STATUS OF POST HARVEST DISEASES OF MANGO AND GUAVA IN DHAKA CITY

BIPLOB KUNDU

REGISTRATION NO. 08-03236

DEPARTMENT OF PLANT PATHOLOGY
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA-1207, BANGLADESH

DECEMBER, 2009

STATUS OF POST HARVEST DISEASES OF MANGO AND GUAVA IN DHAKA CITY

BY

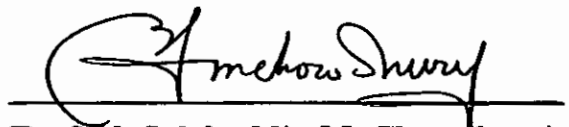
REGISTRATION NO. 08-03236

A Thesis

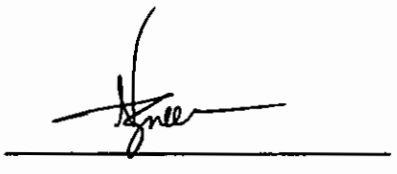
Submitted to the Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka,
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE (MS)
IN
PLANT PATHOLOGY
SEMESTER: July-December, 2008

Approved by:



(Dr. Md. Salahuddin M. Chowdhury)
Associate Professor
Department of Plant Pathology
Sher-e-Bangla Agricultural University
Supervisor



(Nazneen Sultana)
Associate Professor
Department of Plant Pathology
Sher-e-Bangla Agricultural University
Co-supervisor

(Dr. Md. Salahuddin M. Chowdhury)
Chairman
Examination Committee
Department of Plant Pathology
Sher-e-Bangla Agricultural University

Sher-e-Bangla Agricultural University

Sher-e-Bangla Nagar, Dhaka 1207

Ref : **Date :**

CERTIFICATE

This is to certify that the thesis entitled, **"STATUS OF POST-HARVEST DISEASES OF MANGO AND GUAVA IN DHAKA CITY"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, impartial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN PLANT PATHOLOGY,** embodies the result of a piece of bona fide research work carried out by **Biplob Kundu; Registration No. 08-03236,** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

I further certify that any help or sources of information, as has been availed of during the course of this investigation have been duly acknowledged.

Dated:
Dhaka, Bangladesh

(Dr. Md. Salahuddin M. Chowdhury)
Associate Professor
Department of Plant Pathology
Sher-e-Bangla Agricultural University
Supervisor

DEDICATED TO MY BELOVED PARENTS

ACKNOWLEDGEMENT

First of all, the author expresses his gratitude to the greatness of Almighty God for His blessings to enable the author to complete this research work successfully. The author expresses his sincere gratitude, heartfelt respect and immense indebtedness to his reverend Supervisor, Associate professor Dr. M. Salahuddin. M. Chowdhury; Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, for his constant counseling, valuable guidance constructive suggestions and encouragement in the course of this investigation and in preparation of this dissertation.

The author wishes to extend his deepest gratitude and sincere appreciation to his Co-supervisor, Associate Professor Nazneen Sultana, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, for her scholastic guidance, valuable suggestions, kind help and providing necessary assistance with logistic support and constant encouragement throughout the period of research work and preparation of this thesis.

Great appreciation, thanks and gratitude are also extended to all the teachers of the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, for providing the research facilities, valuable advices and encouragement to conduct the experiments and thesis preparation.

Finally, the author expresses his heartfelt gratitude and gratefulness to his beloved parent, sisters, brothers and wellwishers for their blessing, encouragement and sacrifice throughout the whole study period.

The Author

ABSTRACT

The existing market situation of fruits in the country is in a stage to be upgraded for successful fruit marketing to meet the national demand. Proper packaging and proper maintenance is a vital link in the marketing of fruits such as mango and guava. A survey was carried out during January, 2010 to October, 2010 to study the status of fruit trades of mango and guava in wholesale market of Dhaka. The status of fruits trade was observed in 3 wholesale market of Dhaka (Karwanbazar, Zatrabari and Kadamtali). In Mango and guava, mainly 3 diseases of mango and 2 diseases of guava are common such as anthracnose, stem end rot and fusarium rot in mango and anthracnose and scab diseases of guava. Monthwise survey of mango found that incidence and severity was the highest in month of September (33% & 25%). For guava, incidence and severity was the highest in the month of August (21% & 31%). In case of laboratory condition *Colletrotrichum gleosporioides, Botryodiplodia theobromae* and *fusarium* sp infestation percent was highest (23% &19%) and in case of guava, *Pestalotiopsis psidii* infestation was higher in August (36%). The present investigation showed that considerable amount of fruits are being traded every year thus to control the post harvest spoilage of mango and guava and to attention of the concerned authorities to take necessary action.

LIST OF CONTENTS

LIST OF CONTENTS (cont'd)

LIST OF TABLES

LIST OF PLATES

LIST OF GRAPH

CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

The importance of fruits in human diet cannot be over emphasized. They are the chief source of some vitamins, mineral salts and also possess high medicinal values (Kamaluddin, 1994).

In Bangladesh in terms of total area and production of fruit crops, mango ranks first in area and third in production. It occupies 50990 hectares of land and total production is 242605 tons per annum with an average yield of 4.75 tons per hectare (BBS, 2009). But the yield is very low compared to that of India, Pakistan and many other mango growing countries in the world (Hossain and Ahmed, 1994). One of the reasons behind the low yield is diseases caused by fungi, bacteria, nematodes, viruses etc. In Bangladesh 18 mango diseases have been reported. Among these nine are major and the rest are minor (Meah and Khan, 1987). The most common diseases of mangoes are anthracnose (*Colletotrichum gloeosporioides*), stem-end rot (*Botryodiplodia theobromae*) and fusarium rot (*Fusarium sp*).Anthracnose one of the most important disease in Bangladesh. It is the major pre and post-harvest disease of the fruit in all mango producing areas in the world. Anthracnose attacks flowers, young fruits, leaves and twigs. It also appears as a storage disease of mature fruits. Symptoms appear as black, slightly sunken lesions of irregular shape, which gradually enlarge and cause blossom blight, leaf spotting, fruit staining and fruit rot. In Bangladesh, about 25% to 30% loses (Reza and Kader, 1995) of total production occurred due to anthracnose and stem end rot. The secondary spread is through rain drops.

Integrated Crop Management (ICM) is a broad ecological approach to control disease in a compatible manner. It advocates control of the pests and diseases through the combination of several control practices without depending on heavily toxic chemicals. ICM has a holistic approach to crop production based on sound ecological understanding. Indiscriminate use of the chemicals is not only hazardous to living being but disrupt the natural ecological balance by killing the beneficial soil microbe (Ansari, 1995). So, alternatives have to be developed to control anthracnose in order to ensure safe food production as well as the environment.

Mango (*Magifera indica L.*) is one of the most important popular fruit grown in the tropical and sub- tropical countries of the world as well as in Bangladesh. It is not only one of the most popular fruits of the country but it has one season in a year and is also perishable in nature. The mango is considered to be a class one fruit of the country. Pop (1996) also called mango as 'the king of the oriental fruits'. It is widely over the Bangladesh with the quality mangoes solely concentrated in the north western areas especially greater Rajshahi, Dinajpur and Rangpur (Karim. 2001).

Mango ranks third among the tropical fruits grown in the world with a total production of 15 million tons (FAO. 2009). India is the largest producer which alone produces 9.30 million tons followed by Brazil, Pakistan, Mexico, Philippines. Indonesia. Haiti. China. Bangladesh, Egypt, Sudan, Sri Lanka and Cuba (Bhuiyan 1995).

Mango is a popular fruit of the country having sonic special organoleptic features such as excellent flavour. pleasant aroma, attractive colour and taste. It

is rich sources of vitamins, minerals and total soluble solid etc. (Paramanik, 1995). It is also a medium source of carbohydrate as ripe mango pulp contain 16.9% carbohydrate (Salunkhe and Desai, 1998). The minimum dietary requirements of fruit, day/head is 85 g, whereas our availability is only 30-35 g. which is much lower than recommended daily (Siddique and Scanlan, 1995).

Post harvest losses of fresh fruit is one of the important problems in the etropics. A huge quantity of nutritious fruits goes waste due to lack of proper post harvest handling, storage and ripening. A considerable quantity of fruit goes waste through post harvest decay.

Among the microbial decay, stem-end rot of mango caused by *Botryodiplodia theobromae* has been reported to be the most serious and damaging under a hot (28-32°c) and humid (80-90% RH) condition of Bangladesh, affecting all the mango varieties (Meah and Khan,1987). It is the most important post-harvest disease of ripe mango causing 4-6% fruit loss in every year in India (Pathak and Sivastava, 1967). In Bangladesh this disease has been occured with an average disease incidence of 13.6% (Meah and Khan, 1987) and 5.54 to 20.25% (Anonymous, 1988).

In fact, very little is known about variable response of mango to post harvest stem-end rot and anthracnose and prevention of mango from these microbial infection in Bangladesh. That's why, the present study was designed.

Guava (*Psidium guajava L,)* is a quick growing tropical and subtropical fruit. It is a common and important fruit crop in Bangladesh. It is widely grown throughout the country even with any or little care, mainly in the backyards. But

in the district of Chittagong (Kanchannagar) and Barisal (Sarupkatti), this fruit plant is cultivated commercially. No fruits other than amlaki (Emblica officinalis) is known to contain as much vitamin C as is present in guava.

Bangladesh produces 27000m. tons of guava fruits per annum (BBS, 2009). Two crops are grown with major crop having flowering time April-May and peak harvest period July-August. Among the tree fruit plants guava starts bearing within the shortest possible time and produces abundant fruits.

Guava plants are susceptible to many fungal diseases. A total of 10 diseases have been reported on guava in Bangladesh (Meah and Khan,1987). Anthracnose is recognised as second most serious disease, next to wilt (Meah and Khan, 1987). High prevalence of the disease even in epidemic form every year has been reported from different parts of the country (Meah and Khan, 1987; Rahman and Hossain, 1989). About 90% fruits were severely infected in Sarupkatti, Kanchannagar and Mymensingh during the year 1987 and 1988 (Hossain and Meah, 1992). Anthracnose disease causes serious problem for guava cultivation. Many commercial producers think to give up the cultivation of guava owing to a great loss by this disease. Severely anthracnose infected fruits become fully unfit for consumption and lose food value and market price. Besides, it is a great threat to germplasm preservation.

To control guava anthracnose there has been launched various approaches including chemical spray (Rahman and Hossain, 1989; Hossain and Meah, 1992; Hossain, 1993) and cultural practices (Rahman and Hossain, 1989). But no attempt has yet been taken to estimate the loss in guava owing to fruit anthracnose. The present work was therefore, undertaken to show how the level

of anthracnose infection governs the amount of fruit loss, the fruit stage of highest infection level and effective number of chemical sprays protecting the fruit from infection.

Under the above prospective, identification of post harvest diseases, causal organism and isolation of causal organism from diseased of mango and guava is important. However, very little attention has been given in this area in Bangladesh.

Therefore, the present study has been planned and designed with the following objectives:

i. Quantification (incidence and severity) of postharvest diseases of different phases of postharvest handling in Dhaka wholesale market.

ii. Isolation and identification of postharvest pathogens causing diseases of mango and guava in different phases of postharvest handling.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Mango is a popular and nutritious fruit for millions of people all over the world. It is prone to the attack of many post harvest diseases. Among the diseases stem-end rot and anthracnose are the most serious and damaging under a hot and humid condition of Bangladesh. Market diseases of mangoes cause heavy loss to producers, distributors, retailers and wholesalers. Many research works have been done on different aspects like post harvest losses mango due to diseases. Some of available research findings related to the present study have been reviewed and presented in this chapter.

Guava is reported to be attacked with many diseases on its leaves, flowers and fruits. Wilt has been recognized the most devastating disease and ant hracnose/scab of fruits as second important disease in Bangladesh (Meah and Khan, 1987). Wide occurrence of anthracnose in epidemic form in Bangladesh has been recorded (Meah and Khan, 1987). The disease is world wide in distribution (Verma and Sharma, 1978) it is caused by *Colletotrichum gloeosporioides, Pèstalotiopsis psidii* and *Botryodiplodia theobromae* (Hossain and Meah, 1992). Anthracnose causes fruit rots which makes fruits unfit for consumption. This is undoubtedly a big loss to the producers. Not much work has been done in assessing the loss owing to guava fruit anthracnose. Literatures relevant to crop loss assessment have been presented here.

2.1: Review of mango diseases

Lonsdale *et al.* and Lonsdale (1992a) conducted trials with hot water and various chemicals. Hot water treatment at 55^0C and dipping in prochloraz for 5 minute was phytotoxic causing burn on the skin surface. Lonsdale *et al.* (1991b) and Lonsdale (1992a) observed that a mild irradiation (0.75 KGY) in combination with hot water treatment gave effective control of anthracnose.

Hasan *et al.* (1998) observed that hot water treatment at 52 ± 2^0C for five minutes extended shelf life of mango by 5.34 days. Nguyen *et al.* (1998) reported that the hot water treatment at 52^0C for 5/10 minutes significantly reduced the incidence of anthracnose (*Colletotrichum gloeosporioides*) [*Glomerella cingulated*] and stem-end rot (*Botryodiplodia theobromae*) of mango. They also found that fruits treated with hot water and kept in plastic bags had low incidence of shrivel and maintain least chilling injury.

Nyanjage *et al.* (1998) reported that treatment with hot water at 46.5^0C for 45 minutes and 2 days of intermittent warming (34^0C) during storage at 13^0C resulted in a significantly low incidence and severity of external and internal injury, diseases, softer fruits, higher Brix and better general appearance of mango.

Baez *et al.* (2001) observed that hot water (41.1^0C for 65-90 minutes) treated fruits lost more weight than untreated fruits.

Zhu *et al.* (2002) stated that hot water treatment could make the colour of both peel and pulp homogeneous, soluble solid content and p^H value was high.

Prusky *et al.* (2002) reported that hot water spray and fruits brushing for 15-20 s with 225 µg. ml-l Prochloraz was the most effective treatments to control alternaria rot of mango with a high relative quiescent infected surface (RQIS) rating of 36 at harvest. Comparable control was obtained with the commercial treatment of 900 µg. Ml-l Prochloraz spray.

Mukherjee (1956) found that different types of wrapping materials such as polythene, tissue paper, cellophane, plio film prolonged storage life of mango. He also reported that among the selected wrapper materials, polythene was found to be superior and cellophane bag caused a greater retention of total soluble solids. According to singh (1960) polyethene proved superior to other wrapping like tissue paper, cellophane and pliofilm. It was found that during six weeks storage of mango wrapped in polythene bags, the fruits showed lower physiological losses and chilling injury at 7.2^0C.

Chaplin *et al.* (1982) reported that mango fruit cv. 'Kensington' stored in sealed polyethylene bags at 20^0C temperature, rough skin had off-flavour, making them unacceptable. They also observed that the gas atmospheres inside the bags varied between treatments but often the CO_2 concentration exceeded 20% and O_2 was lower than 5%.

Miller *et al.* (1983) conducted an experiment with mango fruits to study the effect of heat-shrinkable plastic films on changes of physical characters during storage. They observed that individual fruit ripened at 21^0C temperature and weight loss was significantly less in sealed film fruit than that of non-sealed fruit. There were no significant differences in firmness,

colour development of skin, decay during development, or time to ripen to the soft ripe stage between sealed and non-sealed fruit.

Miller and Risse (1988) found that film wrapping reduced moisture loss, retarded softening and maintained characteristic freshness with reduced colour development during extended periods of storage and marketing. Noomhorm and Tiasuwan (1988) reported that ripening of mango delayed by controlled atmosphere for 2 weeks compared to untreated samples.

Wavhal and Athale (1989) observed that packing in lots of 10 fruits in polyethylene bag (30×40 cm, 100 gauge with 0.2% perforation) reduced weight loss, maintained fruit quality and prolonged shelf life by 4-8 days, compared with non-wrapped fruits. They also reported that inclusion of a bag of vermiculite (30g) saturated with $KMn0_4$ in the polythene bags gave a reduction of weight loss and storage disorders. Mango fruits cv. 'Alphonso' stored in perforated polythene bags had the lowest weight loss and spoilage during storage and ripening.

Sornsrivichai *et al.* (1989) reported that fruits were individually placed in sealed packages in polyethylene film (0.011 mm thick) or PVC film (0.014 mm thick) and stored at 13^0C with 78% RH or under ambient conditions (28-33^0C, 80% RH). The packaged fruits retained its quality for 6-9 days at ambient temperature and 30-36 days at 13^0C, while unpacked fruits rapidly became shriveled and over ripe.

Gonzalez *et al.* (1990) noted that modified atmosphere packaging delayed fruit ripening, reduced weight loss and any off-flavour. Feng *et al.* (1991) reported that controlled or modified atmosphere delayed ripening and also controlled post harvest diseases.

Mondal *et al.* (1995) reported that shelf life of mango was 21 days in polybag. Noomhorm and Tiasuwan (1995) found that ripening of 'Rad' mango was delayed by controlled atmosphere for two weeks compared to untreated mangoes.

According to Alves *et al.* (1998) mango fruits cv. 'Tommy Atkins' were stored in a modified atmosphere (MA) by packing the fruits in low density polyethylene bag. They found that MA stored fruits showed delay in ripening but these fruits developed off-flavours, did not develop the characteristic internal and external colour or aroma, did not soften, did not develop sweetness and remained more acidic than control fruits.

Reddy and Haripriya (2002) studied the storage behaviors of mango treated with GA_3 and stored in polyethylene absorbent. It significantly reduced weight loss, rate of respiration, delayed colour development and ripening had longer shelf life.

Mortuza *et al.* (2002) showed polyethylene bag wrapping caused maximum reduction in incidence of anthracnose in mango which was followed by newspaper and tissue paper. Polyethylene wrapping delayed ripening considerably. The incidence of stem-end rot increased in fruits wrapped with polyethylene but it decreased in fruits wrapped with newspaper and tissue paper.

Chhatpar *et al.* (1972) stated that use of wax emulsion as coating around the fuits at temperature 5-8^{0}C prolonged period storage about two and half month.

Joarder (1980) observed that wax coating increased the shelf life and prevented the weight loss of mango. Wanlapha *et al.* (1980), observed that the fruits treated with hot benomyl solution and coated with wax and then stored in a refrigerator at 10^0C temperature with 85% relative humidity maximum storage life (one month) with acceptable quality of fruit.

Majumder *et al.* 1981;observed mango ripening could be controlled through the use of chemical, the value for the Brix/acid ratio was low and firmness was high in fruits treated with gibberellic acid and menadione sulphite. Dipping of mango in GA_3 (10^{-6} M), indole-3-acetic acid (IAA) (10^{-6} M) or Kinetin (10^{-5} M) solutions delayed ripening.

Murthy and Rao (1982) reported that the ripening of mango can retard by postharvest treatments with GA_3, mg/L), cycocel, alar and menadione bi-sulphite during storage at 28^0C.

Khader (1991) found maximum delaying in ripening (3 days) and prolonged shelf life with GA_3 (200 mg/L). Hossain (1989) found that fruits dipped in solution containing melted paraffin and 1000 to 1500 ppm maleic hydrazyde (MH) considerably extended shelf life by 50% and 75%, when the treated fruits were stored in the cold storage.

Mohiuddin *et al.* (1991) conducted an experiment to study the storage performance of mango fruit cv. Aswina with different coating materials viz. paraffin, mustard oil and soybean oil with or without prior application of Dithane M-45. They observed that soybean and mustard oil coating on mature mango fruits prolonged shelf life but failed to arrest skin discoloration.

Castrillo and Bermudez (1992) conducted an experiment on post harvest ripening in wax-coated 'Bocado' mango. Wax-coating caused weight loss, exocarp chlorophyll degradation and mesocarp pH change; but did not affect mesocarp chlorophyll, sugar and starch content.

Singh *et al.* (1995) conducted an experiment with GA_3 and Ethrel (ethaphon) to enhance the ripening and improved the quality and shelf life of mango cv. 'Amrapali'. They found that ethrel at 500 ppm was very effective in enhancing the ripening and improving the quality in terms of TSS, total sugar, ascorbic acid and β-carotene content. Youlin *et al.* (1997) observed that fruit of mango cv. Zihua dipped with growth regulator, 2, 4-D, GA_3 or NAA, each together with prochloraz prolonged shelf life.

Jain and Mukherjee (2001), reported that post-harvest treatment with Gibberelic acid at the rate of 200 or 300 mgl-1 significantly delayed ripening of mango fruits cultivar "Langra" when stored at 36.15^{0}C maximum and 27.08^{0}C minimum temperature. GA_3 reduced spoilage in mango.

Om-Prakash *et al.* (2000) investigated the efficacy of various chemicals to control stem-end rot and anthracnose diseases. Benomyl, Carbendazim, Thiabendazole as well as hot water (50^{0}C for 5 minute) effectively controlled the diseases.

Muller and Burt (1989) showed that stem-end rot was controlled in harvested mango fruit by fungicidal dipping of fruit followed by storage at 13^{0}C. Stem-end rot was significantly reduced.

Pandey (1989), reported that Benomyl and Mancozeb gave good inhibition of spore germination of *Colletotrichum gloeosporioides*, the cause of anthracnose of guava.

Johnson *et al.* (1994) recommended that post harvest anthracnose in mango could be effectively controlled by dipping the fruits in hot benomyl at 52^0C for 5 minute or a 30 second. Hot benomyl was superior in control anthracnose of mango under the storage condition.

Quroshi and Meah (1991) carried out infectivity tests, inoculated fruits of the cultivar Fazli began to show symptoms 24-48h after inoculation, but when stored at 40^0C fruits did not show any symptoms up to 20 days after inoculation. Fruits incubated at room temperature (30^0C) or in bamboo baskets (33^0C) developed symptoms 24 h after inoculation, and fruit stored in baskets rotted fastest. They concluded that transport time and storage facilities are the main contributing factors to the prevalence of stem end rot of mango in Bangladesh.

Verma and Om-Prokash (1995) carried out an experiment to quantity the losses when Dashehari mangoes were transported i) after piling them loose on the floor of the truck; ii) after packing them in wooden boxes which were stacked on the truck. Estimated loss was 15.80% and 17.53%.

Suit and Du Charme (1946) found that Copper sulphate sprays was quite effective in killing the red rust alga of mango 15 days interval when the disease was severe.

Zhou *et al.* (2001) observed that the most effective chemical control for preventing attack of young leaves by scab was spraying a copper and

ammonium mixed solution in mid-late March (500 g copper sulfate +2.25 kg ammonium bicarbonate) and spraying three times a solution of 0.4-0.5% jianganmycin at flowering stage.

Kaushik *et al.* (1991) reported that post harvest application of 2, 4, 5-trichlorophenoxyacetic acid (2, 4, 5-T), maleic hydrazide and calcium nitrate reduced weight loss and fruit rot, weight loss increased during prolonged storage of mango. Yuniarti and Suhardi (1992) Showed wax emulsion at 6 or 7% had the greatest effect resulted in the lowest weight loss of mango.Wax with coatirs reduced weight loss by inhibiting transpiration. Yamashita *et al.* (1997) reported that weight loss in heat shrinkable polyolefin film packaged mangoes was significantly lower than that of the non-wrapped control.

Wavhal and Athale (1989) reported that when fruits were stored in polyethylene bags, weight loss reduced. Gonzalez *et al.* (1990) also observed modified atmosphere packaging with polythene bags delayed ripening and reduced weight loss.

Reddy and Haripriya (2002) treated mango fruits with GA_3 and stored in polyethylene bags with ethylene absorbent significantly reduced physiological weight loss. Zora *et al.* (2001) reported that physiological weight loss of mango was reduced when wrapped with polyethylene bags and stored at 13^0C.

Pramanik (1995) observed that dry matter content in Fazli increase from 17.14 to 28.86% during storage in ambient temperature. It is evident that as ripening progress some carbohydrate is completely oxidized to CO_2 and water as a result of respiration. This indicates an actual decrease in dry

matter content. Percent dry matter (%DM) was higher white paper bagged mango fruits.

Jain *et al.* (2001) reported that maximum reduction in P^H content due to both the diseases of stem end rot and black rots was in Langra. Zhu *et al.* (2002) noticed that the P^H of hot water treated fruits was higher than non-hot water treated fruits.

Teaotia and Singh (1971) observed that. Langra and Dudhia were rich in vitamin C (105.2mg/100g) while. Aunupam had less amount of vitamin C (21.0 mg/100g). Ghosh *et al.* (1985) reported that the highest 33.6mg/100g amount of ascorbic acid was found in cv. Jangle as compared to Amrity, Bombay yellow and Bombay green. Joshi and Roy (1988) noticed a continuous decrease in vitamin-C during transport and storage (at 10 ^{0}C for up to 32 days).

Gofur *et al.* (1997) in reported that concentration of ascorbic acid decreased with fruit development Aswina, Fazli and Langra. After 12 weeks of fruit set cv. Langra contained highest quantity of ascorbic acid (105mg/100g) followed by Aswina and Fazli. Ascorbic acid concentration decreased with increase of storage time.

Kumar and Kumar (1998) reported that ascorbic acid (Vitamin C) content was highest in cv. Langra (150 mg /100g juice). Ascorbic acid content decreased after fruit set to maturity in. Langra (Rajput and Pandey, 1998).

The highest ascorbic acid contents (123.33 mg/100gm) were recorded in the fruits of Kashmir Langra (Mitra *et al.* 2000). They found the highest ascorbic acid content (125.40 mg / 100g) in Langra.

El and Ahmed (2001) noted that the lower the temperature the higher the vitamin C content. Dhalla *et al.* (2001) and Jain *et al.* (2001) also reported higher ascorbic acid content of mango fruits stored in cool chamber.

Jain and Mukherjee (2001) observed Gibbrelic acid (GA_3) treatment retarded the loss in ascorbic acid in mango fruits. Mitra and Mitra (2001) found maximum ascorbic acid content (104.66 mg/100g) in Lohajang variety of mango.

Singh (2000a) reported higher percent of vitamin-C (ascorbic acid) in mango fruits cv. Zardalu after five days of storage at room temperature compared to fruits ripened after 9 days of storage. 'Edward' mango showed the highest Vitamin-C (ascorbic acid) content (Laborem *et al.* 2002).

Agnihotri (1963) observed that total acidity remained constant up to 11 days of storage then decreased rapidly. Srivastava (1967) of acid content 22 mango varieties of ranged from 0.67 to 3.66% in green mango and 0.18 to 0.56% in ripe mango fruit.

Krishnamurthy *et al.* (1984) observed that juicy varieties of mango like Royal special and Hyder sahed are generally acidic (0.49 to 0.45%) but table varieties are lesser in acid content (0.13%). The increasing trend of acidity of mango fruits was found from skin to pulp of fruits. Titratable acidity was decreased during storage and ripening (Upadhyay and Tripathi 1985). Ghosh *et al.* (1985) reported maximum acidity of 0.32% in Amriti, Meghlathan and Bombay yellow and minimum in cv. Saradamonibhog. Deblossoming of the early emerging panicles in the cv. Dashehari mango showed unaltered titratable acidity.

Tripathi (1988) reported lowest level of acidity during 6 days of storage. There were differences in titratable acid content when cv. 'Arumanis' mango was stored in cold storage at different temperatures (Lam and Wong, 1988). Postharvest treatments for the extension of storage life delayed in decrease of titratable acid content.

Sanyal *et al.* (1991) noticed high acidity 0.38% in mango cv. Krishnabhog and low acidity in cv. Samar Bahist, Chausa, Zardalu and Bangalora. Absar *et al.* (1993) carried out an experiment on the change in the physico chemical composition of ten mango varieties in Bangladesh at different stages of maturity. They reported that acidity continued to fall with the advances of maturity. Titratable acidity was decreased during post harvest period.

Shahjahan *et al.* (1994) revealed that acidity of mango decreased gradually at the time of storage and ripening. Percent acidity in green and ripe mango cv. Fazli was 0.32 and 0.10 respectively. O'Hare (1995) observed that titratable acidity declined slowly when mango fruits were stored at 13^0C temperature. Ashwani and Dhawan (1995) reported that total acidity to decrease during storage of mango fruits.

Hofman *et al.* (1997) observed that titratable acidity was not affected by bagging (white paper bags) in mango fruit cv. Keitt. Titratable acidity increased after fruitset and slowly decreased towards maturity in mango.

Salles and Tavares (1999) reported that titratable acidity decreased during storage in a refrigerated room. Amrakoon *et al.* (1999) showed in mature mango fruits cv. Karuthacolomban and Velleicolomban harvested before the optimum stage of maturity showed higher tiratable acidity.

Kalra and Tandon (1983) harvested after mango fruit cv. 'Dashehari' 85, 90 or 95 days of fruit set stored at ambient temperature with 39-91% relative humidity showed that the reducing sugar content was higher at each successive harvesting stages.

Castrillo *et al.* (1992) reported reducing sugars increased slightly during ripening. Rangavalli *et al.* (1993) captained reported that reducing sugar content was gradually increased and reached up to 7.5%.

Upadhyay and Tripathi (1985) showed that the reducing sugars content increased gradually with ripening. Tripathi (1988) observed that reducing sugar content was the highest on the 6^{th} day of storage. Lianni *et al.* (1994) found that reducing sugar content of mango increased up to 5 days after harvest.

Mitra and Mitra (2001) observed highest reducing sugar content (6.20%) in Mohan Bhog mango. Lima *et al.* (2001) showed an appreciable increase in reducing sugar during ripening of mango. Kumar *et al.* (2001) found highest amount of reducing sugar (6.30%) in Langra.

Singh and Singh (2002a) noticed that reducing sugar content was higher in mango fruits CV. Zardalu after five days of storage compare to 9 days of storage at room temperature. Highest reducing sugar (8.23%) was recorded in Prabha Shankar mango (Mitra *et al.* 2001) and lowest (4.78%) in Amrapali mango.

Ali and Mazhar (1960) reported that non-reducing sugar content was significantly higher at ripening stage. It was more than 20%. Non-reducing sugar contents increased rapidly during the first 4-5 days of storage.

Joshi and Roy (1988) observed that non-reducing sugar content after attaining a peak remained constant. Rangavalli *et al.* (1993) found a gradual increase in non- reducing sugar in mango during post harvest changes. Lima *et al.* (2001) showed an appreciable increase in the activity of non-reducing sugars during ripening of mango fruits. Highest amount of non-reducing sugar (15.17%) content was found in Dashehari mango fruit.

Ghosh *et al.* (1985) found minimum total sugar (6.2%) in the cv. Meghlanthan and maximum (18.2%) in Sardarpasand. Joshi and Roy (1988) reported that during transport and storage, a rise followed by decline was observed in total sugars. Sanyal *et al.* (1991) showed that sugar content was 14.19% in cv. Zardalu and 17.93% in cv. Dashehari under the West Bengal condition.

Tandon *et al.* (1985) described that total sugar content decreased initially until maturity in 'Mallika' whereas increased throughout the growing period in Langra. Upadhyay and Tripathi (1985) observed that total sugar content increased gradually in mango fruit cv. 'Gaurjeet' when stored for 6 days at room temperature (32-35^{0}C).

Absar *et al.* (1993) observed that sugar content was maximum in cv. Gopalbhog and minimum in Khirsapat at the early stage of development. Maximum total sugar in Langra (20.32%) followed by Gopalbhog (18.59%), khirsapat (18.52%) at the ripening stage.

Singh (1968) reported that soluble solid increased in mango during storage. Total soluble solids (Brix %) varied from variety to variety (Mollah and Siddique, 1973). TSS of mango varieties Fazli and Langra were 7.70 to 14.8% and 12.15 to 18.0% respectively. TSS content was lower in early harvest and higher at later stage (mature stage) of harvesting of ripening.

Tripathi (1988) reported that highest of TSS was found in cv. Gourjeet mango on the 6^{th} day of storage. Joshi and Roy (1988) mentioned that TSS increase initially and declined afterward during storage. Lowest soluble solids (14.8%) after transportation following 6% wax treatment in 'Arumanis' mango compared with 18.8% in control.

Nyanjage *et al.* (1998) reported that hot water treatment at 46.5^0C for 45 minutes in combination with intermittent warming (34^0C) during 12 days of cool storage (13^0C) showed higher brix and better general appearance.

Ahmed and Singh (2000) found the highest TSS (22.15%) in Amrapali mango when treated with GA_3 and packed in perforated polyethylene bag.

Kumar *et al.* (2001) reported that the highest TSS (25.75%) was exhibited in Dashehari mango. Mitra and Mitra (2001) found highest TSS (22.66 brix) in Misri Bhog mango and 20.66^0 Brix was in Prabha Shankar mango.

Singh and Singh (2002a) reported the at TSS was highest (23%) in Amrapali mango. Hofman *et al.*; (1997) observed that TSS was not affected by white paper bagging.

Kumar and Kumar (1998) found that TSS increased when mango fruits were treated with Bavistin (500ppm). The use of different bagging materials did

affect brix. Fruit quality was best when fruits were bagged with white paper at early stage.

Gautam *et al.* (2003) observed that when mango fruits were subjected to various post harvest treatments (Bavistin, wax emulsion coating and NAA) and stored under either ZECC or cold storage conditions had lower TSS compared to the control,highest TSS in Dashehari mango fruit.

2.2 Review of Guava diseases

Rawl (1993) performed a pathogen coefficient analysis on the effect of 4 different fungi (*Phytophthora nicotianae* var. *parasitica*, *Pestalotiopsis psidii*, and *Colletotrichum gloeosporioides* on fruit rot and yield loss in guava. Anthracnose caused by *G.* cingulata was highly correlated with *Phytophthora infestence* (r = O.6881) and correlated with 3 other diseases (fruit rot, styler-end rot and canker) for the weight of diseased fruits. Pathogen incidence and fruit weight were positively associated with infestation of fruit rot, styler-end rot, canker and anthracnose. The direct effect of *P. nicotianae* var. *parasitica*, *Pestalotiopsis psidii* were high but their indirect effects through other diseases were low. Disease incidence and fruit weight accounted for 83% and 73.5% yield loss respectively, following a multiliner regression.

Hossain and Meah (1992) monitored the prevalence of guava anthracnose in Chittagong, Barisal and Mymensingh during 1987-88 and found 100% plant infection and 90-100% fruit infection. They set up an experiment at BAU campus for development of control strategies during 1987-88. Different varieties of guava (Sarupkatti, Kanchan Nagar and Deshi) were sprayed 4-7 times starting from initial flowering stage with Topsin M, Dithane M-45,

Rovral WP and Rovral FLO with or without sticker. Results were very promising and 80% reduction in fruit infection was obtained.

Rahman and Hossain (1988) used 10 spray of different fungicides for controlling guava anthracnose (*Colletotrichum gloeosporioides*). They started spray after first appearance of the disease and continued for 3 times at an interval of 20 days. Topsin M (0.1%) followed by Dithane M-45 (0.2%) proved more effective. Dithane M-45 showed good performance. Bordeaux mixture (4:4:40) reduced 51% fruit infection over control.

Rahman and Hossain (1988) evaluated Bavistin (0.1%), Bordeaux mixture (5:5:50), Cupravit (0.2%), Dithane M-45 (0.2%) and To NI (0.2%) against guava anthracnose at Sarupkatti on Sarupkatti variety. Severity of disease was recorded 10 days after the final spray. They evaluated PDI (percent disease index) on the basis of 0-5 scale (No infection on fruit, 1=10% fruit area infected, 2=11-25% fruit area infected, 3=26-40% fruit area infected, 4=41-60% fruit area infected and 5=61% and above).

Assessment of post harvest losses in Nagpur mandarin was done by Naqvi and Dass (1994). Surveys in several districts of Maharashtra, India during 1988-90 indicated that 43 and 47% of the total losses of mandarins in truck and train transport, respectively, were due to post harvest diseases, Stem end rot caused by *Botryodiplodia theobrornae*, *Colletotrichum gloeosporioides* (*Glomerella cingulata*) and occasionally Alternaria and *Phomopsis* (Diaporthe) c/fri contributed to 2 1-26% of losses, while *Geotrichum candidum* (13-15%),*Penicillium digitatuin* and *Pilcilkum* (1-4%) were also involved.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The experiments were conducted during the period from January, 2010 to October, 2010 to achieve the objectives.

3.1. Experiment I. Study on prevalence of post harvest diseases of mango and guava fruits transported from different parts of the country in the wholesale market of Dhaka

3.1.1. List of selected fruit species tested for the presence of post harvest diseases is given below:

English name	Local name	Scientific name
Mango	Aam	*Magnifera indica*
Guava	Peyara	*Psidium guajava*

3.1.2. Locations

The following wholesale market of Dhaka was surveyed and prevalence of post harvest diseases of selected fruit species was studied:

Name of wholesale market	**Fruits observed**
▪ Kawran Bazar fruit wholesale market ▪ Zatrabari fruit wholesale market ▪ Kadamtali fruit wholesale market, Sadarghat	o Mango o Guava

The survey was conducted in the wholesale market of Dhaka in the areas of Karwan Bazar, Zatrabari and kadamtali, Sadarghat the most important wholesale fruit market of Dhaka (Table 3.1.2).The location situated in a distinct distance from each other and collected most of the fruits from all over the country. They also supplied most of the fruits from all over the country. They also supplied most of the fruits in other areas of Dhaka city.

Table 3.1.3 Location of survey areas of different wholesale market of Dhaka from where data were collected

Fruits	Name of wholesale fruit market	No. of surveyed wholesalers
Mango	Kawran Bazar	20
	Zatrabari	20
	Kadamtali	20
Guava	Kawran Bazar	20
	Zatrabari	20
	Kadamtali	20

The respondents wholesaler sold various types of locally produced fruits and they also imported fruits from other countries. Guava was available for the year round and Mango was available during summer season and in some extent imported Guava was available other than winter season. The commonly sold fruits were mango, jackfruit, guava, Mango, black berry, pineapple, banana, litchi, lemon, berry, custard apple, wood apple, golden apple, star apple, wild date palm, Indian berry, tamarind, melon, watermelon,

cashew nut, pomegranate, plum, rose apple, Indian olive, Indian Guava etc. The responses of the respondents of fruit wholesaler in different market of Dhaka city presented in Table 3.1.3.

Table 3.1.4 Data represents the type of fruits that the respondents sale in different market

Name of wholesale fruit market	Type of fruits sold
Kawran Bazar	Mango, guava, jackfruit, black berry, pineapple, banana, litchi, lemon, custard apple, wood apple, elephant apple, golden apple, Indian berry, black berry, tamarind, melon, watermelon, cashew nut, pomegranate, plum, rose apple, Indian olive, Indian Guava, star apple, wild date palm
Zatrabari	Mango, guava, jackfruit, black berry, pineapple, banana, litchi, lemon, elephant apple, golden apple, tamarind, melon, watermelon, cashew nut, pomegranate, plum, rose apple, Indian olive, Indian Guava
Kadamtali	Mango, guava, jackfruit, black berry, pineapple, banana, litchi, lemon, custard apple, wood apple, elephant apple, golden apple, tamarind, melon, watermelon

3.1.5. Data collection

Experiments conducted on transported fruits from different parts of the country in the wholesale market of Dhaka. The size of the fruit lot was recognized and 1000 fruits of each lot considered for data collection. Data were recorded on the following parameters-

1. Types of fruit that collected for sale
2. Source of collection
3. Frequency of fruit collection
4. Average time required for transportation
5. Mode of transportation
6. Average weight for every truck
7. Average buying price per kg
8. Average sales price per kg
9. Average percentage of fruit loss
10. Main causes of fruit loss

3.2. Experiment-2. A: Identification of post harvest diseases from diseased fruit collected from different locations of Dhaka

3.2.1. Data recording times

Assessment of the incidence and the severity of the diseases of each fruit species were observed five times in growing season for each fruit during the period of January, 2010 to October, 2010. The times of data collection was determined on the basis of harvesting time of the selected fruit in the growing season.

3.2.2. Assessment of disease incidence and severity

Disease incidence was assessed as percentage of fruits infected with at least one spot or visible symptom. Assessment of incidence and severity of the diseases of each fruit species were calculated by the following formula:

$$\text{Percent fruit infection} = \frac{\text{Number of diseased fruits}}{\text{Number of total fruits observed}} \times 100$$

Percent disease incidence (PDI) was calculated using the formula of Rai and Mamatha (2005) (modified) as:

$$\%\ \text{disease incidence (PDI)} = \frac{\text{Number of diseased fruits in each consignment}}{\text{Number of total fruits in each consignment}} \times 100$$

Disease severity was calculated using the formula of Johnston (2000) as:

$$\text{Disease severity} = \frac{\text{Area of fruit tissue infected by disease}}{\text{Total fruit (surface) area}} \times 100$$

3.2.3. Identification of post harvest disease and causal organism of selected fruits

Fruits of selected fruits species was observed carefully and symptoms of the diseases were recorded following the description of Sing (1978),identify the pathogen, diseased fruits were collected using sterilized polythene bags and brought to the laboratory. The sample was washed thoroughly under running tap water (if required) and surface sterilized with 4% NaOCl. The diseased parts then placed on three layers of wet blotters equidistantly in Perspex plates and another set placed on PDA medium. Both sets were incubated for 7 days under 12/12hr. alternate cycles of near ultra violet light and darkness at 22±2°C. After 8 days of incubation, the causal organism(s) were identified. The identification of the fungi was based on the colony character on PDA and on the morphological characters of fruiting bodies, spores or conidia under compound microscope. The pathogens thus recorded were identified following the keys of Ellis (1960) and Mathur and Kongsdal (2003). Data on % presence of pathogen were recorded. Record was kept by keeping permanent slide of pathogenic structure, taking photograph of diseased sample and pathogenic structure under microscope.

3.2.4. Collection and preservation of fruit samples

Fruit species were collected from selected locations of Dhaka. 10 fruits of similar symptom were collected from each location for each fruit for isolation of causal pathogen. The collected fruit samples were brought to the laboratory and subject to a preliminary cleaning and then stored in paper packet in refrigerator for further study.

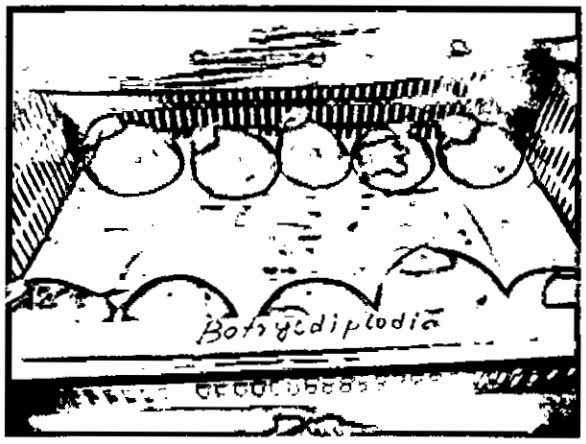


Plate 1.1 Photograph showing *Botriodiplodia theobromae* inoculated in mangoes

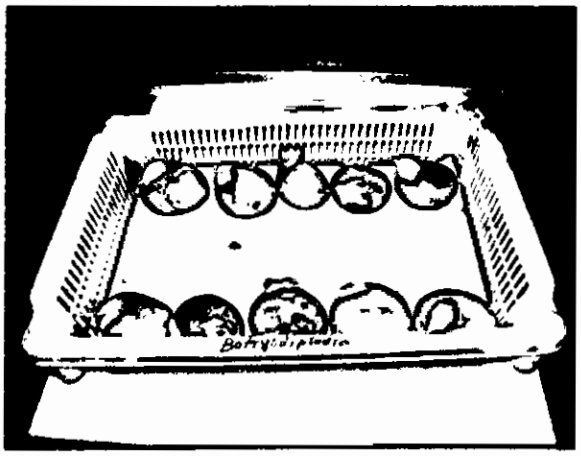


Plate 1. 2 Photograph showing stem end rot of mangoes after 5 days of inoculation by ***Botriodiplodia theobromae***

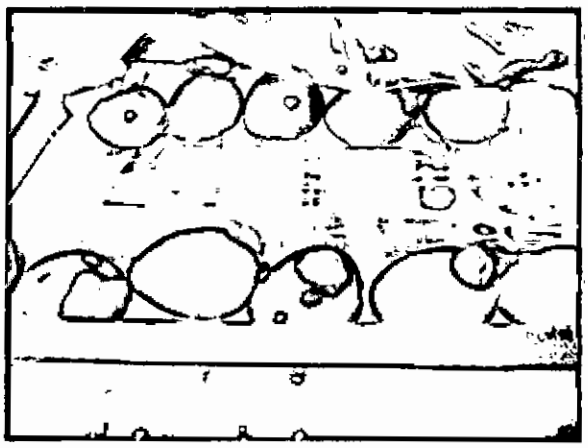


Plate 2.1 Photograph showing status of mango before infection of *Fusarium sp.*

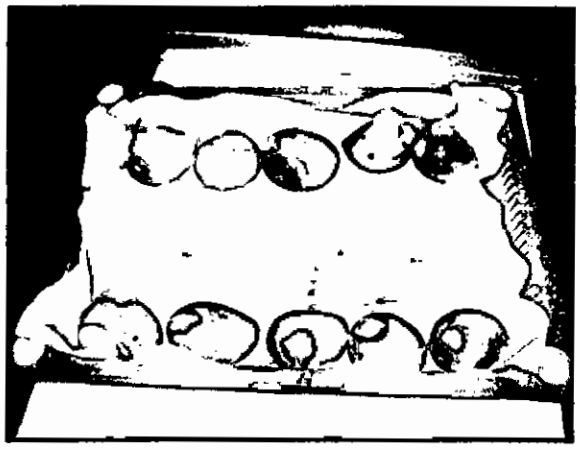


Plate 2.2 Photograph showing fusarium rot of mangoes after 5 days of inoculation by *Fusarium sp.*

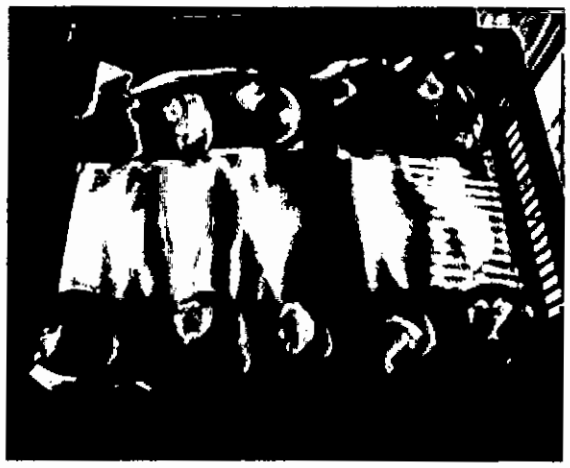


Plate 3.1 Photograph showing status of mango after inoculation of *Colletotrichum gleosporioides.*

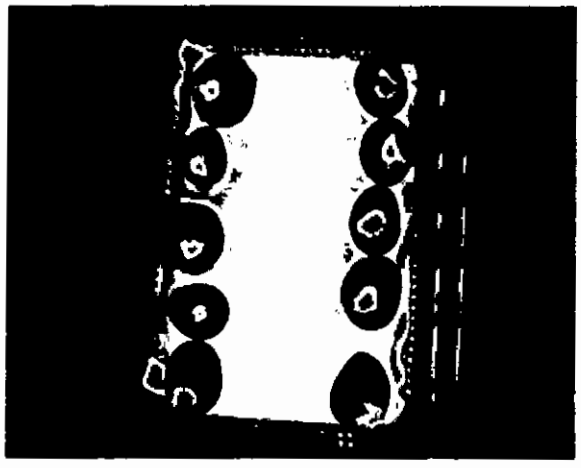


Plate 3.2 Photograph showing status of mango after infection of mango by *Colletotrichum gleosporioides*

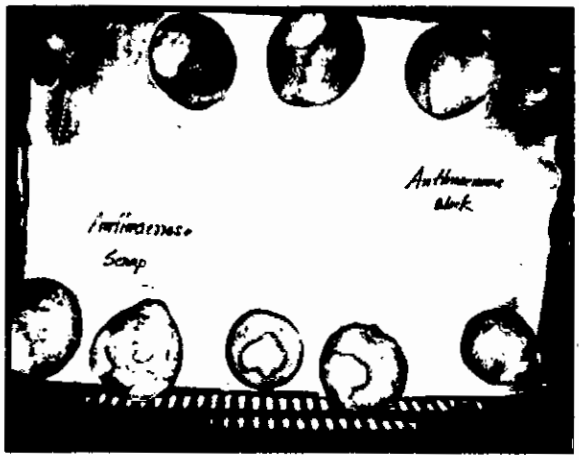


Plate 4.1 Photograph showing status of Guava before inoculation of Anthracnose*(Colletotrichum gleosporioides).*

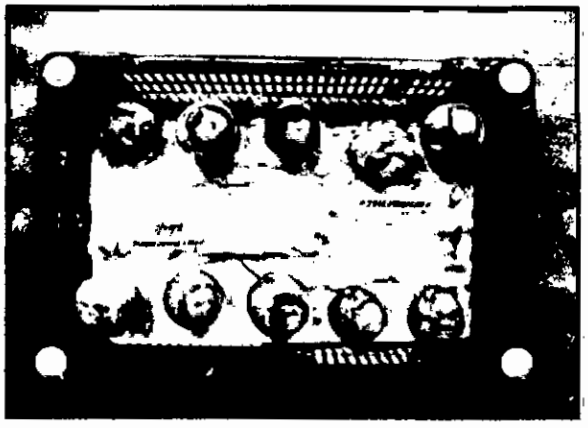


Plate 4.2 Photograph showing status of guava after infection of Anthracnose by *Colletotrichum gleosporioides.*

CHAPTER IV

RESULTS

CHAPTER IV

RESULTS

The present experiment was conducted to find out the status of post harvest diseases of mango and guava fruits in Bangladesh. Consequently three experiments were conducted to observe the prevalence of post harvest diseases and causal organism from diseased mango and guava. The results have been presented and discussed, and possible interpretations have been given experiment wise under the following headings:

4.1 Experiment-1: Study on fruits transported from different parts of the country and identification of post harvest diseases collected from wholesale market of Dhaka.

The survey was conducted in the wholesale market of Dhaka in the area of Kawran Bazar, Zatrabari and kadamtali, most important wholesale fruit markets of Dhaka city. The respondents wholesaler sold various types of locally produced fruits and they also imported fruits from other countries. Mango was available during summer season and guava was available for the year round and in some extent imported guava was available other than winter season.

Mango and guava were collected from different division in Dhaka wholesale market (figure4.1 and 4.2). In case of mango, the highest amount (43%) was collected from Rajshahi division followed by Khulna division (30%). For Guava, the highest amount from Barishal division (35%) followed by Chittagong division (30%).

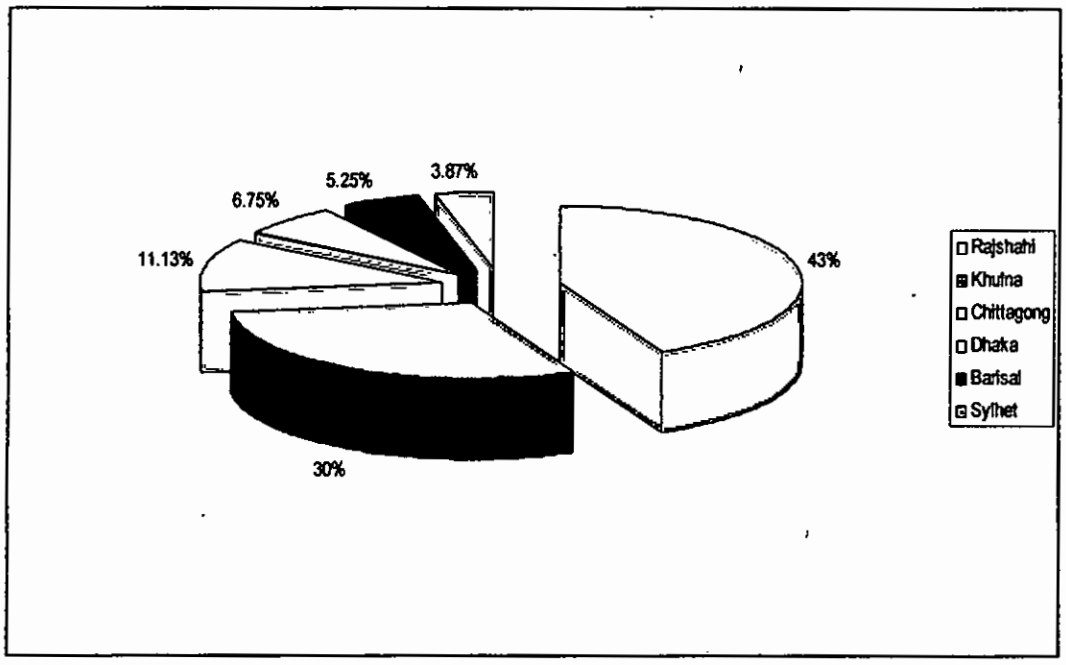


Figure 4.1. Divisionwise mango collection status in Dhaka wholesale market.

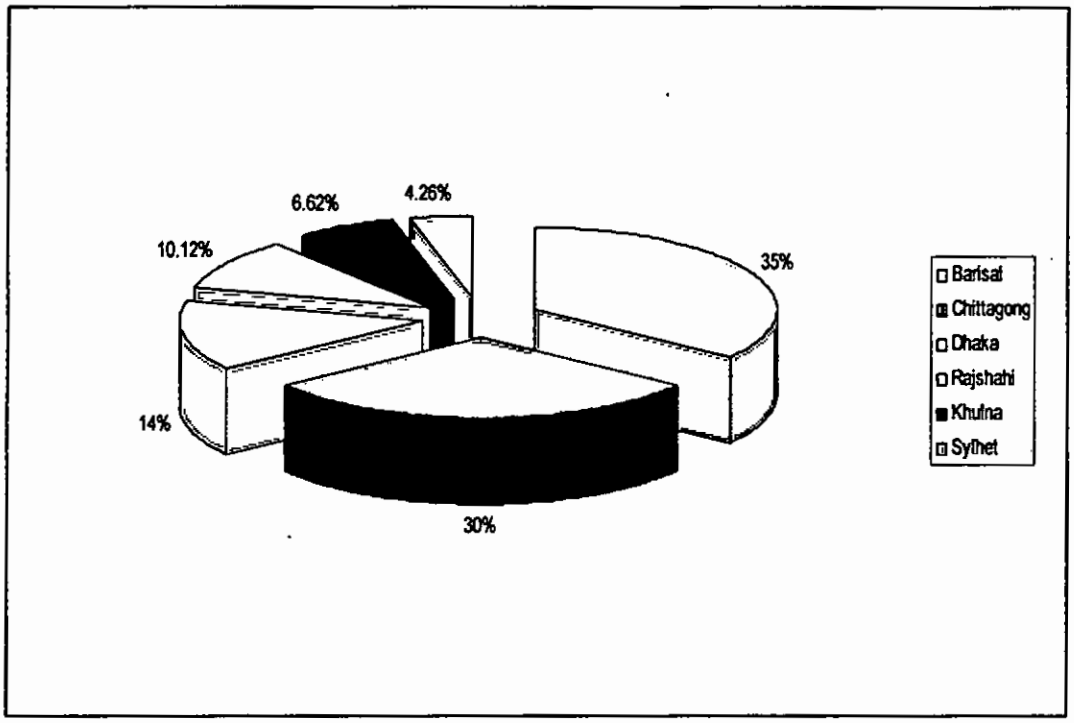


Figure 4.2. Divisionwise guava collection status in Dhaka wholesale market.

According to the response of the respondents on frequency of fruit collection, average time required for transportation, mode of transportation, average weight for every truck, average buying price per kg, average sales price per kg, average parentage of fruit loss and main causes of fruit loss presented in Table 4.1.3.

Table 4.1.1. Data represents the type of fruits that the respondents sale in different market

Fruits	**Mango**	**Guava**
Frequency of fruit collection	5 days/week	3 days/week
Average time required for transportation	5.5 hours	5.5 hours
Mode of transportation	Truck/trolley/Ship	Truck/trolley/Ship
Average weight for every truck	5.5 ton	5 ton
Average buying price per kg	30 Taka	20 Taka
Average sales price per kg	40 Taka	22 Taka
Average percentage of fruit loss	26%	18%
Main causes of fruit loss	Rotten	Rotten

According to the respondents of three wholesale market of Dhaka average one truck of fruit collected from different parts of Bangladesh. The average loss of 17.66 percent of fruits due to rotten by different post harvest diseases and different types of mechanical injury (Table.4.1.2).

Table 4.1.2.Frequency of fruit collection and average fruit loss in three wholesale market of Dhaka during 2010 (May-September)

Name of the traders	Place	Frequency of fruit collection	Percentage of fruit loss (%)
Muktijoddha Banijjaloy	Jatrabari	1 Truck	20
Modhupur Traders	Jatrabari	½ Truck	15
Doyal Vander	Jatrabari	1 Truck	17
Ekota Fruit Syndicate	Jatrabari	2 Truck	18
Nesarabad Traders	Jatrabari	1 Truck	16
Fal bitan	Karwan Bazar	2 Truck	20
New Banijjaloy	Karwan Bazar	1 Truck	19
Masers Binimoy Banijjaloy	Karwan Bazar	½ Truck	12
Alif Vander	Karwan Bazar	1 Truck	17
City Banijjaloy	Karwan Bazar	1 Truck	19
Tamim Enterprise	Kadamtali	1 Truck	16
Sonar Bangla Banijjaloy	Kadamtali	2 Truck	25
Iswardi traders	Kadamtali	½ Truck	14
Kolakopa Banijjaloy	Kadamtali	1 Truck	21
Khaja Banijjaloy	Kadamtali	1 Truck	16
		Average =	17.66

Table 4.1.3. Prevalence of mango diseases in three wholesale market of Dhaka during 2010 (May-September)

Location	Total no. of mangoes inspected(Case)	Total no. of diseased fruits	% diseased fruit
Karwanbazar	700	5,588	9.91
Zatrabari	550	2,423	10.21
kadamtali	650	3,195	8.60
Total	1900	11,206	Average = 9.57

4.1.4Prevelence of disease in wholesale market in Dhaka

A total of 1900 case of mangoes were inspected in three major wholesale market of Dhaka during May, 2010 to sepetember, 2010. Out of which 11,206 mangoes were found infected due to anthracnose, stem end rot and fusarium rot. The average percentage of fruit loss was 9.57%.

4.1.4 Pathogen incidence and severity for Mango

From the month of May, 2010 to September, 2010 total 50 fruits were observed for every month and identified the following pathogen as the causal organisms as per physical symptom:

1. Anthracnose of mango
2. Stem end rot of mango
3. Fusarium rot of mango

On the basis of physical symptom the following incidence and severity was recorded from the month of May, 2010 to September, 2010as follows:

4.1.5 Disease incidence of Mango

Anthracnose, stem end rot and fusarium rot of mango showed significant differences for different month starting from May, 2010 to September, 2010 (table 4.1.4). In case of Anthracnose the highest incidence (33%) was recorded in the month of September, 2010 followed by the month of August, 2010 (28%) whereas the lowest incidence (21%) which was recorded for the month of May, 2010 similar result also recorded in the month of June, 2010 (21%) and for July it was (24%), 2010. Considering stem end rot the highest incidence (21%) was recorded in the month of Septembers, 2010 followed by the month of August, 2010 (16%) whereas the lowest incidence (11%) was recorded in the month of May,2010 and in June it was (12%). In case of fusarium rot of mango the highest incidence (19%) was recorded in the month of September, 2011.Statistically insignificant data were recorded in the month of May, July and August which was 13%, 14% and 14% respectively.

Table 4.1.4 Monthwise disease incidence as per the identified diseases in mango.

Month	Anthracnose	Stem end rot	Fusarium rot
May, 2010	21.00c	11.00c	13.00b
June, 2010	21.00c	12.00c	11.00c
July, 2010	24.00c	13.00c	14.00b
August, 2010	28.00b	16.00b	14.00b
September, 2010	33.00a	21.00a	19.00a
$LSD_{(0.05)}$	3.453	2.321	1.812
Significance level	0.01	0.01	0.01
CV(%)	7.22	8.44	6.78

4.1.6 Disease severity of mango

Anthracnose, fusarium rot and Stem end rot of mango showed significant differences for different month starting from May, 2010 to September, 2010 (table 4.1.5). In case of stem end rot the highest severity (31%) was recorded in the month of September, 2010 followed by the month of February ,2010 (14%) whereas the lowest severity (14%) which was recorded for the month of May ,2010 followed by identical similar with June,2010(18%) and for July was (18%),2010followed by the august,2010.considering Fusarium rot, the highest severity(26%) was recorded in the month of sepetember,2010.followed by the month of August, 2010(25%) whereas the lowest severity (13%) was recorded in the month of May, 2010 which was statistically identical with July ,2010. and same. In case of Anthracnose of mangoes the highest severity(32%) was recorded in the month of sepetember,2010.followed by the month of August,2010(25%) while the lowest severity (22%) was recorded in the month of June, 2010 followed by the month of July,2010(22%)and August,2010(16%)was recorded.

Table 4.1.5 Month wise disease severity as per the identified diseases in mango

Month	Anthracnose	Stem end rot	Fusarium rot
May, 2010	20.00c	14.00c	13.00d
June, 2010	22.00bc	18.00b	15.00c
July, 2010	22.00bc	18.00b	13.00d
August, 2010	25.00b	19.00b	18.00b
September, 2010	32.00a	31.00a	26.00a
$LSD_{(0.05)}$	3.081	3.513	1.435
Significance level	0.01	0.01	0.01
CV(%)	6.76	9.33	7.40

4.1.7 Pathogen incidence and severity for Guava

From the month of April to June, 2010 total 20 fruits were observed for every month and identified the following pathogen as the causal organisms as per physical symptom:

1. Anthracnose
2. Scab

On the basis of physical symptom, the following incidence and severity was recorded from the month of April to June, 2010:

4.1.8 Disease incidence of Guava

Anthracnose and Scab disease of guava showed significant difference for different month starting from April to June, 2010 (Table4.1.6). In case of Anthracnose of guava the highest incidence (11%) was recorded in the month of August, 2010 followed by the month of July, 2010 (4%) whereas the lowest incidence (3%) which was recorded for the month of June ,2010. Considering Scab disease of Guava, the highest incidence (21%) was recorded in the month of August, 2010.followed by the month of July, 2010(16%) whereas the lowest incidence (11%) was recorded in the month of June, 2010 which was statistically identical with August,2010.

Table 4.1.6 Month wise disease incidence as per the identified diseases in Guava

Month	Anthracnose	Scab
June, 2010	3.00b	11.00c
July, 2010	4.00b	16.00b
August, 2010	11.00a	21.00a
$LSD_{(0.05)}$	1.511	3.139
Significance level	0.01	0.01
CV(%)	11.11	8.65

4.1.10 Disease severity of guava

Anthracnose and Scab disease of guava showed significant difference for different month starting from April to June, 2010 (Table 4.1.7). In case of Anthracnose diseases of guava, the highest severity (9%) was recorded in the month of August, 2010 followed by the month of July, 2010 (6%) whereas the lowest severity (4%) which was recorded for the month of June, 2010. Considering Scab disease of Guava, the highest severity (31%) was recorded in the month of August,2010 followed by the month of July, 2010 (19%) whereas the lowest severity (8%) was recorded in the month of June, 2010.

Table 4. 1.7 Month wise disease severity as per the identified diseases in guava

Month	Anthracnose	Scab
June, 2010	4.00c	8.00c
July, 2010	6.00b	19.00b
August, 2010	9.00a	31.00a
$LSD_{(0.05)}$	1.910	2.127
Significance level	0.01	0.01
CV(%)	13.30	4.85

4.2 Experiment-3. Identification of post harvest disease and isolation of causal organism from diseased fruit collected from different locations of Dhaka and infection status under laboratory condition

4.2.1 Infestation status of different pathogen in different condition in mango fruit under laboratory condition

In laboratory condition fruit infestation status for Mango was recorded by infected tissue using block, scarp and control after 5 days. In case of tissue infection it was found that 100% fruit were infected by *Colletotrichum gloeosporioides*, *Fusarium* sp, and *Botryodiplodia theobromae* pathogen (Table 4.3.1). In case of percent tissue infection using block significant variation was recorded for different pathogen. The highest percent infected tissue (19%) was recorded for *Botryodiplodia theobromae* which was followed by *Fusarium* sp (18%) and *Colletotrichum gloeosporioides* (16%). For tissue infection using scrap significant variation was recorded for different pathogen. The highest percent infected tissue (23%) was recorded for *Botryodiplodia theobromae* which was followed by *Fusarium* sp (22%) and then *Colletotrichum gloeosporioides* (19%).

In case of control condition it was found that 8% fruits were infected by *Colletotrichum gloeosporioides*, 5% fruits were infected by *Botrydiplodia theobromae and* 3% fruits were infected by *Fusarium* sp (Table 4.3.1). The highest percent infected tissue (10%) was recorded for *Colletotrichum gloeosporioides* which was followed by *Botryodiplodia theobromae* (7%) then *Fusarium* sp (8%). On the other hand, the lowest percent infected tissue was observed for *Colletotrichum gloeosporioides* (3%).

Table 4.2.1 Infection status of different pathogen in different condition in mango fruit under laboratory condition

Pathogen	Artificial inoculation			Control	
	% Infected tissue		% Infected fruits	(%) Infected fruit (normal)	(%) Tissue Infected
	Block method	Scrap method			
Colletrotrichum gloesporioides	16.00b	19.00b	100	8.00a	10.00a
Botryodiplodia theobromae	19.00a	23.00a	100	5.00b	7.00b
Fusarium sp	18.00a	22.00a	100	3.00c	8.00b
$LSD_{(0.05)}$	1.419	1.545	---	1.226	1.211
Level of significance	0.01	0.01	NS	0.01	0.01
CV (%)	3.83	3.45	---	10.95	6.92

4.2.2 Infestation status of different pathogen in different condition in guava fruit under laboratory condition

In laboratory condition fruit infestation status for Guava was recorded by percent infected tissue using block, scrap and control condition after 5 days of guava collection. In case of tissue infection in block method significant variation was recorded for different pathogen (Table 4.3.2). The highest infected fruit was recorded for *Pestaliopsis psidii* (31%) followed by *Colletotrichum gloeosporioides* (16%). In case of tissue infection using scarp, significant variation was recorded for different pathogen. The highest

infected fruit was recorded for *Pestaliopsis psidii* (36%) which was followed by *Colletotrichum gloeosporioides* (34%).

In case of control condition it was found that 3% and 2% fruits were infected by *Pestaliopsis psidii and Colletotrichum gloeosporioides*, respectively (Table 4.3.2). In case of tissue infection in control condition was recorded for different pathogen and the highest infected tissue (3%) was recorded for *Colletotrichum gloeosporioides* which was followed by then *Pestaliopsis psidii* (2%) (Table 4.3.2). In case of fruit infection in control condition, the highest percent infected tissue (4%) was recorded for *Pestaliopsis psidii* which was followed by *Colletotrichum gloeosporioides* (1%) (Table 4.3.2).

Table 4.2.2 Infestation status of different pathogen in different condition in Guava fruit under laboratory condition

Pathogen	Artificial inoculation			Control	
	% infected tissue		% Infected fruits	% Infected fruit (control)	% Tissue infected
	Block method	Scarp method			
Colletrotrichum gloesporioides	16.00b	34.00b	100	3.00a	4.00a
Pestaliopsis psidii	31.00a	36.00a	100	2.00b	1.00b
$LSD_{(0.05)}$	2.087	1.165	---	0.4713	0.4968
Level of significance	0.01	0.05	NS	0.01	0.01
CV(%)	3.05	2.45	---	8.32	7.21

4.1 Post harvest mango diseases:

A. Anthracnose of mango

Colletrotrichum gloeosporioides

It was characterized by the spots on fruits first appear as brown superficial discolouration of the skin which develop into circular, slightly sunken areas; Gradually the lesions coalesce and sparse mycelia growth appears on the margins of the spots; Infection at late stages of fruit results in mummification and deformation (plate-4.1).pathogen isolated from the plants parts that identified as ***Colletrotrichum gloeosporioides.*** Colonies on Potato Dextrose Ager p(PDA) and stained with cotton blue showed dark blue color. Conidia were hyaline, unicellular and cylindrical.

Plate 4.1& 4.2 Photograph showing infection of mango by Anthracnose and conidia of *Colletotrichum gleosporioides*

B. Fusarium rot of Mango

It was characterized by the superficial blackish of the skin which developed into circular, slightly sunken areas; gradually the lesions coalesce and sparse mycelia growth appears on the margins of the spots. Pathogen isolated from the fruits surface and identified as *Fusarium sp* when stained with cotton blue mycelia were deep blue color. Conidia were dark blue color, 3-5septate and falcate to almost straight.

Plate 4.3 & 4.4 Photograph showing Fusarium rot causing diseases of mango and conidia of *Fusarium sp*

C. Stem end rot of mango

Causal organism:

The fruit symptoms were characterized by irregular light brown spots, it usually induces a wider and softer water soaked margin and greater internal discoloration. Spots lesions coalesced at the later stages. The pathogen isolated from the fruit surface was identified as *Botryiodiplodia theobromae* .Conidia were dark colored bicellular and cylindrical.

Plate 4.5&4.6 Photograph showing stem end rot causing disease of mango and pure culture of *Botryodiplodia theobromae* of mango

3.2.3. Guava

A. Anthracnose of guava

The spots on fruits first appeared as brown superficial discolouration of the skin which develop into circular, slightly sunken areas; Gradually the lesions coalesce and sparse mycelia growth appears on the margins of the spots; the pathogen isolated from the fruits surface was identified as *Colletotrichum gloeosporioides.* Conidia were dark colored, single cell barrel shaped conidia.

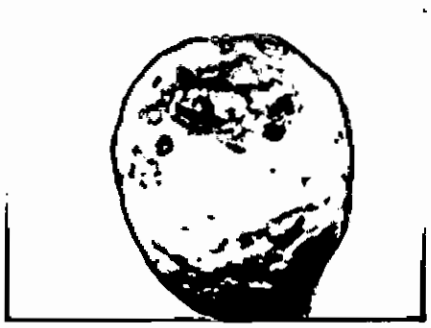


Plate 4.6& 4.7 Photograph showing anthracnose of guava and conidia of ***Colletrotrichum gloeosporioides*** stained with cotton blue

B. Scab of Guava.

It is characterized by dark brown sunken spot on the surface of the fruits. In mature stage of guava fully damage the surface. The pathogen was isolated from ***Pestalotiopsis psidii.*** Conidia were grey- brown, circular to semi – circular covered with mycelium.

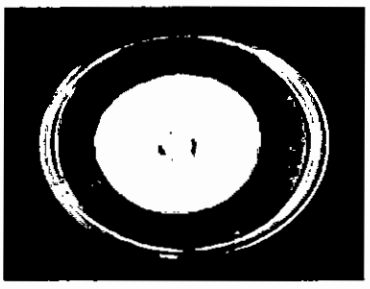


Plate 4.8 & 4.9 Photograph showing scab of guava and pure culture of *pestalotiopsis psidii* of guava

CHAPTER V

DISCUSSION

CHAPTER V
DISCUSSION

The present study was conducted to find out the status of post harvest diseases of mango and guava fruits in Dhaka. Three experiments were conducted for identification of post harvest disease, there prevalence isolation of causal organism from diseased mango and guava.

The survey was conducted in the wholesale markets of Dhaka in the area of Kawran Bazar, Zatrabari and Kadamtali the most important wholesale fruit markets of Dhaka. The respondents wholesaler sold various types of locally produced fruits and they also imported from other countries. Mango was available for the year round and guava was available during winter season and in some extent imported guava was available other than winter season. Mango and Guava were collected from different division in Dhaka wholesale market(figure 4.1 and 4.2). In case of mangos the highest (43%) was collected from Rajshahi division followed by Khulna division(30%). For Guava the highest fruits collected from Barishal division (35%) followed by Chittagong division(30%).

Mango disease incidences and severity were assessed for the month of May, 2010 to October, 2010 as percentage of fruits infected with at least one spot or visible symptom and *Colletrotrichum gloeosporioides*, *Fusarium sp* and *Botryodiplodia theobromae* were found as the causal organisms as per physical symptom. Reports on the occurrence of the two diseases in Bangladesh are available (Meah and Khan, 1987; Jagdish *et al.* 1989). The amount of loss, incidence and severity of these two diseases of twelve mango varieties were recorded during May to September, 2002.

In laboratory condition fruit infestation status for Mango was recorded by infected tissue using block, scarp and normal collected fruits after 5 days. In case of tissue infection it was found that 100% fruit were infected by *Colletrotrichum gloeosporioides*, *Fusarium sp*, and *Botryodiplodia theobromae* pathogen (Table 4.2.1). In case of tissue infection using block significant variation was recorded for different pathogen. The highest infected tissue (19%) was recorded for *Botryodiplodia theobromae* which was followed by *Fusarium sp* (18%)then anthracnose (16%). On the other hand, the lowest infected tissue was observed for *Colletrotrichum gloeosporioides* (16%). For tissue infection using scrap significant variation was recorded for different pathogen. The highest infected tissue (23%) was recorded for *Botrydiplodia theobromae* which was followed by *Fusarium sp* (22%) and then *Colletrotrichum gloeosporioides* (19%). Tripathi (1988) reported lowest level of acidity during 6 days of storage. There were differences in titratable acid content when cv. 'Arumanis' mango was stored in cold storage at different temperatures (Lam and Wong, 1988). Postharvest treatments for the extension of storage life delayed in decrease of titratable acid content (Dhalla and Hanson, 1988).

Colletotrichum gloeosporioides and *Pèstalotiopsis psidii* were of guava anthracnose and scab respectively. In the month of June, the highest incidence and severity (11% and 8%) was obtained for scab, while the lowest incidence and severity (3% and 4%) was recorded for Anthracnose. In the month of July, the highest incidence and severity (16% and 19%) was observed for scab, again the lowest incidence and severity (4% and 6%) was found for Anthracnose. In the month of August, the highest incidence and severity (21% and 31%) was found for Anthracnose (11% and 9%).

In laboratory condition fruit infestation status for guava was recorded by infected tissue using block, scarp and normal collected fruits after 5 days. In case of tissue infection in block condition significant variation was recorded for different pathogen (Table 4.3.1). The highest infected fruit was recorded for *Pèstalotiopsis* psidii (31%) followed by Anthracnose (16%), whereas the lowest was recorded for *Colletrotrichum gloesporioides* (16%). In case of tissue infection using scarp, significant variation was recorded for different pathogen. The highest infected fruit was recorded for *Pèstalotiopsis* psidii (36%) which was followed by *Colletrotrichum gloesporioides* (34%).

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER VI
SUMMARY AND CONCLUSION

The present experiment was conducted during the period from February, 2010 to October, 2010 to find out the status of post harvest diseases of mango and guava fruits in Bangladesh. Consequently three experiments were conducted for identification of post harvest disease, causal organism and isolation of causal organism from diseased of mango and guava. Experiment-I: Study on prevalence of post harvest diseases of mango and guava fruits imported from different parts of the country in the wholesale market of Dhaka. Experinient-2: Identification of post harvest disease and causal organism of mango and guava.

The survey was conducted in the wholesale market of Dhaka in the area of kawran Bazar, Zairabari and Kadamtali, Sadarghat. The commonly sold fruits were mango, jackfruit, guava, mango, guava, black berry, pineapple, banana, litchi, lemon, berry, custard apple, wood apple, golden apple, star apple, wild date palm, Indian berry, tamarind, melon, watermelon, cashew nut, pomegranate, rose apple, Indian olive, Indian guava etc. Mango and guava were collected from different division in Dhaka wholesale market. In case of mango the highest 3 was collected from Dhaka division. . Mango and Guava were collected from different division in Dhaka wholesale market (figure 4.1 and4.2). In case of mangos the highest (43%) was collected from Rajshahi division followed by Khulna division (30%). For guava, diseases of Barishal division (35%) followed by Chittagong division (30%).

In case of mango, Anthracnose, fusarium rot and stem end rot of mango showed significant differences for different month starting from May, 2010 to

September, 2010 (table 4.1.4). In case of stem end rot the highest incidence (21%) was recorded in the month of sepetember,2010 followed by the month of July,2010(16%) whereas the lowest incidence (11%) which was recorded for the month of May, 2010. Considering fusarium rot, the highest incidence (19%) was recorded in the month of September, 2010 followed by the month of August, 2010(14%) whereas the lowest incidence (11%) was recorded in the month of June, 2010. In case of anthracnose the highest incidence (32%) was recorded in the month of September, 2010 followed by the month of August, 2010 (25%) while the lowest incidence (20%) was recorded in the month of June, 2010 followed by the month of June and July 2010 (22%).

In laboratory condition fruit infestation status for mango was recorded by infected tissue using block, scarp and normal collected fruits after 5 days. In case of tissue infection it was found that 100% fruit were infected by *Colletrotrichum gleosporides*, *Fusarium sp*, and *Botryodiplodia theobromae* pathogen (Table 4.3.1). In case of tissue infection using block significant variation was recorded for different pathogen. The highest infected tissue (19%) was recorded for *Botrydiplodia theobromae* which was followed by *Fusarium sp* (18%)then *Colletrotrichum gleosporides* (16%). On the other hand, the lowest infected tissue was observed for *Colletrotrichum gleosporides* (16%). For tissue infection using scrap significant variation was recorded for different pathogen. The highest infected tissue (23%) was recorded for *Botrydiplodia*

theobromae which was followed by *Fusarium sp* (22%) and then *Anthracnose* (19%).

In case of guava, Anthracnose and Scab disease of guava showed significant difference for different month starting from April to June, 2010 (Table 4.1.6). In case of anthracnose, diseases of guava the highest incidence (11%) was recorded in the month of August,2010 followed by the month of July,2010(4%) whereas the lowest incidence (3%) which was recorded for the month of June, 2010 followed by the month of July, 2010 (6%).Considering Scab disease of Guava, the highest incidence (21%) was recorded in the month of August, 2010 followed by the month of July, 2010 (19%) whereas the lowest incidence (11%) was recorded in the month of June, 2010 which was statistically identical with August, 2010 and same.

In case of control condition it was found that 3% and 2% fruits were infected by *Pestalopsis psidii and Anthracnose respectively* (Table 4.3.2). In case of tissue infection in control condition was recorded for different pathogen and the highest infected tissue (3%) was recorded for *Colletrotrichum gleosporides* which was followed by then *Pestalotipsis psidii* (2%) (Table 4.3.2). In case of fruit infection, in control condition was recorded for different pathogen and the highest infected tissue (4%) was recorded for *Pestalotipsis psidii* which was followed by then *Colletrotrichum gleosporides* (1%) (Table 4.3.2).

The present studies revealed that a large portion of mango fruits accumulated in the markets of major districts of Bangladesh is spoiled owing to stem-end rot and anthracnose disease. This is no doubt an alarming situation for the economy of the country. This is an important matter to be looked in trials have indicated

that post treatments with some chemicals are effective in controlling fruit rots. However the residual effects of the chemical and their commercial use have not been determined.

Further studies are required to determine the residual effects of the tested fungicides. For the control of post harvest spoilage of mango and to develop an integrated disease management a detailed study is needed.

REFERENCES

CHAPTER VI

REFERENCES

Anonymous.1990. Plant Pathology. Survey and monitoring of different diseases of mango. Annual Report, Division of Plant Pathology, BARI (Bangladesh Agricultural Research Institute), Joydebpur, Gazipur, Bangladesh. 73 p.

Anonymous. 1988. The year book of Agricultural statistics of Bangladesh 1978-79. Bangladesh Bureau of statistics. Ministry of planning, Dhaka. pp. 275-281.

Absar, N., M.R. Karim and M. Al-Amin. 1993. A comparative study on the changes in the physico-chemical composition often varieties of mango in Bangladesh at different stages of maturity. Bangladesh J. Agric. Res. 18(2):201-208.

Agnihotri, B. N., K. L. Kapoor and J. C. Srivastava. 1963. Physico-chemecal changes in 'Dashehari' mango during storage. Punjab Hort. J., 3.268.

Ali, N. and H. Mazhar. 1960. The tree, flower and fruit characteristics of mango. Punjab Fruit. J., 23:81-86.

Alves, R.M.V., J.M.M. Sigrist and M. Padula. 1998. Tommy Atkins mangoes under modified atmosphere. Revista Brasileira de Fruticultura, 20(2): 220-228.

Amrakoon, R., K. H. Sarananda and D. C. K. Illeperuma. 1999. Quality of mangoes as affected by stage of maturity. Tropical Agril. Res. 11:74-85.

Ansari, R. 1995. Hot water treatment affects ripening quality and storage life of mango (Mangifera indica L.). Pakistan J. Agric. Sci., 44: 23–30.

Ashwani, K. and S.S. Dhawan. 1995. Effects of post harvest treatments on the enhancement of ripening of mango fruit cv. Dashehari. Haryana J. Hort. Sci., 24(2): 105-115.

Baez, S. R., W.A. Bringas, W.A. Mendoza, C. J. Ojeda, R.J. Mercado, N. Ledesma and R. J. Campbell. 2001. Post harvest performance of mango 'Tommy Atkins' treated with hot water and wax. Proc. Intl. Soc. Trop. Hort. 44:39-43.

BBS. 2009. Bangladesh Bureau of Statistics, Ministry of planning, Government of the Peoples Republic of Bangladesh, Dhaka. Available: http://BBS.gov.bd/. Date of Visit, December 2, 2010.

BBS. 2005. Monthly Statistical Bulletin of Bangladesh, October, 2006. Bangladesh Bureau of Statistics, Ministry of planning, Government of the Peoples Republic of Bangladesh, Dhaka. p. 55.

Bhuyan, M.A.J. 1995. Mango (Mangifera indica). In: Fruit production manual. Hort. Res. Dev. Proj. (FAO/UNDP/AsDB project: BDG/87/025). pp. 1-286.

Castrillo, M. And A. Bermudez. 1992. Post harvest ripening in wax coated Bacado mango. Int. J. Food Sci. Tech., 27(4): 457-463.

Chaplin, G. R., K, J. Scott and B. I. Brown. 1982. Effect of storing mangoes in polythene bags at ambient temperature. Singapore J. Primary Ind., 10(2): 84-88 [Cited from Hort. Abstr., 53(6):4665, 1983].

Chhatpar, H. S., A. K. Matto and V. V. Modi. 1972. Some problems pertaining to storage and ripening in mango fruit. Acta Hort., 24:143.

Dhalla, R. S., M.K. Verma and M.K. Agarwal. 2001. Effect of post harvest treatments on physico-chemical characters during storage of mango cv. Totapuri. Haryana J. Hort. Sci., 30(1-2):36-38.

Dhalla, R. S.,and A. J.Hanson,1988. Variation in Physico Chemical and morphogenetic characteristics of some mango varieties of Goa. Acta Hort., 509:243-249.

El, R. D.A. and D.M. Ahmed. 2001. Effect of modified atmosphere packing and cold storage on storage period and quality of 'Tommi Atkins' mango fruits. Assiut J. Agril. Sci., 32(1); 251-262.

FAO, 2009. Food and Agriculture Organization of The United Nations. Available: http://faostat.fao.org/. Date of Visit, December 10, 2009.

Gautam, B., S. K. Sarkar and Y. N. Reddy. 2003. Effect of post-harvest treatments on shelf-life and quality of Banganapalli mango. Indian J. Hort., 60(2):135-139.

Ghosh, S. K., R. S. Dhua and S. K. Mitra. 1985. Studies on physico-chemical characteristics of some mango cultivars grown in West Bengal. Indian Food Pack., 39:46-50.

Gofur, A., M.Z. Shafique, M.O.H. Helali, M. Ibrahim, M.M. Rahman, M.S. Alam and A. Gofur.1997. Studies on extension of post harvest storage life of mango (Mangifera indica L.). Bangladesh J. Sci. Ind. Res., 32(1): 148-152.

Gonzalez, G., E.M. Yahia and I. Higuera. 1990. Modified atmosphere packing (MAP) of mango and avocado fruit. Acta Hort., 269:335-344.

Hasan, M. K., M. F. Mondal and M. S. Haque. 1998. Studies on the storage behaviour of mango. Bangladesh J. Agril. Sci., 25(2): 311-318.

Hofman, P. J., L. G. Smith, D. C. Joyce, G. I. Johnson and G. F. Meiburg. 1997. Bagging of mango (Mangifera indica cv. Keitt) fruits influence fruit quality and mineral composition. Post harvest Biol. Technol. 12(1):83-91.

Hossain, A.K.M.A. and A. Ahmed. 1994. A monograph on mango varieties of Bangladesh. Horticulture Research Center, BARI, Joydevpur, Gazipur, Bangladesh. pp. 1-89.

Hossain, A. K. M. A. and A. Meah. 1992. A monograph on guava varieties of Bangldesh. Horticulture Research Centre, BARI, Joydebpur, Gazipur, Bangladesh. PP. 1-89.

Jain, S. K., S. Mukherjee and N. K. Gupta. 2001. Effect of post harvest treatments and storage condition on the quality of mango during storage. Haryana J. Hort. Sci., 30(3-4):183-187.

S. Jagdish and N. K. Gupta,1989.. Effect of plastic film wrapping on post-harvest fungal rot of mango fruit. Indian Phytopath., 45(1): 126-139.

Joarder, G. K. 1980. Preservation of mango at cold temperature. Bangladesh Coun. Sci. Ind. Res. Lab., Dhaka, Bangladesh. PP. 11-19.

Johnson, G. I., L. M. Coates, A. W. Cooke and I. A. Wells. 1994. Post harvest control of mango diseases. Aust. Centre Intl. Agril. Res., pp. 70-71.

Joshi, G. D. and S. K. Roy. 1988. Influence of maturity, transport and cold storage on biochemical composition of Alphonso mango fruit. J. Moharashtra, Agril. Univ., 13(1): 12-15.

Kalra, S. K. and D. K. Tandon. 1983. Ripening behaviour of Dashehari mango in relation to harvest period. Scientia Hortic., 19(3-4): 263-269.

Kamaluddin, 1994.Studies on some mango varieties of Bangladesh. Bangladesh Hort., 1(2): 16-24.

Kaushik, R. A., K. Ranjit and R. Kumar. 1991. Effect of post harvest application of 2, 4, 5- trichlorophenoxy acetic acid, maleic hydazide and calcium-nitrate on the storage behaviour of Dashehari mango. Haryana Agric. Univ. J. Res., 21(4):287-291.

Khader, S. E. S. A. 1991. Effect of post harvest application of GA_3 on post harvest behaviour of mango fruits. Scientia Hortic., 47(3-4):317-321.

Krishnamurthy, G. V., N. Girtidnar and B. Rughuramaiah. 1984. Suitability of mango varieties for processing. J. Food Sci. and Technol., 21:21-25.

Kumar, N. and N. Kumar. 1998. Physico chemical characteristics of some mango varieties under Bhagalpur (Bihar) conditions. Prog. Hort., 30(1-2):27-28.

Kumar, R., M.P. Patel, U. S. Bose, S. K. Tripathi and R. Kumar. 2001. Physico-chemical studies of some important mango varieties of Madhya Pradesh. Crop Research, Hisar, 22(1):38-42.

Lam &Wong, D.P. 1988. Hot water treatment for disease control and extension of shelf life of 'kesar' mango (mangifera indica l.) Fruits. Acta hort. (ishs) 682:1319-1324.

Lima-LC-de-O, A. B. Chitarra, M. I. F. Chitarra and De-O-Lima-Lc. 2001. Changes in amylase activity, starch and sugar contents in mango fruit pulp of cv. Tommy Atkins with spongy tissue. Brazilian Archives Biol. Technol., 44(1):59-62.

Lonsdale, W. C. Saaiman and D. C. Smith (1991a). Advances in postharvest technology and new technologies in food prosuction, Proc. Seminar. St. Augustine (Trinidad Tobago), pp. 173-183.

Lonsdale, J. H. 1992a. In search of an effective post harvest treatment for the control of post harvest disease of mangoes. Yearbook South African Mango Growers' Association, 12:153-180.

Mahfud, M. C. 1986. Study of anthracnose disease in papaya. Penelitian Horticultura (Indonesia). 38-45.

Majumder, G., V. V. Modi and V. A. Palejwala. 1981. Effect of plant growth regulator on mango ripening. Indian J. Exp. Biol. 19(9):885-886.

Martinez, B.E., G.C. Guevara, M.J. Contreras and R. Rodgiguez. 1997. Preservation of mango Azucar variety (Mangifera indica L.) at different storage stages. Acta Hort., 455: 747-754.

Meah, M. B. and A. A. Khan. 1987. Survey of diseases of some important fruits and vegetables. Annual Progress Report (1985-86). Pp. 1-13. Dept. of Plant Pathology. Bangladesh Agricultural University, Mymensingh.

Miller, W. R. and L. A. Risse. 1988. Recent research of film wrapping of fresh produce in Florida. In 6th Int. Citrus Congress, March 6-11, 1988, held in Middle-East, Tel Aviv Vol. 3 [cited from Post harvest News and Information, 1(4):1671, 1990.

Miller, W. R., P. W. Hale and D. H. Spalding. 1983. Quality and decay of mango fruit wrapping in heat shrinkable film. Hort. Science, 18(6):957-958.

Mitra, S. S. Kundu and S. K. Mitra. 2000. Studies on physical characteristics and chemical composition of some mango varieties grown in west Bengal. J. Interacademicia., 4(4):498-501

Mitra, S. S. Kundu and S. K. Mitra. 2001. Chemical composition of some varieties and hybrids of mango. Environment and Ecology, 19(2):487-488.

Mollah, S. and M. A. Siddique. 1973. Studies on some mango varieties of Bangladesh. Bangladesh Hort., 1(2): 16-24.

Mohiuddin, A. B. M., M. A. Rahim, F. Gheyas and A. M. Farooque. 1991. A note on the prolongation of shelf life of mango (*Mangifera indica* L.) with some coating materials. Bangladesh Hort., 19(1):45-47.

Mondal, M. F., M. A. Rahman and M. A. J. Pramanik. 1995. Effects of different post harvest treatments on physico-chemical changes and shelf life of mango. Bangladesh Hort., 23(1&2):1-5.

Mortuza, M. G., M. M. A. Reza and S. M. K. Alam. 2002. Bangladesh J. Plant Path., 18(1-2):1-5.

Mukherjee, P. K. 1956. The behaviour of mango varieties of mango varieties Dashehari and Langra under low temperature. Ann. Rep. Fruit Res. St., Saharanpur, India, p. 60.

Muller, A. T. and J. R. Burt. 1989. Post harvest storage control of mango stem-end rot with fungicidal dips. Aust. J. Exp. Agric., 29(1):125-127.

Murthy, S. K and K. P. G. Rao. 1982. Regulation of ripening by chemicals in 'Alphonso' mango. Scientia Hortic., 16(2):179-183.

Naqvi and Dass, 1994. The effects of hot water treatment with cooling and/or storage on the physiology and disease of mango fruits (Mangifera indica L.) J. Hort. Sci. Biotechnol., 73(5):589-597.

Nyanjage, M. O., H. Wainwright and C. F. H. Bishop. 1998. The effects of hot water treatment with cooling and/or storage on the physiology and disease of mango fruits (*Mangifera indica* L.) J. Hort. Sci. Biotechnol., 73(5):589-597.

O'Hare, T. J. 1995. Effect of ripening temperature on quality and compositional changes of mango (*Mangifera indica* L.) var. Kensington. Australia J. Expt. Agric., 35(2):259-263.

Om-prakash, B. K. Pandey and O. Prakash. 2000. Control of mango anthracnose by hot water and fungicide treatment. Indian Phytopath., 53(1): 92-94.

Pandey, R. R. 1989. Effect of foliar application of fungicides on the phytoplane mycoflora and fungal pathogens of guava. J. Phytopath. 123(1):52-62.

Pramanik, M. A. J. 1995. Effect of different post harvest treatments on physico-chemical changes during storage and shelf life of mango. M.S. Thesis, Dept. Hort., BAU, Mymensingh.

Prusky, D., Y. Shalom, I. Kobiler, M. Akerman and Y. Fuchs. 2002. The level of quiescent infection of *Alternaria alternata* in mango fruits at harvest determines the post harvest treatment applied for the control of rots during storage. Post harvest Biol. and Technol., 25(3):339-347.

Quroshi, S. U. and M. B. Meah. 1991. Post harvest loss in mango owning to stem-end rot. Intl. J. Trop. Agric., 9(2):98-105.

Rahman, M.A. and Hossain, S. 1988. Annual Report (1987-89). Plant pathology division, BARI, Joydebpur, Gazipur, 64-67.

Rahman, M.A. and Hossain, S. 1989. Annual Report (1988-90). Plant pathology division, BARI, Joydebpur, Gazipur, 35-49.

Rangavalli, K., C. Ravisankar and P. H. Prasad. 1993. Post harvest changes in mango (*Mangifera indica* L.) var. Baneshan. South Indian Hort., 41(3):169-170.

Rawl, R. D. and Ullasa, 13. A. 1993. Comparative efficacy of fungicides against leaf spot guava caused by *Cercospora psidii*. Indian Phytopathology., 411kl): 146-1474

Reddy N. S. and K. Haripriya. 2002. Extension of storage life of mango cvs. Bangalora and Neelum. South-Indian Hort., 50(1-3):7-18.

Reza & Kader, S.E.S.A. 1995. Effect of postharvest application of GA3 on postharvest behaviour of mango fruit. Sci. Hort., 46(4): 444-448.

Salles, J. R. D. J. and J. C. Tavares. 1999. Post harvest life of mango (*Mangifera indica* L., cv. Tommy Atkins): the influence of temperature and state of maturity. Revista Brasileira de Fruticultura, 21(2): 171-176 [Cited from Hort. Abstr., 70(10):936, 2000].

Salunkhe, D. K. and B. B. Desai. 1998. Post harvest Biotechnology of Fruits. Vol. 1. CRC Press, Inc. Boca Raton, Florida. P. 168.

Sanyal, D., R. Raychowdhury, R.S. Dhua and S.K. Mitra. 1991. Study of mango cultivars of West Bengal. Indian Food Pack., 45: 29-33.

Shahjahan, M., S. Shell, M. A. Zaman and M. A. Sakur. 1994. Optimization of harvesting maturities for major mango cultivars in Bangladesh. Bangladesh J. Sci. Res., 12(2): 209-215.

Siddique and Scanlan, 1995. Investigation in to mango stem end rot. MS thesis. Dept. of Plant Path., BAU, Mymensingh. 77p.

Singh, L. B. 1968. The Mango: Botany, Cultivation and Utilization. Leonard Hall, London pp. 363-376.

Singh, S. and S. Singh. (2002b). Effect of size grading on quality and storage of mango cv. Zardalu. Orissa J. Hort., 30(1):92-95.

Singh, S. M. (2002a). Studies on the mango shoot gall in the Tarai region of Uttar Pradesh. Its causes and control. II. Distribution, Nature, Extended Intensity of damage and bionomic of the pest. Hort. Adv., 4:97.

Singh, S., P. Kumar, V. S. Brahmachari and D. M. Singh. 1995. Effect of post harvest spray of GA_3 and Ethrel on storage life of mango cv. Amrapali. Orissa J. Hort., 23(1/2):112-118.

Sornsrivichai, J. P. Anusadorn, C. Oogaki and H. Gemma. 1989. Storage life and quality of mango (cv. 'Keaw Sawoey') fruit stored in seal packaging by plastic films and under low pressure at different temperatures. Nettai Noyyo-Jap. J. Trop. Agric., 33(1):6-17.

Suit, R.E. and Du Charme, E. P. 1946. The *Cepha leuros* disease of citrus. J. Citrus in India. 27:3.

Tandon, D. K., S. K. Kalra and H. C. Lohani. 1985. Changes in some carbohydrates in developing mango fruit cv. Langra and Mallika. Indian J. Hort. 42 (315):222-228.

Teaotia, S.S. and R. D. Singh. 1971. Studies on mango (*Mangifera indica* L.) varieties. II. Morphological and physico-chemicals studies of some important table varieties. Punjab Hort. J., 11:240-245.

Tripathi, J. S. 1988. Post harvest changes during storage and ripening of Gaurjeet mango fruit. Madras Agril. J., 75(3-4): 155-156.

Shahjahan, M., S. Sheil, M. A. Zaman and M. A. Sakur. 1994. Optimization of harvesting maturities for major mango cultivars in Bangladesh. Bangladesh J. Sci. Res., 12(2): 209-215.

Siddique and Scanlan, 1995. Investigation in to mango stem end rot. MS thesis. Dept. of Plant Path., BAU, Mymensingh. 77p.

Singh, L. B. 1968. The Mango: Botany, Cultivation and Utilization. Leonard Hall, London pp. 363-376.

Singh, S. and S. Singh. (2002b). Effect of size grading on quality and storage of mango cv. Zardalu. Orissa J. Hort., 30(1):92-95.

Singh, S. M. (2002a) Studies on the mango shoot gall in the Tarai region of Uttar Pradesh. Its causes and control. II. Distribution, Nature, Extended intensity of damage and bionomic of the pest. Hort. Adv., 4:97.

Singh, S., P. Kumar, V. S. Brahmachari and D. M. Singh. 1995. Effect of post harvest spray of GA3 and Ethrel on storage life of mango cv. Amrapali. Orissa J. Hort., 23(1/2):112-118.

Somsrivichai, J. P. Anusadorn, C. Ogaki and H. Gemma. 1989. Storage life and quality of mango (cv. 'Keaw Sawoey') fruit stored in seal packaging by plastic films and under low pressure at different temperatures. Nettai Nogyo-Iap. J. Trop. Agric., 33(1):6-17.

Suit, R.E. and Du Charme, E. P. 1946. The Ceplu lemon disease of citrus. J Citris in India. 27:3.

Tandon, D. K., S. K. Kalra and H. C. Lobani. 1985. Changes in some carbohydrates in developing mango fruit cv. Langra and Mallika. Indian J. Hort. 42 (3\5):222-228.

Teaotia, S.S. and R. D. Singh. 1971. Studies on mango (Mangifera indica L.) varieties. II. Morphological and physico-chemicals studies of some important table varieties. Punjab Hort. J., 11:240-245.

Tripathi, J. S. 1988. Post harvest changes during storage and ripening Gaujeet mango fruit. Madras Agril. J., 75(3-4): 155-150.

Upadhyay, N. P. and B. M. Tripathi. 1985. Post harvest changes during storage and ripening of Gaurjeeet mango (*Mangifera indica* L.) fruit. Prog. Hort., 17(1):25-27.

Verma, A. and O. Prokash. 1995. A comparative study of different mango transportation practices. Poster session 1-PI-27. Central Institute of Horticulture for Northern plains, Rae Bareli Road Campus, Luknow, Uttar Pradesh, pp. 341-345.

Verma, A. and O. Sharma. 1978. A comparative study of different mango transportation practices. Poster session 1-PI-27. Central Institute of Horticulture for Northern plains, Rae Bareli Road Campus, Luknow, Uttar Pradesh, pp. 341-345.

Wavhal, K. N. and P. W. Athale. 1989. Studies to prolong shelf life of mango fruit. Acta Hort., 231-771-775.

Yamashita, F., M. T. Benassi and T. G. Kieckbusch. 1997. Shelf life extension of individually film wrapped mangoes. Trop. Sci., 37(4):249-255.

Yang, H. R. and Y. T. Lin. 1997. Effect of hot water treatment for controlling anthracnose of mango fruits of Tainung variety. plant protection Bull., 39(3):241-249.

Yuniarti, & Suhardi 1980. Physico-chemical changes of 'Arumanis' mangoes during storage at ambient temperature. Bull. Pen. Hort. 8(11):11-17.

Zhou, Y. S., Ye, T. M, and Huang, Q, W. 2001. The integrated control of citrus diseases and pests. South China Fruits, 30(5): 19-20.

Zhu, D. M., M. Chen, Z.Z. Li, Y. J. Deng, M. J. Yu. and P. Yin. 2002. Effect of mango hot water treatment and artificial ripening on its quality. Transactions Chinese Soc. Agril. Engg. 18(3):139-141.s

Zhou, Y. S., Ye, T. M, and Huang, Q, W. 2001. The integrated control of citrus diseases and pests. South China Fruits, 30(5): 19-20.

APPENDICES

APPENDIX

QUESTIONAIRES COLLECTION FROM FRIUT WHOLESALE MARKET OF DHAKA

DATE: VENUE:

1. Name of fruit traders:
2. Name of shop:
3. What kinds of fruits you sell(name):

☐ Mango ☐ Guava

4. Time of availability:

☐ Year round ☐ winter ☐ Summer

5. From which places you import the fruits:

☐ Dhaka ☐ Rajshahi ☐ Barisal

☐ Khulna ☐ Chittagong ☐ Sylhet

6. Frequency of importation:

☐ Daily ☐ Twice in a week ☐ Thrice in week

☐ 4 times in a week ☐ 5 times in week ☐ six times in a week

7. Time needed in transportation(By truck/troller):

☐ 1-2 hours ☐ 3-4 hours ☐ 5-6 hours

☐ 7-8 hours ☐ 9-10 hours ☐ 11-12hour

8. Approximate quantity (per truck/troller):

☐ 100-500kg ☐ 500-1000kg ☐ 1000-2000kg

☐ 2000-3000kg ☐ 3000-4000kg ☐ 4000-5000kg

9. No of trucks per day:

10. Approaximate amount of wastage of fruits:

11. Price per kg :

12. Fruits of which region perform better:

13. Condition of fruit business:

☐ Satisfactory ☐ Not so good ☐ As usual

14. Do you have any suggestions? :

15. Collection of specimen:

Information Collector