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REVIEW ON PHYSIOLOGICAL POST-HARVEST DISORDERS AND DISEASES OF BANANA

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ABSTRACT

The aim of the present study is to explore different types of physiological post-harvest disorders and diseases of banana. Chilling injury, peel cracking, peel browning, peel bruising are some common physiological post-harvest disorders of banana and the important post-harvest diseases are crown rot, anthracnose and cigar-end rot. This study aimed at reviewing the management of physiological post-harvest disorders and diseases of banana.

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INTRODUCTION

Banana*Musa paradisiacal* L. is one of the most popular and important dessert fruit in India which provide more balanced diet and good source of potassium. It belongs to family Musaceae.During the storage, banana fruits deteriorate through the activity of microorganisms whichis favored by the changing physiological state of the fruit (Jagana *et al*. 2017). The total world production of Banana is about 69.51 million tones and India is the top producer of banana with 16 million tones production during 2001 and the productivity with 32.65 tones \ ha from 0.49 million ha area (FAOSTAT,2001). The banana fruits, whether fresh or dried, have always formed a part of the staple diet of human beings. They are rich in nutrients and provide some of the essential minerals, vitamins to our body (Khan, 2017).Apart from that, theyalso help to cure a number of diseases.

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The health promoting and disease curing properties of fruits depend on environmental condition in which the particular fruit is grown.In the last twenty years, the production of banana, cooking banana and plantain hascontinued to decline as a result of decreasing soil fertility, yield decline phenomena ((Dadzie and Orchard, 1997).

Physiological post-harvest disorders of banana: Physiological disorders are defined as plant or fruit tissue damages caused by neither an infection not a mechanical agent. It's developed as a plant response to environmental conditions. Generally, they affect a very discrete tissue area. They can be superficial, i.e. affecting only the fruit skin (e.g. peel splitting) and leave the pulp intact or affecting also the flesh (e.g. bruising) (Luyckx *et al*. 2016). The productivity as well as the quality of fruit crops is affected to a greater extent due to the physiological and nutritional disorders. The deficiencies of Zn, Mn and B are common in sweet orange, acid lime, banana, guava and papaya in India. Some common terms are bronzing (development of bronze or copper color on the tissue), chlorosis (loss of chlorophyll resulting in loss of green color leading to pale yellow tissues), decline (poor

growth and low productivity), die-back (collapse of the growing tip affecting the younger leaves), firing (burning of tissue accompanied withdark brown or reddish brown color), lesion(a localized wound of the leaf/stem tissue appearedwith loss of normal color), necrosis (death of tissue), scorching (burning of the tissue with light brown color resulting from faulty spray, salt injury etc.

Chilling Injury: Chilling injury is the term used to describe physiological damage of fruit tissues resulting from the exposure of chilling-sensitive fruits to temperatures below a critical threshold. In banana, chilling injury can occur in unripe as well as ripe banana and may reduce fruit quality and market value. This highly sensitive fruit should be definitely stored separately to the other non-sensitive fruits stored at very low temperature (Luyckx *et al*. 2016).

Symptoms: Chilling injury is mostly seen on the peel of the fruit and the peel of banana becomes darkens. Other chilling injury symptoms are watery dark patches on the skin, dull green color and slightly brownish to blackish on ripening, dull yellow to smoky yellow color on ripening. In addition, external symptoms are brown streaks develop in the vascular bundles of the sub epidermal layer and darkening of the placental region of pulp has also been observed (Hewage et.al. 1996).

Physiology: As physiological markers of loss of membrane semi-permeability and membrane lipid per oxidation, were widely used to measure the intensity of this disorder. Only half the conversion of 14C (fed as succinic acid-1, 4-14c) to citric acid and isocitric acid was observed in chilling tissues as compared with healthy ones. A histological study of the tissue showed that the browning substances (polyphenols) present in chilled fruits accumulate around the vascular tissues. Membrane damage and reactive oxygen species production are multifarious adverse effects of chilling as oxidative stress in sensitive banana fruits (Murata et.al. 1969)

Control: The postharvest techniques include temperature conditioning, controlled atmosphere storage, chemical treatments, waxing, other coatings, packeging and growth regulator application. The first three techniques involve manipulating and modifying the storage environment. While the other methods involve directly treating the commodities. (Luyckx *et al*. 2016).

Peel cracking: Post-harvest peel splitting is mainly due to the environmental conditions of storage. It occurs only between the third and the sixth day after the maturation induction (Brat *et al*. 2016).Banana peel cracking is one of the main physiological disorders of post-harvest fruit quality and quantity. Peel splitting results in open wounds promoting rapid moisture loss and pathogen infections. Cracking fruits is not attractive for consumer and also decreases its market value (Luyckx et.al. 2016).

Symptoms: Peel cracking is a physiological disorder reflecting by a longitudinal split of the peel and exposing the pulp. Generally, it appears near the pedicel and more especially at peel junctions between two flat segments (Brat *et al*. 2016). Fruit cracking is a physical failure of thefruit skin that presents as deeper fractures in thepeel or cuticle of certain fruits (Brat *et al*., 2016).

Physiology: The water movement is induced by osmosis due to increasing sugar content in the pulp. Due to this a turgor pressure increase higher than the pressure corresponding to the expansion capability of the fruit cuticle.Then, it was observed a reduction of the peel resistance and a higher water loss by transpiration leading to a peel cracking. (Luyckx et.al. 2016)

Control: The three different bunches was cut in two equal partsand distributed to the some post-harvest treatments i.e. high relative humidity (RH), storage (i.e., storage in plasticbags with 0.01 dm2/m2perforations, corresponding to RHclose to 100 % during fruit ripening) and low relative humidity storage(i.e., storage without a plastic bag, corresponding to RH ofabout 50 % during fruit ripening) (Brat etal. 2016).

Peel Browning: Peel browning is one of the typical symptoms of chilling injury in postharvest banana fruit during cold storage (Liu *et al*. 2019). Peel browning is caused by a stress at low temperature or relative humidity andby storing the ripened bananas in a room at temperature (20 °C) and low relative humidity (50%). Browning reduces shelf-life of the banana and its commercial value. Due to this consumer is not attractive (Luyckx *et al*. 2016).

Symptoms: Bananas peel browning is reflected in a brown discoloration of the peel triggered by a peel handling. Symptoms developed onthe entire banana surface (Luyckx *et al*. 2016).

Physiology: Peel browning due to the contact of phenolics with polyphenol oxidase (PPO) and/or peroxidase (POD), due to this loss of cell membrane integrity caused by the degradation of cellular membrane lipids. In the membrane reactive oxygen species (ROS) is involved for damaging the membrane structure by oxidizing biomolecules such as proteins and lipids. Therefore, peel browning of banana fruit during cold storage could be closely associated with cellular ROS level and redox equilibrium (Liu *et al*.2019).

Control: The atmospheric relative humidity during the shipping and maturation could be managed by a maturation chamber ventilation, air extraction system and use of macro perforated polyethylene bags (Luyckx *et al*. 2016).

Peel Bruising: Peel bruisingis the mostcommon type of mechanical damage whichcan occur during harvesting, handling and transport (Hussein *et al*. 2019).Peel bruising has been identified as a major cause of quality loss, resulting in a decreasing commercial value. Damaged tissue area is thekey factor to pathogen invasion (Luyckx *et al*. 2016).

Symptoms: Bruise damage results from the action of more external force on fruit surface during the impact against a rigid body (Hussein *et al*. 2019).Bruising on fruit due to the breakage of cell membranes due to excessive impact or compression loading in contact with the fruit surface. Loss of cell wall integrity and decrease in peel resistance to mechanical damage leads to bruising (Hussein *et al*. 2019).Bruising leads to the appearance of a brown to black spot on the fruit surface that occurs rapidly after the damage and spreads on all over the infected area. Symptoms are observed on the banana peel but do not impact on the fruit pulp (Luyckx *et al*. 2016).

Physiology: Bruising of banana is due to the several factors as temperature, fruit size and fruit shape or tissue and cellular factors as cell wall strength and elasticity, cell shape and internal structure. Mechanical damages also stimulate respiratory process and ethylene biosynthesis. Thus, phenolic compounds stored in vacuoles and contact with enzyme. This induces oxidation of phenolic compounds to quinones, which polymerize then to brown pigments (Luyckx *et al*. 2016).

Control: Using appropriate commoditiescan prevent peel bruising. Due to higher turgidity allows elevating the threshold at which banana peel is sensitive to bruising, it would be better to harvest fruit in the morning and to improve next steps in order to reduce water loss. Reducing temperature during post-harvest chain can reduce damages caused by bruising(Luyckx *et al*. 2016).

Post-Harvest Diseases: Post-harvest diseases can causes mostserious losses in fruits i.e. both quantity and quality. Fruits infected with disease have no market value. The important diseases are crown rot, anthracnose and cigar-end rot (Dadzie and Orchard, 1997).Post harvest diseases caused by various microbes have considerable influence nutritive value, harvesting, transport and storage of fruits. Diseases like crown-rot, anthracnose, pitting disease, squirter disease, fruit rot, finger-stalk rot, brown specks on fruit, cigar-end rot of fruit and brown spot disease are reported from different parts of the world (Jagana *et al*. 2017).

Anthracnose: *Colletotrichummusae* causes anthracnose lesions which commonly appear on the fruit peel after ripening (Griffee& Burden, 1974). A total of 13 *Colletotrichum* isolates were obtained from different banana cultivars (*Musa* spp.) with symptoms of anthracnose (Zakaria, 2009).

Symptoms: Symptoms of anthracnose include black and sunken lesions with spore masses or acervuli in the lesion. Infection on the banana usually starts during the development of the fruit but remains until the fruit ripens and symptoms also occur during storage and marketing (Prusky & Plumbley, 1992). At later stage, the whole fruits turned to brown and infected fruits showed black coloration of the skin. Another symptom of anthracnose are circular, light brown lesions with white to light pink fungal growth were seen in some samples of Cavendish and Neypoovan varieties (Jagana *et al*. 2017).

Management: Post harvestfruits dipping in Carbendazim 400 ppm, or Benomyl 1000 ppm, or Aureofunginsol 100 ppm.It is important to maintain strict hygiene or sanitation in the plantation and pack house, in order to minimize the number of spores available for infection. All cultural practices reduces scarring and injury to the fruit will prevent anthracnose (Dadzie and Orchard, 1997).

Crown rot: Banana is one of the most important tropical crops and is affected by several fungal diseases, such as crown rot postharvest disease. Crown rot is mainly caused by the *Fusariummusae* and responsible for significant losses in banana fruits (David *et al*. 2016).

Symptoms: Symptoms of crown rots are softening and blackening of tissues at the cut crown surface, and infected tissue turns black and the rot may advance into the finger stalk (Hailu etal.2013).The first symptoms of crown rot appear only after packaging and shipping from producing countries to consuming countries. Crown rot begins with a mycelium development on the crown surface,followed by an internal development (David *et al*. 2016).

Management: Banana treated with cinnamon and thyme oils at high concentration of 4.0% caused 100% reduction in crown rot disease (Abd-Alla *et al*. 2016).The control of crown rot starts in the field with the regular removal of leaf trash. Proper field sanitation can greatly reduce the number of crown rot fungi spores present and not keeping rotting fruits or plant waste materials near the packing station. Finally, postharvest treatment of fruits with an effective fungicide is essential (Gowen, 1995; Dionisio, 2012).

Cigar-end rot: Cigar-end rot of banana and plantain is an important postharvest disease caused by the fungi, *Trachysphaerafructigena*. (Hailu *et al*. 2013). Cigar end rot is one of the most important banana fruit diseases in all banana-producing countries. This disease is of economic importance in Central and Western Africa (Amani and Avagyan, 2013).

Symptoms: The infection which starts with darkening and wrinkling of the skin, originates in the perianth and spreads slowly (Wardlaw, 1931). The darkened area is bordered by a black band and a narrow chlorotic region which separates infected and healthy tissues (Hailu *et al*. 2013).After the flowering begins the symptoms can appear one month. Under wet or humid conditions,powdery grayish conidia on the black end of the fruit, giving rise to the burn tip appearance of the cigar end which the disease gets its name from(Amani and Avagyan, 2013).

Management: The principal method of control is the removal and burning of dead flower parts and infected fruits. Use of fungicide to control the disease is also useful. Cigar-end rot is effectively controlled by covering the flower (immediately after emergence) with a polyethylene bag before the handsemerge (Dadzie and Orchard, 1997).

Conclusion

The fruits dropped on the ground due to physiological disorders are infected by pathogenic organisms and have poor store ability. The predominant physiological disorders are chilling injury; peel cracking, peel browning and peel bruising. Harvest injury, defective handling, inappropriate temperature and humidity affect the storage life of fruits. Temperature conditioning, intermittent warming, controlled-atmosphere storage, avoid injury and chemical treatments can be utilized to control these diseases.

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