Review Article **Open Access**

Preharvest Factors Influencing the Postharvest Disease Development and Fruit Quality of Mango

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Article History
Received
January 11, 2015

Published Online
April 29, 2015

Keywords:
Cultural practices,
Eating quality
Ecological zones,
Mangifera indica;
Mineral contents
Shelf life

Abstract: High postharvest losses are the major concern for commercial mango supply chains. The quality of fruit after harvesting cannot be improved but can only be maintained. It can be improved only at production level. Therefore, an understanding of the production level factors and respective management strategies in place are very crucial to ensure premium quality at harvest and along the supply chain. This review paper includes the account of preharvest factors associated with postharvest disease development and quality attributes of mango. Factors such as genetic, geographic location, environmental conditions and preharvest cultural practices including canopy management, nutrition and irrigation management, plant protection, have been reported to influence postharvest disease development and quality of mango fruit. This review summarizes the important work done on the subject to develop an understanding about recent advances in modeling mango postharvest disease development and fruit quality along the supply chain.

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Cite this article as: Rehman, A., A.U. Malik, H. Ali, M.W. Alam and B. Sarfraz. 2015. **Preharvest factors influencing the postharvest disease development and mango fruit quality**. *Journal of Environmental & Agricultural Sciences*. 3:42-47.

1. Introduction

Mango (*Mangifera indica* L.) is a climacteric fruit, and belongs to family Anacardiaceae. It is the second most popular commercial horticultural fruit crop grown in Pakistan. It is particularly important for the Punjab province as major fruit crop. Pakistan ranks fifth in the world's largest mango producing countries with cultivation area of 1.72 million hectares with production of 1.68 million tons (Anonymous, 2013). Prominently it is cultivated in Punjab and Sindh provinces with production of 1.2 million tons and 0.5 million tons, respectively (Anonymous, 2011).

There is a great demand of Pakistani mango in the international market and therefore, Pakistan is the 6th largest mango exporter with a share of 4.6% in the world market. Although Pakistan is one of the largest mango exporter in the world, yet the export volume is not significant (<10% of production) and export prices paid by the current importers are far less (US$ 425/ton) than earned by many other mango exporters (US$ 715, 879, 1116 and 3147 ton^{-1} for Mexico, India, Brazil and Philippines respectively) (FAOSTAT, 2011). Mango consumption in domestic market is not only increasing, but also the demand of better quality fruit at premium price has been reported (Hussain, 2013). International and domestic mango market is facing different issues regarding management of fruit at postharvest stage (Malik et al., 2010).

Fruit quality losses cause significant economic losses (Jacobi and Giles, 1997). High incidence of disease, green-ripe fruit and poor cosmetic appearance of fruits results in loss of fruit quality and confidence of the consumers, and reduces the profits of everyone from the grower to the retailer. Pre-harvest climatic conditions and cultural practices affect the ultimate fruit quality (Ferguson, 1980). Hewett (2006) stated that production technology and climatic factors affect the fruit growth, as well as the postharvest storage behavior and fruit quality, including Physical weight loss, skin weight, seed weight, dry matter contents, Juice percentage, seed length, cosmetic appearance (colour, firmness, size, shape, blemishes and disease), biochemical (Total soluble solids, vitamin C, sugars, acidity, total phenolics and antioxidants), organoleptic attributes (taste, texture, flavour, pulp colour and aroma) (Fiaz, 2013). Appearance is the fruit quality (Bally et al., 1997; Hofman et al., 1997b), shelf life (Paull 1994) and food safety (Ledger, 1988).

Mango contains essential vitamins and dietary minerals. The antioxidant vitamins A, C and E compose of 25%, 76% and 9% of the Dietary Reference Intake (DRI) in a 165-gram (5.8-oz) serving. Vitamin B6 (pyridoxine, 11% DRI), vitamin K (9% DRI), other B vitamins and essential nutrients, such as potassium, copper and 17 amino acids are at good levels. Mango peel and pulp contain other phytonutrients, such as the pigment antioxidants – carotenoids and polyphenols – and omega-3 and -6 polyunsaturated fatty acids, lignin, pectin and cellulose (Ajila and Prasada, 2008).

Preharvest factors affect fruit growth during development and fruit quality attributes during its storage by changing the concentration of water, dry matter and biochemical compounds (Lechaudel and Joas, 2007). Soil, environment, nutrition and variety differences are the key factors of preharvest stage which affect fruit quality and storage life of horticultural commodities (Ferguson, 1980). Recently, Fiaz (2013) concluded that mango fruit quality is associated with a number of preharvest factors as well as metrological conditions. In order to comprehend the overall picture, a critical review of the available research information is needed to analyze the combined effect of orchard location, management practices and storage conditions on postharvest disease development and quality of mango fruit. These factors are discussed below.

1.1. Genetic Factor

Genetic factors play important role regarding fruit resistance against different postharvest diseases. Local research studies showed that cultivar Sindhri is more resistant to postharvest diseases and has better shipping potential as compared to 'Chaunsa', 'Anwar Retole', 'Langra', and 'Dusahri' (Malik et al., 2010). Sangchote (1997) also stated that varietal susceptibility is an important factor for disease development; 'Alphonso' is more resistant to anthracnose, while more susceptible to stem end rot disease as compared to 'Haden', 'Palmer" and 'Tommy Atkins'.

1.2. Spatial variations in fruit quality

Disease development and quality attributes of horticultural crops varies significantly at spatial scale. In case of mango fruit harvested from different districts showed considerable differences in quality parameters (Fiaz, 2013). Pre-harvest climatic conditions and cultural practices along with postharvest storage environment affect the ultimate fruit quality (Ferguson, 1980). Production practices, especially higher application of soil nitrogen causes less skin colour development at ripe stage in mango fruit (Oosthuyse, 1993). Soil type also has been reported to affect the internal fruit quality (Young and Miner, 1961; Burdon et al., 1991). Mango fruit harvested at mature green stage from two different sites in Australia (Gin Gin and Eumundi) had different response to mango fruit ripening. The cause of 'green ripe' mango fruit from Gin Gin site was linked to preharvest conditions instead of fruit maturity and environmental conditions at the time of harvest (Jacobi et al., 1998). Further, orchard locality did not affect the fruit softness; fruit harvested from both places showed similar patterns towards the fruit softness, at 22°C fruit of both places were considered fully ripe and soft. While on the other hand the production locality did affect the skin colour development. A sigmoidal pattern of skin colour development was exhibited by fruit harvested from Eumundi and opposite colour development behavior was observed in fruit harvested from Gin Gin area. Subjective skin colour assessment using rating scale was the initial parameter of study. By contrast, it was found that the colour development in fruit from Gin Gin was slower than compared to Eumundi.

Hofman et al. (1997) reported that the disease incidence and chilling injury disorder during mango storage were associated with the production locality. Stem end rots and body rots were the significant diseases. The disease severity of stem end rots was significantly higher in fruit harvested from sub-tropical site (site 3) as compared to fruit of tropical sites (site 1 and 2). Severity of body rots was significantly less and inconsistent in fruits of all sites. At normal ripening, fruit harvested from subtropical region gave better colour development as compared to fruit of tropical region (site 1 and site 2) and disease severity (body rot and stem end rot) was high in fruit of subtropical region (site 3) at ripening temperature of 22°C without storage (Hofman et al., 1997b).

Further, under non storage conditions the fruit harvested from two sites of tropical region had same dry matter percentage, while it was different in fruit harvested from subtropical area. On the other hand eating quality of fruit harvested from site 3 was much higher than fruit of both tropical sites. Days to eating soft were also affected by production locality; fruit harvested from site 3 ripened more quickly as compared to other sites. Flesh colour development was significantly increased with respect to date of harvest up to date of eating soft. Fruit of site 1 showed less flesh colour development as compared to fruit of other sites. Higher dry matter percentage was associated with better eating quality of fruit. There was a negative correlation between dry matter percentage and days to eating soft. Lenticels spotting severity was significantly lower in fruit of site 1 and 2, while greater in case of site 3 fruit. Severity of chilling injury was higher in fruits of site 3.

1.3. Fertilizer management

Anthracnose and stem end rots are considered as the major constraint to increase the shelf life of mango fruit and have significant impact on lowering price in domestic as well as international market (Bally et al., 2009). Mixed fertilizer (NPK, Zinc Sulphate, Gypsum and cow dung) application has been reported to minimize the postharvest disease incidence and disease severity of anthracnose (Chowdhury and Rahim, 2007). Similar results were observed by Rahman and Hossain (1988), who stated that the NPK application helped to minimize the disease severity in mango fruit, while application of potassium enhanced the capability to resist against pathogens.

Application of trisulphide phosphate, Urea, Cow dung, Monophosphate, Zinc sulphate and Gypsum in three splits caused to produce superior quality produce in mango with regard to total soluble solids, titratable acidity, Vitamin C, dry matter content, reducing, non-reducing and total sugar content (Sarker and Rahim, 2012). Soil application of nitrogen at the rate of 150g or more caused to produce more proportion of green colour at ripe stage in mango fruit (Nguyen et al., 2004). Further, the disease severity of anthracnose was enhanced with soil application of nitrogen at the rate of 300g per plant and more disease severity of anthracnose and stem end rot was observed in fruits with high green skin colour sourced from an orchard treated with foliar application of nitrogen. Later studies by Bally et al. (2009) also confirmed that the disease development of mango during postharvest life is associated with application of fertilizer during fruit growth and development stage. Application of nitrogenous fertilizer at intermediate stage of flowering and fruit development caused to induce green colour skin, had the highly significant anthracnose severity, so it was concluded that the high disease incidence was observed in response to excessive dose of nitrogen application at preharvest stage (Bally et al., 2009).

Combined application of Paclobutrazol (PBZ) and potassium nitrate caused significant increase in TSS content and weight loss, while decrease the TA and firmness in ripe mango fruit (Martinez et al., 2008). Ferguson (1984) evaluated that shortage of calcium content caused to delay the ripening in mango fruit. Use of calcium fertilizer at preharvest stage increased plant resistance against disease development, especially stem end rot severity in ‘Samar Bahisht Chaunsa’ and ‘Sindhri’ mangoes (Ali, 2014; Khan, 2014). In most recent studies Ca nutrition and internal breakdown have not only monitored soil Ca concentrations but also the concentrations in the fruit. Subramanyam et al. (1971) found tissue with ‘spongy-tissue’ disorder had less Ca concentration.

1.4. Irrigation management

Irrigation, water availability and other cultural practices play significantly effects the tree vigor and fruit quality (Kazmi et al., 2008). Irrigation helped to uptake the nutrients especially calcium and reduced the percentage green colour in mango plant (Lapade, 1977). Increased irrigation interval during rapid fruit expansion stage caused to decrease the days to ripe, lenticel spot on fruit surface, and Ca concentration in fruit (Simmons et al., 1995). Light and temperature can be controlled through pruning and thinning, while water stress can be overcome through irrigation management. It was observed that irrigation reduction during flowering and fruit development stage affected fruit size (Simmons et al., 1995).

1.5. Tree hygiene and canopy management

Pruning is a vital cultural operation for getting quality yield from the fruit trees, which involves sensible removal of vegetative portions of trees. An unpruned tree becomes crowded, which inhibit light penetration inside the canopy. Resultantly, there occurs low photosynthetic activity and relative humidity becomes high which causes the high incidence of disease (Lal and Mishra, 2007). Pruning helps to lower down the incidence of anthracnose disease by reduction of disease inoculum load, possible due to enough penetration of sunlight, which reduced the preharvest growth of the organisms down the inflorescence and peduncle across the canopy.

Johnson et al. (1992) reported another reason for better protection of fruits from anthracnose and stem-end rot, especially in pruned trees, may be associated with rains (less precipitation retention). Moreover, pruning might have increased the rate of natural resistance of fruit against disease development during ripening through the increase of antifungal activity of phenolic compounds (Engels et al., 2009). Pruning practice decrease the disease incidence percentage both of anthracnose and stem-end rot in ripe fruits stored at room temperature. Moreover, it was observed that both matured green and ripened fruits harvested from pruned trees showed relatively lower respiration rates as compared to unpruned trees. The ripe fruits harvested from unpruned trees showed more than double rate of respiration as compared to pruned ones (Asrey et al., 2013). It is predicted that pruning operations might have increased soil nutrient uptake, and changed enzymatic activities. Further, in unpruned trees high respiration, evapotranspiration and ethylene production rates were observed (Sharma and Singh, 2006).

1.6. Protection measures

Many attempts have been made to identify the pathogens and inoculums, mode of infection and development of stem end rot (Johnson et al., 1993). Good cultural practices can avoid the disease development and help in production of excellent quality fruits (Fiaz, 2013). Integrated disease management is considered as most logical approach as preventive measure to minimize the disease severity (Alemu, 2014). Further, it is also considered as preferred strategy against the increased understanding about residual effects.

Appropriate plant protection measures and hygienic practices play vital role in control of postharvest diseases. Application of Mancozeb and Prochloraz at pre harvest stage is considered as effective measure to reduce anthracnose disease of mango fruit (Stovold and Dirou, 2004). Dodd et al. (2007) reported that pre harvest application of Benomyl showed effective control of anthracnose on fruit. Local research studies showed that preharvest application of scholar (0.8ml/L) fungicide, two weeks before harvest, significantly reduced disease development during storage of mangoes cultivar Sufaid Chaunsa (Malik et al., 2015).

Postharvest fungicides application gave better disease control and fruit colour development and resulted lower postharvest disease incidence (Amin et al., 2011). Further, that preharvest and postharvest fungicide application showed no effect on biochemical attributes.

1.7. Physiological and physical disorders

Sap burn, skin abrasion, chilling injury, heat injury, internal flesh breakdown, jelly seed and softnose are the common physiological and physical disorders (Ali, 2014). Spongy tissue is known as major physiological disorder, which is associated with seed germination, while black tip and gridle necrosis are caused by production of gases (fluoride and sulfur dioxide) during pollination and pulp splitting is symptom of Boron deficiency. Further, low temperature storage caused chilling injury and CO_2 injury in mangoes (Shivashankar, 2014).

1.8. Fruit bagging

Preharvest bagging of mango fruit is primarily done for physical protection from fruit fly, but it also influences fruit quality to some extent by promoting peel colour and reducing skin blemishes through changing micro-environment of fruit (Sharma et al., 2014). Further, that bagging can effectively reduce insect-pest attack, disease incidence, mechanical and sunburn injuries and bird damages. However, fruit with plastic bags attained softening faster and also had low shelf life. Therefore, fruit bagging influenced postharvest behavior of mango, especially water evaporation during storage. In fact, water transpiration of fruit during storage significantly increased (Hofman et al., 1997b; Joyce et al., 1997) as a result of fruit bagging with plastic bags during development. Postharvest water loss studies are important since these changes may affect fruit physiology during its ripening, i.e. earlier ethylene synthesis (Paull, 1999).

1.9. Fruit maturity and postharvest quality

There is a long list of maturity indices of mango including fruit size, development of proximal shoulder, development of pulp and skin colour, sugar content, fruit firmness and the time period from fruit setting. To attain the absolute fruit quality fruit maturity at the time of harvest is the most primitive factor that must be taken under consideration. Maturity is the key factor associated with storage life and postharvest quality of mango fruit (Kader, 1999). As Yahia (1998) mentioned that significant losses take place due to harvesting of mango fruits at inappropriate stage of maturity. In addition, storage duration also links with maturity at the time of harvest. At the storage temperature of 12°C, physically mature fruits can survive for more time period as compared to immature fruits (Medlicott et al., 1990). Declining rate of textural properties is associated with specific cultivars, but in general it is referred to stage of harvesting and ripening period. (Jha et al., 2013).

2. Conclusion

Various studies described in this paper demonstrate that a number of preharvest factors including genotype, production locality, environmental factors, cultural practices (irrigation and fertilizers application, canopy management, protective measures) and fruit maturity significantly influence postharvest disease development and quality of mango fruit along supply chain. The effects of these preharvest factors are associated with water accumulation, dry matter content, mineral and biochemical composition and inoculums load etc. which ultimately determines the disease defense capability of fruit during postharvest stages. So, an understanding of the preharvest factors and their judicious manipulation can help reduce disease development and quality retention during postharvest supply chain.

Acknowledgements

We acknowledge the co-operation of workers and special thanks to my teachers.

Competing Interests

Authors declare that we have no competing interest in any kind or any regard.

References

Alemu, K. 2014. Dynamics and management of major postharvest fungal diseases of mango fruits. J. Bio. Agri. Healthcare. 4 (27): 13-21.

Ali, H. 2014. Fruit quality and disease development of mango cv. 'Samar Bahisht Chaunsa' in relation to geographic locality, production practices and storage conditions. M.Sc. (Hons) Thesis. Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan.

Ajila C.M. and R.U.J. Prasada. 2008. Protection against hydrogen peroxide induced oxidative damage in rat erythrocytes by *Mangifera indica* L. peel extract. Food Chem. Toxicol. 46(1): 303-309.

Amin, M., A.U. Malik, A.S. Khan and N. Javed. 2011. Potential of fungicides and plant activator for postharvest disease management in mangoes. Int. J. Agric. Biol. 13: 671–676.

Anonymous. 2013. Pakistan Bureau of Statistics. (Available online with updates at: http://www.pbs.gov.pk/sites/default/files/agriculture_statistics/publications/Agricultural_Statistics_of_Pakistan_201213/tables/table46.pdf).

Anonymous. 2011. Pakistan Bureau of Statistics. (Available online with updates at: http://www.pbs.gov.pk/sites/default/files/agriculture_statistics/publications/Agricultural_Statistics_of_Pakistan_201011/tables/table46.pdf).

Asrey, A., V.B. Patel, K. Barman and R.K. Pal. 2013. Pruning affects fruit yield and postharvest quality in mango (*Mangifera indica* L.) cv. Amrapali. Fruits. 68: 367-380.

Bally, I.S.E., P.J. Hofman, D.E. Irving, L.M. Coates and E.K. Dann. 2009. The effects of nitrogen on postharvest disease in mango (*Mangifera indica* L. *'Keitt'*). Acta Hort. 820: 365-370.

Bally I.S.E., T.J. O'Hare and R.J. Holmes. 1997. Detrimental effects of detergent in the development of mango skin browning. Acta Hort. 455: 612-621.

Burdon, J.N., K.G. Moore and H. Wainwright. 1991. Mineral distribution in mango fruit susceptible to the physiological disorder soft-nose. Sci. Hortic. 48: 329-336.

Chowdhury, M.N.A. and M.A. Rahim. 2007. Effect of fertilizers on the incidence of anthracnose disease, yield and quality of mango. J. Agric. Rural Dev. 5: 70-78.

Dodd, J.C., R. Bugante, I. Koomen, P. Jeffries and M.J. Jeger. 2007. Pre and postharvest control of mango anthracnose in Philippines. Plant Pathol. 40: 576-583.

Engels, C., M. Knödler, Y. Zhao, R. Carle, M.G. Gänzle and A. Schieber. 2009. Antimicrobial activity of gallotannins isolated from mango (*Mangifera indica* L.) kernels. J. Agric. Food Chem. 57: 7712-7718.

FAOSTAT. 2011. Food and Agriculture Organization of the United Nations. (Available online with updates at: http://faostat.fao.org/site/342/default.aspx).

Ferguson, I.B. 1980. Mineral composition of fruit and vegetables in relation to storage life. CSIRO Food Res. Quart. 40: 94-100.

Ferguson, I.B. 1984. Calcium in plant senescence and fruit ripening. Plant Cell Environ. 7: 397-405.

Fiaz, M. 2013. Relationship of orchard location and management practices with disease development and quality of 'Sindhri' and 'Samar Bahisht Chaunsa' mangoes under ambient and low temperature storage conditions. M.Sc. (Hons) Thesis. Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan.

Hewett, E.W. 2006. An overview of preharvest factors influencing postharvest quality of horticultural products. Int. J. Postharvest Technol. 1: 4-15.

Hofman P.J., L.G. Smith, D.J. Joyce, G.I. Johnson and G. Meiburg. 1997a. Bagging of mango (*Mangifera indica* cv. 'Keitt') fruit influences fruit quality and mineral composition. Postharvest Biol. Technol. 12:83-91.

Hofman, P.J., L.G. Smith, G.F. Meiburg and J.E. Giles. 1997b. Production locality affects mango fruit quality. Aust. J. Exp. Agr. 37: 801-808.

Hussain, M.A.F. 2013. Determinants of consumer willingness to pay for premium quality mangoes in Punjab, Pakistan. MS Thesis, Institute of Business Management Sciences, University of Agriculture, Faisalabad, Pakistan.

Jacobi, K.K. and J.E. Giles. 1997. Quality of 'Kensington' mango (*Mangifera indica* L.) fruit following combined vapour heat disinfestation and hot water disease control treatments. Postharvest Biol. Technol. 12: 285-292.

Jacobi, K.K., S.E. Hetherington and E.A. Macrae. 1998. Early detection of abnormal skin ripening characteristics of 'Kensington' mango (*Mangifera indica* L.). Sci. Hortic. 72: 215-225.

Jha, S.N., Jaiswal, P., Narsaiah, K., Kaur, P.P., Singh, A.K. and Kumar, R. 2013. Textural properties of mango cultivars during ripening. J. Food Sci. Technol. 50(6): 1047-1057.

Johnson, G.I., A.J. Mead, A.W. Cooke and J.R. Dean. 1992. Mango stem end rot pathogens–Fruit infection by endophytic colonization of the inflorescence and pedicel, Ann. Appl. Biol. 120: 225-234.

Johnson G.I., A.W. Cooke and A.J. Mend. 1993. Infection and quiescence of mango stem end rot pathogens. Acta Hort. 341: 329-336.

Joyce D.C., D.R. Beasley and A.J. Shorter. 1997. Effect of preharvest bagging on fruit calcium levels, and storage and ripening characteristics of 'Sensation' mangoes. Aust. J. Exp. Agric. 37:383-389.

Kader, A.A. 1999. Fruit maturity, ripening, and quality relationships. Acta Hort. 485: 203-208.

Kazmi, M.R., F.S. Fateh and A. Jabeen. 2008. Role of general mango-orchard management in disease-development. Sci. Technol. Develop. 27 (3-4): 42-44

Khan, Z.M. 2014. Influence of orchard locality, production practices and postharvest storage on postharvest disease development and quality of cv. Sindhri Mangoes. M.Sc. (Hons) Thesis. Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan.

Lal, B. and D. Mishra. 2007. Effect of pruning on growth and bearing behavior of mango cv. Chausa. Indian J. Hortic. 64: 268-270.

Lapade, B.B. 1977. The physical, mineral and hormonal changes in developing 'Carabao' mango fruit under different irrigation treatments. MSc Thesis, University of the Philippines, Los Banos, Philippines.

Lechaudel, M. and J. Joas, 2007. An overview of preharvest factors influencing mango fruit growth, quality and postharvest behaviour. Brazilian J. Plant Physiol. 19(4):287-298.

Ledger, S. 1988. Consumers want assurance for safety and quality. Mango Care Newsletter 24:2-3.

Malik, A. U. and M. Amin 2015. ASLP Mango Value Chain project R&D report. University of Agriculture Faisalabad.

Malik, A.U., O. Hafeez, P. Johnson, J.A. Campbell, M. Amin, M. Saeed, M.S. Mazhar, S. Schouter and J. Adeel. 2010. Toward developing, a sea-freight supply chain for delivering Pakistani mangoes to European supermarket: A private-public sector Model. Acta Hort. 880: 83-89.

Martinez, A.R., A.L.D.A. Perez and J.R. Moreno. 2008. Effects of Paclobutrazol and KNO_3 over flowering and fruit quality in two cultivars of mango Manila. Interciencia 33: 518-522.

Medlicott, A.P., M.N. Diaye and J.M.M. Sigrist. 1990. Harvest maturity and concentration and exposure time to acetylene influence initiation of ripening in mangos. J. Sci. Food Agri. 3:426-430.

Nguyen, H., R. Mcconchie, P. Hofman, B. Stubbings, R. Holmes and I. Bally. 2004. Effect of nitrogen on the Skin colour and other quality attributes of ripe 'Kensington Pride' mango (*Mangifera indica* L.) fruit. J. Horti. Sci. Biotech. 79: 204-210.

Oosthuyse, S.A. 1993. Ripening behaviour and quality on ripening of 'Sensation' mango in relation to cold-storage temperature and tree fertilization. South African Mango Grower's Association Yearbook. 13: 67-75.

Oosthuyse, S.A. and G. Jacobs. 1997. Effect of soil applied Paclobutrazol on fruit retention, fruit size, tree yield and tree revenue in 'Sensation' and 'Tommy Atkins' mango. Acta Hort. 451: 76-83.

Paull, E.R. 1999. Effect of temperature and relative humidity on fresh commodity quality. Postharvest Biol. Technol. 15:263-277.

Paull E.R. 1994. Tropical fruit physiology and storage potential In 'Proceedings of the Postharvest Handling of Tropical Fruits'. 19-23 July 1993, Chiang Mai, Thailand. (Eds RR Champ, E Highley and GI Johnson) 50 pp. 198-204. (ACIAR)

Rahman, M.A. and S. Hossain. 1988. Annual Report for 1987-88. Plant Pathology Division, BARI, Joydebpur, p.64-67.

Sangchote, S. 1997. Effect of Fruit Bagging, Fruit Position, Cultivar, and Postharvest Treatment on Postharvest Diseases of Mangoes. p. 63-66. In: L.M. Coates, P.J. Hofman, and G.I. Johnson (ed.) Disease Control and Storage Life Extension in Fruit. Proc. Aus-Thi. ACIAR Res. Workshop. 22-23 May 1997. Chiang Mai, Thailand.

Sarker, B.C. and M.A. Rahim. 2012. Effects of doses and splits of fertilizer application on harvesting time, yield and quality of mango cv. 'Amrapali'. Bangladesh J. Agril. Res. 37: 279-293.

Sharma, R.R. S.V.R. Reddy and M.J. Jhalegar. 2014. Pre-harvest fruit bagging: a useful approach for plant protection and improved post-harvest fruit quality – a review. J. Hort. Sci. Biotechnol. 89 (2): 101-113.

Sharma, R.R. and R. Singh. 2006. Effect of pruning intensity on light penetration and leaf physiology in Amrapali mango trees under high density planting, Trop. Sci. 46: 16–19.

Shivashankar, S. 2014. Physiological Disorders of Mango Fruit, in Horticultural Reviews: Volume 42 (Ed J. Janick), John Wiley & Sons, Inc., Hoboken, New Jersey.

Simmons, S.L., P.J. Hofman and S.E. Hetherington. 1995. The effects of water stress on mango fruit quality. p. 191-197. Proc. of the Mango 2000 Production Workshop, 1995. Queensland Australia.

Stovold, G.E. and J.F. Dirou. 2004. Blight Diseases in Mangoes. Agnote, Department of Primary Industries, New South Wales, Australia.

Yahia, E.M. 1998. Postharvest handling of mangoes. Agricultural Technology Utilization and Transfer Project, Giza, Egypt. (Available online with updates at: http://www.atut.gov.eg.).

Young, T.W. and J.T. Miner. 1961. Relationship of nitrogen and calcium to 'soft-nose' disorder in mango fruits. J. Amer. Soc. Hort. Sci. 78: 201-208.

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