

**INVESTIGATION ON FRUIT TREE DISEASES OF SELECTED
HOMESTEAD GARDEN OF HAOR AREAS UNDER HABIGANJ
DISTRICT**

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CERTIFICATE

This is to certify that the thesis entitled, **“INVESTIGATION ON FRUIT TREE DISEASES OF SELECTED HOMESTEAD GARDEN OF HAOR AREAS UNDER HABIGANJ DISTRICT”** submitted to the Department of Plant Pathology, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial 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 **MUNSHI MOUDOOD AHMED**, bearing **Registration No.07-02301** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma in elsewhere.

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 and the contents and style of the thesis have been approved and recommended for submission.

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**BY
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LIST OF ABBREVIATIONS

ABBREVIATE FORM	ELABORATION
%	Percentage
⁰ C	Degree Celsius
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics

CV	Coefficient of Variance
<i>et al.</i>	And Others
etc	Etcetera
f. sp.	Forma specialis
GM	Grand Total
i.e.	That is
J.	Journal
LSD	Least Significant Difference
Sci.	Science
sp.	Species

INVESTIGATION ON FRUIT TREE DISEASES OF SELECTED HOMESTEAD GARDEN OF E x EAS UNDER HABIGANJ DIS

ABSTRACT

Occurrence and prevalence of fruit diseases were surveyed in haor area of Ajmiriganj upazila of Habigonj district during January 2013 to July 2013. The surveyed area were Sadar, Kakailchao, Badalpur, Jalsukha and Sibpasha in this experiment and the diseases of 13 fruit trees were recorded from 45 households

of Azmiriganj haor Upazila. Altogether sixteen diseases were recorded from seven fruit trees during the survey. Mango trees were infected by four diseases namely anthracnose, powdery mildew, leaf blight and malformation of which leaf blight was the most predominant caused about 75.55% incidence during July month. Banana plants were infected by two diseases namely Panama and Sigatoka. Between two diseases Panama disease was the most predominant whose incidence was 28.88% in July. Three diseases were recorded in lemon plants namely scab, canker and dieback. Scab disease occurred severely and its incidence reached up to 56.66% during July month. Guava plants were found to be infected by two diseases namely anthracnose and rust. Between the two diseases anthracnose was the most predominant (51.11%) occurring severely in July. Powdery mildew the only one disease which was found in Jujube trees with highest incidence (36.11%) in July month. Coconut trees were infected by two diseases namely grey leaf spot and Phytophthora leaf spot. Grey leaf spot disease was the most predominant (42.21%) disease occurring severely in the month of July. Papaya plants were infected by two diseases namely mosaic and leaf curl. Between two diseases mosaic was the most predominant (13.33%) occurring highly in May and July. No diseases were found in the rest of the six fruit trees like Orange, Sapota, Wax apple, Star fruit, Hog plum and Pummelo during the survey period.

CHAPTER I

INTRODUCTION

Homestead refers to home and adjoining land occupied by a family to cultivate some crops for their own consumption and marketing. Generally, the purpose of homestead is small-scale agricultural production, home upkeep, sanitation, health and nutrition (Ninez, 1984). It is land occupied by the dwelling unit of the household and the immediate area surrounding it, including courtyard, pond, road space around homesteads, space used for cultivation of trees and vegetables and unutilized space (Abdullah, 1986). There are 32.07 million

homesteads in Bangladesh and over 74% of the population lives in the rural areas. Approximately 7% area (0.53 million hectare) of the total 8.4 million hectare of cultivable land in Bangladesh is occupied by homesteads which is extremely productive (BBS, 2011).

The term 'fruit' is more conveniently used to refer to the part of the seed suitable for human consumption, eaten fresh, either ripe or young (Uddin and Mukul, 2007). Fruits, fresh or dried have been a natural staple diet of human beings since ancient times. Replete with minerals, vitamins and enzymes, they are easily digestible. Fruits are not only good sources of nutrients and minerals but they also serve as medicines. Fruits can be eaten as raw or consumed as fresh juice which maintains moisture balance in the body. Dry fruits are storehouses of calcium and iron, essential for strengthening bones and maintaining good blood, respectively. One or two fruits a day clean the digestive tract and aids easy bowel action.

Bangladesh abounds with a large variety of tropical and sub-tropical fruits (Abdoellah, *et al.*, 2006; Akhter *et al.*, 2010). The most widely cultivated fruits are Mango, Jackfruit, Black berry, Pineapple, Banana, Litchi, Lemon, Guava, Hog plum, Custard apple, Wood apple, Elephant apple, Golden apple, Indian berry, Papaya, Coconut, Tamarind, Melon, Watermelon, Cashew nut, Pomegranate, Palmyra, Plum, Rose apple, Indian olive, and Indian jujube. There are many minor edible fruits that are locally available in the wild and are also cultivated, such as latkan, monkey jack, uriam, rattan, river ebony, garcinia, wild date palm, etc. Different fruits grow in Bangladesh round the year because of favorable climatic conditions. Homestead fruit production is quite prevalence in Bangladesh (Alam and Masum, 2005; Motiur *et al.*, 2006). For a person per day dietary requirement of fruit is 85 g, whereas our availability is only 30-35 g. In view of the fact, the consumption and availability of fruits is very negligible. As a result, imbalanced nutrition and

nutrition deficiency diseases are being increased at an alarming rate (Mannan, 2000).

Bangladesh is an agro-based country and almost attained self-sufficiency in cereal food production. Fruit production is very limited to meet up our domestic demand and for consumption of fruit, we depend on foreign supplies. It offers a highly congenial environment for the growth of fruits. During last five decades population of Bangladesh increased from 75 million to 152.81 million (BBS, 2011), simultaneously food grain production increased from 10 million to about 32 million tons (BBS, 2011). But fruit production did not increase at the same rate. Bangladesh produces less than 30 percent of the fruits and vegetables needed to meet the minimum daily requirements for its population. To meet this nutritional deficiency we have to produce more fruits.

Bangladesh is a densely populated country and its cultivable land is also decreasing day by day. Almost 1% of cultivated land is declining continuously in every year which is very alarming. Most lands are being transformed to rural and urban settlements including homestead, pond and road. Therefore, the proper utilization of homestead areas for increasing agricultural productivity is necessary. For the rural poor people, homesteads are the main source of fruits as well as nutrition. A farmer can easily get year round fruit supply from his

homestead garden and also can get more production of fruit from their garden. Among many unfavorable ecosystem area of Bangladesh, Sylhet Haor is considered critical for its special nature. About 30% of the population in Haor basin lies below the lower poverty level (LPL). The majority of households in the poor and extreme poor categories suffer from significant shortage of food. At the same time they are also suffering from malnutrition. Data on child malnutrition shows that 55% children under five in the Haor region are underweight against 41 percent as a whole for Bangladesh. The Haor region covers about 15% of the total area of Bangladesh, of which 12% is settlement. Due to special geographical settings, the housing and settlement patterns of

Haor areas are not similar to other parts of the country and fruit production is also lower to meet up the national demand. But the production of fruits is being decreasing due to many causes. Among the limitations of the production, disease is one of the major problems. In some fruit species pathogen attack can cause up to 100 percent damage. Proper identification of plant diseases is an important step before attempting for their management to increase production.

Considering the importance of fruit production in Haor homestead areas both from economic and nutritional point of view the study was conducted on fruit trees in Haor homesteads of Bangladesh to achieve the following objectives:

- Identification of the diseases prevailing on different fruit species of haor homestead area of Ajmiriganj Upazilla under Habiganj district.
- To identify the prevalence of different fruit diseases of the survey area.
- Determination of the critical period for occurrence of different diseases in selected fruit species.

CHAPTER II

REVIEW OF LITERATURE

The survey was conducted at Ajmiriganj upazilla under Habiganj district with 12 selected fruit species. At the surveyed season, these species were infected by various diseases. In this chapter, an attempt has been made to review the available literatures on symptoms of fruit diseases, their causal organisms and disease status.

2.1. Mango diseases

Powdery mildew was first recorded in 1914 in Brazil, and the fungus was described by Briton Jones (1923).

Pathak (1980) stated that powdery mildew of mango appeared in the form of whitish or grayish powdery areas on tender foliage and inflorescence. The powdery mass consisted mainly of fungal spores. Normally infection spread from tip of inflorescence and covered the floral axis, young leaves and stem.

The occurrence and severity of various disease of mango throughout the year in the orchards of Chapai Nawabganj and Rajshahi were recorded (Anonymous, 1990). It was observed that anthracnose, sooty mould and powdery mildew were predominant diseases in the orchard of the surveyed area, the highest incidence of anthracnose was observed in the variety Aswina (37.16%) and Gooti (37.8%) in Chapai Nawabganj district and the lowest in the variety Kuapahari in the same district.

Mortuza (1990) recorded the occurrence and severity of various diseases of mango from January 1990 to June 1990 in different orchards of Chapai Nawabganj and Rajshahi districts. Different diseases and their severity were recorded; infected leaves and panicles were measured at every two months. Recorded diseases were anthracnose, sooty mould, powdery mildew, dieback and malformation. The highest incidence of anthracnose was observed in Gooti and Aswina varieties by 28.95% and 28.32%, respectively in the Chapai Nawabganj district.

Dodd *et al.* (1991) stated that anthracnose disease, caused by *Colletotrichum gloeosporioides*, is an important pre and post-harvest disease of mango in all mango producing areas of the world. In the field, the initial symptoms on young leaves of mango trees are small dark brown spots, sometimes associated with leaf curl.

Ihsan *et al.* (1999) estimated of losses due to powdery mildew ranged between 0.0 and 70% in the major mango growing countries.

Xie and Xie (1999) observed that anthracnose disease (*Glomerella cingulata*) usually affects the leaves, flowers, fruits and new shoots of mango trees. When young leaves were attacked, many small brown round spots with faint yellow

margins appeared and the badly infected leaves then curled. Infected shoots withered and dried and infected flower clusters turned black and rotted. Infected fruits were abnormal in shape, becoming black then dropping.

Misra (2001) observed powdery mildew caused by *Oidium mangiferae*, as most important disease of mango. It was reported from 35 countries in the world that causes up to 90% loss in India. Besides inflorescence infection, it caused different types of symptoms on leaves and fruits.

Arauz (2000) reported that anthracnose appear as irregular shaped black necrotic spots on both sides in mature leaves. These may coalesce to form larger lesions those laterally often dry up and fall out giving the leaf the 'shot hole' appearance.

Khalid *et al.* (2002); Kazmi *et al.*, (2005) reported that anthracnose, powdery mildew, bacterial blight, malformation and mango slow and quick decline are well known important diseases in mango cultivation.

Dey *et al.* (2007) stated that anthracnose, stem end rot, powdery mildew, sooty mould, malformation and fruit rot complex were very common and destructive disease in Bangladesh.

Sarker (2008) surveyed nursery diseases of mango in Rajshahi and Chapai Nawabganj and found anthracnose, powdery mildew, red rust, scab, bacterial leaf sot, sooty mould, malformation and dieback.

2.2. Banana diseases

Sigatoka leaf spot is an airborne disease caused by *Mycosphaerella musicola*. It was first observed in Java in 1902 (Stover 1962) and thereafter it was reported in Asia, Africa and the Americas. In Africa the disease was first reported in Uganda in 1938 and was later quickly noted in Tanzania in 1939, Cameroon 1941 and thereafter in several other African countries. The disease is now reported present in all tropical Africa. The incidence of the disease is highest in

high elevation systems where black Sigatoka is absent. It has been reported that wherever black Sigatoka has arrived, it has completely or partially displaced yellow Sigatoka (Mourichon and Fullerton 1990) within two years (Jeger *et al.* 1995) though some doubts have been expressed about this phenomenon (Jones 1990).

Panama disease also known as *Fusarium* wilt is caused by the soil-borne fungus *F. oxysporum* f. sp. *cubense* (Ploetz, 2000). The disease was reported in Australia in 1876 but might have originated from Southeast Asia and now is present in all banana producing regions except islands in the South Pacific, the Mediterranean, Melanesia, and Somalia. (Tachin, 2009).

Ploetz (2005) stated that banana production world-wide is under serious threat due to fusarium wilt caused by *Fusarium oxysporum* f. sp. *cubense*.

Hassan (2010) reported that the most serious disease of banana is Sigatoka leaf spots (caused by *Mycosphaerella musicola*). According to 64-68% of the growers of Tangail, Sigatoka is the most serious disease of banana. Panama caused by *Fusarium oxysporum* f.sp. *cubense* (longitudinal splitting of pseudostem) is also a serious disease of banana in the Tangail region of Bangladesh.

Hossain (2014) stated that panama disease or Fusarium wilt caused by *Fusarium oxysporum* f. sp. *cubense* is the most damaging fungal disease in banana production. He explained that infection by this fungus will result in yellowing and wilting of the leaves, which eventually turn brown, the leaves will dry up and hang from the plant and eventually the plant dies. Most of our cultivars are more or less susceptible to this disease. Among the cultivars, Sabri (AAB) is highly susceptible to this disease. At present, no resistant variety developed against this disease in the country and abroad and chemical control is not available. He also explained that foliage of banana is susceptible to sigatoka leaf spots. Sigatoka disease is considered as the most serious disease

of banana resulting in yield loss. In Bangladesh, Amritasagar (AAA) is susceptible to this disease.

2.3. Lemon diseases

Petlier and Federich (1926) reported that under favorable condition the bacteria enter the host through the natural opening such as stomata and the wounds caused by the spines, wind and leaf miners. After entering the host cells the bacteria multiply in the intercellular space, dissolve the middle lamella and establish in the cortex region. Canker pustules develop in the affected regions and bacteria exude in the form of gummy substances. They are freely spread by the wind and rain, the latter being the chief medium.

Ramakrishan (1954b) reported that young tissues of the plant are readily affected. In the nursery stages sweet orange and other varieties also get infected by canker. High humidity, temperature between 20^o- 35^o C and the presence of moisture on the host surface for 20 minutes or more favor the incidence of the disease.

Ajyappa (1958) reported that all cultivated varieties of citrus and some wild species in Karnataka are highly susceptible to canker possibly due to heavy rainfall, high humidity and low temperature.

Nirvan (1961) reported that 43.2 percent of the cankered leaves exclusively owed the leaf miners infestation. Leaves affected by the miner and canker get distorted and usually drop off early.

Reddy and Murti (1990) reported that canker infected leaves, twigs and branches constitute the source of inoculum to spread the disease from season to season. Since the infected leaves drop off early and bacteria perish rapidly in the soil.

Fantin and Kamati (1993) observed *Elsinoe australis* and *Elsinoe fawcettii* were the causal agent of citrus scab.

Rawal and Saxana (1997) reported that symptoms of anthracnose appear on leaves, young shoots and tender fruits. On leaves, the necrotic spots show acervuli arranged in concentric rings. Dead parts of the wings assume silvery grey appearance. Twigs show a slight gumming and a sharp line of separation between healthy and dead tissues. Affected buds fail to develop and fruits drop off. Often, the infected fruits develop reddish brown stain on the rind. This leads to the blight of twig. The infected hyphae produced anthracnose in oranges and grape fruit, if the peel is injured or fruits are over matured.

Singh *et al.* (1998b) reported that scab affected fruit, leaves and young shoots causing irregular, raised, corky, scabby and warty like outgrowth, severely scabbed leaves and fruits become misshapen and distorted. The rind of scabbed fruit is thick and puffy.

Hartmond *et al.* (2000a) in Florida reported that citrus scab caused by the fungus *Elsinoe fawcettii* can occur on all varieties of citrus but it is of economic importance for fruits production of lemons, temples, page, minneala, tangelo and in some situations grape fruit. Citrus scab on foliage and shoots causes stunting of plants during seedling root stock production of rough lemon, sour orange, *Carizzo citroange*, trifoliolate orange and Rangpur lime.

Hartmond *et al.* (2000b) in Florida reported that citrus scab caused by the fungus *Elsinoe fawcettii* can occur on stem and leaves, especially those of the summer flush, provide the main source of over wintering inoculums. Older scab pustules provide relatively little inoculums compared to those pustules on summer and fall shoot growth. Apparently, scab pustules lose their capacity for spore production as they aged.

Singh *et al.* (2000) reported that citrus scab caused by the fungus *Elsinoe fawcettii* is a serious disease of citrus in India. It can be severe deformation of foliage and stunting of certain citrus root stocks.

Amador (2002a) reported that die back affected young branches, start withering from the tip, sometimes producing gum exudation. Wood is discolored underneath the bark. Damage by twig dieback usually is severe.

Alam (2003) conducted a survey in the commercially citrus growing areas of Moulavibazar, Sylhet and Chittagong in Bangladesh and listed scab (*Elsinoe fawcettii*), canker (*Xanthomonas citri*) and dieback (*Colletotrichum gloeosporioides*) are the major diseases of citrus in Bangladesh.

Benyahia *et al.* (2003) reported that citrus trees (*Citrus sinensis* L. Osbeck) with symptoms resembling wither tip on twigs and tear stain on fruits were observed in Morocco, but lime (*Citrus aurantifolia*) was not affected.

Bobby (2003) reported that wither tip (dieback) is the major disease of about all citrus species. Symptoms appear initially from top and transmit downward to bottom of infected plant/tree. Diseased twigs start drying at tips and all affected parts become silvery gray and develop black dots. Defoliation and death of the entire plant also caused under severe condition.

Gopal *et al.* (2003c) observed that dieback of acid lime seedlings in Rayalaseema region of andhra pradesh was found to be caused by combined infection of *Colletotrichum gloeosporioides* and bacterial canker pathogen *Xanthomonas axonopodis* pv. *citri*.

Hassan (2010) reported that die back is observed to be the most serious disease in orange plantation in the Juri and Borolekha Upazillas of Moulvibazar.

2.4. Guava diseases

A total of 10 diseases have been reported on guava in Bangladesh (Meah and Khan, 1987). Among the guava diseases anthracnose caused by *Colletotrichum gloeosporioides* is recognized as the second most serious disease, next to wilt (Meah and Khan, 1988). High prevalence of the disease even in epidemic form

has been reported every year from different parts of the country (Meah and Khan, 1987; Rahman and Hossain, 1989).

Guava, like all other fruits, is vulnerable to attack by several diseases, either in the orchards or during marketing, i.e. leaf spots, die back, wilt, red rust, anthracnose, thread blight, grey blight, sooty mould and fruit rots such as stylar-end rot, canker, soft rot and blue mould (Hossain and Meah, 1992; Dwivedi, 1995; Majumdar and Pathak, 1997; Quintero and Urdaneta, 1997; Wahid, 1999 and Singh, 2000).

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 1987-1988. Different varieties (Sarupkatti, Kanchan Nagar and Deshi) were sprayed 4-7 times 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.

Lim and Manicom (2003) studied diseases of guava including distribution, importance and control of guava diseases, together with characteristics and production of the fruit. Important diseases include the bacterium *Erwinia psidii*, rust (*Puccinia psidii*), anthracnose (*Glomerella cingulata*), damping off (*Rhizoctonia solani*), wilt disease (*Fusarium oxysporum* f. sp. *psidii*) and the gall (*Meloidogyne* spp.).

Rahman *et al.* (2003); Awasthi *et al.*, (2005) reported that anthracnose of guava fruit caused by *Colletotrichum gloeosporioides* were reported by researcher from many parts of the world.

Rahman *et al.* (2003) recognized anthracnose as the second most important disease of guava. In the investigation *Colletotrichum gloeosporioides* were isolated from important diseased leaf.

Misra (2004) studied guava diseases-their symptoms, causes and management. Guava an important fruit of sub-tropical countries that affected by about 177 diseases which 167 are fungal, 3 bacterial, 3 algal and 3 nematodes and one epiphyte. Wilt is the most important disease of guava. Besides this, fruit post harvest diseases are also important which causes serious loss. The fruit diseases are of two types i.e. field disease and post harvest diseases, which develop during transit and storage. Due to its perishable nature number of pathogens is reported on fruits which cause different types of rots in guava fruits. In the present communication all major diseases are described with their symptoms, causal organism and disease management practices.

Chowdhury *et al.* (2011) studied the seedling diseases of guava and the effect of temperature, rainfall and humidity on the prevalence of anthracnose (*Colletotrichum gloeosporioides*) in the nurseries of Bangladesh during 2005-2008. Important plant pathogens viz. *Colletotrichum gloeosporioides* and *Fusarium oxysporum* were detected and identified. Incidence and severity of anthracnose of guava varied significantly from season to season as well as from location to location and was also positively correlated with temperature, rainfall and relative humidity.

Hossain (2011) studied nursery diseases of guava in Bangladesh during the period of 2010-2011. He recorded anthracnose, scab and leaf blight diseases of guava in different guava growing areas of Bangladesh.

2.5. Jujube diseases

Mehta (1950) reported that the mycelium of *Oidium* sp. overwinters and appeared annually in the new growth. These become primary sources of infection. The disease was observed on both cultivated and wild forms of ber.

Lodha (1984) reported powdery mildew (*Oidium erysiphoides* f. sp. *ziziphi*) create great losses in ber in India, particularly in humid areas, and also in Africa.

Morton (1987) reported that powdery mildew (*Oidium* sp.) caused defoliation and fruit-drop.

Sharma and Kore (1990) reported powdery mildew caused by *Oidium* sp. as the most serious disease of jujube.

Azam *et al.* (2001) reported that powdery mildew disease may found earlier if conditions are favorable. The developing young leaves show a whitish powdery mass, which causes them to shrink and defoliate. The disease also appears in the form of white powdery spots. The spots turn into light brown to dark brown discoloration. The infected area becomes slightly raised and rough. He also stated that the mycelium remains external on the host with white, single, upright conidiophores.

Sharma (2003) observed that powdery mildew appeared with increased virulence during high rainfall years and disease incidence can relate to time of pruning as well as to weather, Jamadar and Venkatesh (2003).

Chowdhury (2009) recorded two disease viz. alternaria leaf spot and powdery mildew during the survey on the seedlings of jujube. The fungi, *Alternaria alternata* and *Erysiphe* sp. were isolated from the diseased symptom of alternaria leaf spot and powdery mildew.

Jamadar *et al.* (2009) found 50-60% loss in fruit yield due to powdery mildew disease of jujube and reduced market value of the produce. The disease is causing great loss in productivity and quality of fruits.

Hoque *et al.* (2013) stated that powdery mildew (*Oidium erysiphoides* f.sp. *ziziphi*) is the major disease of indian jujube (*Ziziphus mauritiana*) in Bangladesh.

2.6. Coconut diseases

Joseph and Radha (1975) observed pink to reddish brown younger tissue and leaf necrosis on coconut seedlings due to the attack of *Phytophthora* sp. At the

later stage the younger leaves often showed rotten area on the attacking portion of the *Phytophthora* pathogen.

Anon (1979) reported that in India, 173 fungi associated with coconut and Brown (1973) recorded 35 fungi from coconut leaves. The roots stem and the crown regions are attacked at different growth stages of the crop, which may result in considerable economic loss to the grower.

Schuilung *et al.* (1992) reported that the incidence and severity of leaf spot diseases of coconut differs significantly from region to region in Tanzania.

Rendless *et al.* (1999) showed that severely attack of *Phytophthora* sp on coconut leaves can caused the leaves totally damaged. A lateral necrosis of the petiole developed which caused the leaf to die and hanged from the canopy. The appearance of a normal apex and several yellowish leaves that hanged through green older leaves was characteristic of the phytophthora leaf spot disease.

Ghose (2000) found that coconut mainly suffered from grey leaf spot or blight caused by (*Pestalotiopsis palmarum*) and bud rot caused by *Phytophthora palmivora* in 22 countries and described distribution, alternative hosts, epidemiology, varietal reaction and management of the disease. He also reported that grey leaf spot or blight caused by *Pestalotiopsis palmarum* had no immune or resistant sources against the disease. Little information is available about the incidence, prevalence, epidemiology and management of seedling diseases of coconut in Bangladesh.

Khan and Hossain (2013) investigated on seedling diseases of coconut in different nurseries of Jessore, Jhenaidah and Faridpur during 2010-2011 and 2011-2012 revealed that leaf spot was the most common disease in the nurseries. The leaf spot causal pathogen was identified as *Pestalotia palmarum*. Incidence of leaf spot disease in coconut seedlings varied significantly from season to season as well as location to location that ranged from 26.33 to 80.36 % in 2010-2011 and 24.89 to 74.35% in 2011-2012, respectively. The highest

incidence (80.36 %) of leaf spot was observed in October, 2010 at Faridpur and the lowest (26.33 %) was observed in January, 2011 at Jessore. The severity of leaf spot varied significantly from 18.44 to 40.67 % in 2010-2011 and 15.73 to 27.67 % in 2011- 2012, respectively. The highest severity (40.67 %) was observed in October, 2010. The lowest severity (18.44 %) was recorded in January, 2011 at Faridpur in 2010-2011. In 2011-2012 the highest severity (27.67 %) was recorded in October, 2011 at Jessore and the lowest (15.73 %) was recorded in January, 2012 at Faridpur.

2.7. Papaya diseases

Hassan (2010) reported that papaya mosaic and leaf curl are also found to be the most serious diseases in the papaya plantation in Ishurdi of Pabna, one of the leading papaya growing zones in Bangladesh.

CHAPTER III

MATERIALS AND METHODS

Two experiments were carried out throughout the study period in order to study the homestead fruit diseases.

3.1. Experiment I: Survey on the fruit diseases in homestead haor area

3.1.1. Location of survey

The survey was conducted at Ajmiriganj Upazilla under Habiganj district. The survey area was under the old meghna estuarine floodplain (AEZ-19) located at 24.5472⁰ N 91.2500⁰ E having 14713 units of house hold and consist total area of 223.98 Km². It included of 5 unions/wards, 68 mauzas/mahallas and 79 villages.

3.1.2. Climate of the location

Mean annual rainfall was about 200 mm over most of the region which exceeded 2500 mm in north east and 3000 mm in the extreme south-east. Mean annual temperature was about 26⁰ C.

3.1.3. Selected homestead area

The experiment was conducted at 45 households of 05 union of Ajmiriganj haor Upazila under Habiganj district. The names of the unions are:

- a. Sadar
- b. Kakailchao
- c. Badalpur
- d. Jalsukha
- e. Sibpasha

3.1.4. Selected fruit species

Household possess a various types of fruit species among them only 13 fruit species were accounted. The species were:

i) Mango ii) Banana iii) Coconut iv) Lemon v) Orange vi) Guava vii) Jujube viii) Sapota ix) Papaya x) Wax apple xi) Star fruit xii) Hog plum xiii) Pummelo

These fruit species were selected under the project namely BAS-USDA-PALS Project, CR-43 is running for the modeling of year round fruit production in the Haor homestead. It is assumed that if these fruit species planted in a household, it will supply fruit all around the year and this survey is a part of that project.

3.1.5. Data collection

Data were collected using questionnaire through direct interviews to the head of the family, housewife and others. Data were collected mainly on name and number of fruit species, age of the plant, name of the diseases and name of the infected parts and finally these were used in connection with the prevalence of the diseases.

3.1.6. Observation of the symptoms

Symptoms of the diseases were studied by visual observation. Sometimes a disease was identified based on matching the observed symptoms in the infected plants with the symptoms. Beside this, identification of fungal diseases was confirmed by identification of the associated fungal organisms through compound microscope.

3.2. Experiment II. Prevalence of the diseases of selected fruit species

3.2.1. Survey period

Survey was made during the period from January' 2013 to July' 2013. First survey was made in January' 2013, second survey was made in March' 2013, third survey was made in May' 2013 and fourth survey was made in July' 2013.

3.2.2. Determination of disease incidence and disease severity

For calculation of incidence of disease, total numbers of fruit trees were counted and also counted the infected trees and then expressed in percentage. The disease incidence of homestead fruit trees was determined by the following formula:

$$\text{Disease incidence of fruit trees} = \frac{\text{No. of infected plants}}{\text{No. of total plants}} \times 100$$

Leaf area diseased was measured by eye estimation following disease rating scales and then summations of each leaf area diseased in each tree were made. Total area of a leaf was considered as 100%. About ten infected leaves were randomly selected from each tree for foliar diseases except banana and coconut trees. For banana and coconut trees three leaves were randomly selected. The following rating scales (Horsfall and Barratt, 1945) were used for the foliar diseases:

Criteria	Ratings
No visible symptoms	0
1-5% leaf area diseased	1
5.1-12% leaf area diseased	2
12.1-25 % leaf area diseased	3
25.1-50 % leaf area diseased	4
>50% leaf area diseased	5

Finally Percent Disease Severity was determined by the following formula:

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of total disease rating} \times 100}{\text{No. of total observation} \times \text{highest grade value of the scale}}$$

Whereas, Sum of total rating = No. of observation x grade

3.2.3. Data analysis

Data on different was analyzed in Tukey HSD (Honest Significant Difference) design through computer software Statistix 10. Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) test were performed to determine the level of significant differences and to separate the means within the parameters.

CHAPTER IV

RESULTS

4.1. Survey on the fruit diseases in homestead haor area

Sixteen different diseases were recorded from seven different fruit species in the survey conducted in 45 homestead areas of Habiganj district. The symptoms of different diseases observed in the experimental area were as follows:

4.1.1. Mango diseases

4.1.1.1. Anthracnose (*Colletotrichum gloeosporioides*)

Anthracnose disease was found to occur in leaves. The characteristics symptoms consist of sunken, dark colored, necrotic lesions. As the disease progresses, the small sunken lesions coalesce to form large necrotic patches (Fig. 1).



Figure 1. Symptom of anthracnose disease of mango caused by *Colletotrichum gloeosporioides*

The pathogen was isolated from the diseased leaves and identified as *Colletotrichum gloeosporioides* by observing the conidia under compound microscope. Conidia were dark colored, single celled and barrel shaped characteristics (Plate 1).

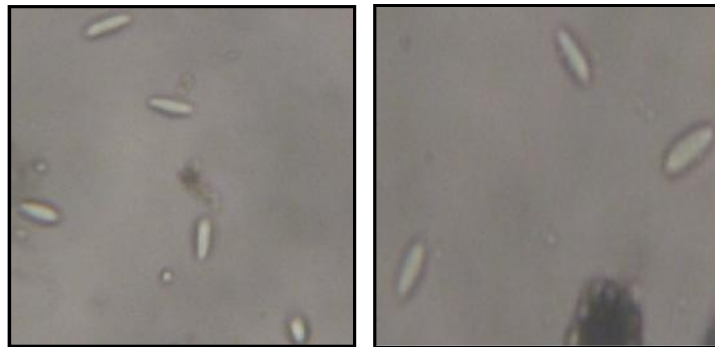


Plate 1. Conidia of *Colletotrichum gloeosporioides* seen under compound microscope (40X)

4.1.1.2. Powdery mildew (*Oidium mangiferae*)

Powdery mildew disease was found to occur on leaves, mostly new leaves. Infection shows initially as small patches of white powdery growth of mycelium, which later coalesce to cover large areas, the characteristics symptoms of powdery mildew disease (Fig. 2).



Figure 2. Symptom of powdery mildew disease of mango caused by *Oidium mangiferae*

The pathogen was observed by making semi-permanent slide from the diseased symptom of leaves and identified as *Oidium mangiferae* by observing under compound microscope. The conidia were hyaline, thin-walled, elliptical to barrel or oblong shaped conidia (oidia), which were unicellular and aseptate (Plate 2).

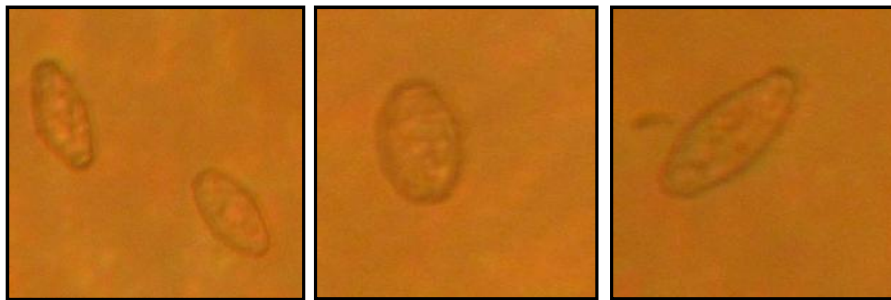


Plate 2. Conidia of *Oidium mangiferae* seen under compound microscope (40X)

4.1.1.3. Leaf blight (*Macrophomina mangiferae*)

On leaves, firstly brown symptoms were found which turned into dark brown with slightly raised and brown margins. As the disease progresses, the lesions were turned into ash color. Spots were round at first but later become oval or irregular in size (Fig. 3).



Figure 3. Symptom of leaf blight disease of mango caused by

Macrophomina mangiferae

4.1.1.4. Mango malformation (*Fusarium subglutinans*)

Abnormal, compact development of shoots was found during the survey. The leaves were significantly smaller than those of healthy plants and leaves were re-curved towards the stem giving a bunchy-top appearance.

4.1.2. Banana diseases

4.1.2.1. Panama (*Fusarium oxysporum*)

The characteristics symptoms consisted of yellowing of the oldest leaves most prominent around the margins. They eventually turned a bright yellow color with dead leaf margins. As the disease advances, most of the leaves became yellow and died (Fig. 4).



Figure 4. Symptom of panama disease of banana caused by *Fusarium oxysporum*

The pathogen was observed on diseased leaves and identified as *Fusarium oxysporum* by the macroconidia under compound microscope having hyaline, thin-walled, nearly straight, slender, curved and tapered apical cell (Plate 3).

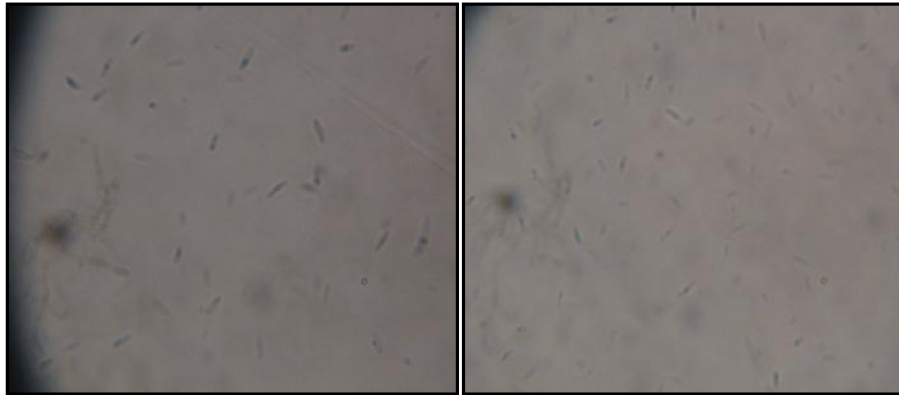


Plate 3. Conidia of *Fusarium oxysporum* seen under compound microscope (40X)

4.1.2.2. Sigatoka (*Mycosphaerella musicola*)

The symptoms were small, light yellow spots or streaks parallel to the side vein of the leaf. Later, the spots were elongated and turned into brown color with light gray centers. As the disease progresses the spots enlarged and coalesced to form large lesions. The tissues around the lesion also turned yellow (Fig. 5).

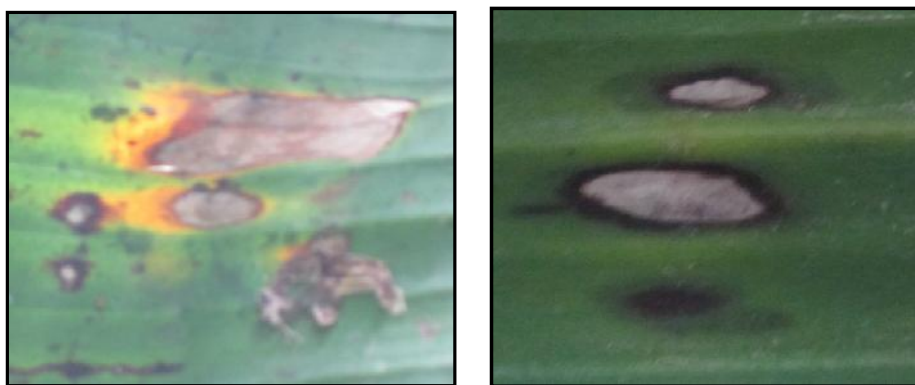


Figure 5. Symptom of sigatoka disease of banana caused by *Mycosphaerella musicola*

4.1.3. Lemon diseases

4.1.3.1. Scab (*Elsinoe fawcetti*)

On leaves lesions were usually found on the lower surface. Lesions were circular to somewhat angular. As lesions enlarged they became white to gray with narrow, dark borders. The affected leaves became wrinkled, stunted, miss shaped and prematurely shed.

4.1.3.2. Canker (*Xanthomonas axonopodis*)

The disease appeared on the leaves, twigs, petioles branches and thrones. Canker symptoms were yellowish spots which gradually enlarged and appeared as rough raised brownish pustules. These pustules were also surrounded by a characteristics yellow halo (Fig. 6).



Figure 6. Symptom of canker disease of citrus caused by *Xanthomonas axonopodis*

4.1.3.3. Die back (*Colletotrichum* sp.)

The young and small branches of the plants were died from top to downward as the characteristics symptoms of this disease (Fig. 7). The leaves became

yellowish in color. As the disease developed small mottling and chlorosis appeared on the leaves. The leaves decreased in size and number. And finally the branches of the plants dried up downward and eventually the plant died.



Figure 7. Symptom of dieback disease of citrus caused by *Colletotrichum* sp.

4.1.4. Guava diseases

4.1.4.1. Anthracnose (*Colletotrichum gloeosporioides*)

Anthracnose disease was found to occur in leaves. The characteristics symptoms consist of sunken, dark colored, necrotic lesions. As the disease progresses, the small sunken lesions coalesced to form large necrotic patches (Fig. 8).

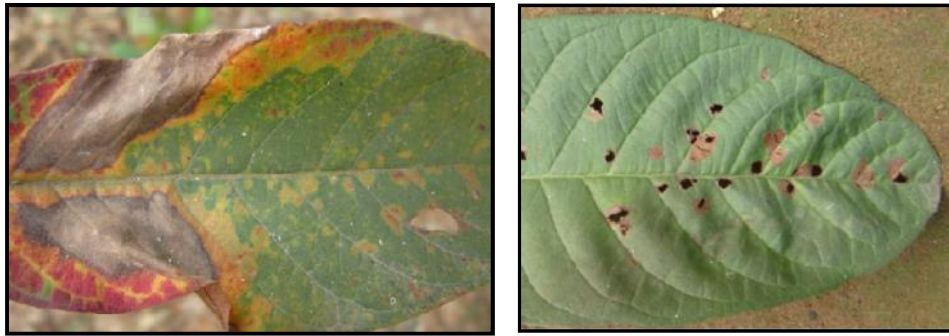


Figure 8. Symptom of anthracnose disease of guava caused by *Colletotrichum gloeosporioides*

The pathogen was observed on diseased leaves and identified as *Colletotrichum gloeosporioides* by observing the conidia under compound microscope having dark colored, single celled and barrel shaped characteristics (Plate 4).

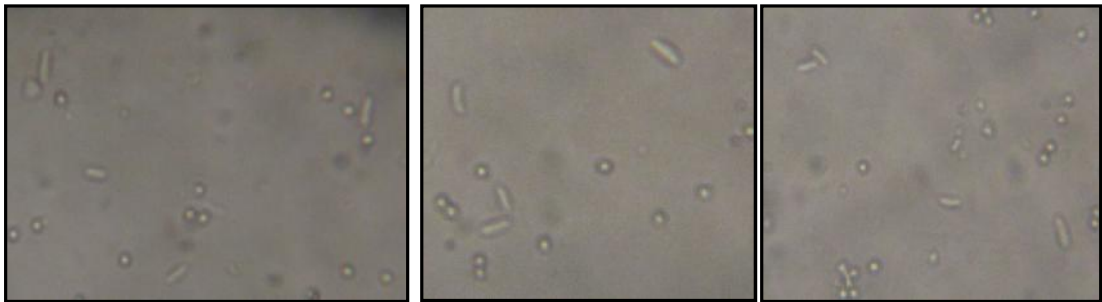


Plate 4. Conidia of *Colletotrichum gloeosporioides* under compound microscope (40X)

4.1.4.2. Rust (*Puccinia psidii*)

Guava rust caused powdery growth on leaves. Infected tissues became covered with bright yellow pustules (uredosori) of the pathogen. Yellow uredosori were

found to form on both upper and lower leaf surfaces during damp weather condition.

4.1.5. Jujube disease

4.1.5.1. Powdery mildew (*Oidium erysiphoides*)

Powdery mildew disease was found to occur on leaves mostly new leaves (Fig. 9). Infection shows initially as small patches of white powdery growth of mycelium, which later coalesce to cover large areas, the characteristics symptoms of powdery mildew disease.



Figure 9. Symptom of powdery mildew disease of jujube caused by *Oidium erysiphoides*

The pathogen was observed from the diseased symptom of leaves and identified as *Oidium erysiphoides* (Plate 5) by the conidia under compound microscope having hyaline, thin-walled, elliptical to barrel or oblong shaped conidia (oidia), which were unicellular or aseptate).

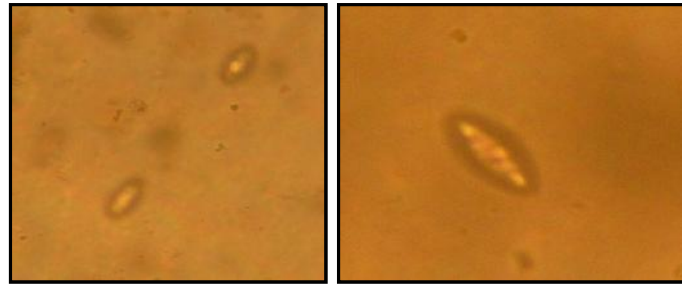


Plate 5. Conidia of *Oidium erysiphoides* under compound microscope (40X)

4.1.6. Coconut diseases

4.1.6.1. Grey leaf spot (*Pestalotiopsis palmarum*)

Disease symptoms mostly developed in the mature leaves, symptoms appeared as minute yellow spots encircled by a grayish margin. At the later stage the symptoms were characterized by the formation of greyish-white spots surrounded by a brown band. As the disease progresses the small sunken lesions coalesce to form large necrotic patches and causes leaf blight (Fig. 10).

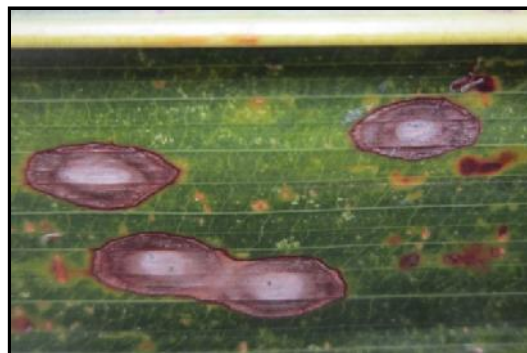


Figure 10. Symptom of grey leaf spot disease of coconut caused by *Pestalotiopsis palmarum*

4.1.6.2. Phytophthora leaf spot (*Phytophthora palmivora*)

The observed symptoms consist of sunken, dark brown colored, necrotic lesions. At the later of time, the small sunken lesions coalesce to form large necrotic patches (Fig. 11).



Figure 11. Symptom of phytophthora leaf spot disease of coconut caused by *Phytophthora palmivora*

4.1.7. Papaya diseases

4.1.7.1. Mosaic (Papaya mosaic virus)

Dark-green patches of tissue alternating with yellowish-green symptoms were appeared on the top young leaves of the plants. The leaves are reduced in size and the leaf petiole was also reduced in length. The infected plants showed a marked reduction in growth (Fig. 12).



Figure 12. Symptom of mosaic disease of papaya caused by
Papaya mosaic virus

4.1.7.2. Leaf curl (Papaya leaf curl virus)

The young leaves were mostly affected by this disease. Severe curling and deformation of the leaves characterized the disease. Thickening of the veins and twisted petioles were also found. In severe cases complete defoliation of the affected plant was observed with stunted growth (Fig. 13).



Figure 13. Symptom of leaf curl disease of papaya caused by
Papaya leaf curl virus

4.2. Prevalence of the diseases of selected fruit species

4.2.1. Mango diseases

In the survey area 45 households were surveyed. Among these, mango tree was found in 45 households. During survey mango trees were found to be infected by four diseases namely anthracnose, powdery mildew, leaf blight and malformation (Table 1).

Incidence of anthracnose of mango varied from union to union that ranged from 27.47-39.47% (Table 1). The highest (39.47%) incidence was recorded at Jalsukha union and the lowest (27.47%) was recorded at Kakailchao union. Disease severity of mango anthracnose also varied from union to union that ranged from 8.63 -10.94%. The highest severity (10.94%) was recorded at Badalpur union and the lowest (8.63%) was recorded at Sadar union. In case of powdery mildew disease the range of disease incidence varied from 31.94-41.66%. The highest incidence (41.66%) was found in Badalpur union and the lowest incidence (31.94%) was found in Jalsukha union. Disease severity of powdery mildew disease varied from 8.24-11.66%. The highest severity (11.66%) was recorded at Badalpur union and the lowest (8.24%) was recorded at Jalsukha union. Incidence of leaf blight disease varied from 49.99-65.28% where the highest incidence (65.28%) was found in Sadar union and the lowest (49.99%) was in Sibpasha union. Disease severity of leaf blight disease varied from 15.32-18.12%. The highest PDI (18.12%) was recorded at Jalsukha union and the lowest (15.32%) was recorded at Sadar union. In malformation disease the range of disease incidence and disease severity varied from 16.66-29.16% where the highest incidence and severity (29.16%) were at Badalpur union and the lowest incidence and severity (16.66%) were at Kakailchao union.

Table 1. Incidence and severity of mango diseases at different unions of Ajmiriganj haor Upazila under Habiganj district from January to July 2013

Unions	Mango			
	Anthracnose	Powdery mildew	Leaf blight	Malformation

	<i>(Colletotrichum gloeosporioides)</i>		<i>(Oidium mangiferae)</i>		<i>(Macrophomina mangiferae)</i>		<i>(Fusarium subglutinans)</i>	
	D.I (%)	PDI (%)	D.I (%)	PDI (%)	D.I (%)	PDI (%)	D.I (%)	PDI (%)
Sadar	36.11 ab	8.63 c	40.27 a	9.07 ab	49.99 a	15.32 b	22.22 ab	22.22 ab
Kakailchao	27.47 b	9.11 bc	34.72 a	10.75 ab	54.16 a	16.44 ab	16.66 b	16.66 b
Badalpur	37.19 ab	10.94 a	41.66 a	12.25 a	55.55 a	18.01 a	29.16 a	29.16 a
Jalsukha	39.47 a	9.44 bc	31.94 a	8.24 b	65.27 a	18.12 a	20.83 ab	20.83 ab
Sibpasha	38.88 ab	10.02 ab	38.88 a	11.66 ab	65.28 a	16.79 ab	19.44 ab	19.44 ab
GM	35.82	9.63	37.49	10.39	58.05	16.94	21.66	21.66
CV%	14.46	5.83	14.25	16.50	13.10	5.60	22.33	22.33
LSD (0.05)	11.69	1.26	12.06	3.87	17.17	2.14	10.92	10.92

Each data represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Incidence of mango anthracnose disease varied from January to July, 2013 (Table 2). The highest incidence (51.11%) was recorded in the month of July and the lowest incidence was recorded in May (26.64%) and January (26.66%) respectively. The severity of anthracnose disease also significantly varied from month to month that ranged from 5.82-14.88%. The highest severity (14.88 %) was recorded in July and the lowest severity (5.82 %) was found in January. In case of powdery mildew, disease incidence varied from 10.00-53.33% and disease severity varied from 2.13-16.15%. The highest incidence (53.33%) and (48.88 %) and the highest severity (16.15%) and (15.31 %) were recorded in

March and July, for both cases; and the lowest incidence (10.00%) and the lowest severity (2.13 %) were recorded in January, for both cases. The highest incidence (75.55 %) and (74.44 %) of leaf blight disease was recorded in the month of May and July and the lowest incidence (32.22%) was recorded in January. Severity of leaf blight disease significantly varied from 25.92-8.26%. Where the highest severity (25.92%) was recorded in July and the lowest severity (8.26%) was recorded in January. In case of mango malformation disease the range of disease incidence and disease severity was same and the range was 12.22- 31.10%. The highest incidence and severity (31.10%) were recorded in July; and the lowest incidence and severity (12.22%) were recorded in January.

Table 2. Diseases of mango in different month of Ajmiriganj haor Upazila under Habiganj district

Time of data collection (2013)	Mango diseases							
	Anthracnose (<i>Colletotrichum gloeosporioides</i>)		Powdery mildew (<i>Oidium mangiferae</i>)		Leaf blight (<i>Macrophomina mangiferae</i>)		Malformation (<i>Fusarium subglutinans</i>)	
	D.I (%)	PDI (%)	D.I (%)	PDI (%)	D.I (%)	PDI (%)	D.I (%)	PDI (%)
January	26.66 c	5.82 d	10.0 0 c	2.13 c	32.22 c	8.26 d	12.22 c	12.22 c
March	38.88 b	10.04 b	53.3 3 a	16.15 a	50.00 b	13.44c	18.88 bc	18.88 bc
May	26.64 c	7.77 c	37.7 7b	7.99 b	74.44 a	20.13b	24.44 ab	24.44 ab
July	51.11 a	14.88 a	48.8 8 a	15.31 a	75.55 a	25.92a	31.10 a	31.10 a
GM	35.82	9.63	37.4	10.39	58.05	16.94	21.66	21.66

E			9					
a	CV%	14.46	5.83	14.25	16.50	13.10	5.60	22.33
c								
h	LSD	9.72	1.05	10.03	3.22	14.28	1.78	9.08
d	(0.05)							
E								
a								

ch data represents

Each data represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Regarding incidence of the four diseases recorded in the present study, leaf blight (75.55%) was the most predominant where powdery mildew (53.33%), anthracnose (51.11%), and malformation (31.10%) had the least occurrence. July month was found to be critical for occurring anthracnose, leaf blight and malformation disease as the highest incidence was recorded during survey; and highest incidence was recorded in March in case of powdery mildew disease.

4.2.2. Banana diseases

In the survey area 45 households were surveyed. Among these, banana was found in 30 households. Banana was found to be infected by two diseases namely Panama and Sigatoka (Table 3). Incidence and severity of Panama disease varied from union to union that ranged from 12.50-27.77%. The highest (27.77%) incidence and severity were recorded at Badalpur union and the lowest (12.50%) were recorded at Sadar union. In case of Sigatoka disease the range of disease incidence varied from 9.72-19.44 %. The highest incidence (19.44%) was found in Badalpur union and the lowest incidence (9.72%) was found in Sadar and Sibpasha union respectively. Disease severity of Sigatoka disease varied from 2.22-3.83%. The highest severity (3.83%) was recorded at Jalsukha union and the lowest (2.22%) was recorded at Sibpasha union.

Table 3. Diseases of banana at different union of Ajmiriganj haor Upazila under Habiganj district

Unions	Banana diseases			
	Panama (<i>Fusarium oxysporum</i>)		Sigatoka (<i>Mycosphaerella musicola</i>)	
	D.I (%)	PDI (%)	D.I (%)	PDI (%)
Sadar	12.50 b	12.50 b	9.72 a	2.44 a
Kakailchao	19.44 ab	19.44 ab	11.11 a	2.57 a
Badalpur	27.77 a	27.77 a	19.44 a	3.61 a
Jalsukha	24.99 a	24.99 a	16.66 a	3.83 a
^E ^a ^c Sibpasha	23.61 a	23.61 a	9.72 a	2.22 a
^h GM	21.66	21.66	13.33	2.93
^d ^a ^t CV%	17.67	17.67	35.06	27.78
^a LSD(0.05)	8.64	8.64	10.55	1.84

^t represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Incidence of Panama disease varied from January to July, 2013 (Table 4) that ranged from 16.66 -28.88 %. The highest (28.88%) incidence and severity were recorded in July and the lowest (16.66 %) were recorded in January and March

respectively. In case of sigatoka, disease incidence varied from 1.11-21.11% where the highest incidence (21.11%), (16.66%) and (14.44%) were recorded in the month of May, March and January respectively. Disease severity of sigatoka varied from 0.22-5.11 % where the highest severity (5.11%) was recorded in the month of May and the lowest severity (0.22%) was recorded in July.

Table 4. Diseases of banana in different month of Ajmiriganj haor Upazila under Habiganj district

Time of data collection (2013)	Banana diseases			
	Panama (<i>Fusarium oxysporum</i>)		Sigatoka (<i>Mycosphaerella musicola</i>)	
	D.I (%)	PDI (%)	D.I (%)	PDI (%)
January	16.66 b	16.66 b	14.44 a	2.88 b
March	16.66 b	16.66 b	16.66 a	3.52 b
May	24.44 a	24.44 a	21.11 a	5.11 a
July	28.88 a	28.88 a	1.11 b	0.22 c
GM	21.66	21.66	13.33	2.93
CV%	17.67	17.67	35.06	27.78
LSD (0.05)	7.18	7.18	8.78	1.53

represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Regarding incidence of the two diseases recorded in the present study, panama

disease (28.88%) was the most predominant in the month of July.

4.2.3. Lemon diseases

In the survey area 45 households were surveyed. Among these, lemon tree was found in 45 households. Three diseases namely canker, scab and dieback were found associated with the lemon plant. Incidence of canker disease varied from union to union that ranged from 19.44-38.89% (Table 5). The highest (38.89%) incidence was recorded at Badalpur union and the lowest (19.44%) was recorded at Sadar union which was followed by Kakailchao and Jalsukha (20.83%) and Sibpasha (23.61%) union. Disease severity of canker disease varied from 4.46-7.27%. The highest severity (7.27%) was recorded at Badalpur union and the lowest (4.46%) was recorded at Sadar union. In case of scab disease the range of disease incidence varied from 37.49-51.38%. The highest incidence (51.38%) was found in Sibpasha union which was followed by Sadar (50.00%), Badalpur (44.44%), Kakailchao (43.05%) and Jalsukha (37.49%) union. Severity of scab disease varied from 7.08-9.43%. The highest severity (9.43%) was recorded at Badalpur union and the lowest (7.08%) was recorded at Sadar union. Incidence of dieback disease varied from union to union that ranged from 8.33-13.89%. The highest (13.89%) incidence was recorded at Badalpur union which was followed by Sibpasha (13.88 %), Kakailchao (12.50%), Sadar (11.11%) and Jalsukha (8.33%) union. Severity of dieback disease varied from 1.44-2.83%. The highest severity (2.83%) was recorded at Kakailchao which was followed by Badalpur (2.38%), Sibpasha (2.11%), Jalsukha (1.55%) and Sadar (1.44%) union.

Table 5. Diseases of Lemon at different union of Ajmiriganj haor Upazila under Habiganj district

Unions	Lemon diseases		
	Canker (<i>Xanthomonas axonopodis</i>)	Scab (<i>Elsinoe fawcetti</i>)	Dieback (<i>Colletotrichum sp.</i>)

	D.I (%)	PDI (%)	D.I (%)	PDI (%)	D.I (%)	PDI (%)	
E a	Sadar	19.44 b	4.46 b	50.00 a	7.08 b	11.11 a	1.44 a
c h	Kakailchao	20.83 b	5.11 ab	43.05 a	8.41 ab	12.50 a	2.83 a
d	Badalpur	38.89 a	7.27 a	44.44 a	9.43 a	13.89 a	2.38 a
a	Jalsukha	20.83 b	6.24 ab	37.49 a	7.97 ab	8.33 a	1.55 a
t a	Sibpasha	23.61 b	5.28 ab	51.38 a	9.36 a	13.88 a	2.11 a
E	GM	24.72	5.67	45.27	8.45	11.94	2.06
a	CV%	23.84	18.84	15.07	10.59	35.00	37.76
c h	LSD (0.05)	13.305	2.41	15.40	2.02	9.43	1.76

Each data represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Incidence of canker disease varied from January to July, 2013 (Table 6) that ranged from 15.55-42.22%. The highest (42.22%) incidence was recorded in July and the lowest (15.55%) was recorded in January. Disease severity of canker varied from 3.06-9.71% where the highest severity (9.71%) was recorded in the month of July and the lowest severity (3.06%) was recorded in January. Incidence of scab disease varied from 35.55-56.66% where the highest incidence (56.66%) was recorded in the month of July and the lowest incidence (35.55%) was recorded in January. Disease severity of scab varied from 5.37-12.57% where the highest severity (12.57%) was recorded in the month of July and the lowest severity (5.37%) was recorded in January. Incidence of dieback disease varied from 0.00-26.66% where the highest incidence (26.66%) was recorded in the month of July and the lowest incidence (0.00%) was recorded in January and March. Disease severity of scab varied from 0.00-4.88% where the highest severity (4.88%) was recorded in the month of July and the lowest severity (0.00%) was recorded in January and March.

Table 6. Diseases of lemon in different month of Ajmiriganj haor Upazila under Habiganj district

Time of data collection (2013)	Lemon diseases					
	Canker (<i>Xanthomonas axonopodis</i>)		Scab (<i>Elsinoe fawcetti</i>)		Dieback (<i>Colletotrichum</i> sp.)	
	D.I (%)	PDI (%)	D.I (%)	PDI (%)	D.I (%)	PDI (%)
January	15.55 b	3.06 c	35.55 b	5.37 c	0.00 b	0.00 c
March	16.66 b	4.14 bc	41.10 b	7.28 b	0.00 b	0.00 c
May	24.44 b	5.77 b	47.78 ab	8.58 b	21.11 a	3.37 b
July	42.22 a	9.71 a	56.66 a	12.57 a	26.66 a	4.88 a
GM	24.72	5.67	45.27	8.45	11.94	2.06
CV%	23.84	18.84	15.07	10.59	35.00	37.76
LSD (0.05)	11.06	2.00	12.81	1.68	7.85	1.46

represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Regarding incidence of the three diseases recorded in the present study, scab disease (56.66%) was the most predominant in the month of July whereas the incidence of canker (42.22%) was higher than dieback (26.66%) in the month of July.

4.2.4. Guava diseases

In the survey area 45 households were surveyed. Among these, guava was found in 29 households. Two diseases namely anthracnose and rust were found associated with the guava plant. Incidence of anthracnose disease varied from union to union that ranged from 24.99-47.22% (Table 7). The highest incidence (47.22%) was recorded at Sibpasha union and the lowest (24.99%) was

recorded at Badalpur union. Disease severity of anthracnose varied from 3.83-8.19%. The highest severity (8.19%) was recorded at Badalpur union and the lowest (3.83%) was recorded at Sibpasha union. In case of rust disease the range of disease incidence varied from 12.50-24.99%. The highest incidence (24.99%) was found in Sadar union which was followed by Sibpasha (19.44%), Kakailchao (19.05%), Jalsukha (13.89%) and Badalpur (12.50%), union. Severity of rust disease varied from 0.00-38.88%. The highest severity (38.88%) was recorded at Jalsukha union and the lowest (0.00%) was recorded at Sadar union.

Table 7. Diseases of guava at different union of Ajmiriganj haor Upazila under Habiganj district

Unions	Guava diseases			
	Anthracnose (<i>Colletotrichum gloeosporioides</i>)		Rust (<i>Puccinia psidii</i>)	
	D.I (%)	PDI (%)	D.I (%)	PDI (%)
Sadar	41.66 ab	6.86 ab	24.99 a	0.00 c
Kakailchao	33.330 bc	5.44 b	18.05 a	5.55 c
Badalpur	47.22 a	8.19 a	12.50 a	26.66 b

Jalsukha	36.11 abc	5.91 b	13.89 a	38.88 a
Sibpasha	24.99 c	3.83 c	19.44 a	17.77
GM	36.66	6.05	17.77	33.87
CV%	14.10	11.32	33.87	11.30
LSD (0.05)	11.67	1.54	13.59	

Each data represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Incidence of anthracnose disease varied from January to July, 2013 (Table 8) that ranged from 23.33-51.11%. The highest (51.11%) incidence was recorded in July and the lowest (23.33%) was recorded in January. Disease severity of anthracnose significantly varied from 5.29-8.91% where the highest severity (8.91%) was recorded in the month of July and the lowest severity (5.29%) was recorded in March. In case of rust disease, incidence varied from 0.00-38.88% where the highest incidence (38.88%) was recorded in the month of July and the lowest incidence was recorded in of January. Disease severity of rust varied from 0.00-8.62 % where the highest severity (8.62%) was recorded in July and the lowest severity (0.00%) was recorded in January.

Time of data	Guava diseases
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T collection (2013) b l e	Anthracnose (<i>Colletotrichum gloeosporioides</i>)		Rust (<i>Puccinia psidii</i>)	
	D.I (%)	PDI (%)	D.I (%)	PDI (%)
January	23.33 c	3.11 d	0.00 c	0.00 c
March	32.22 bc	5.29 c	5.55 c	0.75 c
May	39.99 b	6.88 b	26.66 b	6.11 b
July	51.11 a	8.91 a	38.88 a	8.62 a
GM	36.66	6.05	17.77	3.87
CV%	14.10	11.32	33.87	15.59
LSD (0.05)	9.71	1.28	11.30	1.13

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Each data represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Regarding incidence of the two diseases recorded in the present study, anthracnose disease (51.11%) was the most predominant. In January month there was no development of rust disease. The highest incidence was found in July month for both diseases.

4.2.5. Jujube disease

In the survey area 45 households were surveyed. Among these, jujube was found in 25 households. Only powdery mildew disease was found to be associated with these jujube trees. Incidence of powdery mildew disease varied from union to union that ranged from 22.22-36.11% (Table 9). The highest

incidence (36.11%) was recorded at Badalpur union which was followed by Sadar (33.33%), Jalsukha (31.94%), Sibpasha (30.55%) and Badalpur (22.22%) union. Disease severity of powdery mildew varied from 7.41-11.77%. The highest severity (11.77%) was recorded at Badalpur union and the lowest (7.41%) was recorded at Sadar union.

Table 9. Disease of jujube at different union of Ajmiriganj haor Upazila under Habiganj district

Unions	Jujube disease	
	Powdery mildew (<i>Oidium erysiphoides</i>)	
	D.I (%)	PDI (%)
Sadar	33.33 a	7.41 b
Kakailchao	22.22 a	7.69 b
Badalpur	36.11 a	11.77 a
Jalsukha	31.94 a	7.74 b
Sibpasha	30.55 a	8.46 b
GM	30.83	8.61
CV%	27.23	15.87
LSD (0.05)	18.95	3.08

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represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Incidence of powdery mildew disease varied from January to July, 2013 (Table 10) that ranged from 15.55-54.44%. The highest (54.44%) incidence was recorded in July and the lowest (15.55%) was recorded in January. Disease severity of powdery mildew varied from 4.62-13.39% where the highest severity (13.39%) was recorded in the month of July and the lowest severity (4.62%) was recorded in January.

Table 10. Disease of jujube in different month of Azmiriganj haor Upazila under Habiganj district

Time of data collection (2013)	Jujube disease	
	Powdery mildew (<i>Oidium erysiphoides</i>)	
	D.I (%)	PDI (%)
January	15.55 c	4.62 c
March	17.77 c	7.12 bc
May	35.55 b	9.33 b
July	54.44 a	13.39 a
GM	30.83	8.61
CV%	27.23	15.87
LSD (0.05)	15.76	2.56

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ta represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Regarding incidence of the disease recorded in the present study, the highest incidence of powdery mildew disease (54.44%) was found in July month.

4.2.6. Coconut diseases

In the survey area 45 households were surveyed. Among these, coconut was found in 36 households. Two diseases were found to be associated with these coconut trees namely grey leaf spot and phytophthora leaf spot. Incidence of grey leaf spot disease varied from union to union that ranged from 24.94-

36.10% (Table 11). The highest incidence (36.10%) was recorded at Sadar union which was followed by Kakailchao (31.94%), Jalsukha (26.39%), Sibpasha (24.99%) and Badalpur (24.94%) union. Disease severity of phytophthora leaf spot varied from 9.60-14.63%. The highest severity (14.63%) was recorded at Sadar union and the lowest severity (9.60%) was recorded at Badalpur union. In case of phytophthora leaf spot, disease incidence varied from 9.72-27.77% where the highest incidence (27.77%) was recorded at Badalpur union and the lowest incidence (9.72%) was recorded at Kakailchao union. Disease severity of phytophthora leaf spot varied from 5.06-7.01% where the highest severity (7.01%) was recorded at Badalpur union and the lowest incidence (5.06%) was recorded at Kakailchao union.

Table 11. Diseases of coconut at different union of Ajmiriganj haor Upazila under Habiganj district

Unions	Coconut diseases			
	Grey leaf spot (<i>Pestalotiopsis palmarum</i>)		Phytophthora leaf spot (<i>Phytophthora palmivora</i>)	
	D.I (%)	PDI (%)	D.I (%)	PDI (%)
Sadar	36.10 a	14.63 a	22.22 a	5.12 b
Kakailchao	31.94 a	12.77 ab	9.72 b	5.06 b
Badalpur	24.94 a	9.60 c	27.77 a	7.01 a
Jalsukha	26.39 a	13.46 a	18.05 ab	5.59 ab
Sibpasha	24.99 a	9.82 bc	22.22 a	5.95 ab
GM	28.87	12.05	20.00	5.74
CV%	22.56	11.46	24.71	13.09
LSD (0.05)	14.70	3.11	11.15	1.69

Each data

represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Incidence of grey leaf spot disease varied from January to July, 2013 (Table 12) that ranged from 13.33-42.21%. The highest (42.21%) incidence was recorded in July and the lowest (13.33%) was recorded in January. Disease severity of grey leaf spot significantly varied from 9.78-19.06% where the highest severity (19.06%) was recorded in the month of July and the lowest severity (9.78%) was recorded in March. In case of Phytophthora leaf spot disease, incidence varied from 7.77-38.88% where the highest incidence (38.88%) was recorded in the month of July and the lowest incidence (7.77%) was recorded in the month of January. Disease severity of Phytophthora leaf spot significantly varied from 3.77-10.44 % where the highest severity (10.44%) was recorded in the month of July and the lowest severity (3.77%) was recorded in March.

Table 12. Diseases of coconut in different month of Ajmiriganj haor Upazila under Habiganj district

Time of data collection (2013)	Coconut diseases			
	Grey leaf spot (<i>Pestalotiopsis palmarum</i>)		Phytophthora leaf spot (<i>Phytophthora palmivora</i>)	
	D.I (%)	PDI (%)	D.I (%)	PDI (%)
January	13.33 c	4.88 d	7.77 c	1.22 d
March	26.62 b	9.78 c	15.55 bc	3.77 c
May	33.33 ab	14.50 b	17.77 b	7.55 b
July	42.21 a	19.06 a	38.88 a	10.44 a
GM	28.87	12.05	20.00	5.74
CV%	22.56	11.46	24.71	13.09
LSD (0.05)	12.23	2.59	9.28	1.41

Each data

represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Regarding incidence of the two diseases recorded in the present study, grey leaf spot disease (42.21%) was the most predominant in July month.

4.2.7. Papaya diseases

In the survey area 45 households were surveyed. Among these, papaya was found in 29 households. Two diseases were found to be associated with these papaya plants namely mosaic and leaf curl. Incidence and severity of mosaic disease varied from union to union that ranged from 0.00-27.77% (Table 13). The highest incidence and severity (27.77%) were recorded at Badalpur union where the lowest incidence and severity were at Sadar union. In case of leaf curl, disease incidence and severity varied from 0.00-13.89% where the highest incidence and severity (13.89%) were recorded at Jalsukha union and the lowest incidence and severity (0.00%) were recorded at Sibpasha union.

Table 13. Diseases of papaya at different union of Ajmiriganj haor Upazila under Habiganj district

E a c h d a t a r e	Unions	Papaya diseases			
		Mosaic		Leaf curl	
		(Papaya mosaic virus)		(Papaya leaf curl virus)	
		D.I (%)	PDI (%)	D.I (%)	PDI (%)
	Sadar	0.00 c	0.00 c	2.77 b	2.77 b
	Kakailchao	11.11 b	11.11 b	4.17 b	4.17 b
	Badalpur	27.77a	27.77a	5.55 b	5.55 b
	Jalsukha	4.17 bc	4.17 bc	13.89 a	13.89 a
E a c h	Sibpasha	5.55 bc	5.55 bc	0.00 b	0.00 b
	GM	9.72	9.72	5.27	5.27
d a	CV%	33.80	33.80	62.26	62.26
t a	LSD (0.05)	7.41	7.41	7.41	7.41

represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Incidence of mosaic disease varied from January to July, 2013 (Table 14) that ranged from 5.55-13.33%. The highest (13.33%) incidence and severity were recorded in May and July month where the lowest incidence and severity (5.55%) were recorded in January. In case of leaf curl disease, incidence and severity varied from 2.22-8.89% where the highest incidence and severity (8.89%) were recorded in the month of July and the lowest incidence and severity (2.22%) were recorded in January.

Table 14. Diseases of papaya in different month of Ajmiriganj haor Upazila under Habiganj district

Time of data collection (2013)	Papaya diseases			
	Mosaic (Papaya mosaic virus)		Leaf curl (Papaya leaf curl virus)	
	D.I (%)	PDI (%)	D.I (%)	PDI (%)
January	5.55 b	5.55 b	2.22 b	2.22 b
March	6.66 b	6.66 b	3.33 ab	3.33 ab
May	13.33 a	13.33 a	6.66 ab	6.66 ab
July	13.33 a	13.33 a	8.89 a	8.89 a

E	GM	9.72	9.72	5.27	5.27
a					
E	CV%	33.80	33.80	62.26	62.26
a					
c	LSD (0.05)	6.17	6.17	6.17	6.17
h					
d					

ata

Each data represents the mean value of nine households and values having same lettering did not differ significantly, D.I. = Disease Incidence, PDI = Percent Disease Index

Regarding incidence of the two diseases recorded in the present study, mosaic disease (13.33 %) was the most predominant in May and July month.

CHAPTER V

DISCUSSION

The present study was conducted to find out the disease status of selected fruit trees in haor area. The experiment was conducted at 45 households of 05 unions of Ajmiriganj haor Upazila under Habiganj district. Thirteen fruit trees

were selected for this experiment and about sixteen different diseases were recorded from seven fruit trees. Six fruit trees showed no symptom of disease in this study. During survey four diseases were recorded in mango tree namely anthracnose, powdery mildew, leaf blight and malformation. Among four diseases the highest disease incidence was recorded in case of leaf blight disease (75.55%) in the month of July. Anthracnose, leaf blight and malformation diseases showed the highest disease incidence (51.11%, 75.55% and 31.10%) in the month of July whereas the rest disease, powdery mildew showed the highest disease incidence (53.33%) in the month of March. Sarker (2008) found anthracnose, powdery mildew, red rust, scab, bacterial leaf spot, sooty mould, malformation and dieback diseases in mango trees during survey in Rajshahi and Chapai Nawabganj district. Khalid *et al.* (2002) and Kazmi *et al.*, (2005) also reported anthracnose, powdery mildew, bacterial blight, malformation, mango slow and quick decline were important diseases in mango cultivation. Mortuza (1990) recorded the highest incidence of anthracnose disease in Gooti and Aswina varieties by 28.95% and 28.32%, respectively in the Chapai Nawabganj district.

Panama disease was the most predominant in banana whose incidence was 28.88% in July. Ploetz (2005) found fusarium wilt, a serious threat world-wide in banana production. Hassan (2010) reported sigatoka leaf spots and panama were the most serious disease in banana production, who also found panama, a serious disease of banana in the Tangail region of Bangladesh.

Scab, canker and dieback were three important diseases recorded during survey in lemon plants. The highest disease incidence (56.66%) was recorded in case of scab disease which was followed by canker (42.22%) and dieback (26.66%) disease respectively. All the diseases showed their highest disease incidence in July month. Alam (2003) conducted a survey in the commercially citrus growing areas of Moulavibazer, Sylhet and Chittagong in Bangladesh and listed scab (*Elsinoe fawcettii*), canker (*Xanthomonas citri*) and dieback (*Colletotrichum gloeosporioides*) were the major diseases of citrus in

Bangladesh. Hassan (2010) also reported that die back is a serious disease in orange plantation in the Juri and Borolekha Upazillas of Moulvibazar.

Guava was found to be infected by two diseases namely anthracnose and rust. Anthracnose was the most predominant (51.11%) occurring severely in July month. The highest incidence of rust disease (38.88%) was also recorded in the month of July. Lim and Manicom (2003) studied guava diseases and concluded that rust (*Puccinia psidii*), anthracnose (*Glomerella cingulata*), damping off (*Rhizoctonia solani*), wilt (*Fusarium oxysporum* f. sp. *psidii*) and gall (*Meloidogyne* spp.) are important diseases. Rahman *et al.* (2003) recognized anthracnose as the second most important disease of guava. Hossain (2011) who also recorded anthracnose, scab and leaf blight diseases of guava in different guava growing areas of Bangladesh.

Powdery mildew the only one disease which was found in this experiment in jujube trees. The disease showed its highest incidence (36.11%) in July month. Jamadar *et al.* (2009) stated that in India about 50-60% yield loss was due to powdery mildew disease of jujube which was also responsible for reducing the market value of the fruit. Hoque *et al.* (2013) also stated that powdery mildew (*Oidium erysiphoides* f.sp. *ziziphi*) is the major disease of indian jujube (*Ziziphus mauritiana*) in Bangladesh.

Coconut disease incidence and severity were assessed for the month of January, 2013 to July, 2013 in this experiment. [*Phytophthora* sp.](#) ([Phytophthora](#) leaf spot) and *Pestalotiopsis palmarum* (grey leaf spot) were found as the causal organisms as per physical symptom of disease. The most predominant (42.21%) disease was grey leaf spot and both diseases were occurring severely in the month of July. Ghose (2000) concluded that coconut mainly suffered from grey leaf spot or blight caused by *Pestalotiopsis palmarum* and bud rot caused by *Phytophthora palmivora* in 22 countries. Khan and Hossain (2013) investigated on seedling diseases of coconut in different nurseries of Jessore,

Jhenaidah and Faridpur and concluded that leaf spot (*Pestalotiopsis palmarum*) was the most common disease in the nurseries and the highest incidence (80.36 %) of this disease was observed in the month of October.

Papaya plants were also infected by two diseases namely mosaic and leaf curl. Between two diseases mosaic was the most predominant (13.33%) and this disease showed the highest incidence in the month of May and July. The highest incidence of leaf curl disease was 8.89% in July month. Hassan (2010) reported that papaya mosaic and leaf curl are the most serious diseases in the papaya plantation in Ishurdi of Pabna which is one of the leading papaya growing zones in Bangladesh.

CHAPTER VI

SUMMARY AND CONCLUSION

Fruit trees are vulnerable to attack by various diseases in Bangladesh, but least concrete information regarding their distribution, incidence, severity is available. Therefore, the present study has been designed to study occurrence and prevalence of diseases of selected fruit trees at Ajmiriganj upazilla under Habiganj district. In the survey area 45 households were surveyed to identify the diseases of the selected fruit trees. The survey was done through a questionnaire by the direct interviews of the owner of the households.

Two experiments were carried out throughout the study period from January to July, 2013. The diseases were identified based on the observed symptoms in the infected plants as well as the presence of fungi on the infected parts of plant by preparation of slides and examining them under compound microscope. After identification of the diseases the prevalence of those diseases was also recorded to fulfill the purpose of the survey.

Among thirteen fruit trees, seven trees were found to be infected by sixteen diseases. Mango trees were infected by four diseases namely anthracnose, powdery mildew, leaf blight and malformation. Leaf blight was the most predominant caused 75.55% infection and July month was found to be critical for occurring leaf blight in mango.

Banana plants were infected by two diseases namely panama and sigatoka. Between two diseases panama disease (28.88%) was the most predominant whose incidence was also high in July.

Lemon plants were infected by three diseases namely canker, scab and dieback. Among three diseases scab disease was the most predominant (56.66%) occurred highly in July.

Guava plants were infected by two diseases namely anthracnose and rust. Between two diseases anthracnose disease was the most predominant (51.11%) occurring highly in July. There was no development of rust disease in guava plants in the month of January but the highest incidence was found in July.

Jujube trees were infected by only one disease namely powdery mildew which was predominant in July month.

Coconut trees were infected by two diseases namely grey leaf spot and phytophthora leaf spot. Between two diseases grey leaf spot disease was the most predominant (42.21%) disease occurring severely in July month.

Papaya plants were infected by two diseases namely mosaic and leaf curl. Between two diseases mosaic was the most predominant (13.33 %) occurring highly in May and July.

The rest six trees such as Orange, Sapota, Wax apple, Star fruit, Hog plum and Pummelo were not infected by any disease during the survey period.

To become successful in modeling of year round fruit production in the Haor homestead, it was important to consider the pathological aspects more elaborately. In this case, presence of pathogens in an environment and their range of infection level on host plant vary with the different seasons. So four months survey was not sufficient but it provides the seasonal reports. For this it was needed to conduct the survey as year round basis to find out the complete and full report on different pathogens and their level of infection that will facilitate to control the diseases caused by pathogens and finally increased the productivity of fruit trees.

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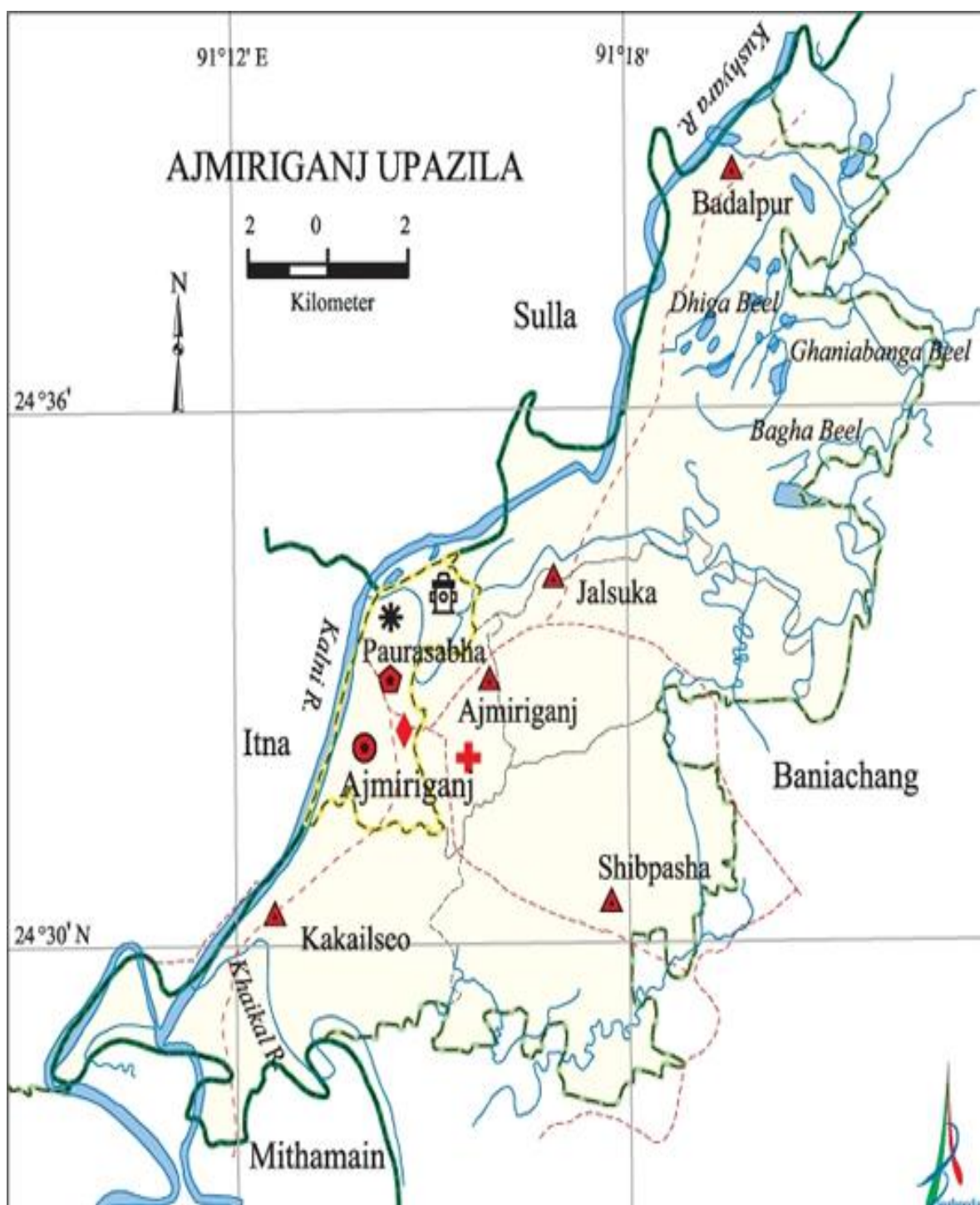
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APPENDICES

Appendix I. A map of study area of Ajmiriganj upazila



Appendix II. Short Questionnaire on Survey

Union	Name of the plant	Age of Plant	Total trees	Name of diseases	Level of Damage	
					Infected parts	% of Disease
1.					Leaf/ Branch/ stem/ Fruit/ Inflorescence	
					Leaf/ Branch/Stem/ Fruit/ Inflorescence	
2.					Leaf/ Branch/Stem/ Fruit/ Inflorescence	
					Leaf/ Branch/ stem/ Fruit/ Inflorescence	
3.					Leaf/ Branch/Stem/ Fruit/ Inflorescence	
					Leaf/ Branch/Stem/ Fruit/	

					Inflorescence	
4.					Leaf/ Branch/Stem/ Fruit/ Inflorescence	
					Leaf/ Branch/Stem/ Fruit/ Inflorescence	
5.					Leaf/ Branch/Stem/ Fruit/ Inflorescence	
					Leaf/ Branch/Stem/ Fruit/ Inflorescence	

Thanks for your co-operation.

Signature of the interviewer with Date