated in the United States and elsewhere for control of postharvest rots of citrus fruits. Four that have been found to be superior to sodium orthophenylphenate, a standard treatment for Florida citrus fruit, are 5-aceto, 8-dydroxy quinoline sulfate (Geigy 20072) (*7*), 2-aminobutane (2-AB) (*5*, *9*), benomyl (Benlate) (*2*, *3*, *7*, *8*), and thiabendazole (TBZ) (*9*). The effectiveness of Geigy 20072 has not been reported previously from Florida but has been shown to be effective for the control of green mold in Israel (*7*) and South Africa (*4*). The other fungicides have been tested under Florida conditions and found to be effective in controlling both stem-end rot (*Phomopsis citri* and *Diplodia natalensis*) and green mold (*Penicillium digitatum*), the usual decays affecting freshly harvested Florida oranges (*2*, *3*, *9*, *10*). During the 1968-1969 harvest season, these fungicides, in addition to sodium orthophenylphenate (SOPP) and hot water, were compared in 16 tests with early ('Hamlin'), midseason ('Pineapple'), and late ('Valencia') varieties of Florida oranges.

Following approval of TBZ by the Food and Drug Administration in February 1969 (*6*), which established a residue tolerance of 2 ppm on citrus fruit, four shipping tests were conducted to compare TBZ with SOPP under commercial conditions.

MATERIALS AND METHODS

Laboratory tests: The fruits used in the tests conducted at the Horticultural Field Station, Orlando, Florida, were 'Hamlin,' 'Pineapple,' and 'Valencia' oranges harvested from commercial groves in Orance County, Florida, by clipping. Fruit for successive tests was picked from the same trees.

'Hamlin' oranges requiring degreening were placed in the "coloring" room and treated with approximately 5 ppm ethylene gas at 85°F. and 90% relative humidity for periods up to 67 hours, depending on the natural color of the fruit. 'Pineapple' and 'Valencia' oranges were not degreened. Fruit was washed, dried, and randomized into samples of 100-125 fruit each for treatment on the day after harvest or on removal from the coloring room. The treatments evaluated in these tests are listed in Table 1, together with their common or trade names and concentration used. SOPP + hexamine was applied by recommended procedures (*1*). The other chemical treatments were applied to the fruit by flooding well agitated aqueous solutions or suspensions at the indicated concentrations by a recirculation system; the fruit was not rinsed following application. Hot-water treatment was applied according to the method described by Smoot and Melvin (*12*). After treatment, all samples were dried with 125° air and waxed with a commercial solvent-type wax (Flavorseal). Samples were held at 70° and were inspected weekly for decay, physiological rind breakdown, and chemical injury. Results

are expressed in percentage of fruit affected. Causal organisms were isolated to confirm identification of decays.

Shipping tests: Four shipping tests to the New York City-Philadelphia area were conducted in May 1969 from Winter Haven, Florida, to determine the arrival and keeping qualities of TBZ-treated and SOPP-treated 'Valencia' oranges.

The oranges in each of these tests were comparable fruit produced in the same grove. Test packages consisted of three 4/5-bushel cartons for each of the following treatments:

1. Washed and waxed only
2. SOPP + hexamine (Laboratory treated)
3. TBZ—500 ppm (Laboratory treated)
4. TBZ—500 ppm (Packinghouse treated)

In test 4, an additional treatment of TBZ (1,000 ppm) was applied at the packinghouse. In the packinghouse, TBZ was flooded on the fruit following washing and prior to drying in a method similar to that used in the laboratory. Absorber rolls were used to remove the excess water prior to application and to remove excess TBZ following application. Test samples were waxed following treatment and were held with the fruit that made up the remainder of the shipment until loaded. The first two tests were shipped in 40-foot truck trailers and the third and fourth tests in piggyback rail trailers. All trailers were in good condition and were mechanically refrigerated with thermostats set at 40°F. The test packages were located at the middle half centerline position. Ryan recording thermometers were placed in two test packages of fruit in each trailer at the time of packing. Trailers were loaded using the conventional air stack pattern.

Fruit in test packages was examined at the U. S. Department of Agriculture laboratory, Belle Mead, New Jersey, for decay, rind breakdown, and mechanical injury on arrival and was re-inspected after 1 and 2 weeks at 70°F. and 85% relative humidity.

Results and Discussion

Laboratory tests: Treatments shown in Table 1 were evaluated using 'Hamlin' oranges in four tests conducted from November 1 to mid-December with fruit requiring from 21 to 67 hours' ethylene treatment. Figure 1A shows that Benlate and Geigy 20072 were most effective, with less than 1 percent decay after 3 weeks at 70°F. The other treatments in descending order of decay control were 2-AB, TBZ, hot water, and SOPP + hexamine. Phomopsis stem-end rot was the most prevalent of the decays encountered, with lesser amounts of Diplodia stem-end rot and green-mold decay.

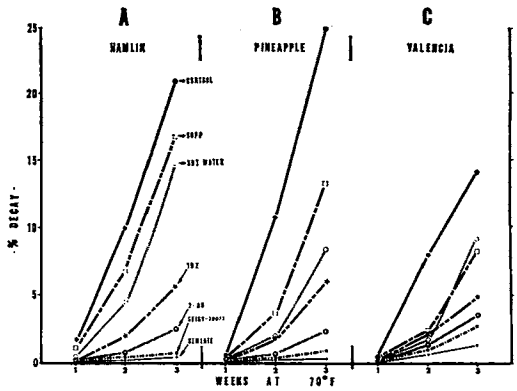

Figure 1.—A comparison of six postharvest fungicides for decay control of three varieties of Florida oranges. 1968-1969.

'Pineapple' oranges which did not require ethylene degreening were given the same treatments in seven tests in January and February. After 3 weeks, untreated controls had 26% decay, primarily Phomopsis stem-end rot with some green-mold rot (Fig. 1B). A reduction to 1 percent or less was effected by both Benlate and Geigy 20072. The relative effectiveness of the other fungicides was the same as with 'Hamlin' oranges.

In five tests with 'Valencia' oranges conducted from late March to early June, results were similar to those obtained with the other two varieties with respect to the relative effectiveness of the six treatments (Fig. 1C). Benlate was again the most effective fungicide. The decay in the controls was predominantly Phomopsis stem-end rot with less amounts of Diplodia stem-end rot, green-mold rot, and anthracnose.

Physiological rind breakdown (aging and pitting) was not increased appreciably by any of the treatments on the three varieties used in these tests. Greatest amount occurred in the lots treated with SOPP + hexamine (data not shown). No chemical injury or burning resulted. All treated lots were equal in appearance to the waxed-only controls with regard to shine and color.

Table 1. Postharvest treatments of Florida oranges evaluated in the laboratory. All fruit was washed before treatment and waxed afterward.

Treatment	Concentration or rate of application
1. Control (washed and waxed only) (Flavorseal wax[1/])	
2. Sodium orthophenylphenate + hexamine (SOPP + hex) (Dow-hex[1/])	2% + 1%
3. Methyl 1-(butylcarbamoyl)-2-benzimidazole carbamate (Benlate[1/]) (benomyl)	0.05%
4. 2-(4'thiazolyl)-benzimidazole (Thiabendazole) (TBZ) (Merteck 260[1/])	0.1%
5. 2-Aminobutane, phosphate (2-AB)	1.0%
6. 5-Aceto, 8-hydroxy quinoline sulphate (Geigy 20072[1/])	0.5%
7. Hot water	128° - 5 min.

1/ Trade names are used for identification, and their use is not to be construed as an endorsement of the product by the U.S. Department of Agriculture.

These results demonstrate the superiority of the four experimental fungicides to SOPP, the standard commercial treatment, and to hot water under laboratory conditions. The relative effectiveness of the four fungicides was consistent throughout the season for the three varieties tested.

The 1968-1969 season was, in general, a "low-decay year" in comparison with the previous 5-year average (*11*). The types of decay encountered were typical of those in previous years, but the incidence was lower. It can be reasonably assumed, however, that results would be similar during a "high-decay year" with only a difference in magnitude.

SOPP, TBZ, and hot water are approved by

Table 2. Test shipments of 'Valencia' oranges from Winter Haven, Florida, for the evaluation of TBZ and SOPP for decay control.

Test No.	Shipping method	Shipping date 1969	Unloading date 1969	Destination	Fruit temperature at loading	Fruit temperature at unloading
					°F.	°F.
1	Truck trailer	May 1	May 4	Philadelphia, Pa.	79	59
2	Truck trailer	May 10	May 12	Philadelphia, Pa.	79	63
3	Piggyback	May 16	May 20	Kearney, N. J.	79	42
4	Piggyback	May 21	May 26	Kearney, N. J.	80	46

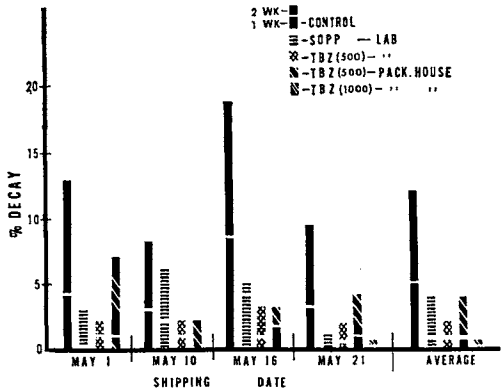

Figure 2.—Effect of TBZ and SOPP on decay of 'Valencia' oranges shipped from Florida to northern markets. Bars indicate decap after 1 and 2 weeks at 70° F. following unloading.

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Shipping tests: 'Valencia' oranges in the four test shipments were not precooled prior to unloading, thus accounting for initial fruit pulp temperatures of 79°-80°F. (Table 2). Variation in temperature at unloading was related to the time between loading and unloading. The truck trailer shipments (tests 1 and 2) were unloaded after 2-3 days, and the fruit was 15-20 degrees warmer than that in piggyback shipments (tests 3 and 4) which were not unloaded until after 4-5 days.

The fruit arrived in good condition with no visible difference between treatments. No decay was observed at the arrival inspection except in test 3 in which less than 1% occurred in each of the treated lots. Figure 2 shows percent decay after 1 and 2 weeks. Although decay varied among tests, fruit from all treatments had less decay than the waxed-only controls. In test 1, the 500-ppm TBZ treatment applied at the packinghouse was less effective than the Lab-applied treatments. This first test was conducted soon after semi-experimental equipment was set up to apply TBZ at the packinghouse, and treatment might have been inadequate. The average of all four tests shows that the Lab-applied TBZ controlled decay more effectively than the Lab-applied SOPP. In test 4, 1,000 ppm TBZ applied at the packinghouse gave excellent control.

These results, though by no means conclusive, indicate that under commercial conditions TBZ controls decay better than the standard SOPP treatment. As with the laboratory tests, the natural decay in these 'Valencia' oranges was lower than would be expected normally. Further testing with TBZ under commercial conditions will be continued this next season. Better formulations of TBZ and improved methods of application should produce more striking results with fruit having a higher decay potential.

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