Wax in Combination with Botran, Benomyl, and Heat for Reduction of Post-Harvest Rots of Peaches and Nectarines

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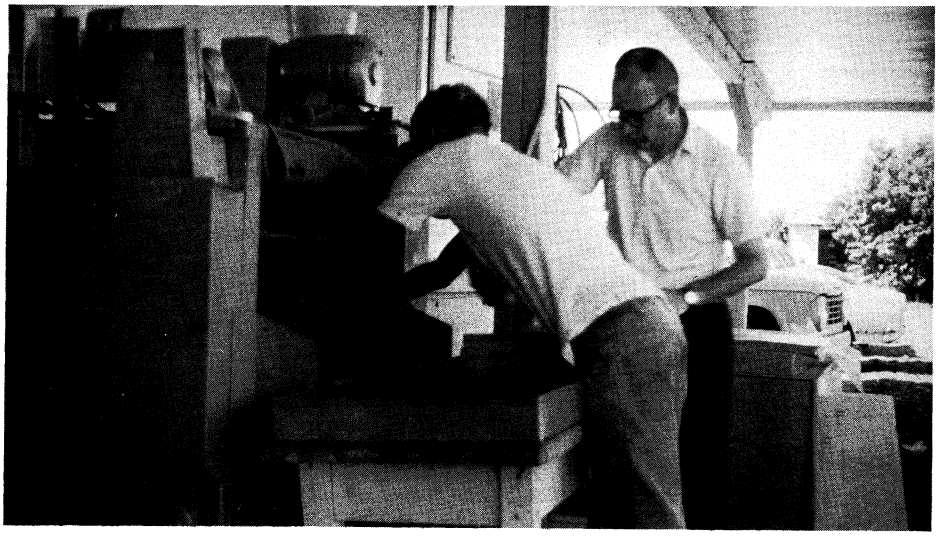
The postharvest diseases, brown rot and Rhizopus rot, are primarily responsible for limiting the storage and shelf life of peaches and nectarines. The control of rots is of particular concern to western growers and shippers since most of their fruit is transported to distant markets in the East, and high quality must be maintained during transit as well as during normal storage and marketing periods. Most losses due to rots occur when fruit is transferred to ripening temperatures. Thus, shipments of acceptable quality at the packing shed may develop rots when ripened at destination.



Experimental Botran and benomyl wax applications were evaluated in laboratory. Fruit was then packed and held for simulated storage and ripening periods.

A common postharvest treatment for peaches and nectarines in western growing areas is a wax-fungicide spray applied in the packing shed. These fruits are washed against rotating brushes, then sprayed with an oil- or paraffin-based wax emulsion containing one or more fungicides. In a 1969 study conducted at the U. S. Department of Agriculture's Market Quality Research laboratory in Fresno, California, commercial wax-fungicide treatments were compared with other postharvest treatments for control of rots.[1] A wax-Botran treatment, in general, was as effective as either a commercial hot-water dip (1½ minutes in 125° F. water), or a commercial hot-Botran dip (½ minute in 125° F. water containing 1/4 to 3/8 lb. Botran 75% WP per 100 gallons).

ACCURATE CONTROL REQUIRED

Wax-Botran applications, however, require accurate control of fungicide levels to assure that a sufficient amount is deposited on the fruit. In the 1969 test, waxers were monitored periodically during the season, and residues of 0.5 to 2.3 parts per million (ppm) of Botran were deposited on samples of peaches and nectarines. These samples, held for 7 days at 35° and 3 days at 70° F. to simulate transit and marketing conditions, developed 65 to 85% less decay than untreated checks, depending upon the level of residue. In general, samples with the highest residues had the least decay.

More recent work at the Fresno laboratory indicates that wax-fungicide treatments can be significantly improved. Increasing the residue of fungicide on fruit (within approved tolerances) improved decay control and heating the wax-fungicide spray during application further reduced decay. Experimentally, the combination of Botran with benomyl improved decay control, but benomyl is not yet approved for use.

Waxing units in commercial packing sheds were compared by treating comparable samples of nectarines in each shed. The treated fruit was held in commercial lugs with polyethylene liners for 3 days at 35° and 6 days at 70° F., and examined for decay. Fruit was considered decayed if brown rot, Rhizopus rot, or any miscellaneous rots were present at any stage of development. Botran residues were determined with a gas chromatograph.

LABORATORY EVALUATIONS

Experimental Botran- and benomyl-wax applications to fruit were evaluated in the laboratory, using a small commercial waxer. The fruit was washed against rotating brushes in a

Fruit treated with wax sprays containing Botran or combination of Botran and benomyl developed 2-3% decay.

TABLE 1

Percent decay and Botran residues on nectarines treated in different commercial sheds, and held for 3 days at 35° and 6 days at 70° F.

Shed	Percent decay in indicated variety[1] Late Le Grand	Gold King	Late Le Grand	MEAN	Botran residues[2]
	%	%	%	%	ppm
Check	32	17	23	24.0 c	0
A	28	16	18	20.7 bc	0.8
B	9	12	19	13.3 b	1.2
C	2	1	1	1.3 a	8.7
D	0	0	2	0.7 a	20.0

[1] Percent of 100-120 fruit per treatment. Means not followed by the same letter are significantly different at the 5% level.

[2] Mean residues from three determinations.

TABLE 2

Percent decay of nectarines waxed for 3 seconds with emulsions containing Botran or a mixture of Botran and benomyl, and held for 3 days at 35° and 5-6 days at 70° F.

Wax treatment	Percent decay in indicated variety[1] Sun Grand	Late Le Grand	Late Le Grand	Reg. Grand	Flame Kist	Gold King	Mean percent decay[2]
	%	%	%	%	%	%	%
Dry check	6	17	48	25	33	13	23.7 e
Wax check	7	13	22	10	10	11	12.1 d
Botran 450 ppm	7	4	14	7	5	9	7.7 cd
Botran 900 ppm	5	3	7	5	3	7	5.3 bc
Botran 1800 ppm	0	3	5	5	2	3	3.0 ab
Botran 450 ppm + benomyl 33 ppm	1	2	17	10	10	7	7.6 cd
Botran 450 ppm + benomyl 100 ppm	2	0	14	5	3	4	4.7 abc
Botran 450 ppm + benomyl 333 ppm	1	2	2	2	0	6	2.1 a

[1] Percent of 60-120 fruit per treatment.

[2] Means not followed by the same letter are significantly different at the 5% level; test for significance based on arcsin transformations.

TABLE 3

Percent decay of peaches and nectarines treated with hot (125° F.) or cold (75° F.) wax-fungicide dips or sprays, or a hot water dip. Fruit held for 3 days at 35° and 6-8 days at 70° F.

Treatment	Percent decay in indicated variety[1]	Peaches Sun-crest	Rio Oso	Nectarines Late Le Grand	Late Le Grand	Sept. Grand	MEAN
	sec.	%	%	%	%	%	%
Dry check	—	21	60	28	66	9	36.8 d
Cold wax-fungicide spray[2]	3	9	8	7	11	4	7.8 bc
Cold wax-fungicide spray[2]	10	1	8	4	3	3	3.8 ab
Hot wax-fungicide spray[2]	3	1	4	4	5	2	3.2 ab
Hot wax-fungicide spray[2]	10	0	2	0	1	0	0.6 a
Hot water dip	90	22	28	11	38	8	10.8 bcd

[1] Percentage of 100 fruit per treatment. Means not followed by the same letter are significantly different at the 5% level; test for significance based on arcsin transformations.

[2] 15 X dilution of a paraffin-base wax emulsion containing 133-300 ppm Dowicide A, 450 ppm Botran, and 100 ppm benomyl.

spray containing a 0.5% solution of sodium dodecylbenzenesulfonate, rinsed in fresh water, and sprayed with a wax-fungicide emulsion for approximately 3 seconds. Fungicides were suspended in a 15X dilution of a concentrated paraffin-base, wax emulsion (Decco Peach Wax WT-52) containing 0.2 to 0.5% orthophenylphenate (Dowicide A) as a preservative. Botran 75% WP was tested at 450, 900, and 1800 ppm (½, 1, and 2 lbs. per 100 gallons, respectively), and Benomyl 50% WP at 33, 100, and 333 ppm. Benomyl was tested in combination with 450 ppm Botran since benomyl is not active against Rhizopus rot.

HEATED WAX-FUNGICIDE

Heated wax-fungicide sprays also were tested in the laboratory. The heated wax spray was applied in a modified commercial waxer in which two flood-spray nozzels were placed 6 inches above the brushes. The nozzels were connected by an insulated line to a dip-tank in which the wax-emulsion was diluted, heated, and mixed with 450 ppm Botran and 100 ppm benomyl. The temperatures of the suspension could be adjusted, and to deliver a 125° F. spray at brush level, it was necessary to raise the tank temperature to 145°.

In other laboratory tests, peaches were artificially-inoculated with the brown rot organism 16 hours before treatment. Botran treatments at 225, 450, and 900 ppm, and benomyl treatments at 33, 100, and 333 ppm in combination with the heated wax were tested. After treatment the fruit was stored in polyethylene bags for 3 days at 35° F. and then ripened for 2 days at 70°. Decay development was determined by measuring lesion diameters and calculating an average for each test lot. Larger-scaled tests were conducted later in the harvest season when the incidence of natural decay was high.

DECAY OF NECTARINES

Decay of nectarines treated in commercial packing sheds with wax-Botran sprays and held for 3 days at 35° and 6 days at 70° F., decreased as Botran residues increased (Table 1). Fruit with Botran residues averaging 1.2 ppm developed 13.3% rot during the 6-day ripening period compared to 24% rot in the untreated checks. Lots with Botran residues averaging 8.7

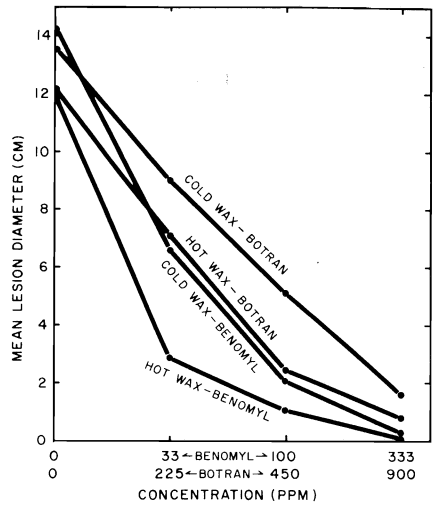


Fig. 1. Mean diameters of brown rot lesions on peaches artificially inoculated with Monilinia fructicola and treated for 10 seconds with hot (125° F.) or cold (75° F.) wax emulsions containing different concentrations of Botran or benomyl. Each point represents an average of 3 tests.

ppm developed only 1.3% decay. Residues of less than 1 ppm were not effective in reducing decay, while those of 20 ppm did not control decay significantly better than 8.7 ppm. The Food and Drug Administration (FDA) permits Botran residues of 20 ppm on peaches and on nectarines (temporary tolerance), but considerably less than this amount may be necessary for decay control under most commercial conditions. Optimum Botran residue levels appear to be slightly above 9 ppm.

Peaches and nectarines sprayed for 3 seconds with a wax emulsion containing 900 ppm Botran (1 lb./100 gal.) and held for 3 days at 35° and 5 to 6 days at 70° F., developed 5.3% decay compared to 23.7% decay in the dry check lots (Table 2). Fruit treated with 1800 ppm Botran (2 lbs./100 gal.) had only 3.0% decay—a reduction of 88% from the level in the checks. Wax sprays with 450 ppm Botran (7.7% decay) were not significantly more effective than treatments with the wax alone (12.1% decay) unless supplemented with 100 or 333 ppm benomyl. Fruit waxed with 450 ppm Botran and 100 ppm benomyl developed 4.7% decay. Supplements of 33 ppm benomyl were not effective, and 333 ppm was not significantly more effective than 100 ppm benomyl.

Fruit treated with wax alone had significantly less decay than the dry checks, which may have been due to the detergent and the fresh water rinses prior to the actual waxing operation, or to the presence of 133-300 ppm Dowicide A in the wax itself.

Brown rot lesions on inoculated peaches treated with a hot wax-Botran or wax-benomyl spray for 10 seconds, and then held for 3 days at 35° and 2 days at 70° F. were significantly smaller than on fruit treated with cold sprays (Figure 1). The mean lesion diameter, for example, on peaches treated with a 125° wax spray containing 450 ppm Botran was 2.4 mm compared to 5.2 mm on fruit similarly treated with a cold (75°) Botran spray.

Naturally-infected peaches and nectarines treated for 3 seconds with an unheated wax-spray containing Botran and benomyl resulted in an average of 7.8% decay compared to 36.8% decay in the dry checks (Table 3). Lots treated with a similar spray heated to 125° F. developed an average of only 3.2% decay. Although heated wax-sprays generally resulted in a lower level of decay development than cold wax sprays, the differences were not large enough to be statistically significant under these test conditions. However, fruit treated with a 10-second, hot wax-fungicide spray had less than 1% decay after an 8-day ripening period, which was considerably less than any other lot. The 10-second, hot-wax spray also was significantly more effective than a 90-second hot water dip.

Untreated check fruit developed an average of 24% decay after 5-6 days of ripening.

Further testing of wax-fungicide treatments in commercial equipment modified to deliver heated sprays is necessary to fully evaluate this technique. Although benomyl is not permitted by the FDA for postharvest applications on peaches or nectarines, a temporary registration is currently pending. Hot-wax sprays should, in the meantime, be tested with Botran applications alone.

[1]Wells, J. M. 1970. Postharvest hot-water and fungicide treatments for reduction of decay of California peaches, plums, and nectarines. U. S. Dept. Agriculture Mktg. Res. Rept. 908, 11 p.

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