



APPLE SUPERFICIAL SCALD: RECENT ADVANCES FOR ITS CONTROL

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ABSTRACT

Keywords:

Apple (*Malus × domestica*) is an important temperate fruit of India, cultivated over 0.31 million ha with a production of 1.9 million tonnes annually, accounting for over 2.5% of the global production. It contributes 2.8% and 4.3% of the total fruit production and area of India respectively (N.H.B. 2014). Apple export in world is about 8624 lakhs and from India it is just more than Rs.50 cr. Annually (A.P.E.D.A. 2015) but post-harvest loss of fruits is still very high due to several postharvest disorders (N.H.B. 2014). Although, several problems are limiting its storage, consumption and export, but superficial scald is one of the main reason of storage loss in apple cultivars especially in Granny Smith, Gala, Red Delicious (David, 2009). There is urgent need to use eco-friendly approaches to reduce superficial scald, as the commercial method of treatment by D.P.A. and ethoxyquin are getting banned due to health safety concerns (Crouch, 2013). Studies says that the causes of this malady is Reactive Oxygen Species (R.O.S.) (Edna, 2012). Long storage (Anet, 1972) and Oxidative mechanism (Whitaker, 2004). The recent effective environmental and health friendly methods are mentioned in this article like Low oxygen pre-treatment just after harvesting and controlled oxygen concentration during C.A. storage proved to be a promising control agent (Edna, 2012). Combined effect of C.A. storage with ethanol treatment has been reported to reduce Apple Scald (Chervin, 2001). In the similar way preharvest use of ethaphone is also shown the promising results (Padfield, 2011). Thus, with standardisation of nontoxic safe methods along with preharvest and postharvest techniques the effective controls can further be explored for decreasing the incidence of apple scald and to maintain the storage and export quality of apple fruit.

What is superficial scald / storage scald of apple?

Storage scald is the diffuse browning of the skin of apples that appears after storage. Storage scald has also been called superficial scald and common scald.

Appearance

There are no crisp margins between affected and unaffected tissue. This browning is only skin deep and the flesh is usually not affected. The discoloration is usually irregular in shape varying from light brown to dark brown. It can occur on any part of the skin. In some cases the lenticels are not affected, leaving uninjured green spots.

Occurrence

Storage scald appears most often on the less colored side of red colored fruit mainly the side of the fruit facing the inside of the tree, but randomly on green cultivars. It is also found on less mature fruit. Storage scald appears only after the fruit has been in either regular storage or controlled atmosphere storage.

Severity Storage scald is the most economically serious postharvest disorder of apples and pears and is very severe in some apple cultivars.

Disorder Progression

Storage scald most often appears after fruit have been removed from storage. Except in the most severe cases, scald does not appear on fruit while in storage and develops

following removal from storage. Storage scald develops faster at warmer temperatures, thus warming the fruit during packing will speed visualization of the disorder. Apples with scald will usually visualize the maximum amount of scald within a few days at ambient temperatures, or longer if temperatures are colder. Thus it is quite common for apples to look fine leaving the packinghouse, but develop serious scald symptoms by the time they reach the consumer in a distant market.

How to differentiate superficial scald from other postharvest apple disorders

Other types of skin browning are often confused with scald, including soft scald, which is a problem of senescence or low temperature breakdown. Soft scald has discrete brown lesions that are smooth, slightly sunken and confined to the equatorial parts of the apples. There is a sharp margin between affected and unaffected tissue. The flesh may be pale brown, soft and spongy.

There is also the disorder called delayed sunburn that develops on apples in storage from heat either immediately prior to harvest or following harvest. Varieties that have multiple harvests may have fruit with this problem when previously shaded fruit become exposed to the sun. It is also possible to develop this problem on fruit on the top of the bin following harvest is exposed to the sun. Delayed sunburn is not seen clearly at harvest, but develops over

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time in storage. It is often round and may be quite burned in appearance. It will not worsen over time following storage nor will any postharvest treatment reduce its development.

Factors influencing superficial scald

Scientists have connected a number of factors with the risk of storage scald. Here are some of the factors.

1. **Variety** – apple varieties vary in their susceptibility to storage scald.
2. **Maturity** – less mature fruit will scald more easily than more mature fruit.
3. **Orchard temperatures** – scientists have been examining weather records to determine their correlation with the risk of scald. See the next section (Orchard Climate and Scald) for this discussion.
4. **Red color** – varieties with greater coverage of red skin color will scald less than striped or tricolor apples. The green portion of the fruit will scald more easily than the red portion. Fruit from the center of the tree will scald more easily.
5. **Nutrient content** – fruits with high nitrogen and low calcium content have a greater risk of scald. Fruits with higher potassium have a greater risk of scald.
6. **Fruit size** – larger fruit have a tendency to scald more than smaller fruit. Very small, immature fruit from the inside of the tree also will scald easily.
7. **Soil moisture content** – orchards with low moisture content will have a greater risk of scald.
8. **Spraying** – spraying Granny Smith fruit with Ethephon has shown that scald can be reduced, but not as effectively as when diphenylamine (DPA) is used.

Orchard climate and scald

There are two aspects of orchard temperatures that relate to the risk of storage scald. These are the accumulation of cold (night time) temperatures and the temperature during the day.

Scientists at several fruit growing locations have determined that cold temperatures immediately prior to harvest reduce the risk of storage scald. Temperatures below 10 °C (50 °F) in the month prior to harvest correlate well with diminished risk of scald. For example, in orchards in Washington State, there is less risk of storage scald to Granny Smith apples than when the same variety is grown in California where they do not get cold temperatures close to harvest. In fact, the Washington Apple Maturity Program has been relying upon accumulated cold temperatures as an important indicator of harvest maturity. Thus, when Red Delicious accumulate 150 hours below 10 °C, the risk of scald is minimal and growers feel it is safe to harvest.

Analysis of cold units accumulated below different base temperatures has shown that using 10 °C gives a correlation superior to other threshold temperatures. However, the strength of the correlation varies by location. Base 10 °C is stronger in the eastern United States than in the west and the base 10 °C has not proven to be consistently applicable under New Zealand conditions. The number of days below 10 °C is a better indicator than hours below 10 °C.

A model is being developed using harvest date, starch score, and the number of pre-harvest days below 10 °C to predict whether a given lot of Red Delicious apples will develop

severe, moderate or slight scald. It is worthwhile to note that as scald risk decreases, as indicated by the model, the concentration of DPA necessary to control scald also decreases. Thus, storage operators may be able to reduce the concentration of DPA as the harvest season progresses.

However, this may not work in all growing regions. A region in which temperatures are normally cool may need a drop in temperatures to increase scald protection to a greater degree than in a growing region in which the temperatures are warmer.

Then there is the effect of high (daytime) temperatures. English researchers report that usually high temperatures during the growing season increase the risk of scald. In Washington, temperature above 25 °C (77 °F) during the month prior to harvest increases the risk of scald.

Low moisture or rainfall will do likewise.

Advanced control measures of superficial scald

Postharvest chemical control

Ever since the discovery of DPA in the 1950s there has been little research into alternative chemicals for the control of storage scald. Prior to DPA, mineral oil was used on the fruit as a liquid or paper wrap to control scald. Since the registration of DPA, only the chemical ethoxyquin has been added for scald control. Ethoxyquin is not as effective as DPA and is labelled for use only on pears in the United States at the present time. There were a number of trials in which DPA and ethoxyquin were tested together and alone against scald on various apple cultivars.

DPA must be applied soon after harvest and is most effective on fruit at ambient temperature. It is applied as a dip or drench, most often at 2,000 to 2,500 ppm. Delaying control even by as little as 10 days after harvest can reduce the effectiveness of DPA.

DPA use is currently under review by the U.S. Environmental Protection Agency, and indications are that it will be reregistered for use in the United States.

The fogging of DPA into closed storage rooms has not been tested in the United States, as it is not a legal treatment. It has been used in Europe and South Africa with mixed results.

Other chemicals such as sesame oil, Vitamin E, ascorbic acid (Vitamin C), BHT, BHA and other antioxidants have been tested and although they reduce scald, they have not been as effective as DPA. Postharvest drenches with calcium salts have been shown to reduce the severity of scald only slightly.

Postharvest non-chemical control

A number of strategies have been employed to reduce the risk of storage scald thorough manipulation of the storage atmosphere. Let's consider several of them.

Ultra-low oxygen storage

In a number of storage rooms in British Columbia, Canada, growers are storing Red Delicious apples without any scald treatment by coupling information on risk, as indicated by

orchard temperatures and maturity, with very low levels of oxygen (0.7%). Ultra-low oxygen (ULO) reduced scald better than application of DPA. One must remember that they are doing this effectively with Red Delicious and are located in a growing district with cooler temperatures than that in Washington or California. And have been doing this commercially successfully for several years.

Initial Low Oxygen Shock (ILOS)

Exposure of Granny Smith to 0.5% oxygen reduced scald over continuous storage at 1% in Australia, but this did not positively affect Red Delicious. In another case, LOS (10 days at 0.5% oxygen) followed by CA (1% oxygen, 3% carbon dioxide, 1 °C and at 34 °F) without DPA controlled scald on Granny Smith and Red Delicious in South Africa. ILOS also markedly reduced scald in Granny Smith, Rome and Red Delicious.

Purging CA Systems

Storage scald is reduced on fruit that are well ventilated. Researchers have reported successful control of scald using a hollow fiber membrane air separator in a purge mode to supply air at 1.5% oxygen with carbon dioxide below 3% at 0 or 3 °C (32 or 37 °F).

The atmosphere is established within 7 days of loading the room and fruit are held in a continuous purging system. The purge was at a rate sufficient to maintain the atmosphere.

Temperature

Scientists have noted that superficial scald is a true low temperature disorder. Raising the temperature in the storage reduces scald but quality would be adversely affected.

Ethylene

The elimination of ethylene to below 1 ppm has been reported to delay the development of scald in England, but not in Canada. It has shown only limited benefit in Michigan tests as well.

Carbon Dioxide

Elevated levels of carbon dioxide (10% for Golden Delicious) have also been shown to reduce scald in certain cultivars. It must be remembered that cultivars differ in their susceptibility to damage by carbon dioxide, which may be external and/or internal.

Ethanol vapour

Research showed that the application of ethanol vapour suppressed scald following storage. Ethanol vapour at 6,000 ppm for 1 to 2 weeks at the start of storage reduced scald after 4 months in CA, but not for longer periods. This was more effective with Red Delicious than with Rome or Granny Smith.

Ventilation

Restricted ventilation increased the risk of scald in a number of studies. Thus fruit in polybags or packed have a greater risk of scald than those stored in open bins.

Length of Time in Storage

Reducing the time in storage has been shown to reduce the risk of scald in limited instances. It is thought many of the chemical reactions that promote scald take place within the first month of storage, and with increased time in storage the risk rises.

Pre storage heating

Research showed that hot water treatment (50 °C for 60 seconds) can effectively reduce scald in Granny Smith, but skin color and condition can be affected. The effective temperature is very close to the injury temperature, so conditions must be perfect. It is interesting to note that applying warm DPA is more effective than cold. This may be the reason for uneven results when DPA is applied on fruit already in storage.

Conclusion:

By following under listed best methods concluded through which one can control apple superficial scald in a holistic manner.

1. Choose an orchard site with a large shift in day/night temperature at harvest
2. Choose varieties low in susceptibility
3. Keep apples supplied with calcium; minimize nitrogen application
4. Promote a uniform crop on the tree
5. Harvest fruit slightly more mature
6. Keep track of cold temperatures and add to harvest indicators
7. Cool fruit rapidly
8. Use antioxidants when indicated
9. Store suitable fruit in ULO
10. Use purge rather than re-circulating CA
11. Maximize ventilation
12. Minimize the length of time in storage

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