scaffolds
Update on Pest Management and Crop Development
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DISEASES

IN THE BIN

POSTHARVEST FUNGICIDES FOR APPLES IN 2009

(Dave Rosenberger, Plant Pathology, Highland)

❖❖ Apple storage decays can cause significant losses of apples held in long-term controlled atmosphere storages, especially when apples are stored for more than six or seven months. With some cultivars (e.g., Honeycrisp), storage decays can develop more quickly after harvest and can become significant even when fruit are held in regular air storage. The most common storage decays are blue mold caused by *Penicillium expansum* (Fig. 1) and gray mold caused by *Botrytis cinerea* (Fig. 2).

In the northeastern United States, neither blue mold nor gray mold is commonly found on apple fruit in the field. Blue mold develops almost exclusively as a result of spores that enter wounds or fruit stems during harvest and postharvest handling. Gray mold can also develop from wound infections. However, in New York, gray mold usually originates from the calyx of intact apple fruit and may result from *Botrytis* infections that occur during late bloom and then remain quiescent until fruit have been harvested.

The best options for minimizing blue mold decay in stored fruit include using clean bins, avoiding recycling drenches after harvest, and storing apples in sanitized storage rooms. This combina-

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Figure 1. Blue mold decay on Empire apple showing typical watery collapsed tissue and blue sporulation of *Penicillium expansum* on the stem.

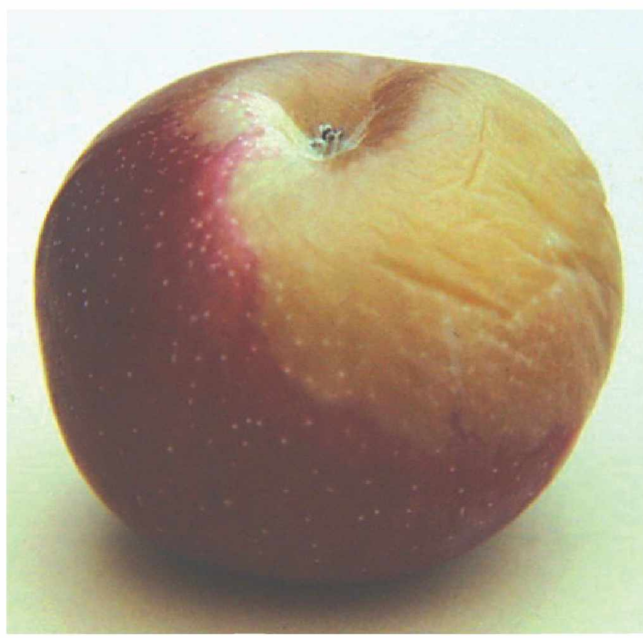

Figure 2. Gray mold decay caused by *Botrytis cinerea* that apparently invaded the fruit from the calyx end during controlled-atmosphere storage. *Botrytis* causes a firm, tan decay that leaves fruit looking much like a baked apple.

tion of sanitation practices will minimize exposure of fruit to spores of *P. expansum*. However, postharvest treatments with diphenylamine (DPA) may be needed to control storage scald and/or carbon dioxide injury. Also, in the absence of a postharvest fungicide treatment, three to five percent of fruit left untreated may develop gray mold in some years and on some cultivars. A fungicide should ALWAYS be included in any recycling drench solutions used to apply DPA because the recycling drenches accumulate decay spores and act as inoculum baths in the absence of fungicides.

The four fungicides labeled for postharvest applications on apples include captan, thiabendazole (Mertect 340F), fludioxonil (Scholar) and pyrimethanil (Penbotec). However, Scholar and Penbotec may not yet be acceptable for some export destinations. Some buyers may have additional restrictions that are more stringent than the legal limitations on fruit residues.

Following is a summary of advantages, disadvantages, and considerations for each of the postharvest fungicides that can be used on apples:

• Mertect 340F: the label rate for drenches is 1 pt/100 gal. Mertect is the only remaining benzimidazole (BZ) fungicide registered for postharvest use since registrations for Benlate and Topsin M were discontinued. In many storages, it is ineffective against blue mold due to BZ-resistant *Penicillium* that recycles on bins, but it still seems to work well in some smaller storages. Because of the unpredictability of resistance problems, Mertect should be used only in combinations with Captan. When combined with DPA, Mertect still controls gray mold (including the presumed latent infections on fruit calyces) because *Botrytis* has not yet developed resistance to the Mertect/DPA combination.

• Captan: the label rates for drenches are 25 oz/100 gal for Captan 80WDG and 1.25 qt/100 gal for Captec 4L. The pH of the drench water should be tested and acidified, if necessary, to keep the pH below 7, since Captan will degrade under alkaline conditions. Captan is relatively ineffective for protecting wounds if spores enter wounds just before or after Captan treatment. However, Captan slowly kills spores that collect in recycling drench solutions, thereby lowering inoculum levels. Where a Captan-Mertect combination is used, Captan lowers inoculum levels for both BZ-sensitive and BZ-resistant strains of *Penicillium*, but it is never 100% effective. Mertect arrests growth of BZ-sensitive spores that get into wounds before Captan can kill them, but will not control resistant isolates. Where inoculum density and/or incidence of BZ-resistance are low, the combined action of Mertect plus Captan may be adequate to suppress postharvest blue mold. Adding Captan with Penbotec or Scholar can help to reduce selection pressure for resistance to these newer fungicides.

• Penbotec: the label rate is 1 pt/100 gal. Penbotec is extremely effective against both BZ-sensitive and BZ-resistant strains of *Penicillium*. However, Penbotec-resistant strains of *P. expansum* are likely to develop if this product is used continuously as the sole fungicide for controlling postharvest decays. Two strategies are suggested for managing resistance to Penbotec. First, it is

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absolutely essential that storage operators alternate fungicides by using Penbotec one year and Scholar the next year since these products have equivalent efficacy but different modes of action. Using different products in successive years will ensure that spores on bins are not exposed to the same fungicide over extended periods of time. Second, using a combination of Penbotec plus captan should slow selection for resistance because Captan will reduce inoculum levels in recycling drenches. Using Penbotec-Captan combinations will be less effective for resistance management than yearly alternation between Penbotec and Scholar, so using a tank mix combination should not be substituted for alternating products from year to year. The very best strategy may be yearly alternations between Penbotec-Captan and Scholar-Captan combinations. However, the use of Captan may not be essential if the other two products are alternated yearly.

• Scholar has a 2(ee) label for blue mold and gray mold at rates of 10 fl oz/100 gal for Scholar SC and 6 oz/100 gal for Scholar 50W. These reduced rates make Scholar more cost-competitive with other options and still provide excellent control of blue mold and gray mold. As with Penbotec, continuous use of Scholar year after year will inevitably result in selection for Scholar-resistant strains of *Penicillium*. Resistance management strategies are the same as for Penbotec: Alternate the chemistry that is used from year to year and, where feasible, use Scholar in combinations with Captan.

In summary, Penbotec and Scholar provide apple storage operators with powerful new tools for managing storage decays, but these new fungicides will remain effective only if users manage them carefully to avoid selection for fungicide resistance. No postharvest fungicides may be needed if apples are moved directly to storage without DPA drenches. In other cases, a Mertect-captan combination may continue to provide adequate control of postharvest decays if sanitation measures are employed to keep inoculum levels low. ❖❖

IN THE BARN

SANITIZERS AND BIOCIDES FOR APPLE STORAGE AND PACKING OPERATIONS

(Dave Rosenberger, Plant Pathology, Highland)

❖❖ This article provides a brief summary of factors to consider when implementing sanitation in apple storages and packing facilities in eastern United States. First, we should clarify some terminology. Biocides and sanitizers both kill microorganisms, and most sanitizers could also be called biocides. However, the term “sanitizer” is commonly used for a product that is applied to hard surfaces AFTER the surface has been cleaned. Sanitizers are applied specifically to reduce microbial contamination. However, sanitizers will not kill microbes that are contained within decaying organic matter (e.g., a rotten apple) or within dirty films that accumulate on hard surfaces. Thus, sanitizers are effective only when applied to surfaces that have already been cleaned by removing visible organic matter and/or scrubbing with a detergent to remove dirty films. In general, quaternary ammonium products (quats) are the preferred sanitizers for hard surfaces in apple packinghouses and storages because quats are less affected by the combination of short exposure times and presence of underlying organic matter (e.g., wood in wooden bins) that often limits the effectiveness of hypochlorite solutions.

I prefer to use the term “biocide” for products that are introduced into water flumes to control microorganisms that would otherwise accumulate in water. The most commonly used biocide is sodium hypochlorite, the active ingredient in chlorinated water.

Activity of all sanitizers and biocides is affected by interactions among the following four factors:

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1. Product concentration
2. Exposure time
3. Temperature
4. Introduction of contaminating organic matter

In addition, activity of sodium hypochlorite is strongly affected by the pH of the treatment solutions. The pH of chlorinated flume water should always be maintained between 6.5 and 7.0. Quaternary ammonium products can be compromised by hard water, and a water conditioner may need to be added to hard water before the quaternary ammonium is added to preserve activity of the quat sanitizer.

Product concentrations that can be used in sanitation procedures are regulated by label restrictions. With quaternary ammonium sanitizers, the labels may allow a higher concentration if hard surfaces receive a clean water rinse following application of the sanitizer. Only lower concentrations are allowed for surfaces that will not be rinsed. For most applications in the apple industry, the lower concentration without a water rinse will be both adequate and easier to use.

When sodium hypochlorite is added to water flumes, the optimal concentration depends on a variety of factors. Although concentrations of up to 200 ppm of free chlorine are allowed on some product labels, concentrations above 100 ppm increase chances of injuring fruit. The standard recommendation has been to maintain the concentration of free chlorine between 50 and 100 ppm in water flumes where chlorine is added manually so as to ensure that an effective concentration will be maintained, even if there is a sudden influx of organic debris that neutralizes some of the hypochlorite. Where automated systems are used to meter in chlorine and buffer solutions on an as-needed basis, free chlorine concentrations as low as 15 to 25 ppm will prove effective. When chlorinated water is used in large pre-sort operations, using lower concentrations of hypochlorite will minimize salt accumulations in water flumes where it is not feasible to change out the entire volume of water on a regular basis. High levels of salts that sometimes accumulate in the water flumes of pre-sort lines can result in fruit injury.

Exposure time can be a limiting factor for effectiveness of both quaternary ammonium sanitizers and hypochlorite solutions, especially in situations where solution temperatures drop below 70°F. Where possible, quat sanitizers should be applied to warm surfaces using solutions that are close to ambient summer temperatures.

In addition to use of quaternary ammonium sanitizers, other options for sanitizing bins and storage rooms include fogging with peroxide compounds such as Stor-Ox. Fogging over an extended period provides the added contact time that is needed for effective sanitizing with this product. However, the temperature/exposure time relationship still holds, so sanitizing via fogging is best done with warm rooms and warm bins.

The same temperature/exposure-time limitations allow bins coming out of chlorinated water dumps on packing lines to retain large numbers of viable *P. expansum* spores. The temperature of flume water on packing lines is usually between 43 and 50°F because the water is constantly cooled by the introduction of the cold apples coming out of storage. At these temperatures, and assuming that the chlorinated water in the dump tank is adjusted to 100 ppm of free chorine, an exposure time of at least 15 minutes might be required for an effective kill of P. expansum spores on bin surfaces. Activity of the chlorinated water on wooden bin surfaces may be further reduced by interaction of the hypochlorite with wood fibers or with other adhering organic matter.

So, if using chlorinated water in flumes and bin dumps does not fully sanitize bins, why is it recommended? The reason for chlorinating water flumes is to prevent cross-contamination of large volumes of fruit by microorganisms that are introduced with

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the fruit from each bin that is emptied. Despite the fact that bins may not be fully sanitized in cold flume waters, spores of *P. expansum* that are released into the water will be exposed for much longer periods and will ultimately be killed by the hypochlorite. More importantly, bacteria are far more sensitive to hypochlorite than are spores of *P. expansum*, so bacteria introduced into the water flumes will be killed rapidly despite the cold water temperatures. Using chlorinating flume water on packing lines should be a standard practice for food safety reasons.

All of the commonly used sanitizers and biocides are oxidizers, so all of them will cause corrosion to some degree. The need to include a biocide in water dump tanks means that all packinghouse operators will probably need to switch to stainless steel tanks at some point because the older steel tanks are almost impossible to maintain when water is constantly chlorinated. Switching to stainless steel can be very expensive, but it is a change that will be necessitated by increasing concerns with food safety. Eventually, certification schemes will probably require that recirculating water flumes contain an effective biocide, and sodium hypochlorite will prove the easiest to use even though it is corrosive. ❖❖

INSECTS

IN THE FLESH

2009 FRUIT ARTHROPOD PEST REVIEW

(Art Agnello, Entomology, Geneva)

❖❖ It seems that no growing season can be considered as "normal" these days, and this one has distinguished itself as being among the coolest and wettest of summers we've ever had. I've gotten a number of inquiries from people who don't often pay attention to how the weather affects fruit growers, along the lines of whether "the rain has hurt the apples this year". While acknowledging that it's been a challenge keeping fruit diseases under control, I have generally concluded that most insect pests were not too bad this season, although strangely this didn't translate into having any less work or our being less busy keeping on top of things.

True to our typical go-stop-go weather patterns, the spring actually started off with a warmer May than we usually get, and the big cool-down didn't settle in until June. This helped to kick the early season pests out of bed, but didn't give them much impetus to move after that. Plum curculio got about two-thirds of the way through its egglaying period, and then seemed to be in a holding pattern for weeks, so that most orchards ended up needing two additional cover sprays to protect the fruit beyond petal fall. Flights of oriental fruit moth and codling moth similarly started pretty much on schedule, but didn't seem to develop the numbers we have been getting in recent years. In fact, reports of all the "worm" pests, including obliquebanded leafroller, tended to be uncharacteristically low during the first half of the summer.

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The rainy season had its usual effect of suppressing many of the foliar pests also, such as European red mite and pear psylla, although the flush of foliar growth that resulted encouraged populations of rosy apple aphids and green aphids, and woolly apple aphids were not difficult to find relatively early in the season. Taking advantage of the many weather fronts moving through the area, potato leafhoppers seemed to occur in several waves.

A brief but intense dose of true summer temperatures starting in mid-August created some interesting situations just as we thought everything was coasting toward a calm finish. The most notable was apple maggot, which evidently decided to claim 2009 as a breakout year, as we saw adult emergence at higher levels and for a longer period than has occurred in a long time. Not every orchard was targeted, but in the traditional problem spots, large numbers of flies emerged from the rain-softened soil and were caught by the dozens on a weekly basis. European red mites were also late-breaking news, as the summer eggs took advantage of the high temperatures to hatch out and blossom into some large motile populations that covered the foliage just as it was beginning its autumn decline, which effectively shut down most infestations.

Japanese beetle continued its run as a perennial nuisance, and internal leps are still in evidence at this time, although apparently not at crisis levels in most cases. Some other sporadic pests were also found, including stink bugs and San Jose scale, but we'll await reports from the harvest period before concluding that this covers all the bases. ❖❖

IN THE BAG

PACKING LINE

(Art Agnello & Dave Kain, Entomology, Geneva)

❖❖ With this issue, Scaffolds ceases publication for the season; we anticipate starting up again next March. In February, as usual, we'll send out an email to all current subscribers to set up next year's mailing list. Our thanks to all of you who have sent comments, suggestions, and articles our way, a practice we hope you'll continue. As a wrap-up, here's our annual summary of the year's pheromone trap results and an Index of Volume 18, 2009 of Scaffolds Fruit Journal.

KEY = GFW - Green Fruitworm; RBLR - Red-banded Leafroller; STLM - Spotted Tentiform Leafminer; OFM - Oriental Fruit Moth (in apples); LAW - Lesser Appleworm; CM - Codling Moth; SJS - San Jose Scale; APB - American Plum Borer (in cherries); LPTB - Lesser Peachtree Borer (in cherries); DWB - Dogwood Borer; PL - Pandemis Leafroller; OBLR - Obliquebanded Leafroller; PTB - Peachtree Borer; TABM - Tufted Apple Budmoth; VLR - Variegated Leafroller; AM - Apple Maggot; * - first catch of the generation
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Geneva Pest Trapping Results - Avg/Trap/Day

DATE	GFW	RBLR	STLM	OFM	LAW	CM	SJS	APB	LPTB	PTB	PL	OBLR
4/20	0.1	10.9	0.4*									
4/22	0.0	5.3	1.8									
4/27	0.0	19.1	21.5	1.4*								
4/30	0.0	29.7	65.0	8.2								
5/4	0.1	23.9	32.8	10.0								
5/7	0.0	13.7	27.3	4.7								
5/11	0.0	12.9	24.8	11.4				0.1*				
5/18		5.5	12.1	6.5	0.0	4.2*		0.3	0.3*			
5/21		2.8	13.0	1.2	0.3*	3.0	1083*	0.3	2.0			
5/26		2.0	2.5	0.5	0.5	1.8	500	0.6	0.6			
5/28		1.3	0.8	0.8	0.8	1.0	12.5	0.5	0.0			
6/1		1.5	0.5	0.6	0.1	1.0	0.6	0.5	0.5			
6/4		0.1	0.7	1.0	0.0	0.7	0.8	1.0	0.1			
6/8		0.1	0.3	0.1	0.0	0.5	0.0	0.5	0.1		0.5*	
6/11		0.0	0.3	0.3	0.8	1.0	0.0	1.2	1.3		0.7	
6/19		0.0	0.9	0.1	0.1	0.3	0.0	0.1	0.3		0.1	
6/22		-	4.0	0.0	0.7	0.0	-	0.0	0.0	0.0	0.3	
6/25		0.2	32.5*	0.0	0.3	0.0	0.0	0.2	0.7	0.2*	0.5	0.3*

Geneva Pest Trapping Results - Avg/Trap/Day

DATE	RBLR	STLM	OFM	LAW	CM	SJS	APB	LPTB	PTB	PL	OBLR	AM
6/29	0.4	18.6	0.0	0.6	0.1	0.0	0.1	1.0	0.3	0.3	0.0	
7/2	1.7	14.7	0.8	0.2	0.2	0.0	0.0	0.0	0.0	0.2	0.0	
7/6	1.9	9.4	1.4	0.0	0.1	0.0	0.1	0.3	0.0	0.1	0.0	
7/13	1.8	6.4	0.9	0.0	0.0	0.0	0.1	0.6	0.1		0.0	
7/16	2.0	13.2	1.0	0.0	0.1	0.0	0.1	0.3	0.0		0.0	
7/20	2.8	13.0	0.5	0.0	0.0	0.5	0.1	0.3	0.0		0.0	
7/23	1.2	11.5	0.5	0.0	0.1	133*	0.1	0.0	0.0		0.0	1.7*
7/27	2.6	5.5	1.0	0.1	0.1	139	0.0	0.0	0.1		0.0	1.3
7/30	3.0	3.8	0.3	0.0	0.2	1383	0.5	0.3	0.0		0.0	2.5
8/3	1.8	3.0	0.0	0.0	0.0	1713	0.0	0.0	0.1		0.0	2.4
8/6	0.5	9.0	0.2	0.0	0.3	108	0.7	0.0	0.0		0.0	1.3
8/10	1.0	2.5	0.8	0.1	0.9	688	0.3	0.0	0.0		0.0	1.5
8/13	0.8	23.0	0.5	0.2	0.5	1467	0.7	0.0	0.0		0.0	1.0
8/17	0.4	4.3	0.4	0.0	0.0	650	0.1	0.3	0.0		0.0	2.0
8/24	1.8	1.0	1.3	0.2	0.5	42.9	0.1	0.3	0.0			1.3
8/27	3.0	3.7	2.2	0.0	0.2	29.2	0.0	0.0	0.0			3.0
8/31	3.1	1.4	3.8	0.0	0.0	5.6	0.0	0.0	0.0			2.1

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Hudson Valley (Highland) Pest Trapping Results - Avg/Trap/Day

DATE	GFW	STLM	RBLR	OFM	LAW	CM	OBLR	TABM	VLR	AM
3/30	0.1*	0.0	1.0*	0.0						
4/6	0.6	2.6*	3.8	0.1*	0.3*					
4/13	0.1	5.0	2.6	0.1	0.0					
4/20	1.3	76.2	18.1	0.5	0.0					
4/27	0.4	115.7	14.8	8.6	0.0					
5/4	0.0	66.2	17.4	13.3	0.1	0.0				
5/11		1.6	1.5	3.9	2.0	0.4*				
5/18		6.3	2.4	4.2	2.9	1.5				
5/26		3.6	0.3	2.3	12.9	3.1				
6/1		0.1	0.1	0.4	4.5	0.3	0.2*			
6/8		36.6	0.0	0.3	17.9	1.7	4.6			
6/15		49.5	0.0	0.0	15.9	1.9	6.6			
6/22		145	1.4	0.1	8.6	1.8	1.4			
6/29		253	6.5	1.1	9.8	1.6	4.9	2.3*	0.5*	0.1*
7/6		183	5.9	3.5	5.3	0.6	3.6	0.6	0.1	0.2
7/13		183	5.9	1.4	3.6	0.4	2.4	0.4	0.1	0.2
7/20		153	4.9	1.1	5.3	0.7	0.6	0.1	0.0	0.3
7/27		168	2.4	1.6	9.4	2.0	0.2	0.0	0.4	0.3
8/3		148	1.8	1.1	13.1	2.1	0.1	0.0	0.5	1.6
8/11		130	2.0	1.1	26.4	3.3	0.1	0.1	1.6	2.7
8/17		85.5	3.4	0.5	26.1	1.9	0.0	0.1	0.6	1.8
8/24		37.8	10.7	1.9	21.6	0.1	0.1	0.0	0.0	1.9
8/31		4.5	10.7	2.0	8.8	0.0	0.3	0.5	0.0	0.8

Hudson Valley (Highland) Pest Trapping Results - Avg/Trap/Day

DATE	LPTB	DWB	PTB
5/26	0.6*	0.6*	
6/1	0.0	0.0	0.0
6/8	0.2	0.1	0.0
6/15	0.1	0.0	0.2*
6/22	0.0	0.1	0.0
6/29	0.2	0.7	0.4
7/6	0.1	0.0	1.3
7/13	0.2	0.2	2.1
7/20	0.4	0.1	2.2
7/27	0.1	0.1	2.0
8/3	0.4	1.3	3.2
8/11	0.3	0.4	2.9
8/17	1.0	0.1	1.3
8/24	0.1	0.0	0.3
8/31	0.0	0.0	0.0

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