

**A BRIEF HANDOUT TO AID IN THE IDENTIFICATION AND
CONTROL OF COMMON POSTHARVEST DISEASES
OF APPLES AND PEARS**

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USE OF THIS DECAY CONTROL HANDOUT

This guide is intended for use by the operators of packing and storage plants to assist them in minimizing decay problems which may cause fruit loss during the long storage periods required by today's marketing programs.

The information contained should allow you to determine the decay confronting you, the areas to attack to give you an advantage in its control, and a range of materials, which can be used in that control.

Start with the Decay Description (Table 1) to begin the identification process, and then use the Decay Classification Key (Table 2) to pinpoint the decay. It is quite possible that you will find more than one cause with any given situation. A picture identification sheet has been included to help in the identification process. Once the decay has been identified, go to the individual decay information sheet. This sheet will indicate the source of the problem, the primary point of infection and methods and materials generally used to control the decay at the primary point of infection.

You will note that the primary source of infection of some of the decay problems is in the orchard and will require involvement of your field staff and growers in order to do an adequate job of control.

Also included is a short discussion of warehouse sanitation in order to assist your understanding of the importance of that area of decay control.

This guide is intended to be as useful a tool as possible. If you have a suggestion for its improvement or additions you would like to see included, that can be easily done. Contact Dr. Gene Kupferman at the WSU Tree Fruit Research and Extension Center in Wenatchee (509 663-8181 ext. 239) if you would like to see changes made.

WAREHOUSE CLEANING AND SANITATION

The term sanitation generally refers to procedures in the warehouse that reduce or eliminate spore loads and includes those procedures, which we commonly call disinfecting treatments. Sanitation can only be effective if it follows a cleaning procedure. Clean first, then sanitize.

There are three areas of concern in the warehouse, each of which requires a different approach, using generally the same materials. These areas of concern are:

- Surfaces of plant and equipment
- Water used to drench, float or transport fruit
- Fruit surfaces

Materials commonly used for treatment of these problem areas are:

- Chloride dioxide, either foam or gas
- Quaternary ammonia compounds
- Ozone
- Hypochlorite-Chlorine

These materials are generally very quick acting with little or no residual action and require close attention in order to keep the treatment chemicals at the proper level of concentration for effective control.

Use these materials as recommended by the manufacturers, depending on the area in which the material is being applied.

TABLE 1. DECAY DESCRIPTION

Criteria	Blue Mold	Gray Mold	Mucor	Bull's-Eye
Texture of decay	Very soft, watery spots easily separated from healthy tissue; skin in involved areas loose and wrinkled, easily broken	Firm, does not separate easily from healthy tissue; skin in affected areas generally tight and tough	Soft, watery; involved tissue will separate easily from healthy tissue	Very firm with mealy texture; skin does not easily break
Color of decay	Light tan to dark brown, translucent, glassy	Pale tan to brown; translucent, on red varieties decay-affected areas may have freckled appearance	Light brown	Pale yellow to cream with brown, usually alternating to form a bull's-eye appearance
Shape	Initially small, round with sharp margins	Spreads from stem or calyx end in irregular pattern from initial infection or nesting; totally decayed fruit may retain shape with 'tough' feel	Lesions start usually as round but often become slightly irregular	Generally round, flat to sunken
Odor	Musty	Sweetish fermented	Alcoholic when well rotted	Non-distinctive
Growth/enlargement pattern	Rapid, increasing in depth at about the same rate as growth in diameter, resulting in a cone-shaped decayed area; does not nest	At normal refrigeration temperatures will develop more quickly than Blue Mold; growth follows an irregular pattern; will exhibit nesting	Advances even at 32 °F. Can involve the whole fruit in 30 to 60 days from first infection	Grows slowly at 32 °F; circular lesions usually remain relatively small, usually U-shaped, in cross-section; seldom does it involve the whole fruit
Location	Commonly invades wounds; can often enter through stems, open calyx or lenticels	Initial entry at stem or calyx end; during nesting phase can enter through undamaged skin	Enters stem end with organisms entering from stem abscission layer and moving down into the fruit; can also enter through calyx and juncture wounds	Generally on the sides of the fruit, often with early infection in the stem end or calyx

TABLE 1. DECAY DESCRIPTION

Criteria	Blue Mold	Gray Mold	Mucor	Bull's-Eye
Color of spore-bearing fungus	Initially short white tufts, turning greenish-blue to blue over time; low growing	Long, loose whitish strands; cottony appearance, turning gray as it matures	Long hair-like, dirty, cottony appearance; will eventually develop black nodes on the tips of cottony growths	In advanced stages, short, wet appearing, cream colored; can protrude through skin
Other	Fruit increases in susceptibility as it ages; in final stages fruit will collapse and become very sloppy	Does not seem to be directly related to maturity; fruit usually retains its original form in final stages of decay	Will exude large quantities of juice while still holding together as decay progresses; late harvested overmature fruit is more susceptible; appears as a "bag of water"	Good maturity will slow the progress of this disease
Margin between decay and healthy tissue	Very sharp	Diffuse	Sharp	Diffuse

TABLE 2. DECAY CLASSIFICATION KEY

Texture	Color of decay	Shape	Odor	Growth pattern	Location	Color of spore-bearing fungus	Other	Decay
Firm	Pale tan to brown	Irregular pattern, usually starting from stem or calyx end	Sweetish, fermented	Slow, irregular pattern	Initial entry through stem or open calyx, during nesting may enter through unbroken skin	Short, white, cottony appearing, turning gray in late stages	Totally involved fruit still retains much of its original shape	Gray Mold
	Pale yellow to cream alternating with brown; appearance of bull's-eye	Round, flat to sunken	Indistinctive	Slow, V-shaped areas of decay	Most often stem bowl or calyx; may also enter open lenticels	Wet appearing short, cream-colored; young lesions show no spare growth	Seldom involves the total fruit	Bull's-eye
Soft, watery		Round, sharp margins	Musty	Rapid, well-formed, cone-shaped area of decay	Primary entry through wounds; may also enter through stems, calyx or open lenticels	Short, white tufts, turning blue-green to blue	In final stages causes complete collapse of the fruit; very wet and sloppy	Blue Mold
	Tan to dark brown	Start as round lesions, often become irregular in shape, with irregular margins	Alcoholic	Rapid, irregular growth pattern	Generally enters through stem, secondarily through calyx and wounds	Long, dirty, cottony appearing; black nodes on lips	In final stages takes on appearance of elephant skin; will exude large amounts of juice while still retaining some original shape	Mucor

BLUE MOLD DECAY

Scientific name: *Penicillium expansum*

Problem location: Warehouse

Primary source of infection: Equipment and area contamination

Primary control: Cleaning, then sanitation

Areas of sanitation

Drench tank
 Dump tank
 Elevator rolls
 Brush bed, cleaning
 Sponge bed
 Brush bed, waxing
 Drying tunnel, including rolls
 Sorting tables
 Singulator
 Sizing cups
 Transfer belts
 Run-off aprons
 Tub liners/tubs
 Floors/walls
 Air filtration

Secondary control: Fungicide application

Discussion: Blue Mold organisms are present everywhere in the environment. However, because of their very nature, they are numerous in the storage and packing areas of the typical warehouse. They can enter the fruit through any break in the skin, even minute openings. The fruit is susceptible to infection at any time during its life cycle, particularly as it ages during storage.

Primary control: Cleaning and sanitation are the first line of defense against Blue Mold and can be quite successful if properly done. The following areas in the packing cycle are listed with a suggested frequency of cleaning and sanitation. In the final analysis, the severity of the infection problem will determine the areas treated and any changes in frequency.

Drench tank	Weekly	Somewhat dependent on the materials being used in the drench.
Dump tank		Each time the dump tank contents are changed or several times a week.

Elevator rolls	Daily	Twice a day if excessive decay is coming out of the dump tank.
Brush beds cleaning	Daily	Twice a day if decayed fruit is crossing the brush bed.
Sponge bed	As often as practical	A huge potential reservoir for decay spores.
Brush beds waxing	Daily	To maximize the wax job, brushes should be kept clean.
Drying tunnel (incl. rolls)	Weekly	Remove fruit and fruit pieces from the floor of the dryer.
Sorting tables	Daily	
Singulator	Weekly	
Sizing cups	Weekly	
Transfer belts	Weekly	
Run-off aprons	Weekly	
Tubs/tub liners	Weekly	
Floors/walls	Every 6 months	
Air filtration	Daily	

The following materials are available for sanitation:

- Chlorine Dioxide Foam
- Quaternary Ammonia Compounds
- Chlorine

Use in accordance with manufacturer's label.

Secondary control:

The following fungicides will give protection when used in accordance with the manufacturer's label recommendations.

TBZ (Mertect)—Some resistance to TBZ (Mertect) has been found so it is recommended that multiple applications be avoided and that they be used in conjunction with the other fungicides in order to obtain the best possible results.

SOPP—on pears only

Captan

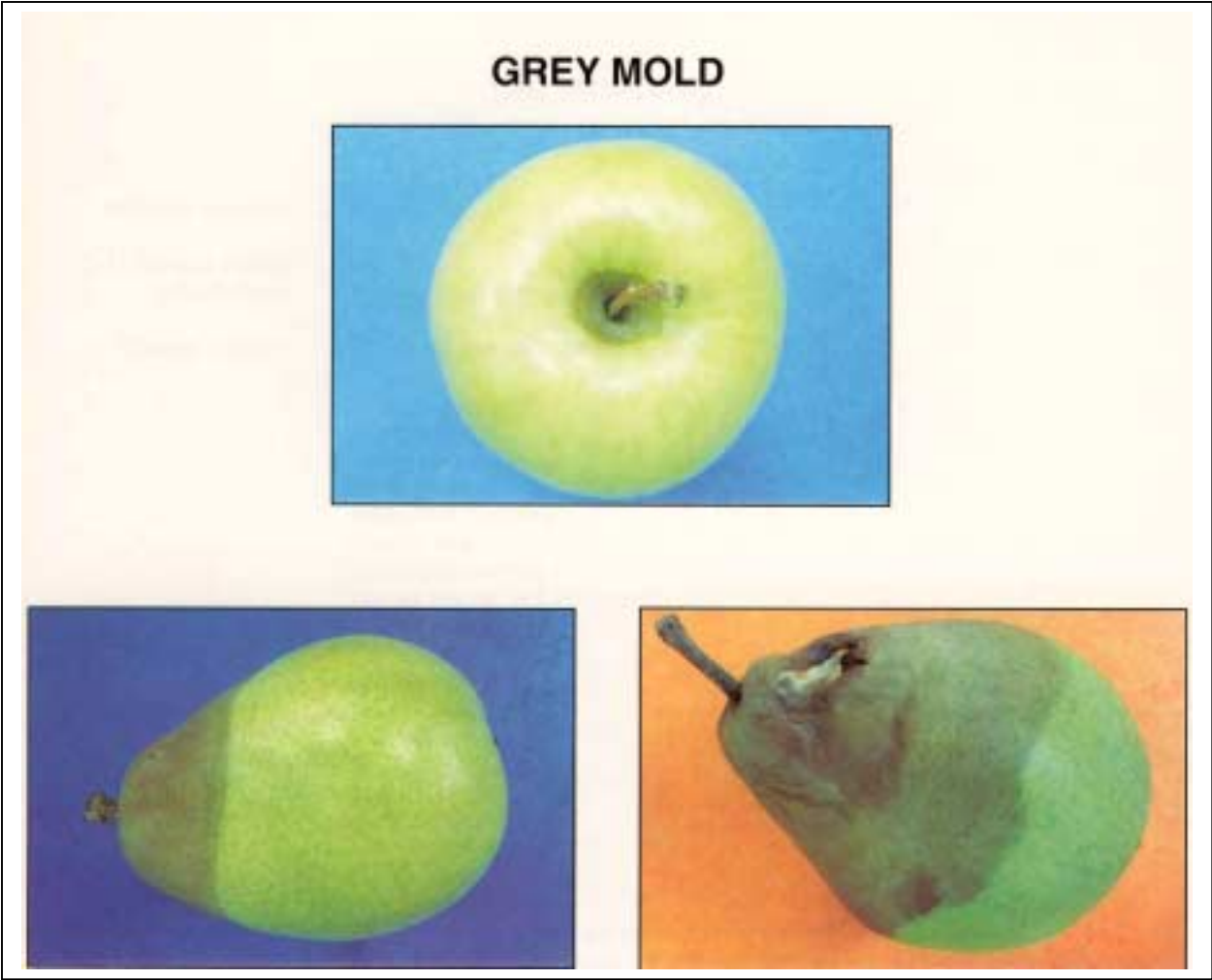
Biocontrol agents are currently under evaluation



GRAY MOLD DECAY

Scientific name: *Botrytis cineria*

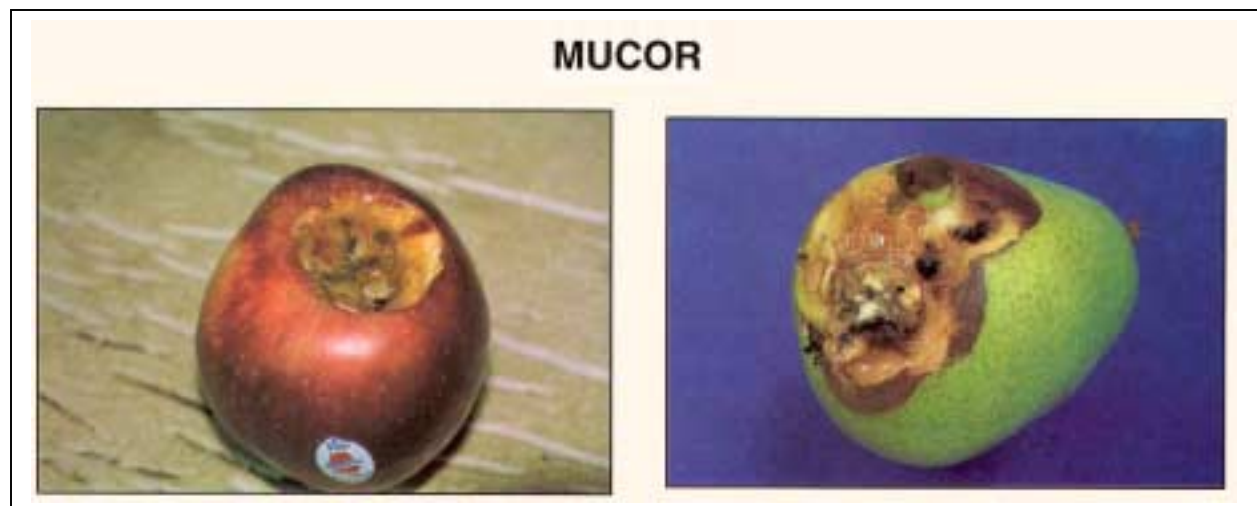
- Problem location: Warehouse/orchard
- Primary source of infection: Decaying organic matter
- Primary control: Harvest practices
- Secondary source of infection: Warehouse contamination
- Secondary control: Fungicide intervention
- Discussion: The most severe infestations of Gray Mold occur during or shortly after harvest. The most common entrance point on pears is down through the stem, entering when the fruit is separated from the tree or when in the bin. It can also enter through wounds, openings or by contact with other infected fruits. On apples, the entrance is most commonly in the stem bowl or calyx. The infecting spores are to be found in decaying organic matter, weeds and dropped fruit and, to some degree, on the surface of the soil.
- Control in orchard: The best defense against Gray Mold is to reduce the presence of infecting spores in the orchard. The following is suggested to accomplish this:
- Do not mow your orchard within 30 days of harvest. This will reduce the amount of freshly decaying organic matter.
- Remove any decayed or decaying fruit from the orchard floor.
- Clean and disinfect your picking bags prior to harvest. Do not throw picking bags on the ground. Store them temporarily by hanging them in the tree.
- Control in warehouse: Make sure your bins do not contain any residual decayed fruit. Any warehouse treatment must occur shortly after harvest to be effective. The more deeply the infection has penetrated into the fruit the more difficult it becomes to control. The use of the following fungicidal materials during the packing cycle may give protection against secondary infections occurring during packing and storage.
- TBZ (Mertect)
SOPP-on pears only
Biocontrol agents are currently under evaluation
Captan
- Use in accordance with label recommendations.
- It is recommended to use more than one of these materials in sequence in order to reduce the potential of developing resistant strains.



MUCOR DECAY

Scientific name: *Mucor* spp.

- Problem location: Warehouse/orchard
- Primary source of infection: Soil
- Primary control: Harvest practices
- Secondary source of infection: Warehouse contamination
- Secondary control: Fungicide intervention
- Discussion: *Mucor* is a soil-borne organism. Its primary point of infection is in the orchard during the movement of bins into the orchard and after they are filled and being transported from the picking area to the collection point and on to the warehouse. Care must be exercised to keep the forks of the forklift clear of dirt and grass clumps. The bin side runners must be kept clean.
- Control in orchard: Keep the bins and fruit clean of dirt and grass clumps. Remove decayed and decaying fruit from the orchard prior to harvest.
- Control in warehouse: While the primary protection from *Mucor* needs to occur during harvest in the orchard, some secondary infections can be prevented in the warehouse by the application of the following materials:
- TBZ (Mertect)
 - SOPP-on pears only
 - Biocontrol agents are currently under evaluation
 - Captan
- Use in accordance with label recommendations.
- It is recommended to use more than one of these materials in sequence in order to reduce the potential of developing resistant strains.



BULL'S-EYE DECAY

Scientific name: *Pezizula malicorticis*

Problem location: Orchard

Primary source of infection: Perennial canker lesions

Primary control: Orchard sprays

Discussion: Bull's-eye results from spores of perennial canker infecting fruit during the growing season. It can happen at any time while the fruit is on the tree, from shortly after bloom until harvest. Once the fruit has been infected, there is very little that can be done during the packing cycle to control this disease.

Control: Spray as many times as is required, using the manufacturer's label recommendations for perennial canker control.

Clean, treat and paint perennial canker lesions on the trees.

Spray for woolly apple aphid control. This particular insect keeps tree wounds open and susceptible to perennial canker infestations.

Control the use of overhead sprinklers in blocks with perennial canker infestations. Water falling through the tree can wash spores from the lesions onto the fruit.

