LEMONS, *Citrus limon* (L.) Burm
Postharvest citrus green mold; *Penicillium digitatum*
Postharvest citrus blue mold; *Penicillium italicum*

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Control of postharvest green and blue molds of lemons with potassium phosphite and hydrogen peroxide, 2011.

Significant losses can occur after the harvest during the storage and marketing of citrus fruit in California due to green and blue molds, caused by *P. digitatum* and *P. italicum,* respectively. Currently, both diseases are controlled by application of the fungicides imazalil, sodium ortho-phenyl phenate, pyrimethanil, or thiabendazole. Alternative methods are needed because the widespread use of these chemicals in packinghouses has led to the proliferation of resistant strains of the pathogens, fungicide residues comprise marketing issues for some buyers, and the discharge of used solutions from packinghouses has come under increasing regulatory scrutiny. The aim of this test was to determine the efficacy of several generic compounds to control green mold and blue mold. Most are either exempt from or would have minimal residue and other regulatory requirements before they could be used. Freshly harvested, light green lemons cv. Eureka were randomized and then inoculated 24 hours before treatment by dipping a stainless steel rod with a 1 mm wide by 2 mm in length tip into a suspension containing10^6 conidia/ml of each pathogen and making a single puncture near the blossom end (blue mold) or stem end (green mold) on each fruit. *P. digitatum* and *P. italicum* isolates were cultured for two weeks at 25°C on potato dextrose agar. The temperature of the fruit at the time of inoculation and subsequent storage was 20°C. Five replicates of 20 fruit each were prepared for each treatment. The fruit were immersed for 60 seconds in a 2% (vol/vol) solution of H_2O_2 (30% a.i., hydrogen peroxide, Brenntag Pacific, Inc., Fresno, CA) containing 6 mM copper sulfate (Sigma-Aldrich Chemical Co., St, Louis, MO), either alone or followed by a second treatment of 60 seconds immersion in (2% a.i., wt/vol) solutions of potassium phosphite (54% a.i., Helena-Prophyt, Helena Chemical Co., Collierville, TN), potassium sorbate (99% a.i., Fruit Growers Supply, Exeter, CA), or sodium bicarbonate (99% a.i., Dwight and Church, Inc., Princeton, NJ).The fruit were not rinsed after treatment and the solution volume of each treatment was 20 liters. The temperature of the solutions was 25°C or 50°C (±1°C). For comparison purposes, fruit were also immersed for 15 seconds in a 50°C solution of 200 mg/L imazalil (Deccozil, 22.5% a.i., DECCO US Post-Harvest, Inc., Monrovia, CA), which simulates a common commercial packinghouse treatment. After treatment, the fruit were stored at 20°C and the number of infections counted after 7 days.

Both blue mold and green mold were controlled effectively by the combination of treatments of hydrogen peroxide followed by potassium phosphite, even when both of the solutions were 25°C. Applied alone, potassium sorbate and potassium phosphite were superior to hydrogen peroxide or sodium bicarbonate. Heating them improved their effectiveness. Hydrogen peroxide treatment followed by a second treatment with potassium sorbate or sodium bicarbonate was moderately effective at 25°C and improved markedly at 50°C. Imazalil completely controlled both diseases. Hydrogen peroxide injured the rind of some fruit when used at 50°C, but not 25°C. The sequence of hydrogen peroxide followed by potassium phosphite was the most promising treatment, primarily because the control of both diseases occurred without heating the solutions, which entails considerable expense and increases risk of injury to the fruit, they do not deposit residues in the fruit of concern, and disposal of used solutions containing these compounds in relatively easy to do, except copper sulfate would may be an issue in some locations and require approved disposal or reclamation.

	Disease Incidence (%)*			
	25 °C		50 °C	
Treatments	Green mold	Blue mold	Green mold	Blue mold
Water control	100 a	94 a	48 a	25 a
Hydrogen peroxide	60 b	48 bc	21 bc	15 a
Sodium bicarbonate	45 b	40 b	28 b	12 ab
Potassium sorbate	20 c	11 de	13 bcd	9 b
Potassium phosphite	16 c	7 e	11 bcd	4 b
Hydrogen peroxide → Potassium sorbate	26 c	28 cd	8 cd	3 b
Hydrogen peroxide → Sodium bicarbonate	15 c	13 de	1 d	1 b
Hydrogen peroxide → Potassium phosphite	1 d	0 f	0 d	0 b
Imazalil	…	…	0 d	0 b

*Values followed by unlike letters are significantly different according to Tukey's HSD ($P = 0.05$).