Bio-Science Research Bulletin
http://www.bpasjournals.com

Original Research Article

Print version ISSN 0970 0889
Online version ISSN 2320 3161
DOI: 10.5958/2320-3161.2021.00005.5
Vol. 37 No. 1, January-June 2021: P.17-22

Integrated Management for Post-Harvest Diseases of Fruits and Vegetables

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Received on 22.03.2021
Accepted on 25.05.2021

ABSTRACT
The post-harvest diseases known as the diseases which developed during harvesting of part of the plants like fruits, vegetables and seeds. Due to high moisture content and nutrient in harvested fruits and vegetables they are vulnerable to attack by pathogenic organism. Injuries of fruits and vegetables maybe caused during harvesting, packing, transposition, storage and after consumer purchase. They help in pathogen to enter the host and cause damage. The plant parts may get infected in field, but expression of symptom may take place later, at any stage before final consumption. The post-harvest disease that causes spoilage of both durable and perishable commodities is wide spread. The capability of a microorganism to initiate post-harvest diseases, as well as its final outcome, depend on number of factors that can conveniently be associated with, microorganism, host and the environment. This study discussed the physical, chemical and biological integrated methods for the control of post-harvest diseases.

KEYWORDS: Fruits, Vegetables, Post-harvest, Pathogen, Diseases, Biological

INTRODUCTION

Post-harvest means the study of specialized area deals with the problems during picking, packing, transportation and storage of vegetables and fruits. Due to post harvest diseases fruits and vegetables are lost their nutrients. Important nutrients and fibers which are essential for the growth of human were lost (Tripathi et al., 2013). When estimating post-harvesting disease, it is important to consider reduction in fruit quantity and quality as some disease may not render produce unsaleable yet still reduce the product value. Virtually all post-harvest disease of the fruits and vegetables are caused by fungus and bacteria. In some root of brassica and other crops, viral infection present before harvest can sometimes develop more rapidly after harvest. So we can say that post-harvest disease is own classified according to how infection is initiated in the fruits and vegetables. Disease caused by pathogen. Pathogen enters after harvesting. During harvesting fruits and vegetables injured and pathogen attacks into the fruits and vegetables (Table 1). Total 10-30% yield of crops is destroying by post-harvest diseases (Agrios, 2005). In India total 20-30% loss of crop yield during post harvesting of fruits and vegetables (Sumbali et al., 2001).

For example, blemished fruit may not be sold as fresh fruit but may still be stable for processing in which case, it brings a lower price. Some fruits are mention below the table in which pathogen attack.

Table 1: Post-harvest diseases of fruits and vegetables

Sr. No	Fruits& Veg.	Causing pathogen	Diseases	References
1	Apple	*Glomerella cingulate, Penicillium expansom*	Bitter rot Blue mold	Blum et al., 2004 McLaughlin et al.,1990
2	Banana	*Colletotoichummusae* *Fusarium roseum*	Anthrancnose Crown Rot	Blum et al., 2004
3	Pineapple	*Thielaviopsis paradxin* *Saccharomyces*	Water blistes Yeasty Rot	Tian et al., 2002
4	Mango	*Aspergillus niger* *Botrytis cinerea*	*Rhizopus*Rot Grey Mold	Zhang et al., 2007a
5	Avocado	*Colletotrichum gloeosportoides, Botryosphaeria*	Anthracnose, Stem Rot	Blum et al., 2004
6	Tomato	*Botrytis cinerea, Fusarium*	Grey Mold, *Fusarium* rot	Zhang et al., 2007a Tian et al., 2002
7	Cucurbit	*Botrytis cinerea, Fusarium*	Grey Mold, *Fusarium*rot	Tian et al., 2002
8	Brassicas	*Botrytis cinerea* *Alternaria* spp.	Grey Mold, *Alternaria*Rot	Zhang et al., 2007a
9	Peach	*Rhizopus stolonifer* *Botrytis cinerea*	*Rhizopus*rot, Grey Mold	Zhang et al., 2007a Tian et al., 2002
10	Plum	*Lasiodiplodia theobromae*	Brown Rot	Pusey and Wilson, 1984
11	Strawberry	*Alternaria* spp. *Botrytis cinerea,*	*Alternaria* rot, grey mold rot,	Smith and Worthington, 1965
12	Cherry	*Botrytis cinerea*	*Botrytis* rot	Utkhede and Sholberg,1986

TYPES OF POST-HARVEST DISEASES

1. **Pathogenic Diseases**: When pathogens directly interact to vegetables and fruits and decrease to yield of crops example Fungi, Bacteria and viruses. A large number of fungi are responsible for storage diseases of fruit and vegetables. *Rhizopus* spp. highly loss of tomatoes, grapes, cucurbits, peaches and strawberries. Pathogens are green mold blue mold, soft rot, dry rot and black rot diseases are found in crops.

2. **Non Pathogenic Diseases**: Some diseases without pathogen mean during the picking packaging and during storages no proper regulation of the vegetables and fruits causing the diseases. Pathogen not directly interact the vegetables and fruits. For example when potatoes and apples are stored in a poorly ventilated room CO_2 level is highly in atmosphere and low level of O_2.

MODE OF INFECTIONS

Infection of fruits and vegetables by post-harvest pathogen can occur before, during or after harvest. Infection occurs before harvest and then remains quiescent until some point during ripening are particularly common amongst tropical fruits crops. Anthracnose which is the most serious post-harvest disease of a wide range of tropical and sub-tropical range of tropical and sub-tropical fruits such as mango, banana, papaya and avocado is an example of disease arising from quiescent infection established prior to harvest (Singh, 2013).

The infection process begins when conidia germinate on the surface of host tissue to produce a germ tube and an aspersorium, although it is known like cycle of fungus

(Pandey et al., 1987). It is not entirely clear whether the germinated aspersorium represents the quiescent stage. Different study have reported conflicting results it may be that fungus behave differently on different hosts, or perhaps some researchers have been unable to detect appressorial germination due to limitations and the technique used. Natural antifungal compound present in fruits tissue may be involved in regulating the quiescence of *Collectotrichum* infection (Beno-Moualem and Prusky, 2000).

Grey mold of strawberry caused by *Botrytis cineria* is another important post-harvest disease sometimes arising from quiescent infections established before harvest (Weber and Hahn, 2000).

Conidia of *B. cineria* on the surface of necrotic flower parts germinate in the presence of moisture. The fungus colonies the necrotic tissue and then remain quiescent in the base of the floral receptacle. Several months later when fruits are harvested infection develop as a stem end and fruit. Many post-harvest diseases develop from the stem, fruit and the mode of infection involved into the group. Many common post-harvest pathogens are unable to direct penetrate the host cuticle. The natural resistance of fruits and vegetables to diseases declines with storage during and ripeness. Weak pathogen which normally require wound in order to infect can become a problem in produce that has been stored for long period of time.

HOST PHYSIOLOGY STATUS

The development of post-harvest disease is intimately associated with physiological status of host tissue all plant organs under goes the physiological process of growth, development and senescence (Nooden, 2012).

Growth and development generally only occur while the organ is attached to the plant (with exception of seed germination and sprouting of storage organs) but senescence will occur regardless of whether the organ is attached or not. Maturity is a term often used in reference to fruits and is frequently confused with the term ripeness.

Fruits are often classified into two groups on the basis of how they ripen: -

Climacteric fruits:
Exhibit a pronounced increase in respiration and ethylene production co-incidentally with ripening climacteric fruits can be harvested in an unripe state and providing, they are sufficiently mature will ripen to an acceptable quality.

Non climacteric fruits:
Do not exhibit a rapid increase respiration during the ripening process. The eating quality of non-climacteric fruits does not improve after harvest, although they may undergo some changes in color, development and softening. For this reason, they should not be harvested until they are ready to eat.

Traditional strategies for post-harvest disease control and prevention:
Fungicides:
Fungicides are used to extensively for post-harvest diseases control in fruit and vegetables. Fungicides used to depend primarily on the target pathogen and when infection occurs. For post-harvest pathogen which infects produce before harvest, field application of fungicides is often necessary. Regularly sprayed with a protectant fungicide such as mancozeb during flowering and fruit development. If rain occurs during flowering, systemic fungicide is applied to inactivate infections already established and guard against new infection. In the case of infection which occurs during and after harvest, fungicides can be used to interrupt pathogen development. Disinfection such as sodium hypochlorite can be used kill pathogen propagules on the surface of fruit, but are unable to control pathogen once they gained entry to host tissue.Dips and sprays are commonly as dips or sprays include the benzimidazole and the triazoles. The benzimdazoles group of fungicides is very useful for the control of many important post-harvest (Prusky et al., 1985).

Fumigation:
Sulphur dioxide fumigants used for the control of grey mould of grape and various post-harvest diseases of lychee (Kore and Chakraborty, 2014).

FRUIT WRAPS, WAXING, COATING AND PACKING

Post-harvest fungicides can be applied as dips sprays, fumigants, treated wraps and box liners or in wax coating. Potassium iodide wraps control of apples diseases by *Gliocladium roseum* (Sumbali and Mehrotra, 1983). Use of Carbendazim and Thiabendazole using with fruits in newspaper impregnated and checked blue mold rot when stored in cold storage (El-Ghaouth et al., 1992).

Maintenance of host resistance to infection through manipulation of the post–harvest environment. Temperatures are perhaps the single most important factor influencing diseases development after harvest. Low temperature storage of fruits and vegetables is used extensively to delay ripening and the development of the disease (Kolesnik and Bruev, 1983).

Many temperate fruits and vegetables (apple peaches and broccoli) can be stored 0^0C, where as many tropical fruits cannot be stored below 10^0C without developing symptoms of chilling injury. The relative humidity of the storage environment can have a major influence on the development of post-harvest disease. High humidity is often used to minimize, water loss of produce.

1) **Hygiene practices**
   Maintenance of hygiene out all stages during production and post-harvest handling is critical in minimizing sources of inoculation post-harvest disease. Source of inoculation occurs. In case of post-harvest infections practice which make the crop environment less favorable to pathogen will help reduce the amount of infection which occurs during the growing season. For example, in tree crops pruning and skirting can increase ventilation within the tree canopy, making conditions less favorable for and bacteria.

2) **Heat treatment**
   Heat treatment applied after harvest can be used to control certain post-harvest disease. Heat works by either killing the pathogen or by suppressing its rate of development following treatment (Conway et al. 1994; Klein and Lurie 1991).For example, most temperate fruit type is quite susceptible to head injury particularly at the temperature required to achieve disease control.

3) **Ionizing radiation**
   Ionizing radiation is another physical treatment that can be used after harvest to reduce disease in some commodities (Salunkhe, 1961; Abdel-Kader et al., 1968). Like heal commodities must be able to tolerate the doses of ionizing radiation required to achieve disease control. For example, strawberry can tolerate the doses of radiation required to effectively control grey mould caused by *Botrytis cinerea*.

4) **Biological control**
   In recent years there has been considerable interest in the use of antagonistic microorganisms for the control of post harvesting disease (Wilson and Wisniewski 1989; Korsten et al., 1994). Such organism can be isolated from a variety of sources including fermented food products and the surface of leaves, fruits and vegetables. Once isolated organism (whether they be bacteria, yeast or filamentous fungi) can be screened to various ways for inhibition of selected pathogens.

There are a number of reports in literature concerning the biological control of wound pathogens in various fruits and vegetables. To be effective against wound pathogens an antagonist must be able to successfully colonies wound sites to the exclusive of the pathogen

CONCLUSION

The post-harvest diseases caused huge economical loss to perishables throughout the world. The fungal and bacteria pathogen causes post-harvest disease in fruits and vegetables. Some of those infects produce before harvest and then remain quiescent until conditions are more favorable for disease development after harvest. Many pre harvest factors directly and indirectly influence the development of post-harvest disease even in the case of infection initiated after harvest. This is required to reduce chemical usage in post-harvest diseases and initiates to the

integrated management in the interests of nature and mankind.

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How to cite this article: Kumar M, Singh R, Sharma I (2021). Integrated Management for Post-Harvest Diseases of Fruits and Vegetables. *Bio-Science Research Bulletin,* 37(1), 17-22.