# IMPACT OF POSTHARVEST DISEASES AND THEIR MANAGEMENT IN FRUIT CROPS: AN OVERVIEW

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## INTRODUCTION

Postharvest disease may occur at any time during postharvest handling, from harvest to consumption. Losses caused by postharvest diseases are greater than generally realized because the value of fresh fruits increases several fold while passing from the field to the consumer. Postharvest losses are estimated to range from 10 to 30% per year despite the use of modern storage facilities and techniques. When estimating postharvest disease losses, it is important to consider reductions in fruit quantity and quality, as some diseases may not render produce unsalable yet still reduce product value. Postharvest diseases affect a wide variety of crops particularly in developing countries which lack sophisticated postharvest storage facilities. Infection by fungi and bacteria may occur during the growing season, at harvest time, during handling, storage, transport and marketing, or even after purchase by the consumer. It is also important to take into account costs such as harvesting, packaging and transport when determining the value of produce lost as a result of postharvest wastage. Aside from direct economic considerations, diseased produce poses a potential health risk. A number of fungal genera such as *Penicillium, Alternaria* and *Fusarium* are known to produce mycotoxins under certain conditions. Generally speaking, the greatest risk of mycotoxin contamination occurs when diseased produce is used in the production of processed food or animal feed.

Losses due to postharvest disease are affected by a great number of factors including:

1. Commodity type
2. Cultivar susceptibility to postharvest disease
3. Postharvest environment (temperature, relative humidity, atmosphere composition, etc.)
4. Produce maturity and ripeness stage
5. Treatments used for disease control
6. Produce handling methods
7. Postharvest hygiene.

Virtually all postharvest diseases of fruit are caused by fungi and bacteria. In general, however, viruses are not an important cause of postharvest disease. The so-called 'quiescent' or 'latent' infections are those where the pathogen initiates infection of the host at some point in time (usually before harvest), but then enters a period of inactivity or dormancy until the physiological status of the host tissue changes in such a way that infection can proceed. Examples of postharvest diseases arising from quiescent infections include anthracnose of various tropical fruit caused by *Colletotrichum spp.* and grey mould of strawberry caused by *Botrytis cinerea*. The other major groups of postharvest diseases are those which arise from infections initiated during and after harvest.

**Postharvest diseases of fruit crops:** Fruit crops are attacked by a wide range of microorganisms in the postharvest phase. Actual disease only occurs when the attacking pathogen starts to actively grow in the host. Diseases are loosely classified according to their signs and symptoms. Signs are visible growths of the causal agents, and symptoms the discernible responses produced by the host. Postharvest diseases are caused primarily by microscopic bacteria and fungi, with fungi the most important causal agent in fruit crops. Fungi are further subdivided into classes and are described as lower fungi, characterized by the production of sporangia which give rise to numerous sporangiospores, or higher fungi, described as ascomycetes, deuteromycetes, and basidiomycetes.

Ascomycetes are exemplified by fruiting bodies that release sexual spores when mature. Deuteromycetes, a form of ascomycetes, only release asexual spores. They are more common than the sexual ascomycetes stage in postharvest crops. Deuteromycetes are further subdivided into hyphomycetes and coelomycetes based on spore and structural characteristics. The agonomycetes contain important soil pathogens that form survival structures known as sclerotia that allow them to survive in the absence of the host. Table 1 lists many important diseases of fruit crops according to host and causal agents (Hartman, J. 2010).

**Causes of postharvest disease of fruit crops:** Correct identification of the pathogen causing postharvest disease is central to the selection of an appropriate disease control strategy. Many of the fungi which cause postharvest disease belong to the phylum Ascomycota and the associated fungi Anamorphici. In the case of the Ascomycota, the asexual stage of fungus (anamorph) is usually encountered more frequently in postharvest diseases than the sexual stage of the fungus (teleomorph). Important genera of anamorphic postharvest pathogens include *Penicillium, Aspergillus, Geotrichum, Botrytis, Fusarium, Alternaria, Colletotrichum, Dothiorella, Lasiodiplodia* and *Phomopsis*.

In the phylum Oomycota, the genera Phytophthora and Pythium are important postharvest pathogens, causing a number of diseases such as brown rot in citrus (*Phytophthora citrophthora* and *P. parasitica*). *Rhizopus* and *Mucor* are important genera of postharvest pathogens in the phylum *Zygornycota*. *R. stolonifer* is a common wound pathogen of a very wide range of fruit, causing a rapidly spreading watery soft rot. Genera within the phylum Basidiomycota are generally not important causal agents of postharvest disease, although fungi such as *Sclerotium rolfsii* and *Rhizoctonia solani*. The major causal agents of bacterial soft rots are various species of *Erwinia, Pseudomonas, Bacillus, Lactobacillus* and *Xanthomonas*. Bacterial soft rots are very important postharvest diseases generally of less importance in most fruit (Table 1).

**Host physiological status:** The development of postharvest disease is intimately associated with the physiological status of the host tissue. To create the right environment for minimizing postharvest losses due to disease it is important to understand the physiological changes that occur after produce is harvested. All plant organs undergo the physiological processes of growth, development and senescence. Growth and development generally only occur while the organ is attached to the plant (with the exception of seed germination and sprouting of storage organs), but senescence will occur regardless of whether the organ is attached or not. When an organ such as a fruit is harvested from a plant, it continues to respire and transpire depleting both food reserves and water. Maturity is a term often used in reference to fruit and is frequently confused with the term ripeness.

Fruit are often classified into two groups on the basis of how they ripen (Table 2). Climacteric fruit exhibit a pronounced increase in respiration and ethylene production coincidentally with ripening. **Climacteric fruit** can be harvested in an unripe state and providing they are sufficiently mature, will ripen to an acceptable quality. **Non-climacteric fruit** do not exhibit a rapid increase in respiration during the ripening process. The eating quality of non-climacteric fruit does not improve after harvest, although they may undergo some changes in colour development and softening. For this reason they should not be harvested until they are ready to eat.

**Table 1:-** Common postharvest diseases and pathogens of fruit crops.

| S. No. | Fruit crops | Disease | Pathogen |
|---|---|---|---|
| 1 | **Temperate fruits** | Blue mould | *Penicillium spp.* |
| 2 | Pome fruit | Gray mould | *Botrytis cinerea* |
| 3 | | Bitter rot | *Colletrotrichum gloeosporioides* |
| 4 | | Alternaria rot | *Alternaria spp.* |
| 5 | Stone fruit | Brown rot | *Monilia spp.* |
| 6 | | Grey mould | *Botrytis cinerea* |
| 7 | | Blue mould | *Penicillium spp.* |
| 8 | | Alternaria rot | *Alternaria alternata* |
| 9 | Grapes | Grey mould | *Botrytis cinerea* |
| 10 | | Blue mould | *Penicillium spp.* |

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|---|---|---|---|
| 11 | Berries | Grey mould | *Botrytis cinerea* |
| 12 | | Cladosporium rot | *Cladosporium spp.* |
| 13 | | Blue mould | *Penicillium spp.* |
| 14 | **Subtropical fruit** | Blue mould | *Penicillium italicum* |
| 15 | Citrus fruit | Green mould | *Penicillium digitatum* |
| 16 | | Black centre rot | *Alternaria citri* |
| 17 | | Stem end rot | *Phomopsis citri* |
| 18 | Avocado | Anthracnose | *Colletotrichum gloeosporioides,* |
| 19 | | Anthracnose | *Colletotrichum acutatum* |
| 20 | | Stem end rot | *Dothiorella spp.* |
| 21 | | Bacterial soft rot | *Erwinia carotovora* |
| 22 | **Tropical fruit** | Anthracnose | *Colletrotrichum musae* |
| 23 | Banana | Crown rot | *Fusarium spp.* |
| 24 | | Black end | *Nigrospora spharica* |
| 25 | | Ceratocystis fruit rot | *Thielaviopsis paradoxa* |
| 26 | Mango | Anthracnose | *Colletrotrichum gloeosporioides* |
| 27 | | Stem end rot | *Phomopsis mangifera* |
| 28 | | Black mould | *Aspergillus niger* |
| 29 | | Alternaria rot | *Alternaria alternate* |
| 30 | | Grey mould | *Botrytis cinerea* |
| 31 | | Blue mould | *Penicillium expansum* |
| 32 | Pawpaw (Papaya) | Anthracnose | *Colletrotrichum spp.* |
| 33 | | Black rot | *Phoma caricae papaya* |
| 34 | | Phomopsis rot | *Phomopsis caricae papaya* |
| 35 | Pine apple | Water blister | *Thielaviopsis paradoxa* |
| 36 | | Fruit let core rot | *Penicillium funiculosum* |
| 37 | | Yeasty rot | *Saccharomyces spp.* |
| 38 | | Bacterial brown rot | *Erwinia ananas* |

**Table 2:-** Classification of some common edible fruit is according to respiratory behavior during ripening.

| S. No. | Climacteric fruit | Non-climacteric fruit |
|---|---|---|
| 1 | Apple | Blackberry |
| 2 | Apricot | Carambola |
| 3 | Avocado | Cherry |
| 4 | Banana | Grape |
| 5 | Blueberry | Grapefruit |
| 6 | Custard apple | Lemon |
| 7 | Guava | Lime |
| 8 | Kiwi fruit | Longan |
| 9 | Mango | Litchi |
| 10 | Pawpaw (Papaya) | Mandarin |
| 11 | Passion-fruit | Orange |
| 12 | Peach | Pineapple |
| 13 | Pear | Raspberry |
| 14 | Plum | strawberry |

**Mode of infection:** Infection of fruit by postharvest pathogens can occur before, during or after harvest. Infections which occur before harvest and then remain quiescent until some point during ripening are particularly common amongst tropical fruit crops. Anthracnose, which is the most serious postharvest disease of a wide range of tropical and sub-tropical fruit such as mango, banana, papaya and avocado, is an example of a disease arising from quiescent infections established prior to harvest. Various species of *Colletotrichum* can cause anthracnose. In avocado for example, early studies reported that ungerminated appressoria were the quiescent phase of *C. gloeosporioides*. Studies conducted two decades later however showed that appressoria germinated to produce infection hyphae prior to the onset of quiescence. In any case, the fungus ceases growth soon after appressorium formation and remains in a quiescent state until fruit ripening occurs.

In avocados, antifungal dienes are present in the peel of unripe fruit at concentrations inhibitory to *Colletotrichum gloeosporioides*, the avocado anthracnose pathogen. Grey mould of strawberry caused by *Botrytis cinerea* is another important postharvest disease sometimes arising from quiescent infections established before harvest. Conidia of *B. cinerea* on the surface of necrotic flower parts germinate in the presence of moisture. The fungus colonises the necrotic tissue and then remains quiescent in the base of the floral receptacle. Many postharvest diseases develop from the stem end of fruit. The mode of infection involved in this group of diseases can however vary considerably. In the example of *B. cinerea*, lesions occurring at the stem end of fruit arise from quiescent floral infections. Stem end rots of citrus caused by *Lasiodiplodia theobromae* and *Phomopsis citri* result from quiescent infections in the stem button of fruit. In other stem end rot diseases, infection occurs during and after harvest through the wound created by severing the fruit from the plant (e.g. banana crown rot). Endophytic infection, where by the fungus symptomlessly and systemically colonises the stem, inflorescence and fruit pedicel tissue, is important in a number of stem end rot diseases of tropical fruit. Mango stem end rot caused by *Dothiorella dominicana* is one example of a postharvest disease arising from endophytic colonisation of fruit pedicel tissue. In this case, the fungus colonises the pedicel and stem end tissue of unripe fruit, where it remains quiescent until fruit ripening commences.

Postharvest diseases which can arise from late season infections include brown rot of peach (*Monilinia fructicola*) and grey mould of grape (*Botrytis cinerea*). Mechanical injuries such as cuts, abrasions, pressure damage and impact damage commonly occur during harvesting and handling. Some chemical treatments used after harvest, such as fumigants used in insect disinfestations and disinfectants such as chlorine, may also injure produce if applied incorrectly. Tropical fruit in particular are very sensitive to low temperatures, many developing symptoms of chilling injury below I3$^0$C (depending on storage duration). For example, the incidence of *alternaria rot* in pawpaw and apple is increased by exposure to excessive cold. For example, hot water dipping of mangoes for excessive times or temperatures can result in increased levels of stem end rot (*Dothioretla spp*.).

## PREHARVEST FACTORS THAT INFLUENCE POSTHARVEST DIESIESES

**Weather:** Weather affects many factors related to plant diseases, from the amount of inoculum that overwinters successfully to the amount of pesticide residue that remains on the crop at harvest. Abundant inoculum and favorable conditions for infection during the season often result in heavy infection by the time the produce is harvested. For example, conidia of the fungus that causes bull's-eye rot are rain dispersed from cankers and infected bark to fruit especially if rainfall is prolonged near harvest time, causing rotten fruit in cold storage several months later.

**Physiological condition:** Condition of produce at harvest determines how long the crop can be safely stored. For example, apples are picked slightly immature to ensure that they can be stored safely for several months. The onset of ripening and senescence in various fruits renders them more susceptible to infection by pathogens. On the other hand, fruits can be made less prone to decay by management of crop nutrition.

**Fungicide Sprays:** Certain pre-harvest sprays are known to reduce decay in storage. Several studies have been done on the effectiveness of pre-harvest ziram fungicide application on pome fruit and show an average reduction in decay of about 25 to 50% with a single spray (Coats, *et al.* 1995). Iprodione has been used for several years as a pre-harvest spray 1 day before harvest to prevent infection of stone fruit by *Monilinia spp*. In combination with wax and/or oil its decay control spectrum is increased and it will also control postharvest fungi such as Rhizopus, and Alternaria. The new class of strobilurin fungicides promises to provide postharvest control of several diseases in fruits. They are especially effective against fruit scab on apples and should reduce the presence of pin point scab in storage.

## POSTHARVEST FACTORS THAT INFLUENCE DECAY

**Packing Sanitation:** It is important to maintain sanitary conditions in all areas where produce is packed. Organic matter (culls, extraneous plant parts, soil) can act as substrates for decay-causing pathogens. For example, in apple and pear packinghouses, the flumes and dump tank accumulate spores and may act as sources of contamination if steps are not taken to destroy or remove them. Chlorine readily kills microorganisms suspended in dump tanks and flumes if the amount of available chlorine is adequate. A level of 50 to 100 ppm of active chlorine provides excellent fungicidal activity. Chlorine measured as hypochlorous acid can be obtained by adding chlorine gas, sodium hypochlorite, or dry calcium hypochlorite. Although chlorine effectively kills spores in water it does not protect wounded tissue against subsequent infection from spores lodged in wounds. Organic matter in the water inactivates chlorine, and levels of chlorine must be constantly monitored. Recently, in precisely controlled tests in water or as foam, chlorine dioxide was found to be effective against common postharvest decay fungi on fruit packinghouse surfaces (Dubey, S.R. 2012).

**Postharvest Treatments:** Products used for postharvest decay control should only be used after the following critical points are considered:

Type of pathogen involved in the decay.

1. Location of the pathogen in the produce.
2. Best time for application of the treatment.
3. Maturity of the host.
4. Environment during storage, transportation and marketing of produce. Specific materials are selected based on these conditions and fall into either chemical or biological categories listed below.

**Fungicide treatments:** Several fungicides are presently used as postharvest treatments for control of a wide spectrum of decay-causing microorganisms. However, when compared to preharvest pest control products the number is very small. For example, intensive and continuous use of fungicides for control of blue and green mold on citrus has led to resistance by the causal pathogens of these diseases. Chemical treatments that are presently used are thiabendazole, dichloran, and imazalil. However, resistance to thiabendazole and imazalil is widespread (Kleynen, *et al.* 2005) and their use as effective materials is declining. These products include sodium benzoate, the parabens, sorbic acid, propionic acid, $SO_2$, acetic acid, nitrites and nitrates, and antibiotics such as nisin.

**Biological control:** Postharvest biological control is a relatively new approach and offers several advantages over conventional biological control.

1. Exact environmental conditions can be established and maintained.
2. The bio-control agent can be targeted much more efficiently.
3. Expensive control procedures are cost-effective on harvested food.

Several biological control agents have been developed in recent years, and a few have actually been registered for use on fruit crops. The first biological control agent developed for postharvest use was a strain of Bacillus subtitles. It controlled peach brown rot, but when a commercial formulation of the bacterium was made, adequate disease control was not obtained.

**Irradiation:** Although ultraviolet light has a lethal effect on bacteria and fungi that are exposed to the direct rays, there is no evidence that it reduces decay of packaged fruits. More recently, low doses of ultraviolet light irradiation (254 nm UV-C) reduced postharvest brown rot of peaches. In this case, the low dose ultraviolet light treatments had two effects on brown rot development; reduction in the inoculum of the pathogen and induced resistance in the host. Gamma radiation has been studied for controlling decay, disinfestation, and extending the storage and shelf-life of fresh fruits. A dose of 250 Gy has an adverse effect on grapefruits increasing skin pitting, scald, and decay. Low doses of 150 for fruit flies and 250 gray (Gy) for codling moth are acceptable quarantine procedures (Makinen and Soderling 1980). Gamma irradiation may be used more in the future once methyl bromide is no longer available to control insect infestation in stored products. All uses of methyl bromide are being phased out to avoid any further damage to the protective layer of ozone surrounding the earth.

**Temperature and relative humidity:** Proper management of temperature is so critical to postharvest disease control that all other treatments can be considered as supplements to refrigeration. Fruit rot fungi generally grow optimally at 20 to 25$^0$C (68 to 77$^0$F) and can be conveniently divided into those with a growth minimum of 5 to 10$^0$C (41 to 50$^0$F) or -6 to 0$^0$C (21.2 to 32$^0$F). Fungi with a minimum growth temperature below -2$^0$C (28.4$^0$F) cannot be completely stopped by refrigeration without freezing fruit (Shine, *et al.* 2007). High temperature may be used to control postharvest decay on crops that are injured by low temperatures such as mango and papaya. Heating of pears at temperatures from 21 to 38$^0$C (69.8 to 100.4$^0$F) for 1 to 7 days reduced postharvest decay. Decay in 'Golden Delicious' apples was reduced by exposure to 38$^0$C (100.4$^0$F) for 4 days and virtually eliminated when treated after inoculation (Kader, A.A. 1999).

**Modified or controlled atmospheres:** Alterations in $O_2$ and $CO_2$ concentrations are sometimes provided around fruit and vegetables. Because the pathogen respires as does produce, lowering the $O_2$ or raising the $CO_2$ above 5% can suppress pathogenic growth in the host. In crops such as stone fruits, a direct suppression occurs when fungal respiration and growth are reduced by the high $CO_2$ of the modified atmosphere (Shen and Huang 2003). Low $O_2$ does not appreciably suppress fungal growth until the concentration is below 2%. Important growth reductions result if the $O_2$ is lowered to 1% or lower although there is a danger that the crop will start respiring an aerobically and develop off-flavor (Makino and Hirata 1997).

**Integrated control of postharvest diseases:** Effective and consistent control of storage diseases is dependent upon integration of the following practices:

1. Select disease resistant cultivars where possible.
2. Maintain correct crop nutrition by use of leaf and soil analysis.
3. Irrigate based on crop requirements and avoid overhead irrigation.
4. Apply pre-harvest treatments to control insects and diseases.
5. Harvest the crop at the correct maturity for storage.
6. Apply postharvest treatments to disinfest and control diseases and disorders on produce.
7. Maintain good sanitation in packing areas and keep dump water free of contamination.
8. Store produce under conditions least conducive to growth of pathogens.

Integration of cultural methods and biological treatments with yeast bio-controls has been studied on pears

(Belasque, *et al*. 2008). These results demonstrated that unrelated cultural and biological methods that influenced pear decay susceptibility can be combined into an integrated program to substantially reduce decay. As a general rule, alternatives to chemical control are often less effective than many fungicides. Therefore, it will generally be necessary to combine several alternative methods to develop an integrated strategy to successfully reduce postharvest decay.

## POSTHARVEST LOSSES AND THEIR MANAGEMENT

Postharvest disease, disorders or losses in quality have economic impacts vastly greater than the actual losses caused by frequency and intensity of their occurrence. For example there are direct financial losses incurred by the grower from batches of fruit expressing the disease and disorder. Direct losses can also cause financial losses for postharvest operators and marketers. Another point to remember is that the loss of value of a downgraded product is likely to be substantially greater for highly differentiated branded products which sell at a premium in the market. All the hard work that has gone into promoting and raising the profile of a branded product can be quickly eroded if there are postharvest quality problems with some lines of that product.

**Management:** Horticultural produce is alive and has to stay alive long after harvest. Like other living material it uses up oxygen and gives out carbon dioxide. It also means that it has to receive intensive care. For a plant, harvesting is a kind of amputation. In the field it is connected to roots that give it water and leaves which provide it with the food energy it needs to live. Once harvested and separated from its sources of water and nourishment it must inevitably die. Horticultural managers must possess many skills to succeed in this. They need a keen appreciation of horticultural diversity. For example, apples and bananas each have their own requirements (Wang, *et al.* 1996).

**Harvest handling:** The care taken during harvesting is repaid later, because fewer bruises and other injuries mean less disease and enhanced value. Good managers train their pickers so that they select the product at the correct stage of maturity with adequate care. It is worthwhile reducing the amount of hard physical work required in picking fruit as far as possible.

**Pre-cooling:** The harvested produce has to be transported to the packing shed without delay. In the field the heat of the sun and the respiration of the produce combine to heat up the produce, especially in the centre of field bins. This accumulation of "field heat" reduces the postharvest life of the product and has to be removed quickly. Strawberries for example, respire nearly eight times faster at a field temperature of $25^0$C as they do in a storage temperature of $0^0$C. Pre-cooling requires a greater refrigeration capacity than doe's cool storage and is often best done as a separate step. Hydro-cooling with cold water drenches, forced air cooling through stacks that ensure proper air distribution and packing with ice are the systems most commonly used, with the choice depending on the individual requirements of the commodity.

**Natural fungicides:** Many compounds produced naturally by microorganisms and plants have fungicidal properties. Chitosan, for example, is not only an elicitor of host defence responses but also has direct fungicidal action against a range of postharvest pathogens. Antibiotics produced by various species of *Trichoderrna* have potent antifungal activity against *Botrytis cinerea, Sclerotinia sclerotiorum, Corticium rolfsii* and other important plant pathogens. There are many other natural compounds which have been isolated and shown to possess considerable antifungal activity (Dubey and Jalal 2013).

Postharvest fungicides can be applied as dips, sprays, fumigants, treated wraps and box liners or in waxes and coatings. Dips and sprays are very commonly used and depending on the compound, can take the form of aqueous solutions, suspensions or emulsions. Fungicides commonly applied as dips or sprays include the benzimidazoles (e.g. benomyl and thiabendazole) and the triazoles (e.g. prochloraz and imazalil). The benzimidazole groups of fungicides are very useful for the control of many important postharvest pathogens such as *Penicillium* and *Colletotrichum*, Fumigants, such as sulphur dioxide for the control of grey mould (*Botrytis cinerea*) of grape and various postharvest diseases of litchi, are sometimes used for disease control. Other fumigants used in certain situations include carbon dioxide, ozone and ammonia. Fruit wraps or box liners impregnated with the fungicide biphenyl are used in some countries for the control of *Penicillium* in citrus. Fungicides to control postharvest diseases of citrus and some other fruit are often applied to the fruit in wax on the packing line.

**Refrigeration:** Refrigeration is the most important tool for extending the life of fruit. In a typical cool store. To maintain a storage temperature of $0^0$C the temperature of the coils will have to be appreciably below $0^0$C. Moisture is therefore removed from the air and this accumulates as ice on the coils. The lower the average temperature of the cooling coils, the more moisture will be removed. The drier and cooler air then circulates around the room where it warms and picks up moisture. The more moisture that freezes on the refrigerator coils, the greater the frequency of defrosts cycles and these make good temperature management control more difficult to attain. An even distribution of air produces a room with a consistent temperature, but if the flow of cooled air is "short circuited" back to the coiling coils, the areas starved of circulation will become warmer.

**Quality control:** Most consumers have been disappointed with the quality of fresh produce they have purchased at one time or another. Fruit are to be stored or transported over long distances may have to be picked in an immature state so that the fruit are firm and store or travel well. In recent years, much work has been done to improve the quality of fruit. New varieties have been introduced which gives consumers a wider choice and some, such as new varieties of nectarine have improved flavor. However, despite the best efforts to handle fresh produce in the optimum way there will always be compromises to be made which affect the final quality of the product. Much of the fresh produce we eat must travel many kilometers to reach the central or wholesale market or distribution centre and from there it travels to local or distant retail outlets. Good handling will ensure that the final consumers are satisfied and so will return again to buy that product (Vander Steen, *et al.* 2001).

## CONCLUSIONS

A wide variety of fungal and bacterial pathogens cause postharvest disease in fruits. Some of these infect produce before harvest and then remain quiescent until conditions are more favourable for disease development after harvest. Other pathogens infect produce during and after harvest through surface injuries. In the development of strategies for postharvest disease control, it is imperative to take a step back and consider the production and postharvest handling systems in their entirety. Many preharvest factors directly and indirectly influence the development of postharvest disease, even in the case of infections initiated after harvest. Traditionally fungicides have played a central role in postharvest disease control. However, trends towards reduced chemical usage in horticulture are forcing the development of new strategies. All fruits are storage as the average temperature for the good marketing whereas fruit crops are affected by the many pathogens on postharvest. Thus, proper growth of postharvest technology of fruits is vital for development of India's economy.

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