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Controlling Apple Storage Scald

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APPLE STORAGE SCALD (common scald) is a troublesome physiological disorder affecting apples during and following storage under refrigeration and controlled atmospheres. It is associated with advanced aging of the fruit, and consequently it becomes more prevalent and severe as the storage and marketing season is prolonged.

Although its actual cause is not proven, it can be controlled by chemical means and regulated somewhat by the application of good handling and storage practices.

Storage scald initially appears as a superficial browning of the skin of the green-colored portion of the fruit. With further development, it affects the red-colored skin, and eventually the browning may extend as deep as one-quarter inch into the flesh.

Sometimes it is evident when the apples are taken from storage; at other times it becomes apparent only after the fruit is taken from storage and exposed to room temperatures. In such cases it is not detected until after the apples have entered distribution and market channels. Also, slight scald apparent at the time of packing may become severe by the time the apples reach the consumer.

Scald does not usually adversely affect the eating quality of the fruit, yet its unsightly appearance markedly reduces marketability. The scalded tissues, unless the disorder is extremely severe, are removed by peeling of the apples in preparation for processing.

Susceptible Varieties

Many apple varieties are susceptible to storage scald, but it is most commonly observed on *Rome Beauty*, *Stayman*, *Turley* and *Cortland*. It is a frequent and sometimes serious problem on the popular fresh market varieties of *McIntosh* and *Delicious*. The *Rhode Island Greening* scalds but there is less

concern about it on this processing variety than on fresh market fruit.

Idared and *Jonathan* occasionally develop enough scald to affect marketability. The soft scald (ribbon scald) disorder of *Jonathan*, however, is an entirely different disorder that requires separate control measures.

The *Golden Delicious* variety occasionally develops a scald disorder, similar in appearance to that on other varieties, but only on the more mature and most yellow fruit rather than on fruit picked somewhat immature and of greenish undercolor as characteristic for other varieties, so it is called "senescent scald."

The only important storage variety in Michigan which does not scald is *Northern Spy*.

There is always the danger of economic loss due to the development of scald on susceptible varieties which are stored more than two or three months after harvest. Its development can be somewhat delayed by prompt storage of the fruit after picking, by rapid cooling of the apples to the storage temperature and by employing the lowest possible storage temperatures in keeping with the varietal requirements. CA storage may delay the development of scald but will not prevent it. Adequate control can be obtained only by the use of chemical scald inhibitors.

Chemical Control

Two chemical inhibitors are approved and suitable for use on apples: diphenylamine (DPA) and ethoxyquin (6-ethoxy-1,2-dihydro-2,2,4-trimethylquinoline). DPA occasionally causes injury on *Rome Beauty* and its several strains; it appears as blackened areas of dead tissue where the material has accumulated and has become concentrated upon evaporation. Ethoxyquin on *Golden Delicious* may result in

the formation of a scald-like brownish stain of the skin. It is less effective than DPA on *Delicious*. On the other hand, ethoxyquin sometimes gives better scald control than DPA on other varieties, particularly when used on cold apples several weeks after harvest.

There are residue tolerances established by law for both materials and label directions for the use of these chemicals must be followed explicitly.

Application

The most economical method of application is by drenching or flooding the fruit in bins as it is received from the orchard and prior to placement into storage. Bin applicators vary in design and size. Some handle individual bins; others drench stacked bins while still loaded on the truck or trailer used for hauling the fruit to the storage.

Rapid and complete coverage of all the apples with the chemical is essential; therefore, 10 to 15 gallons per minute of liquid should be supplied to each square foot of top area being drenched. To assure adequate coverage of fruit in the bottom bin when stacked 2 or 3 high, the bin floor should have ample openings between the boards or enough holes to permit this rate of liquid flow. The liquid should fall a distance no greater than 18 inches onto the fruit to avoid damage to the apples by penetration of the chemicals into the lenticels and calyx opening. A given stack of fruit should be drenched until the liquid flows in good volume from the bottom bin. Several minutes of drainage is needed to permit most of the nonadhering liquid to return to the applicator reservoir when the drenching is completed.

Less practical methods of application, such as dipping the bins of fruit or tree sprays to the fruit just prior to harvest, may be used as long as good coverage is

obtained. Multiple applications must be avoided to prevent excessive residues on the fruit.

Materials and Concentrations

Use DPA at 2,000 ppm on all varieties, with the possible exceptions of *Rome Beauty* and *Golden Delicious*, or 2,700 ppm ethoxyquin on all varieties except *Red* and *Golden Delicious*. The slight scald that occurs on *Jonathan*, *Idared*, and late-picked *Rome Beauty*, and senescent scald on *Golden Delicious* can be controlled with 1,000 ppm DPA without the hazard of injury.

Good mixing of the application liquid is necessary to maintain either of the scald inhibitors in suspension or emulsion, and therefore, maintain the proper concentration to assure scald control. Recirculating systems with a positive flow of the material at the bottom of the reservoir tank to the pump are best. Low-pressure pumps are preferred to centrifugal pumps since the extensive agitation developed by the latter may cause the emulsion to break and create frothing. This frothing or foaming carries away the fine particles of chemical and reduces the concentration in the system. The liquid lost as a result of application to the fruit should be replaced at the proper concentration. Liquid that is dirty in appearance or which deposits a soiled residue or stain on the fruit should be discarded. Aging for several weeks and the presence of orchard debris does not seem to destroy the effec-

tiveness of a scald inhibitor, so it can be saved for occasional use over a period of time, provided good mixing can be achieved each time.

Additives

Wetting agents or other adjuvants need not be added to provide good wetting and coverage of the fruit. Frothing or foaming, if either becomes a problem, can be reduced by the use of defoamers as needed.

Fungicide, either thiabendazole (TBZ) or benomyl, should be added to the scald inhibitor liquid to prevent the widespread development of blue mold or soft rot and gray mold diseases on the apples during the subsequent storage and handling. The label directions for postharvest application of these materials should be followed.

Timing and Temperature

Best control of storage scald is achieved when the fruit is treated at normal orchard temperatures within a day or so after harvest. Cold fruit, directly from the orchard or from storage for up to 2 weeks after harvest, can be effectively treated for scald control, but the maximum concentration of DPA or ethoxyquin must be applied. The chemicals become less effective as the treatment is delayed; however, it is better to make a late application of the material to apples intended for long-term storage than not at all.

Source of Scald Inhibitors

DPA is available as wettable powder or liquid suspension; ethoxyquin is available as a liquid. Cautious use of either is essential, and the label directions for safe and proper use should be followed. Used materials and containers should be disposed of in the proper manner.

Label Fruit

Market containers of treated fruit must be labeled. For ethoxyquin the label should read: "*Treated with ethoxyquin to retard spoilage*"; for DPA: "*Treated with diphenylamine to retard spoilage*." The letters must be as large as other lettering on the container. Labeling of the master container is adequate for bagged apples.

Check for Scald

In years of severe scald development, the inhibitors may not give complete control, or other factors may reduce their effectiveness. Therefore, whether or not you have treated the fruit, check it periodically, such as every 2 to 3 weeks, after several months of storage have elapsed. Samples of fruit should be held at room temperature for scald development. Lots showing a scald potential can often be marketed immediately without difficulty.

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