

POSTHARVEST TREATMENT OF FLORIDA FRESH MARKET TOMATOES WITH FUNGICIDAL WAX TO REDUCE DECAY

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Abstract. Fresh market tomatoes (*Lycopersicon esculentum* Mill.) were treated with a fungicidal wax containing o-phenylphenol (OPP) at 2.5% in a commercial packinghouse. Three weeks after packing, light pink tomatoes stored in ambient conditions exhibited 35.2% decay in tomatoes waxed with plain wax and 20.2% in fruit treated with fungicidal wax. After 4 weeks, light green tomatoes had 23.5% decay in fruit treated with plain wax and 7.3% in fruit treated with fungicidal wax. Residue levels indicate that very little OPP was necessary to achieve the desired effect.

During the 1987-88 crop year, Florida packers shipped 76 million 25 lb. cartons of fresh market tomatoes (*Lycopersicon esculentum* Mill.) with a FOB price of \$7.00 carton. Tomatoes account for about 40% of the value of all vegetables shipped (8) and is the single most important vegetable crop grown in Florida.

Reports of market losses in tomatoes have ranged from 14% to as high as 70% from all causes, with the major losses due to decay (4, 11), and in simulated export tests with unwaxed tomatoes loss from decay was found to be as high as 50% in some lots (19). Decay in shipments affect the return to the packer, therefore methods of reducing postharvest rots are desirable to Florida packers.

Several organisms have been identified as causing postharvest losses in commercial tomato shipments (15, 20). Many of these, are controlled in varying degrees by the fungicide o-phenylphenol (OPP) (5).

In Florida, few packers use any decay control materials other than chlorine (21, 23) while most packers in California use one of the commercially available (3) waxes containing OPP. The literature does not indicate any reason for this difference. Those reports on the use of OPP either do not test under commercial conditions (4) or test at wax application rates far higher than normally found in Florida (3). In Florida, the normal application rate of wax on tomatoes is often below 0.1 ml/kg, while in California rates of 0.5 ml/kg are reported as normal (3).

United States standards for mature tomatoes give 6 colors; green, turning, breaking, pink, light red and red (24). Commercial packers may further divide these for their own marketing strategy. Green fruit are subjected to ethylene prior to shipping to stimulate ripening (9).

Tomatoes are waxed to improve appearance, improve shelf-life, lubricate fruit to improve handling and reduce

shrinkage (12). Of these effects, the reduction of shrinkage is most affected by the wax on the stem scar (2). Cost of the wax is a minor factor (16) compared to the overall cost of processing tomatoes.

Since a difference between Florida and California packers use of fungicidal wax does exist, this work was undertaken to determine if the reason for this difference was that this type of product would not be effective under Florida conditions. The effectiveness of OPP in the wax, under commercial conditions, was tested by comparing the decay in fresh market tomatoes waxed with and without the fungicide in the wax.

Materials and Methods

Trials were run in a commercial packinghouse on 3 consecutive days on 'Sunny' tomatoes. Fruit were harvested in the morning in the Ft. Pierce area and brought to the packinghouse for packing on the same day.

At the start of each day, the packline was run for about 1 hour with non-fungicidal (Fresh Wax 51V) wax to allow the packinghouse to reach normal operating conditions. Then filled cartons of light pink tomatoes were taken as the plain wax treatment. At the same time a 2 pound sample was collected for residue analysis. Next, 3 cartons of light green tomatoes were taken and a sample collected.

At this point, the wax was changed to a fungicidal wax containing 2.5% OPP (Fresh Wax 52VF) and the line was run for 3 hours before cartons of treated tomatoes were taken for storage by the same procedure. Each sample consisted of 3 cartons size 6x6 (2 16/32 to 2 26/32 inches (6.35 to 7.14 cm)) (6) tomatoes of light green (green) and light pink (pink) colors. Fruit of each color was treated as a separate trial. On subsequent days this process was repeated with each day's run treated as a separate trial. Thus 3 trials on green tomatoes and 3 trials on pink tomatoes were conducted with each trial comparing fungicidal wax with non-fungicidal wax.

Samples taken for residue analyses were sent to a commercial laboratory² where analysis for OPP residues were performed by High-Speed Liquid Chromatography (HSLC) in a procedure modified from Reeder (17).

The pack line was typical of commercial tomato packinghouses (14) and the operating conditions for all the trials were the same throughout. Fruit were processed at 63,000 lb./hour with a wax application rate of 0.25 lb./hour and a wax applicator temperature of 106F.

At the conclusion of each day's run, the light green tomatoes were placed in a degreening room held at 70 to 72F, 85 to 90% relative humidity, and 100 to 150 ppm ethylene. Ethylene was generated by the use of a catalytic generator (7). At the end of 96 hours fruit was transferred to cold storage at 52 to 54F. The light pink fruit was placed directly in the cold storage room at the conclusion of each day's run. The accumulated fruit were then transferred to the laboratory in Ocoee, FL, where they were held at am-

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²CL Technology, Inc., Corona California.

Table 1. Storage and handling of tomatoes after waxing.

Color at treatment	Date packed	Days			
		Ripening ^y	Holding ^x	Ambient ^w	Total ^v
Pink	28/3	0	6	13	19
	29/3	0	5	13	18
	30/3	0	4	13	17
Green	28/3	4	3	22	29
	29/3	4	2	22	28
	30/3	4	1	22	27

^zDays held at various treatments.

^yEthylene 150 to 200 ppm, 70 to 72F, 85 to 90% RH.

^xCold storage at 52 to 54F.

^wAmbient conditions in laboratory 72 to 78F.

^vTotal days between packing and examination.

bient conditions until examination. These conditions are summarized in Table 1.

The light pink fruit was examined on 17 Apr. 1989 after 20 to 22 days after packing. The light green fruit were examined on 26 Apr. after 32 to 34 days. Decay is reported as the average of 3 cartons.

Results and Discussion

The analysis by HSLC of all samples found less than 0.2 ppm OPP, the limit of detection of the method used.

Three weeks after packing, light pink tomatoes stored in ambient conditions averaged 36.2% decay in tomatoes waxed with plain wax and 20.2% in fruit treated with fungicidal wax. These results are summarized in Table 2.

After 4 weeks, light green tomatoes had 23.5% decay in fruit treated with plain wax and 7.3% in fruit treated with fungicidal wax. These results are summarized in Table 3.

Several different organisms were identified as causing decay in these trials. Among the rots identified were: *Alternaria* Rot (*Alternaria tenuis* auct.), Anthracnose (*Colletotrichum coccodes* (Wallr.) Hughes), Bacterial Soft Rot (*Erwinia carotovora* (L. R. Jones) Hughes) and Sour Rot (*Geotrichum candidum* Pers. emend. Carmichael) with *Alternaria* being the most common in the trials with light green tomatoes. Because all organisms causing postharvest decay result in unmarketable fruit, no effort was made to distinguish the types of decay found.

From the residue levels found in the samples tested, it seems that very little OPP is necessary to significantly reduce market diseases of tomatoes. Some of this effect might be attributed to the report that the stem scar has a tendency to absorb oily materials more readily than water (2) and that many decay organisms enter by infusion through the stem scar and other defects in the peel (1, 20,

Table 2. Light pink tomatoes examined 17 April 20 to 22 days after treatment.

Wax treatment	Packing date (% decay)			
	28/3	29/3	30/3	Average
Plain	46.4a ^z	40.3a	17.9a	35.2a
Fungicide	30.2b	16.2b	15.0a	20.2b

^zMeans in columns not followed by the same letter differ significantly at the 5% level of confidence.

Table 3. Light green tomatoes examined on 26 April 32 to 34 days after treatment.

Wax treatment	Packing date (% decay)			
	28/3	29/3	30/3	Average
Plain	40.8a ^z	16.2a	18.1a	23.5a
Fungicide	9.0b	6.2b	5.8b	7.3b

^zMeans in columns not followed by the same letter differ significantly at the 5% level of confidence.

23). A concentration of fungicide here could be acting as a barrier to infection. It is also possible that contamination of the wax in the waxer is serving as a source of inoculation. When using commercial non-fungicidal waxes of the same type used on tomatoes (10) in tests with cucumbers, tomatoes and bell peppers various authors found that those fruit treated with wax showed a higher incidence of decay than those not waxed (13, 18, 20, 22).

In each trial conducted, OPP reduced decay and also "nesting" due to fruit-to-fruit infection. The use of OPP in wax greatly reduces the incidence of postharvest decay on waxed tomatoes. The cost of a fungicidal wax is not much higher than a plain wax and the benefits to the Florida tomato packer is unquestionable.

Literature Cited

- Bartz, J. A. 1988. Potential for postharvest disease in tomato fruit infiltrated with chlorinated water. *Plant Dis.* 72:9-13.
- Bartz, J. A. 1982. Infiltration of tomatoes immersed at different temperatures to different depths in suspensions of *Erwinia carotovora* subsp. *carotovora*. *Plant Dis.* 66:302-306.
- Chastagner, G. A. and J. M. Ogawa. 1979. A fungicide-wax treatment to suppress *Botrytis cinera* and protect fresh market tomatoes. *Phytopathology* 69:59-63.
- Domenico, J. A., A. R. Rahman, and D. E. Westcott. 1972. Effects of fungicides in combination with hot water and wax on the shelf life of tomato fruit. *J. Food Sci.* 37:957-960.
- Eckert, J. W. and J. M. Ogawa. 1988. The chemical control of postharvest diseases: deciduous fruits, berries, vegetables and root/tuber crops. *Ann. Rev. Phytopathol.* 26:433-469.
- Florida Tomato Committee. 1988. Handling Regulations. PO Box 140635, Orlando, FL 32814-0635.
- Freebairn, H. T. and M. H. Cohen. 1976. Gas generating apparatus. United States Patent 3,951,610.
- Freie, R. L. and H. V. Young. 1989. Florida agricultural statistics: vegetable summary. Fla. Dept. Agr. Cons. Serv. Tallahassee. April 1989.
- Gull, D. D. Ripening tomatoes with ethylene. Fla. Coop. Extn. Serv., Univ. Fla. Vegetable Crops Fact Sheet VC-29.
- Hall, D. J. 1981. Innovations in citrus waxing—An overview. *Proc. Fla. State Hort. Soc.* 94:258-263.
- Harvey, J. M. 1978. Reduction of losses in fresh market fruits and vegetables. *Ann. Rev. Phytopathol.* 16:321-341.
- Iverson, V. E. 1937. Factors affecting the keeping qualities of tomatoes in storage. *Proc. Am. Soc. Hort. Sci.* 34:539.
- Johnson, H. B. 1966. Bacterial soft rot in bell peppers, cause and commercial control. US Dept. Agr., Agr. Res. Serv. MRR No. 738.
- Kasmire, R. F. 1985. Postharvest handling systems: Fruit vegetables. In: A. A. Kader (ed.), *Postharvest Technology of Horticultural Crops.* p. 139-142. Univ. Calif. Special Pub. 3311.
- McColloch, L. P., H. T. Cook, and W. R. Wright. 1968. Market diseases of tomatoes, peppers, and eggplants. *Agriculture Handbook* No. 28. US Dept. Agr., Washington, DC.
- Mongelli, R. C. 1984. Marketing Fresh Market Tomatoes, Systems and Costs. US Dept. Agr. Agr. Mking. Serv. MRR No. 1137.
- Reeder, S. K. High-speed liquid chromatographic determination of o-phenylphenol residues in citrus products. Products Research and Development Division, Sunkist Growers, Inc. Ontario, CA. Mimeo report.

18. Risse, L. A., W. R. Miller, and D. Chun. 1985. Effect of film wrapping, waxing and imazalil on weight loss and decay of Florida cucumbers. *Proc. Fla. State Hort. Soc.* 98:189-191.
19. Risse, L. A., T. Moffitt, and A. Dow. 1980. Effect of storage temperature on color and incidence of decay of tomatoes under simulated export conditions. *Proc. Fla. State Hort. Soc.* 93:310-313.
20. Segall, R. H. and A. Dow. 1976. Soft rot of tomatoes resulting from dump-tank and washer-water contamination and its control by chlorination. *Proc. Fla. State Hort. Soc.* 89:204-205.
21. Segall, R. H., A. Dow, and P. L. Davis. 1974. Effect of waxing on decay, weight loss, and volatile pattern of cucumbers. *Proc. Fla. State Hort. Soc.* 87:250-251.
22. Segall, R. H., C. M. Geraldson, and P. H. Everett. 1973. The effects of cultural and postharvest practices on postharvest decay and ripening of two tomato cultivars. *Proc. Fla. State Hort. Soc.* 86:246-249.
23. Sherman, M., R. K. Showalter, J. R. Bartz, and G. W. Simone. Tomato packinghouse dump tank sanitation. *Fla. Coop. Extn. Serv., Univ. Fla. Vegetable Crops Fact Sheet VC-31.*
24. United States Department of Agriculture. 1976. United States standards for grades of fresh tomatoes. US Dept. Agr. Agr. Mktng. Serv. Washington, DC.

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FOOD BAITS FOR PRE-PLANT SAMPLING OF WIREWORMS (COLEOPTERA:ELATERIDAE) IN POTATO FIELDS IN SOUTHERN FLORIDA

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Abstract. Wireworms [*Melanotus communis* (Gyllenhal) and *Conoderus* spp.] are the most important insect pests of Irish potato (*Solanum tuberosum tuberosum* L.) in southern Florida. Studies were conducted during 3 consecutive growing seasons to develop a pre-plant sampling plan for wireworm larvae in the Perrine marl soils of southern Dade county. Eight food baits were tested for attractiveness to wireworm larvae: hybrid sweet corn seed, hybrid sorghum-sudangrass seed, a 1:1 mixture of sweet corn and sorghum-sudangrass seed, a whole sweet corn ear, potato seed pieces, a 1:1 mixture of oatmeal and corn flake, carrots, and rolled oats. Oatmeal:corn flake and rolled oat baits were most attractive to wireworm larvae. More *M. communis* larvae. More *M. communis* larvae were consistently found in these baits than in other food baits. Numbers of *Conoderus* spp. larvae did not consistently differ among food baits. Further studies determined spatial patterns of wireworm larvae using rolled oat baits. Wireworm larvae were clumped in potato fields. An excessive number of samples was needed to reliably estimate wireworm density within 10% of the mean; however, a reasonable number of samples was needed to reliably estimate density within 40% of the mean. Rolled oat baits are currently being used for pre-plant sampling of wireworms in potato fields in southern Florida.

Irish potato is the fifth most economically important vegetable crop in Dade county Florida with a crop value of \$12.8 million (1). In southern Florida, potatoes are planted between mid-Oct. and late Dec. and harvested between mid-Feb. and late Apr.. After harvest, fields are usually planted with a summer cover crop, a sorghum-sudangrass

hybrid to improve the tilth of the soil, increase the organic matter, and reduce weed populations in the following potato crop. Unfortunately, the sorghum-sudangrass cover crop is also very attractive to adult wireworms (click beetles). Adults fly into fields planted with the cover crop, mate, and lay eggs in the cracks and crevices of soil at the base of plants. Wireworm larvae that hatch out of eggs eventually attack tubers in the following potato crop (5).

Currently, a pre-plant sampling plan for estimating wireworm larval densities in potato fields in southern Florida is lacking. Historically, growers have sampled for wireworms before planting by removing several soil samples (ca. 3,540 cm³) from each field. This method is time consuming and its reliability is unknown. For this reason, alternative methods for sampling wireworms in potato fields are needed.

Several reports showed that several food baits, such as wheat seed, wheat:corn seed, sorghum seed, oatmeal, wheat flour, and whole wheat:corn seed mixtures, were effective at attracting and collecting wireworm larvae in soil (2,3,4,6,9,12). The present studies were conducted to (1) evaluate the effectiveness of various food baits for sampling wireworms before planting, (2) compare the effectiveness of food baits with soil samples for sampling wireworms, and (3) assess the reliability of food bait sampling methods (i.e., would the number of food bait samples needed to reliably estimate wireworm densities be realistic?).

Materials and Methods

The attractiveness of 8 food baits was assessed during 2 consecutive growing seasons in 1986 and 1987. Baits evaluated the first year included: 3 cups of corn seed, 3 cups of sorghum-sudangrass seed, 3 cups of corn and sorghum-sudangrass seed (1:1), one sweet corn ear, 6 potato seed pieces, and 3 cups of oatmeal and corn flake (1:1). Eight food baits were evaluated the second year: the 6 baits, and quantities, tested during the first year with the addition of 3 whole carrots and 3 cups of rolled oats. All seed baits were soaked overnight in water to enhance germination.

Four trials (1-4) were conducted (one in 1986 and three in 1987). Treatments were arranged in randomized complete block designs with 9 or 12 replications. Bait locations

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