STUDY ON SEEDLING DISEASES OF MANGO (*Mangifera indica*) IN SOME SELECTED AREAS OF BANGLADESH

DEPARTMENT OF PLANT PATHOLOGY

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CERTIFICATE

This is to certify that thesis entitled, "STUDY ON SEEDLING DISEASES OF MANGO **(*Mangifera indica*)** *IN SOME SELECTED AREAS OF BANGLADESH" 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 IN PLANT PATHOLOGY, embodies the result of a piece of bonafide research work carried out by* ***MD. NUR ISLAM****, Registration No.* ***04-01461*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated:
Dhaka, Bangladesh

(Dr. Ismail Hossain)
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DEDICATED

TO

MY BELOVED PARENTS

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The Author

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LIST OF SYMBOLS AND ABBREVIATIONS

% = Percentage

et al. = and others

Spp. = Species

J. = Journal

No. = Number

Viz. = Namely

df. = Degrees of freedom

@ = At the rate of

etc = Etcetera

PDA = Potato Dextrose Agar media

^{0}C = Degree Celsius

Cm = Centimeter

BBS = Bangladesh Bureau of Statistics

ANOVA = Analysis of variances

Kg = Kilogram

CV% = Percentages of Co-efficient of Variance

LSD = Least Significant Difference

Sci. = Science

FULL WORDS	ABBREVIATION
Percentage	%
Cultivar	cv.
Ton	t
Hector	ha
Exempli gratia (by way of example)	e.g.
Metric ton	Mt
Bangladesh Agriculture Research Institute	BARI
Sher-e-Bangla Agricultural University	SAU
Form species	f.sp.
United States Department of Agriculture	USDA
International Seed Testing Association	ISTA
United Nations Development Program	UNDP
Food and Agricultural Organization	FAO
Department of Agricultural Extension	DAE
At the rate of	@
Milliliter	ml
Kilogram	Kg
Bangladesh Institute of Nuclear Agriculture	BINA
Bangabandhu Sheikh Mujibur Rahman Agricultural University	BSMRAU
Bangladesh Agricultural University	BAU

STUDY ON SEEDLING DISEASES OF MANGO (*Mangifera indica*) IN SOME SELECTED AREAS OF BANGLADESH

ABSTRACT

Occurrence and prevalence of disease of mango was studied in eight nurseries located at Dhaka, Gajipur, Barisal and Khagrachari district during July 2010 to April 2012. Altogether three diseases were recorded during the survey. The disease, in order of prevalence (Incidence and severity) was Anthracnose (66.79 and 55.13), leaf spot (65.84 and 56.21) and sooty mould of mango (24.18 and 12.08). The fungi *Colletotrichum gloeosporioides, Pestalotiopsis mangiferae* were identified under compound microscope from anthracnose, leaf spot infected leaves. However, sooty mould (*Capnodium roseum)* was recorded only on the basis of symptoms observed. The prevalence of recorded three diseases varied to each other with respect to nursery and its location. Among the three diseases recorded two disease viz. Anthracnose and leaf spot were studied to see their relation with temperature and relative humidity. A positive correlation was observed between prevalence of anthracnose and leaf spot with temperature and relative humidity. The highest prevalence of anthracnose and leaf spot was observed in the month of October and lowest in the month of January. In terms of relative humidity a positive correlation was observed between prevalence of leaf spot and prevalence of sooty mould of mango. The prevalence of leaf spot and sooty mould was in the month of October and no prevalence observed in the month of January. Thus leaf spot is being reported as a most severe disease of mango seedlings in the country.

CHAPTER I
INTRODUCTION

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae is one of the most important popular and delicious fruits grown throughout the tropics and sub-tropics of the world. It was thought to be originated in the region of Eastern Indo Bangladesh, Myanmar, Malaysia (Anonymous, 1989). According to Mukherjee (1958), the natural spread of the genus is limited to the Indo-Malaysian region, stretching from India to Philippines and New Guinea in the east. Mango is being cultivated for more than 4000 years (Candole, 1984).Among all types of fruits mango is considered as the class one fruit in the world. Popenoe (1964) mentioned mango as "the king of the oriental fruits" It is widely grown all over Bangladesh; while the quality mangoes solely concentrated in the north-west areas, especially greater Rajshahi, Dinajpur and Rangpur (Karim, 1985). It ranks third among the tropical fruits grown in the world with total production of 30.147 million tons (FAO, 2010). In Bangladesh, mango ranks second fruit in terms of area cultivated and third in production. The country produced 640 thousand tons of mangos in 25.91 thousands ha of mango orchard during the period of 2005-06 (BBS, 2006)
In Bangladesh, there exists a wide variability in mango due to its cross pollination and seed propagation. Mango is a popular fruit of the country having some special organoleptic features such as excellent flavor, pleasant aroma, attractive color and test. It is a rich source of vitamins, minerals and total soluble solids (Pramanik, 1995).It is also a medium source of carbohydrate as ripe mango pulp contains 16.9% carbohydrate (Salunkhe and Deasai, 1984).The minimum dietary requirement of fruit/day/head is 85g, whereas our availability is only 30-35g, which is much lower than recommended daily allowance (Siddique and Scanlan, 1995).

The demand of fruit (Mango) is increasing day by day with growing population and decline in production results in scarcity every year. Plant diseases play a major

role in reducing yields of Horticultural crops in Bangladesh. Various factors are responsible for lowering the yield of Mango. It has been estimated that the production could be increased at least by 28%, if the crop could be protected against various disease. Mango is one of the important fruit crops in the world as well as Bangladesh which is also affected by many diseases.

Seedling of Mango is frequently affected by physical and physiological disorders as well as diseased caused by Fungi, Bacteria and Viruses. Disease is a major cause of lower production of mango in Bangladesh (Meah and Khan, 1987). Meah and Khan conducted a survey throughout Bangladesh and reported that mango is attacked by as many as 18 different diseases.

A good number of diseases of mango were recorded by many researchers of Bangladesh (Mortuza,1990; Hussein,1997; Reza and Kader,1996a/b; Sarkar, S. R,2008; Choudhory, 2009; Choudhory *et al,* 2011) and in the world (Singh,1968; Pathak,1980; Fitzell and Peak,1984; Peterson,1986; Jeger *et al*,1988; Xie and Xie,1999; Colon *et al*, 2002; Awasthi *et al,* 2005; Dey *et al*, (2007) reported anthracnose, stem end rot, powdery mildew, sooty mould, malformation and fruit rot complex were very common and destructive disease in Bangladesh. Out of these diseases Anthracnose, die back, powdery mildew, leaf spot, sooty mould and red rust are important. They are caused by *Colletotrichum gloeosporioides*, *Diplodia natalenis, Oidium mangifera, Alternaria alternata*, *Capnodium ramosum* and *Cephaleurous virescencs* respectively are predominant diseases.

In Bangladesh The climate of Bangladesh harbors plant pathogens and provide luxuriant environment for the growth and reproduction of large number of plant pathogen. Healthy and disease free seedlings are of prime need and basic raw material for establishment of orchard as well as production of Mango. But seedling diseases are one of the important problems in the tropics. Although a huge number of nurseries are engaged in producing seedlings, they fail to produce high quality seedling due to lack of knowledge about disease. Thus production of healthy

seedling ensure good plantation and save money, labor, and energy of mango gardeners. Mango seedlings suffer from various diseases in Bangladesh (Sarkar, 2008), but no concrete information regarding their distribution, incidence, severity and epidemiology all over Bangladesh available. Therefore, attempt should be put forward to study the prevalence of various diseases occurring on mango seedlings in some selected nurseries of Dhaka, Gazipur, Barisal and Khagrachari.

Considering the above facts, the present research program has been designed with the following objectives:

- Survey on the prevalence of seedling diseases of mango in some selected nurseries of Dhaka, Gazipur, Barisal and Khagrachari.
- To identify the pathogen (s) associated with the diseases.
- To study the epidemiology especially in relation to the effect of temperature, relative humidity and rainfall on incidence and severity of nursery diseases of mango.

CHAPTER 2
REVIEW OF LITERATURE

Mango plants are prone to the attack by many diseases at all stages of growth. The diseases of mango trees as well as fruits have been studied in Bangladesh in some details but little attention has been paid to the nursery diseases. In this Chapter, an attempt has been made to review the available literatures on symptoms of nursery diseases of mango, their causal organisms, disease status and their epidemiology in different locations of Dhaka.Gajipur, Barisal and Khagrachori.

2.1. Diseases of mango

Bitancourt and Jenkins (1943) studied symptoms of scab of mango. The disease attacked leaves, twigs, blossoms panicles and fruits. These spots on young nursery plants in Cuba were pale to brown and covered with a delicate bull down, which represented the vegetative stage of the fungus. On older foliage, the lesions showed a larger size and wore grey in appearance, surrounded by a darker margin, and bore on their surface small dot-like structures, which were the ascomata, the perfect stage of the fungus. In Brazil, however the lesions were circular to elongated or irregular, with a grey centre and a darker periphery. These were mainly centered on the midrib or were disposed in close proximity to it. Both foregoing types of lesion had been observed in Puerto Rico, the Canal Zone, and Florida.

Suit and Du charme (1946) observed that the red rust alga attacked the foliage, bark and twig of the host plant (mango. litchi etc.). They also observed that in serious infection the bark become thickened and the twigs enlarged and remain stunted. Many species of *Cephaleuros* are reported to infect different host in all parts of the world.

Singh (1968) described the symptoms of anthracnose, powdery mildew, red rust, sooty mould, malformation, scab, malformation, bacterial leaf spot and gummosis.

Singh (1968) stated that the thallus of red rust alga of mango was a pseudoparenchymatous tissue one to several cells in thickness in which the cells are radially arranged. A discord mass, which grows just beneath the circular layer of epidermal cells, often has regular branches on its underside. It grows down between the cells of the epidermis and the deeper-lying tissues. The under surface of the algal mass bears numerous unbranched filaments, which project through the cuticle. Some of these erect filaments are sterile hairs; others bear a cluster of sporangia or gamentangia at their apex. Cells of both sterile and fertile hairs are usually reddish-brown.

Singh (1968) further stated that reproduction of red rust algae in mango was by means of zoospores which were formed in sporangia produced at the extremities of fertile hairs. The sporangia were born in clusters and each lies at the end of short stalk-cell. When mature, the sporangia break away and dispersed by the wind. The produced biflagellate zoospores as soon as they were moistened. If the sporangium was one that has fallen on a leaf or twig of a suitable host, the zoospore might germinate to form a new thallus. There was also formation of biflagellate gametes within the gagametingum resulting from enlargement of certain cells in the pseudoparenchymatous portion of the thallus.

Singh (1978) described the symptoms of bacterial leaf spot of mango. In the initial stages, tiny water soaked dark brown spots appeared on leaves. Later on the spots gradually increased in area and become slightly raised. If at this juncture rain occurred, the bacterial infection increased enormously taking on an epidemic form. The affected tissue exhibited deep longitudinal cracks, exuding gum. In 1978 Singh also slated that anthracnose mostly affected the tender parts of the tree such as the young shoots, leaves, panicles, flowers and fruits. The symptoms varied

according to the plant part infected. Dark brown necrotic areas were appeared on the leaves, elongated black necrotic patches on the twigs.

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. Moreover, he described the symptoms of sooty mould of mango. The sooty mould grew on the honey dew secreted by hoppers, scales and coccids on leaves and twigs, and produced masses of black spores which sticks to the leaf surface. He also described the symptoms of bacterial leaf spot of mango, the small water soaked lesions appeared in groups towards the tip of the leaf blade. He also mentioned that red rust of mango could easily be recognized by the rusty-red spots mainly on leaves and sometimes on petioles young twigs. The spots were at first greenish-grey in color and velvety in texture. Later they turned reddish-brown.

Fitzell and Peak (1984) stated that the conidia of *Colletorichum gloeosporioides* were produced in lesions on leaves, defoliated branch terminals, mummified inflorescence and flower bracts over a wide range of environmental conditions (10- 30^0C, >95% relative humidity).

Mango malformation caused by *Fusarium moniliforme* was first reported from Florida in 1972. Mango malformation was not an important problem in Florida but the incidence of infection seemed to be increasing slowly. Symptoms were observed in several orchards in Dad and Palm Beach counties. Infections were most severe under usually wet conditions. A good general program of diseased and pest control kept mango malformation under control, if it was combined with prompt removal of diseased tissues from the trees.

Peterson (1986) reported that anthracnose (*Colletorichum gloeosporioides, Glomerella cingulata*), stem end rot (*Botryodiplodia theobromae*, *Dothiorella*

dominicana and *Phomopsis mangiferae*), soft brown rot (*Hendersonia creberrima*), mango malformation (*Fusarium subglutinans*), bacterial black rot (*Xanthomonas campestris pv. mangiferae indicae)* and powdery mildew (*Oidium mangiferae*) were the major diseases aspects of etiology and epidemiology.

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 Gootee (37.8%) in Chapai Nawabganj district and the lowest in the variety Kuapahari in the same district.

Mortuza (1990) recorded the occurrences 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. Red rust, a new disease (*Cephaleuros virescens*) was recorded. Other recorded diseases were anthracnose (*Colletotrichum gloeosporioides*), sooty mould (*Capnodium ramosum*), powdery mildew (*Oidium mangiferae*), Die-back (*Diplodia natalenis*) and malformation (unknown). The highest incidence of anthracnose was observed in Gooti and Aswina varieties by 28.95% and 28.32%, respectively in the Chapai Nawabganj district.

Ploetz *et al*., (1994) described the symptoms of Alternaria leaf spot, Anthracnose, leaf spot, Malformation, Powdery mildew, Pink disease, Red rust, Bacterial leaf spot and Scab.

Reza and Kader (1996 a) conducted an experiment to evaluate 27 germplasms against the major disease of mango at Mango Research Station, Chapai Nawabganj, Bangladesh. They observed the incidence of anthracnose was

maximum in Rad (4.20%) and minimum in Misridagi (0.02%). Red rust was highest in Ruby and the lowest in Baromashi (0.62%). Sooty mould was the highest in Lata Bombai, Keitt. Golapkhas, Baromashi and was free from Sooty mould. Floral malformation was the highest in Lata Bombai (60.05%), Agmamshu, Zill and Ruby were affected by vegetative malformation. Zill was susceptible to scab disease. Lata Bombai, Agmamshu, Totapuri, Gohapkhash and Misridagi were tolerant to scab disease.

Reza and Kader (1996 b) conducted a survey program to record the prevalence of different diseases of mango in Chapai Nawabganj district, Bangladesh during June 1996. They found that Khir Mohanada and Kalia were free from anthracnose on leaves and shoots. Sooty mould disease was found minimum in all varieties. Lata Bombai was susceptible to red rust. At Horticulture base of Kallyanpur, Chapai Nawabganj, the variety Gopalbhog was severely infected by anthracnose and Fazli was susceptible to red rust. Infections of sooty mould were the highest in Langra.

Conde *et al*. (1997) identified *Elsinoe mangiferae*, the cause of mango scab for the first time in Australia as a result of intense investigation into severe scarring and distortion of mangoes in the Darwin rural area of the Northern Territory. Spotting and scarring of mango fruit had been observed in the Northern Territory since about 1990 and was believed by growers to be due to a form of anthracnose caused by *Colletotrichum gloeosporioides.*

Hussein (1997) studied leaf spot of mango in El-Minia Governorate, Egypt. He isolated and identified *Alternaria altenata*, *Cladosporium sphaerospermum* and *Epicoccum nigrum* as the causal agents of the disease. leaf spot severity increased with increasing period after artificial inoculation of these pathogens.

Jeger *et al*. (1988) reported that anthracnose caused by *Colletotrichum gloeosporioides* (*Glomerella cingulata*) is a major constraint on the expansion of export trade in fruits such as mango.

Singh (1998) described the symptoms of bacterial leaf spot of mango. Minute water-soaked lesions appeared in groups towards the tip of the leaf blade. They increased in size to about 1-4mm, brown to black in color and surrounded by chlorotic haloes. They were surrounded by the veins. Large necrotic patches might be formed by coalescing of several lesions. The patches sometimes dried up. These patches were often rough and rose due to heavy bacterial exudate. When a greater portion of the lamina surface had been affected, the leaf fall occurred. Petioles and tender stems were also infected.

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. Spraying with chlorothalonil, carbendazim, or Topsin-M (thiophanate-methyl) during the flowering and fruit growing period controlled the disease.

Rivas-Figueredo and Edwin-Gakegne (2001) reported diverse fungal parasites damage leaves, flowers and fruits of mango (*Mangifera indica*) that affect production. In this work, a new disease that causes defoliation in young leaves was observed.

Kuo (2001) reported that in order to monitored the sensitivity of the mango anthracnose fungus, *Colletotrichum gloeosporioides* [*Glomerella cingulata*], to the eradicative imidazole fungicide prochloraz, A total of 43 mango orchards were surveyed throughout the Tainan area in Taiwan, covering 4000 ha region of mango plantations.

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 cause up to 90% loss in India. Besides inflorescence infection, it causesd different types of symptoms on leaves and fruits. Based on epidemiological studies and control measures conducted for the last 15 years at CISH, Lucknow (Uttar Pradesh, India), a disease cycle and an integrated disease management practice was proposed. Disease could easily be controlled by adopting suitable cultural practices and timely application of spray schedule. As the disease was weather-sensitive, need-based control measures were suggested based on the prevailing environmental conditions.

Colon-Garay (2002) reported that *Colletotrichum gloeosporioides (Glomerella cingulata*) caused anthracnose in various tropical crops, including mango (*Mangifera indica*). Intensive chemical applications used to control this disease resulted in fungicide resistance and potential environmental pollution. An alternative control could be including resistance in mango with hypovirulent (HV) isolates of C. *gloeosporioides*. Hypovirulent mutants were obtained by conidial mutagenesis using ultraviolet light. Mycelial plugs (4 mm) of HV mutants were used to inoculate the surface of detached mango fruits, either 24 or 120h previous to the virulent isolate inoculation. Fruits were kept in humid chamber (i.e. 100% relative humidity). Lesion size was measured 8 and 14 days after inoculation with the HV mutants 120h prior to the virulent isolate inoculation and kept under shade-house virulent isolate. Lesion size was measured 4 and 10 days after inoculation with the virulent isolate. Fourteen days after inoculations, 3 HV mutants reduced lesion size in detached fruits by 50%. Locally induced resistance (in situ) was observed in middle leaves of mango seedlings. All 3 HV mutants tested reduced lesion development in middle leaves of mango seedling 10 days after inoculation. Hypovirulent isolates HV-49 and HV-165 induced systemic resistance to the upper leaves of the plant. The HV mutants appeared to inhibit pathogen development by activating defense mechanisms in mango fruits and seedlings.

Jianguo *et al.* (2002) found that antagonistic microorganisms significantly reduced in incidence of leaf anthracnose disease caused by (*Colletotrichum gloeosporioides*) on mango, and markedly increased the activities polyphenol oxidase (eatechol oxidase), phenylalanine ammonia-lyase and peroxidase in host leaves. The result indicated that the pathogen suppressive substances produced by the antagonistic microorganisms and the increase in enzyme activity in host leaves reduced disease severity.

Awasthi *et al*. (2005) surveyed different orchards, nurseries and market in new alluvial plains of West Bengal, India to observe the prevalence of different diseases of some major fruit crops. On mango four diseases, namely Anthracnose (*Colletotrichum gloeosporioides*), Powdery mildew (*Oidium mangiferae*), leaf blight (*Macrophoma mangiferae*), phoma blight (*Phoma glomerata*) and red rust (*Cephaleuros* sp.), were found to occur in the orchard and two diseases, namely vegetative malformation (*Fusarium moniliforme var. subglutinans*) and wilt (*Fusarium* sp.) in the nursery, while two diseases, namely anthracnose (*Colletotrichum gloeosporioides*)and diplodia stem end rot (*Diiplodia natalensis*) were the major problem causing post-harvest fruit rot.

Hamid and Jalaluddin (2006) studied and identified the association of 18 fungi including species of *Aspegillus, Alternaria, Botryodiplodia, Capnodia, Colletotrichum, Curvularia, Fusarium* and *Helminthosporium* in sooty mass on the upper leaves of mango from Karachi in Pakistan.

Tiwari *et al*. (2004) studied the resistance of 44 mango cultivates to powdery mildew caused by *Oidium mangiferae* in Madhya Pradesh, India. They found that powdery mildew incidence ranged for 0 to 75%. Cultivers Baigan Phalli, Barbalia, Dabari, Dilpasand, Khirama, Nagarideeh, Oloor and Totapari were highly resistant recording 0% incidence of powdery mildew, whereas cv. Aamrpali was the most susceptible, recording 75% incidence of the disease.

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.

Suchana Rani Sarkar (2008) surveyed nursery diseases of mango in Rajshahi and Chapai Nawabganj and found Anthracnose, Powdery mildew, Red rust, Scab, Bacterial leaf spot, Sooty mould, Malformation and Die-back.

2.2. Isolation and identification of the pathogen

Ploetz *et al*. (1994) isolated and identified the causal organism of Alternaria leaf spot (*Alternaria alternata*), Anthracnose (*Colletotrichum gloeosporioides*), Powdery mildew (*Oidium* mangiferae), Red rust (*Cephaleurous virescencs*), Bacterial leaf spot (*Xanthomonas campestris*), Pink disease (*Erythricium salmonicolor*), leaf spot (*Pestalotiopsis mangiferae),* Malformation (*Fusarium mangiferae)* and Scab (*Elsinoe mangiferae).*

Akhtar *et al*. (1999) studied that healthy and malformed samples of both floral and vegetative tissues were collected from different varieties of mango grown in several locations to verify the association of F. *moniliforme* [*Gibberella fujikurio*] mango malformation disease in Pakistan. The fungus was isolated and cultured. Frequency of fungal association with the disease ranged between 90-94%. However, seedling germplasm and land races showing resistance to mango malformation were identified. The in-vitro growth characters of the fungus were determined on different culture media, at varying temperatures, light and pH conditions. Mycelial growth on potato dextrose agar was better than on 9 other media tested. At pH 7, the ideal temperature for growth was between 25-30 degrees C. Normally, the malformation is not controlled by fungicide application. The in-vitro sensitivity of fungus to six fungicides at three concentrations was determined to seek potential means of chemical control.

Lahav *et al*. (2001) recorded presence of *Fusarium subglutinans* [*Gibberella fuzikuroi var. subglutinans*] causing mango malformation in several orchards in Israel was determined by PCR analysis using samples from infected portions of main branches of mango trees. In a related experiment to determine the direction of the growth of the fungal mycelium, saplings grafted with infected scion material were tested using PCR.

Okigbo and Osuinde (2003) found that the incidence of fungal leaf spot diseases on mango (*Mangiferae indica*) in Southeastern Nigeria during 1999-2001. The survey proved that the incidence of leaf spot diseases was greatest in Umuahia (72%) followed by Okigwe and Ojoto, with a peak at the beginning of the rainy season (February-March). Three pathogenic fungi, *Pestaiotiopsis mangiferae, Botryodiplodia theobromae, [Lasiodiplodia theobromae], and Macrophoma mangiferae,* were isolated from leaf spots. Pathogenicity tests showed that P. *mangiferae* B. *theobromae* and M. *mangiferae* were the causal agents of the fungal leaf spot diseases. Symptoms developed 5 weeks after inoculation of healthy leaves. *Bacillus subtilis*, isolated from soil under a mango tree, inhibited P. *mangiferae,* B. *theobromae* and M. *mangiferae* by 57, 61 and 58%, respectively on agar plates.

Freeman *et al*. (2004) studied that 10 isolates of *Fusarium mangiferae* that were cultured on potato dextrose agar containing chloramphenicol. Conidia were mixed with soil and incubated at 25°C. Conidial presence and survival in flowers, fruitlets and mature fruits were assessed. Decline in survival rate was very rapid for all 10 F. mangiferae isolates including the NitM mutant isolate. Within 102 days, under controlled conditions, survival declined to zero compared to the control while less than 40% population survival was recorded after 28 days. The fungi were detected in stem sections, 15 months after inoculation. All flowers and fruitlets from diseased panicles were 100% infected, whether surface disinfected or not. F. mangiferae was not detected in comparable flowers and fruitlets from

healthy trees. The pathogen was not detected within the seed or on seed coats, or in the flesh of any diseased fruit.

2.3. Epidemiology of disease incidence and severity

Occurrence and severity of various diseases of mango throughout the year in the orchards of Nawabganj and Rajshahi (Kajia) were recorded (Annonymous, 1990). Anthracnose, sooty mold and powdery mildew diseases were observed in the orchards of the surveyed area. The highest incidence of anthracnose was observed in the variety Aswina (37.16%) and Gootee (37.8%) in Nawabganj district and the lowest in the variety Kuapahari in the same district.

Ploetz *et al*., (1994) described the epidemiology of Alternaria leaf spot, Anthracnose, Powdery mildew, Red rust and Bacterial leaf spot. A minimum of 350 hr of relative humidity over 80% was needed for Alternaria leaf spot disease development. The conidia of *Colletotrichum gloeosporioides* spread by rain,70-90% relative humidity and 22-28°C temperature helps to develop the mango Anthracnose disease. Conidia germination of Powdery mildew takes 5-6 hr at 23°C temperature and 20% relative humidity, but optional disease development occurs in the diurnal range of 10-30°C and 50-80% relative humidity. A wet and humid environment within the tree canopy is conducive to spread and establishment of alga.

Akhtar *et al.* (1999) studied powdery mildew disease of mango and found *Oidium mangiferae* to be associated with the disease. They found that there was a positive trend between rising temperature, lowering relative humidity and number of spores in the air after a low temperature, high humidity and cloudy spell of weather. The maximum spore occurrence was noted around 25^{o} C and relative humidity of 40-60%. It took 5-8 days for the emergence of disease symptoms after the first detection of air borne conidia.

Yamashita (2000) reported that mango production in Japan was restricted to the southernmost district of the country. Cv. Irwin grafted on Formosa seedling was grown in plastic houses to be free from winter injury and anthracnose disease. Flower bud differentiation proceeds in autumn in response to cool weather on the terminal buds of the new shoots flushed after summer pruning. House heating starts in January with a night temperature regime over 23 degrees C. Flowers open in February and fruits were harvested in June. This is the standard type of production. Another 2 methods are developing to expand the harvesting period to May and August. Flowering control is imperative to both systems. In all systems, fully red-colored mature fruits with a Brix value of >15 degrees are harvested. They are very expensive, but they satisfy urban consumers in place of the low quality imported mangoes (10000 t/year).

Ekbote *et al.* (2001) conducted a survey during November 1993, and April and August 1994 in Dharwad, Karnataka, India to determine the prevalence of anthracnose in mangoes caused by *Colletotrichum gloeosporioides [Glomerella cingulate]*. The highest incidence of the disease was recorded during August 1994, which was characterized by high relative humidity (78-98%) and temperature (22-28°C).

CHAPTER III

MATERIALS AND METHODS

Three experiments were carried out throughout the study period in order to study the seedling diseases of mango. The experiment were as follows:

- Survey on the seedling diseases of mango in some selected nurseries of Bangladesh.
- Identification of causal organisms of the seedling diseases of mango
- Epidemiological survey on the disease prevelance of seedling diseases of mango.

3.1. Experiment I. Survey on the seedling diseases of mango in some selected nurseries of Bangladesh

3.1.1. Location of survey area

Prevalence of diseases occurring on mango seedlings raised in the selected nurseries was surveyed. The experiment was carried out in eight nurseries of Dhaka, Gazipur, Barisal and Khagrachari.

3.1.2. Selection of nursery

The eight nurseries of four districts were surveyed:

Name of District	Name of nursery
Dhaka	• Green orchid nursery, Agargaon • Barisal nursery, Savar
Gazipur	• Gazipur nursery, Gazipur • Laxmipur nursery, Gazipur
Barisal	• Sarchina nursery, Barisal • Riyad nursery, Barisal
Khagrachari	• Hill Research Center, Khagrachari • Ramghar nursery, Ramghar

3.1.3. Age and number of seedlings

The age and number of the seedlings included for the survey are presented in Table1.

Table1. Age of mango seedlings and total number of seedlings in selected eight nurseries from July, 2010 to April, 2012.

Nurseries	Age of the seedling (Years)	Total Number of seedlings surveyed in			
		(July,2010 July,2011)	(October,2010 October,2011)	(January,2011-January,2012)	(April,2011-April,2011)
Green orchid nursery, Agargaon, Dhaka	2	40	60	80	45
Barisal nursery, Savar, Dhaka	2	70	100	100	100
Gazipur nursery,Gazipur	2	80	100	90	80
Laxmipur nursery, Gazipur	2	80	60	80	60
Sarchina nursery, Barisal	2	60	60	70	60
Riyad nursery, Barisal	2	50	50	50	50
Hill Research Center, Khagrachari	2	60	50	80	70
Ramghar nursery, Ramghar, Khagrachari	2	60	80	80	70

3.1.4. Observation of the symptoms

Symptoms of the diseases were studied by visual observation. Sometimes hand lens was used for critical observation of the disease and sometimes a disease was identified based on matching the observed symptoms in the infected plants with the symptoms published in Ber and other mango disease compendium.

3.2. Experiment II: Identification of causal organisms

3.2.1. Collection of diseased specimen

Diseased leaves were collected from the infected plants representing the different areas of survey. The specimens were preserved in the laboratory following standard procedure of preservation of disease specimens until isolation was made.

3.2.2. Isolation of causal organisms

3.2.2.1. Moist blotter method

The pathogen associated with the diseased plant parts (leaves) were cut into several pieces by sterilized scissors and placed on the moist filter paper (Whatman no.1). Three pieces of filter paper were moistened by dipping in sterile water. The petri-dishes with the diseased specimens were incubated at 22±2°C under 12/12 alternating cycles of NUV and darkness in the incubation room of the Seed Pathology Lab (SPL) for three to five days. After incubation the plates were examined under stereomicroscope for primary identification of the organisms (fungi). The fungi were transferred to PDA plates for proper sporulation and purification.

3.2.2.2. Agar plate method

The diseased plant parts (leaves) were surface sterilized by dipping them in 0.001% $HgCl_2$ solution for 1.5 minutes and washed three times with sterile water and there after placed on PDA (Potato = 200g, Dextrose = 17g, Agar = 17 - 20g, Water = 100ml) plates aseptically. The plates were incubated at 28°±1°C for several days and examined daily for any fungal growth.

3.2.3. Purification

The fungi which grew out on medium were transferred to PDA plates following isolation of single hyphal tip technique of Riker and Riker (1921). On PDA media *Oidium magniferae* and *Cephaleuros virescense* did not sporulate and for that matter it was not sub-cultured.

3.2.4. Identification of the pathogen

Slides were prepared directly from diseased specimens and observed under compound microscope for identification of the associated organisms specially for *Oidium mangiferae* and *Cephaleuros virescens.* Attempts were also made to identify the fungal organisms grown out the inocula incubated in sterile wet filter paper by observing their growth characteristics under stereo-microscope. The fungal organisms, cultured on PDA media, were also identified under compound microscope following the keys of Govindu and Thirumalachar (1954), Barnett and Barry (1972) and Mathur and Kongsdal (2003).

3.3. Experiment III: Epidemiology of disease incidence and severity

3.3.1. Survey period

Altogether eight surveys were made during the period from July, 2010 to April, 2012, where first, second, third, fourth, fifth, sixth, seventh, and eighth surveys were made in July, 2010; October, 2010; January, 2011; April, 2011; July, 2011; October, 2011; January, 2012; and April, 2012 respectively.

3.3.2. Data collection during survey

During the survey in the nurseries, total numbers of mango seedlings as well as number of diseased seedlings in the nurseries were recorded. Then 30 seedlings were randomly selected for counting diseased leaves and disease free leaves. Moreover, five leaves per plant were randomly selected to determine the disease severity.

3.3.3. Determination of disease incidence and disease severity

For calculation of incidence of disease every seedling was counted in the nursery and also counted the infected seedlings and then expressed in percentage. Percent disease incidence (PDI) of foliar diseases was determined by the following formula (Rai and Mamatha, 2005):

$$\text{Percent Disease Incidence (Leaves)} = \frac{\text{Number of diseased leaves on each plant}}{\text{Number of total leaves on each plant}} \times 100$$

Percent Disease severity (PDI) was determined by the following formula (Rai and Mamatha, 2005):

$$\text{Percent Disease Severity (Leaves)} = \frac{\text{Area of leaf tissue infected by disease}}{\text{Total leaf area of the plant}} \times 100$$

3.4. Meterological data collection

Meterologial data of the experimental period were collected from Meterological Department, Agargaon, Dhaka

3.5. Satistical analysis

Data on different parameters were analyzed in two factor randomized block design (RCBD) through computer software MSTAT- C (Anonymous 1989). 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 nursery diseases of mango

Three different diseases viz . anthracnose, leaf spot and sooty mould were recorded in the survey conducted in eight nurseries of Dhaka , Gazipur, Barisal and Khagrachari districts.

4.2. Symptom of the diseases and identification of the pathogen

4.2.1. Anthracnose of mango

The characteristics symptoms consist of sunken, dark colored, necrotic lesions. Under humid conditions, the necrotic lesions become covered with pinkish spore masses. As the disease progresses, the small sunken lesions coalesce to form large necrotic patches (plate 1).

Plate 1. Symptoms of anthracnose of mango

The pathogen isolated from the diseased symptom was identified as *Colletotrichum gloeosporioides* (Plate 2) by observing the conidia were dark coloured, single cell barrel shaped characteristics.

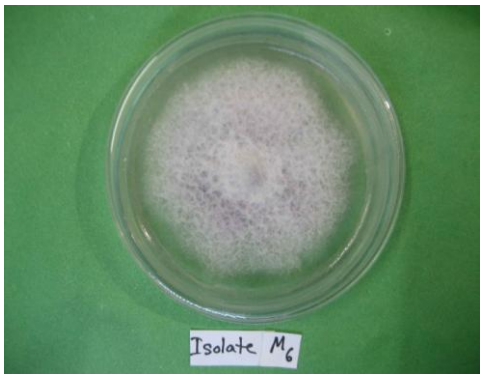


Plate 2. Culture of *Colletotrichum gloeosporioides* (Penz.)

Plate 3. Fruiting structure of C*olletotrichum gloeosporioides* (Penz.) produce in culture.

4.2.2. Leaf spot of mango

On leaves, symptoms were light grey spots, usually 2-20 mm in diameter. These may coalesce to form large patches of narcotic tissue on leaves. Lesions are surrounded by dark, raised margins, and as they mature, raised black dots are evident in lesion centers. *Pestalotiopsis mangiferae* produces abundant conidia in acervuli that develop in grey leaf spot lesions and narcotic areas on frits (Lim and Khoo, 1985). As lesion age, black columns of spores emanate through ruptures in the host epidermis. Conidia are produced that have three thick-walled, brownish, con-colors median cells and thin-walled, hyaline apical and basal cells; the apical cells bear three characteristic appendages.

Plate 4. Symptoms of leaf spot of mango

Plate 5. Culture of *Pestalotiopsis mangiferae*

Plate 6. Conidia of *Pestalotiopsis mangiferae* produce in culture.

4.2.3 Sooty mould of mango

The disease was recognized in the nursery by the presence of a black velvety covering on the leaf surface of seedlings. The entire leaf surface was covered by black sooty mould in patches on the leaf the sooty mould formed a thin membranous covering over the affected parts. The covering can be rubbed off easily from the leaf surface.

Plate 7. Symptoms of sooty mould of mango

4.3. Epidemiology of disease incidence and severity

4.3.1.1. Incidence and severity of anthracnose of mango at different locations of Bangladesh from July, 2010 to April, 2012

Incidence of anthracnose of mango varied from location to location and year to year that ranged from 37.59-46.62% in 2010-2011 and 48.74-52.48% in 2011-2012 (Table 2). The highest incidence was recorded at Khagrachari and the lowest was recorded at Barisal in both the years. The severity of Anthracnose of mango also varied from location to location and year to year that ranged from 28.57-34.75% in 2010-2011 and 32.96-39.50% in 2011-2012. The highest severity was recorded at Dhaka in 2010-2011 and Khagrachari in 2011-2012. The lowest was recorded at Barisal in 2010-2011 and Gazipur in 2011-2012.

Table 2. Incidence and severity of anthracnose of mango at different locations of Bangladesh from July, 2010 to April, 2012

Location	Anthracnose			
	Incidence (%)		Severity (%)	
	July, 2010-April, 2011	July, 2011-April, 2012	July, 2010-April, 2011	July, 2011-April, 2012
Dhaka	42.02 ab	52.11 a	31.23 ab	39.07 a
Barishal	37.59 b	48.74 ab	28.57 b	35.55 b
Gazipur	38.33 b	45.63 b	34.75 a	32.96 c
Khagrachari	46.62 a	52.48 a	34.67 a	39.50 a
$LSD_{(p\geq0.05)}$	4.713	5.398	3.487	1.657
CV%	3.29	3.54	2.17	3.69

Each data represents the mean value of three nurseries

4.3.1.2. Incidence and severity of anthracnose of mango during July, 2010 To April, 2012

Incidence of anthracnose of mango varied from July, 2010 to April, 2012. Incidence ranged from 24.30- 60.28% in 2010-2011 and 25.50-66.79% in 2011-2012 (Table 3). The highest incidence was recorded in October and the lowest was recorded in January in both the years. The severity of Anthracnose of mango also varied from year to year that ranged from 17.39-50.50% in 2010-2011 and 16.14-55.13% in 2011-2012. The highest severity was recorded in October in both the years, and the lowest was recorded in January in both the years.

Table 3. Incidence and severity of anthracnose of mango during July, 2010 To April, 2012

Recording Time of data collection	Anthracnose			
	Incidence (%)		Severity (%)	
	July, 2010-April, 2011	July, 2011-April, 2012	July, 2010-April, 2011	July, 2011-April, 2012
July	51.70 b	56.10 b	40.31 b	45.78 b
October	60.28 a	66.79 a	50.50 a	55.13 a
January	24.30 d	25.50 d	17.39 d	16.14 d
April	28.27 c	50.56 c	21.01 c	30.02 c
$LSD_{(p\geq 0.05)}$	2.280	1.820	1.929	2.286
CV%	3.29	3.54	2.17	3.69

Each data represents the mean value of three nurseries.

4.3.1.3. Incidence and severity of anthracnose of mango during July, 2010 to April, 2012 of different experimental locations of Bangladesh.

Incidence of anthracnose of mango varied significantly from season to season as well as location to location and that ranged from 21.33- 65.33% in 2010-2011 and 24.00-71.33% in 2011-2012 (Table 4). The highest (65.33%) and (71.33%) incidence of Anthracnose of mango recorded in the month of October, 2010 and October, 2011 at Dhaka and Khagrachori respectively. The lowest (21.33%) and (24.00%) incidence was observed in the month of January, for both the years at Barisal and Gazipur respectively. The severity of anthracnose of mango also varied significantly from season to season as well as location to location and that ranged from15.80-54.67% in 2010-2011 and 13.16-60.08% in 2011-2012. The highest (54.67 %) and (60.08%) severity of anthracnose of mango observed in the month of October, 2010 and October, 2011 at Dhaka while the lowest (15.80%) and (13.16%) was recorded in the month of January, 2011 at Barisal and January, 2012 at Gazipur respectively.

Table 4. Incidence and severity of anthracnose of mango during July, 2010 to April, 2012 of different experimental locations of Bangladesh .

Location	Recording time(month)	Anthracnose			
		Incidence(%)		Severity(%)	
		July, 2010-April, 2011	July, 2011-April, 2012	July, 2010-April, 2011	July, 2011-April, 2012
Dhaka.	July	49.67 e	58.23 e	31.00 d	47.45 cd
	October	65.33 a	71.33 a	54.67 a	60.08 a
	January	24.00 jk	25.33 k	18.00 g	17.33 i
	April	29.07 gh	53.53 g	21.27 f	31.40 g
Barisal	July	42.43 f	55.56 f	27.73 e	44.63 e
	October	59.27 c	65.40 c	50.27 b	52.40 b
	January	21.33 l	25.00 k	15.80 h	15.87 i
	April	27.32 hi	49.00 h	20.47 f	29.29 g
Gazipur	July	51.37 e	50.78 h	55.45 a	43.81 e
	October	54.33 d	62.00 d	45.33 c	49.73 c
	January	21.75 kl	24.00 k	17.90 g	13.16 j
	April	25.89 ij	45.73 i	20.33 f	25.13 h
Khagrachari	July	63.33 ab	59.84 e	47.07 c	47.21 d
	October	62.20 b	68.45 b	51.73 b	58.33 a
	January	30.13 g	27.67 j	17.87 g	18.20 i
	April	30.80 g	53.97 fg	22.00 f	34.25 f
$LSD_{(p\geq 0.05)}$		2.280	1.820	1.929	2.286
CV(%)		3.29	3.54	2.17	3.69

Each data represents the mean value of three nurseries.

4.3.1.4. Effect of different weather factors on the incidence and severity of anthracnose of mango seedling during July, 2010 to April, 2011

In different growing seasons of mango seedlings, the highest incidence (60.28%) and (66.79%) and the highest severity (50.5%) and (55.13%) of anthracnose disease were recorded in October, for both the years ;(Fig.1 and 2), when average temperature, relative humidity and rainfall were 28.63°C, 80.2% and 7.13cm, and 29.5°C, 81.50%, 5.95cm, respectively. On the other hand, lowest incidence (24.3%) and (25.5%) and the lowest severity (17.39%) and (16.14%) were recorded in January, for both the years ; having average temperature, relative humidity and rainfall 16.88°C, 73.80% and 0.52cm, and 18.46°C, 76%, 0.60cm, respectively (Fig.1&2).

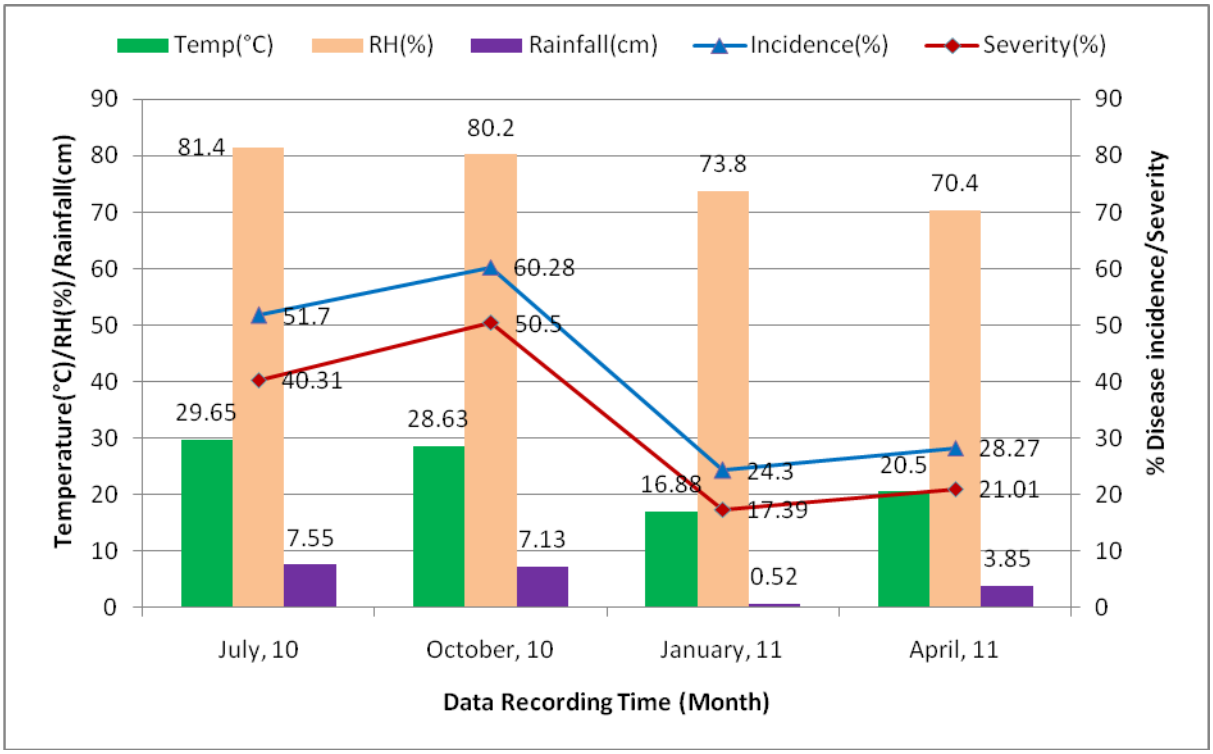


Figure 1. Effect of different weather factors on the incidence and severity of anthracnose of mango seedling during July, 2010 to April, 2011

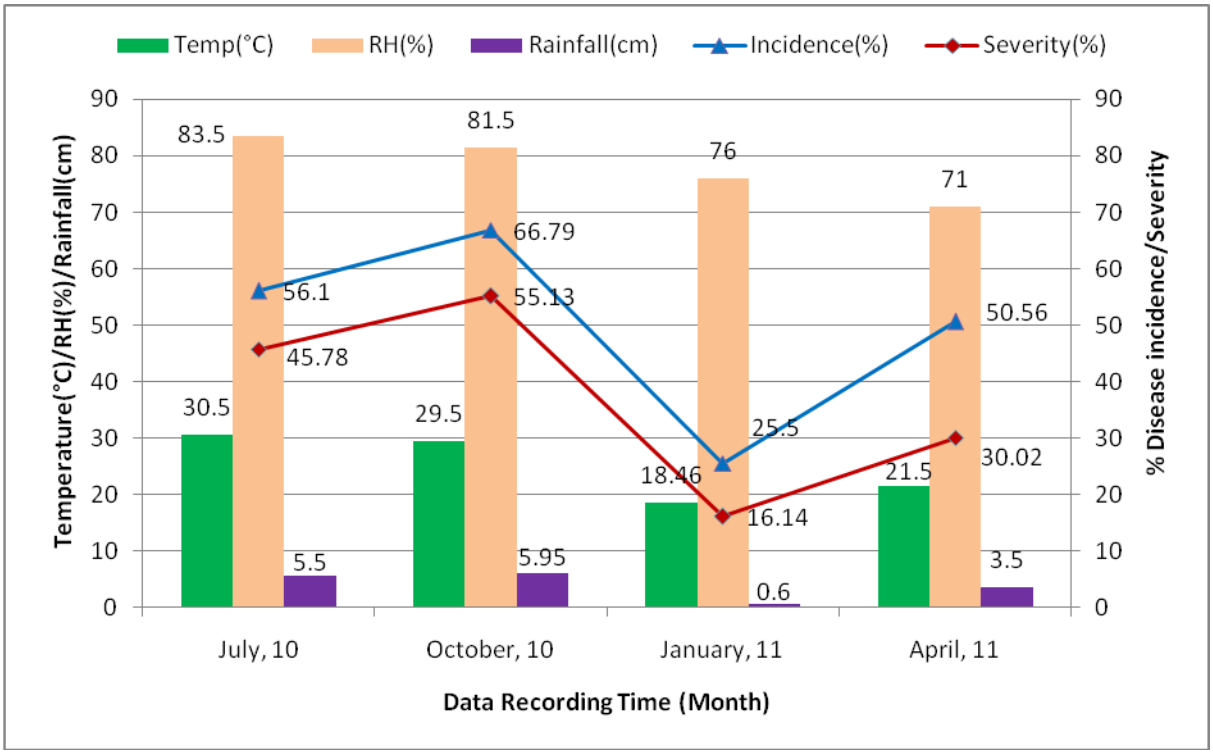


Figure 2. Effect of different weather factors on the incidence and severity of Anthracnose of mango seedling during July, 2011 to April, 2012

4.4.1.5a. Relation between anthracnose disease incidence as well as severity of mango seedlings and temperature.

A significant negative correlation between anthracnose disease incidence as well as severity and temperature were observed for both the years (Fig.3 and 4). The relationship between disease incidence and temperature could be expressed by the equation Y = 2.693x - 23.28, (R^2 = 0.910) and Y = 2.533x - 13.58, (R^2= 0.736), where x=temperature and y=disease incidence. Here, the R^2 value indicates that the contribution of temperature to the incidence of anthracnose of mango. On the other hand, the relationship between disease severity and temperature could be expressed by the equation Y = 2.366x - 24.29 (R^2=0.874), and Y= 2.755x - 32.08 (R^2 = 0.900), where x=temperature and y=disease severity. Here, the R^2 value indicates the contribution of temperature to the severity of anthracnose of mango.

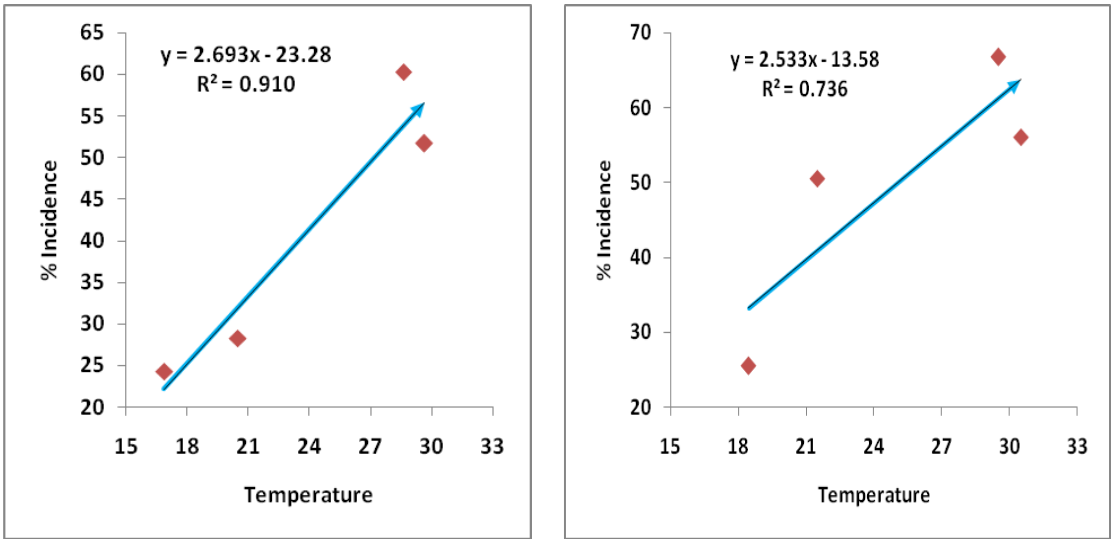


Figure 3. Linear regression analysis of the effect of temperature on incidence of anthracnose of mango during July, 2010 to April, 2012

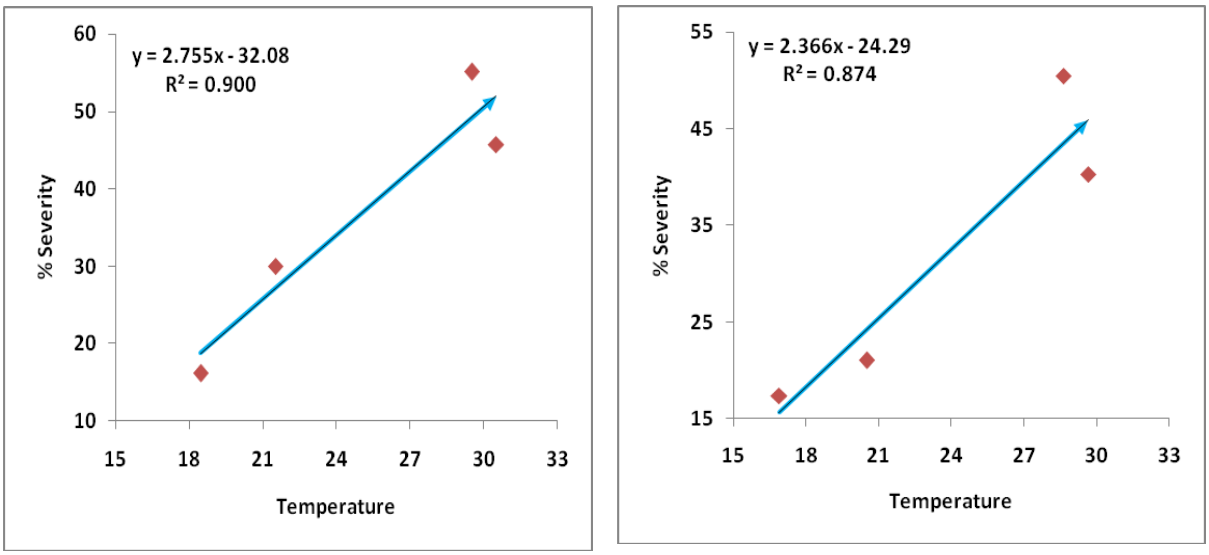


Figure 4. Linear regression analysis of the effect of temperature on severity of anthracnose of mango during July, 2010 to April, 2012

4.4.1.5b. Relation between anthracnose disease incidence as well as severity of mango seedlings and relative humidity.

A significant negative correlation between anthracnose disease incidence as well as severity and relative humidity were observed for both the years (Fig.5 and 6). The relationship between disease incidence and relative humidity could be expressed by the equation Y= 2.999x - 188.1, (R^2 = 0.797) and Y= 1.438x - 62.48,

(R^2=0.215), where x= relative humidity and y=disease incidence. Here, the R^2 value indicates that the contribution of relative humidity to the incidence of anthracnose of mango. On the other hand, the relationship between disease severity and relative humidity could be expressed by the equation Y = 2.624x - 168.3, (R^2=0.759) and Y= 2.118x - 128.4, (R^2 = 0.481), where x= relative humidity and y=disease severity. Here, the R^2 value indicates that the contribution of relative humidity to the severity of anthracnose of mango.

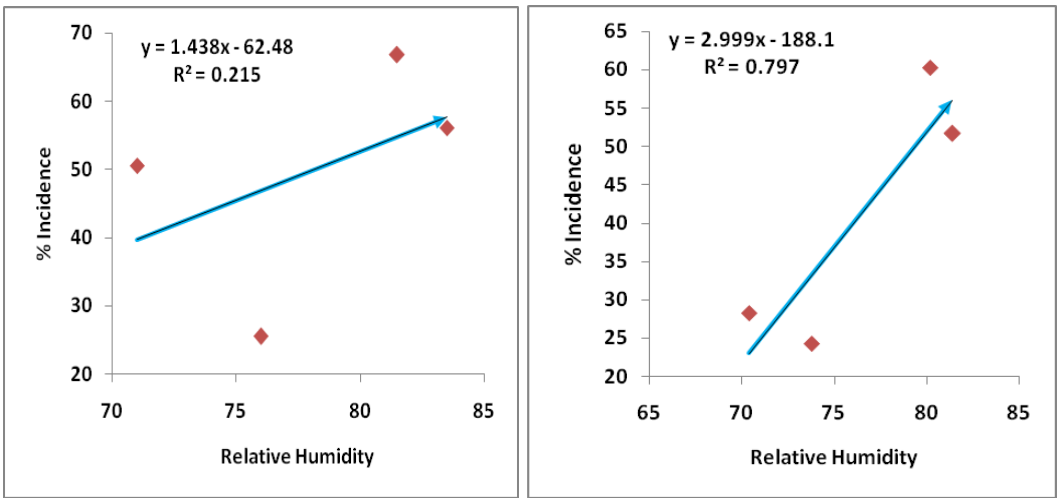


Figure 5. Linear regression analysis of the effect of relative humidity on incidence of anthracnose of mango during July, 2010 to April, 2012

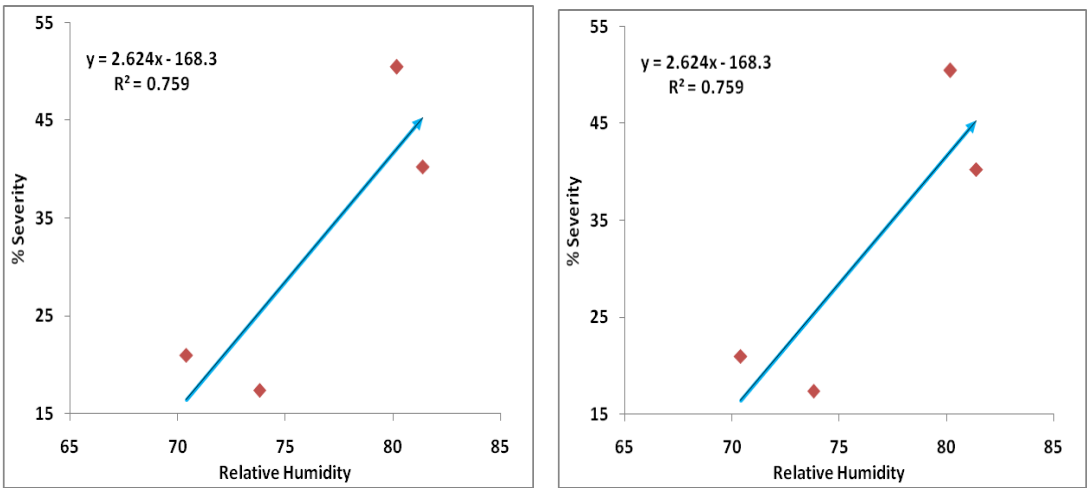


Figure 6. Linear regression analysis of the effect of relative humidity on severity of anthracnose of mango during July, 2010 to April, 2012

4.4.1.5c. Relation between anthracnose disease incidence as well as severity Of mango seedlings and rainfall.

A significant positive correlation between anthracnose disease incidence as well as severity and rainfall were observed for both the years (Fig.7 and 8). The relationship between disease incidence and rainfall could be expressed by the equation Y= 4.903x + 17.78, (R^2 =0.835) and Y=7.006x + 22.50, (R^2=0.951), where x= rainfall and y=disease incidence. Here, the R^2 value indicates that the contribution of rainfall to the incidence of anthracnose of mango. On the other hand, the relationship between disease severity and rainfall could be expressed by the equation Y = 4.315x + 11.75, (R^2=0.804) and Y= 6.896x + 9.958, (R^2 = 0.952), where x= rainfall and y=disease severity. Here, the R^2 value indicates that the contribution of rainfall to the severity of anthracnose of mango.

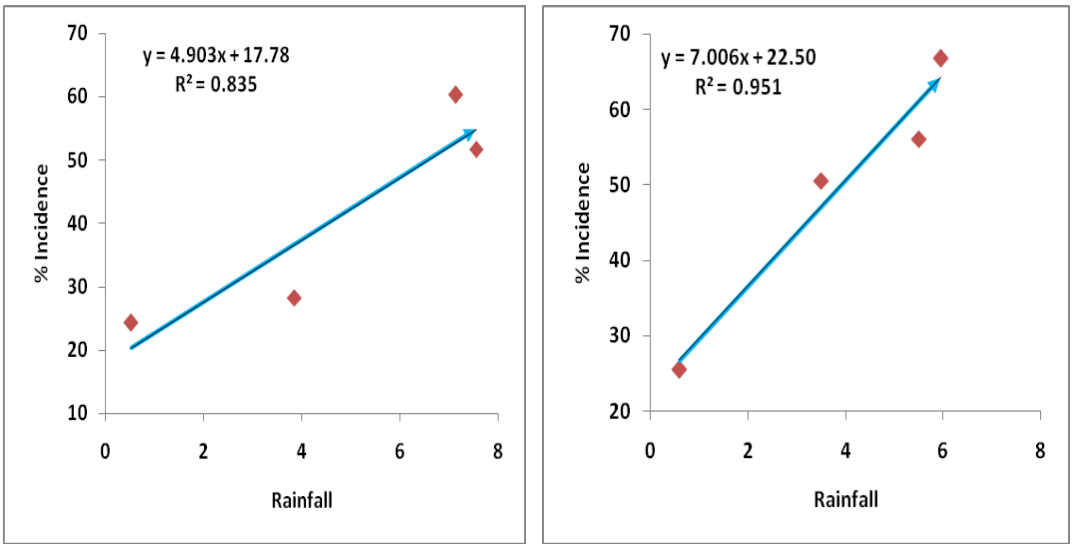


Figure 7. Linear regression analysis of the effect of rainfall on incidence of anthracnose of mango during July, 2010 to April, 2012

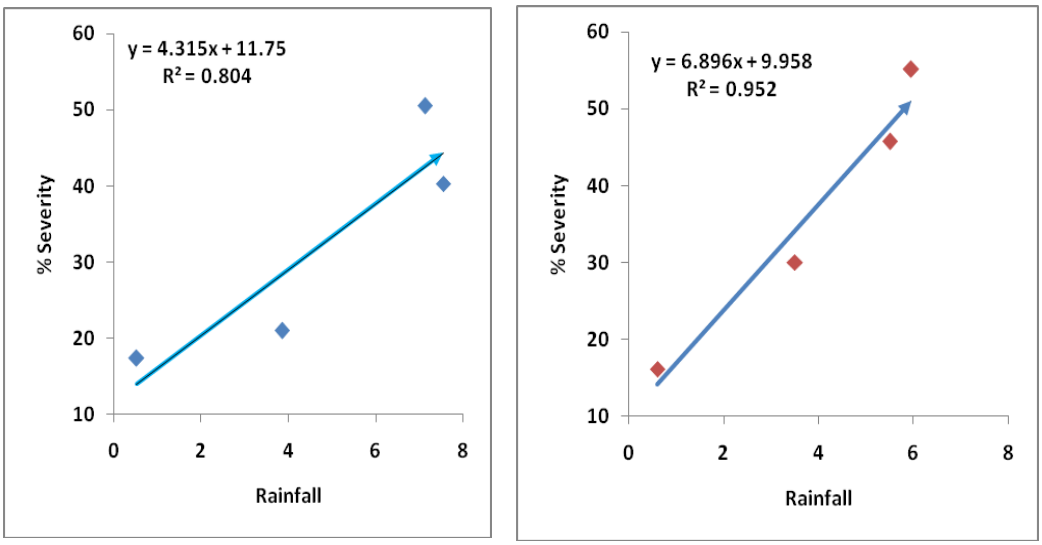


Figure 8. Linear regression analysis of the effect of rainfall on severity of anthracnose of mango during July, 2010 to April, 2012

4.3.2.1. Incidence and severity of leaf spot of mango at different locations of Bangladesh from July, 2010 to April, 2012

Incidence of leaf spot of mango varied from location to location and year to year that ranged from 39.71% -46.13 in 2010-2011 and 41.31% -49.95 in 2011-2012 (Table 5). The highest incidence was recorded at Khagrachari and the lowest was recorded at Gazipur in both the years. The severity of leaf spot of mango also varied from location to location and year to year that ranged from 31.95%-36.45 in 2010-2011 and 35.19% -38.89 in 2011-2012. The highest severity was recorded at Khagrachari in 2010-2011and Dhaka in 2011-2012, and the lowest was recorded at Gazipur and Barisal in both the years.

Table 5. Incidence and severity of leaf spot of mango at different locations of Bangladesh from July, 2010 to April, 2012

Location	leaf spot of mango			
	Incidence (%)		Severity (%)	
	2010-2011	2011-2012	2010-2011	2011-2012
Dhaka	43.16 ab	47.59 a	35.54 a	38.89 a
Barisal	40.55 b	44.10 ab	34.28 a	36.13 a
Gazipur	39.71 b	41.31 b	31.95 a	35.19 a
Khagrachari	46.13 a	49.95 a	36.45 a	38.42 a
$LSD_{(p\geq0.05)}$	4.408	5.742	6.061	6.153
CV%	2.38	1.61	1.64	2.86

Each data represents the mean value of three nurseries

4.3.2.2. Incidence and severity of leaf spot of mango during July, 2010 to April, 2012.

Incidence of leaf spot of mango varied from July, 2010 to April, 2012 and that ranged from 26.76-62.40% in 2010-2011 and 31.28- 65.84% in 2011-2012 (Table 6). The highest incidence was recorded in October for both the years. And the lowest was recorded in month of January, for both the years. The severity of leaf spot of mango also varied from year to year that ranged from 19.12-54.72% in 2010-2011 and 21.81-56.21% in 2011-2012. The highest severity was recorded in October, for both the years. And the lowest was recorded in April in 2010-2011and in January in 2011-2012.

Table 6. Incidence and severity of leaf spot of mango during July, 2010 to April, 2012

Time of data collection	leaf spot			
	Incidence (%)		Severity (%)	
	2010-2011	2011-2012	2010-2011	2011-2012
July	49.58 b	53.80 b	44.48 b	48.66 b
October	62.40 a	65.84 a	54.72 a	56.21 a
January	26.76 d	31.28 c	19.90 c	21.81 c
April	30.82 c	32.03 c	19.12 c	21.95 c
$LSD_{(p\geq0.05)}$	1.698	1.266	0.9398	1.788
CV%	2.38	1.61	1.64	2.86

Each data represents the mean value of three nurseries

4.3.2.3. Incidence and severity of leaf spot of mango during July, 2010 to April, 2012 of different experimental locations of Bangladesh

Incidence of leaf spot of mango varied significantly from season to season as well as location to location and that ranged from24.50-68.50% in 2010-2011 and 28.17-70.37% in 2011-2012 (Table 7). The highest (68.50%) and (70.37%) incidence of leaf spot of mango recorded in the month of October, at Kkahagrachari in 2010-2011 and at Dhaka in 2011-2012 respectively. The lowest (24.50%) and (28.17%) incidence was observed in the month of January, 2010-2011 at Barisal and January, 2011-2012 at Gazipur respectively. The severity of leaf spot of mango also varied significantly from season to season as well as location to location and that ranged from 17.22-56.40% in 2010-2011 and 20.39-61.08% in 2011-2012. The highest (56.40%) and (61.08%) severity of leaf spot of mango observed in the month of October, at Kkahagrachari in 2010-2011 and at Dhaka in 2011-2012 respectively, while the lowest (17.22%) and (20.39%) was recorded in the month of April, 2010-2011 at Gazipur and January, 2011-2012 in Gazipur.

Table 7. Incidence and severity of leaf spot of mango during July, 2010 to April, 2012 of different experimental locations of Ba ngladesh.

Location	Data recording time(month)	Leaf spot			
		Incidence(%)		Severity(%)	
		2010-2011	2011-2012	2010-2011	2011-2012
Dhaka.	July	50.00 e	56.05 e	45.00 e	49.00 d
	October	62.78 b	70.37 a	56.33 a	61.08 a
	January	27.50 i	31.17 j	20.44 h	23.04 f
	April	32.37 g	32.78 i	20.40 h	22.43fgh
Barisal	July	47.83 f	50.83 f	44.43 e	46.81 e
	October	59.83 c	65.11 c	54.37 b	55.96 c
	January	24.50 j	30.00 j	19.03 i	21.03 ghi
	April	30.04 h	30.44 j	19.30 i	20.70 hi
Gazipur	July	47.33 f	49.37 g	41.50 f	50.17 d
	October	58.50 c	59.33 d	51.77 c	49.71 d
	January	25.17 j	28.17 k	17.30 j	20.39 i
	April	27.83 i	28.37 k	17.22 j	20.50 hi
Khagrachari	July	53.13 d	58.96 d	47.00 d	48.65 d
	October	68.50 a	68.54 b	56.40 a	58.11 b
	January	29.87 h	35.77 h	22.83 g	22.77 fg
	April	33.03 g	36.52 h	19.56 hi	24.17 f
$LSD_{(p\geq 0.05)}$		1.698	1.266	0.9398	1.788
CV(%)		2.38	1.61	1.64	2.86

Each data represents the mean value of three nurseries.

4.4.2.4. Effect of weather components on the incidence and severity of leaf spot disease of mango seedling

In different growing seasons of mango seedlings, the highest incidence (62.40%) and (65.84%) and the highest severity (54.72%) and (56.21%) of leaf spot disease were recorded in October for both years (Fig 9 and 10), when average temperature, relative humidity and rainfall were 28.63°C, 80.2% and 7.13cm, and 29.50°C, 81.50%, 5.95cm, respectively. On the other hand, lowest incidence (26.76%) and (31.28%) and the lowest severity (19.12%) and (21.81%) were recorded in April 11 and January 11; having average temperature, relative humidity and rainfall 20.50°C, 70.40% and 3.85cm, and 21.50°C, 71.00%, 3.50cm, respectively (Fig. 9&10).

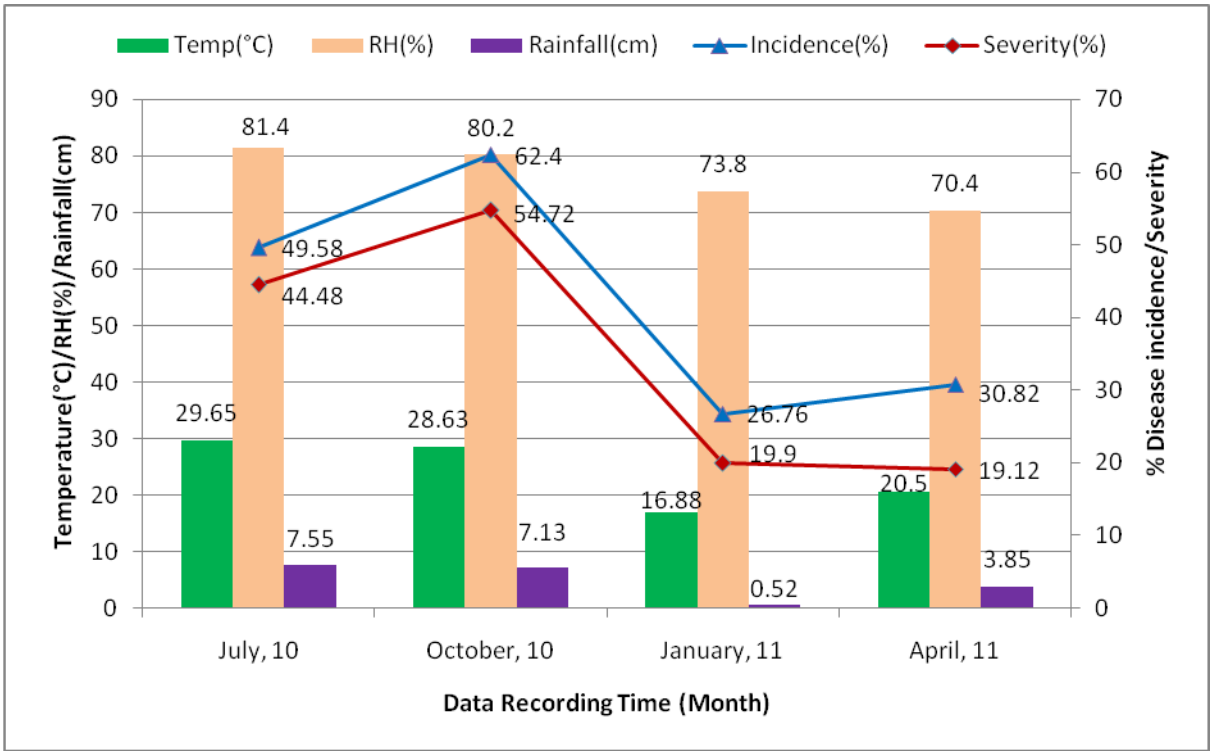


Figure 9. Effect of different weather factors on the incidence and severity of leaf spot of mango seedling during July, 2010 to April, 2011

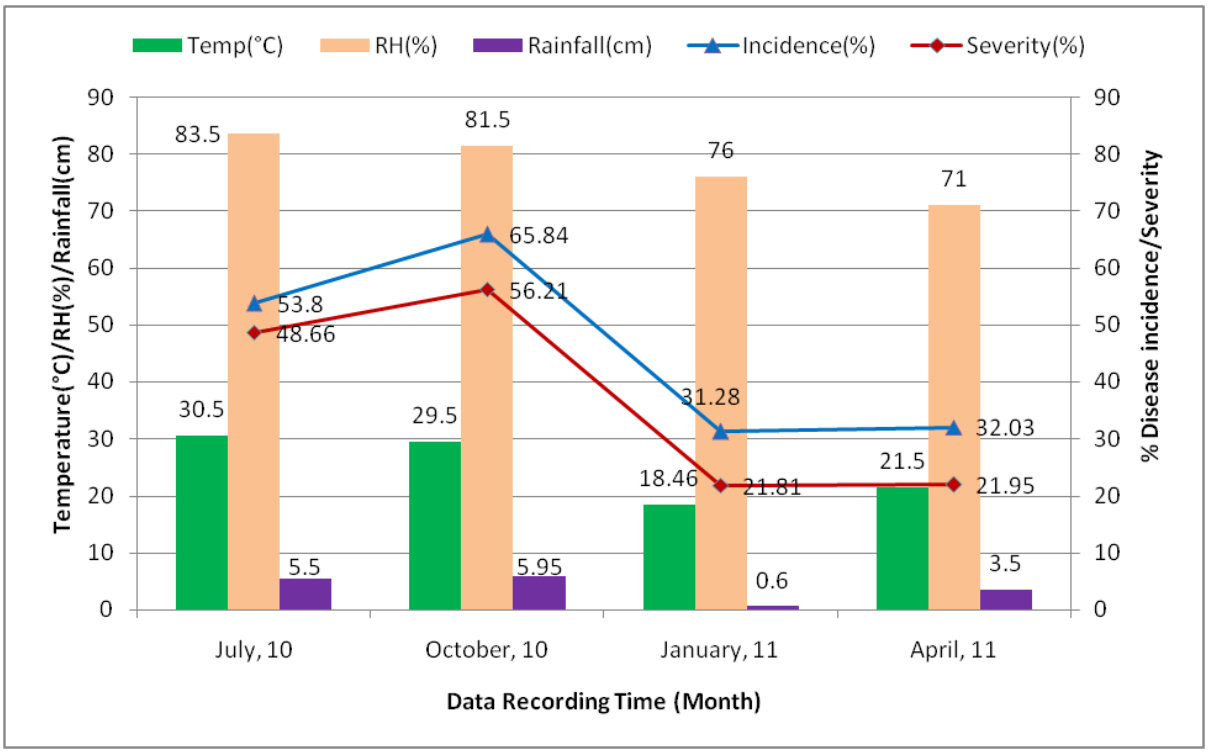


Figure 10. Effect of different weather factors on the incidence and severity of leaf spot of mango seedling during July, 2011 to April, 2012

4.3.2.5a. Relation between Leaf spot disease incidence as well as severity of mango seedlings and temperature.

A significant positive correlation between leaf spot disease incidence as well as severity and temperature were observed for both the years (Fig 11 and 12). The relationship between disease incidence and temperature could be expressed by the equation Y=2.451x - 16.23, (R^2 = 0.841) and Y= 2.628x - 19.94, (R^2=0.841), where x=temperature and y=disease incidence. Here, the R^2 value indicates that the contribution of temperature to the incidence of leaf spot of mango. On the other hand, the relationship between disease severity and temperature could be expressed by the equation Y = 2.647x - 28.75, (R^2=0.850), and Y= 2.867x - 34.50, (R^2 = 0.901), where x=temperature and y=disease severity. Here, the R^2 value indicates that the contribution of temperature to the severity of leaf spot of mango.

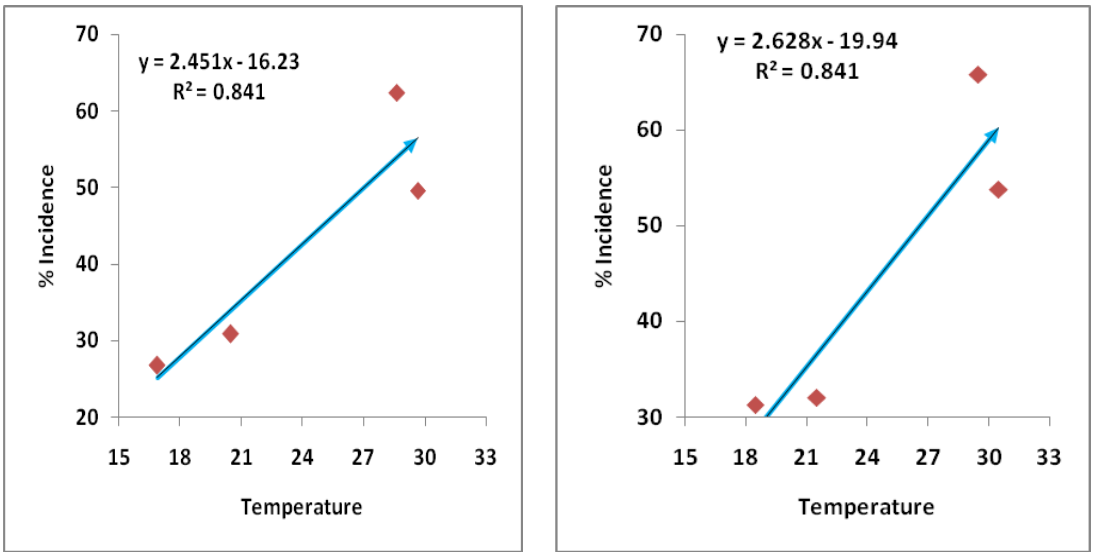


Figure 11. Linear regression analysis of the effect of temperature on incidence of leaf spot of mango during July, 2010 to April, 2012

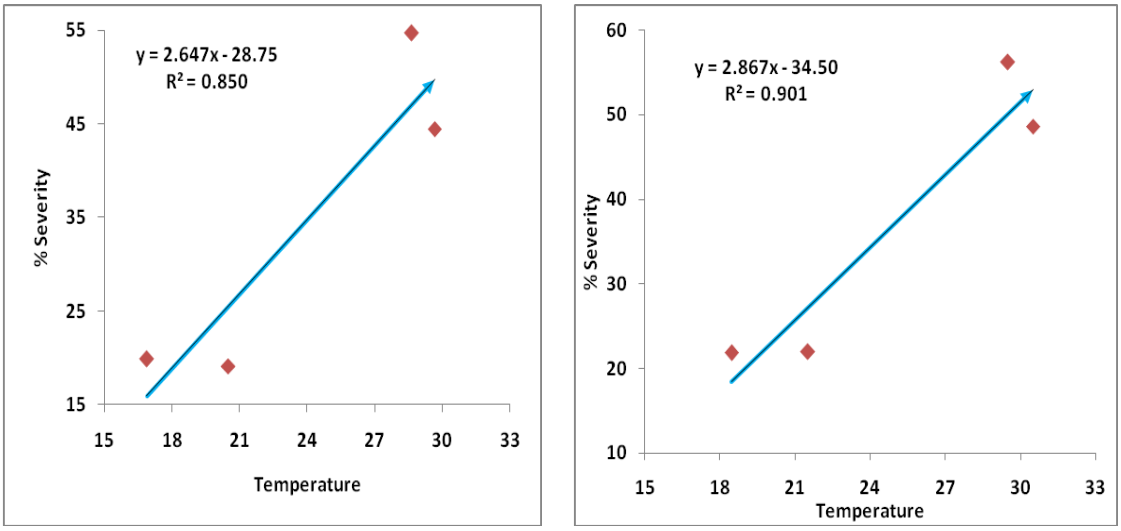


Figure 12. Linear regression analysis of the effect of temperature on severity of leaf spot of mango during July, 2010 to April, 2012

4.3.2.5b. Relation between leaf spot disease incidence as well as severity of mango seedlings and relative humidity

A significant positive correlation between leaf spot disease incidence as well as severity and relative humidity were observed for both the years (Fig 13 and 14). The relationship between disease incidence and relative humidity could be expressed by the equation Y= 2.701x - 164.1, (R^2 = 0.722) and Y= 2.508x - 149.9, (R^2=0.694), where x= relative humidity and y=disease incidence. Here, the R^2 value indicates that the contribution of relative humidity to the incidence of leaf spot of mango. On the other hand, the relationship between disease severity and relative humidity could be expressed by the equation Y = 3.126x - 204.4, (R^2=0.838), and Y= 2.796x - 180.9, (R^2 = 0.776), where x= relative humidity and y=disease severity. Here, the R^2 value indicates that the contribution of relative humidity to the severity of leaf spot of mango.

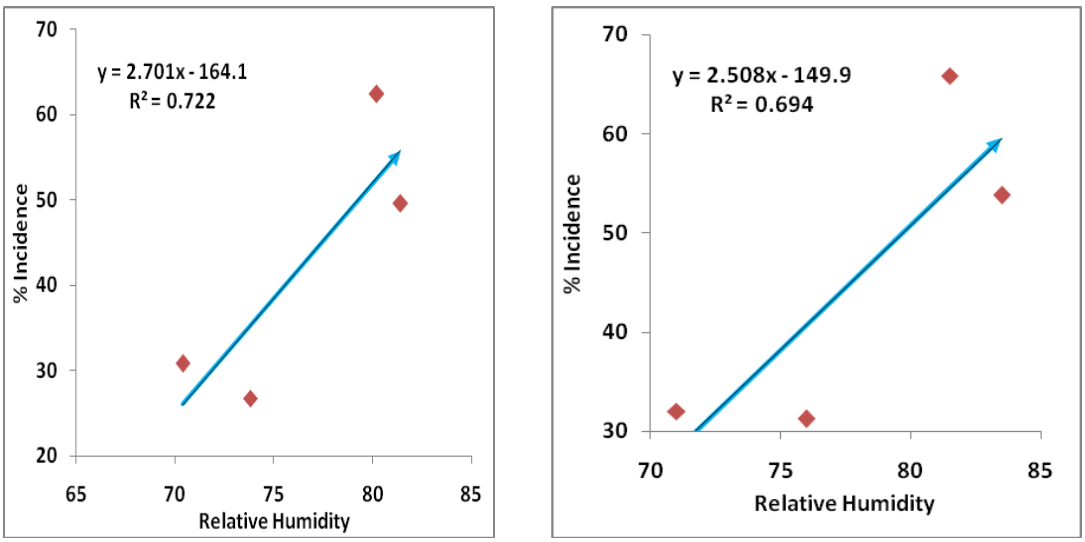


Figure 13. Linear regression analysis of the effect of relative humidity on incidence of leaf spot of mango during July, 2010 to April, 2012

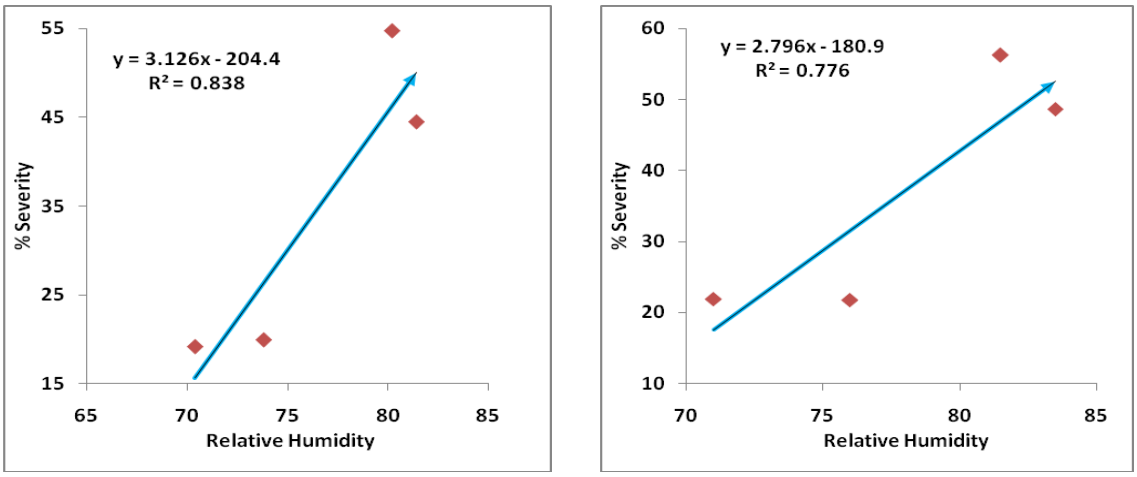


Figure 14. Linear regression analysis of the effect of relative humidity on severity of leaf spot of mango during July, 2010 to April, 2012

4.3.2.5c. Relation between leaf spot disease incidence as well as severity of mango seedlings and rainfall.

A significant positive correlation between leaf spot disease incidence as well as severity and rainfall were observed for both the years (Fig 15 and 16). The relationship between disease incidence and rainfall could be expressed by the equation Y= 4.479x + 21.05, (R^2 = 0.778) and Y= 6.024x + 22.31, (R^2=0.746), where x= rainfall and y=disease incidence. Here, the R^2 value indicates that the contribution of rainfall to the incidence of leaf spot of mango. On the other hand, the relationship between disease severity and rainfall could be expressed by the equation Y = 4.709x + 12.12, (R^2=0.745), and Y= 6.411x + 12.23, (R^2 = 0.760), where x= rainfall and y=disease severity. Here, the R^2 value indicates that the contribution of rainfall to the severity of leaf spot of mango.

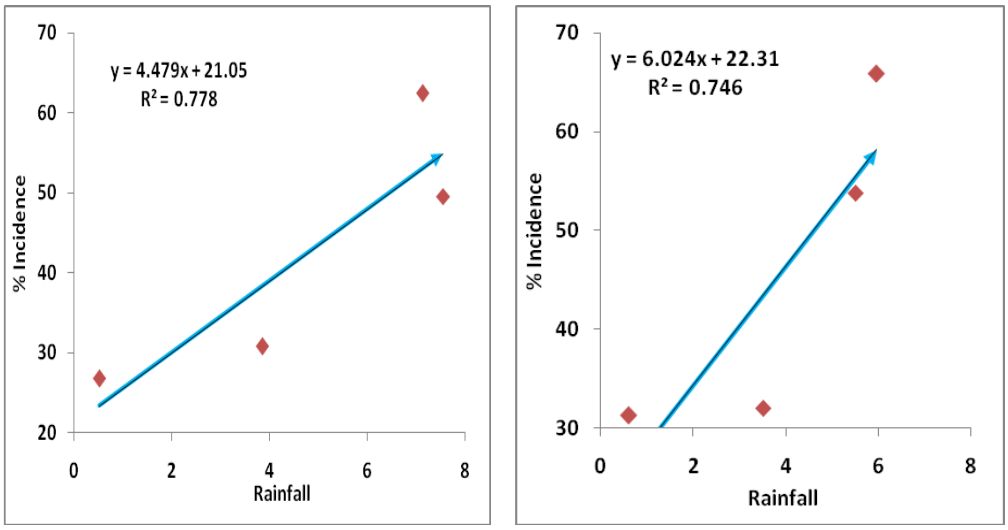


Figure 15. Linear regression analysis of the effect of rainfall on incidence of leaf spot of mango during July, 2010 to April, 2012

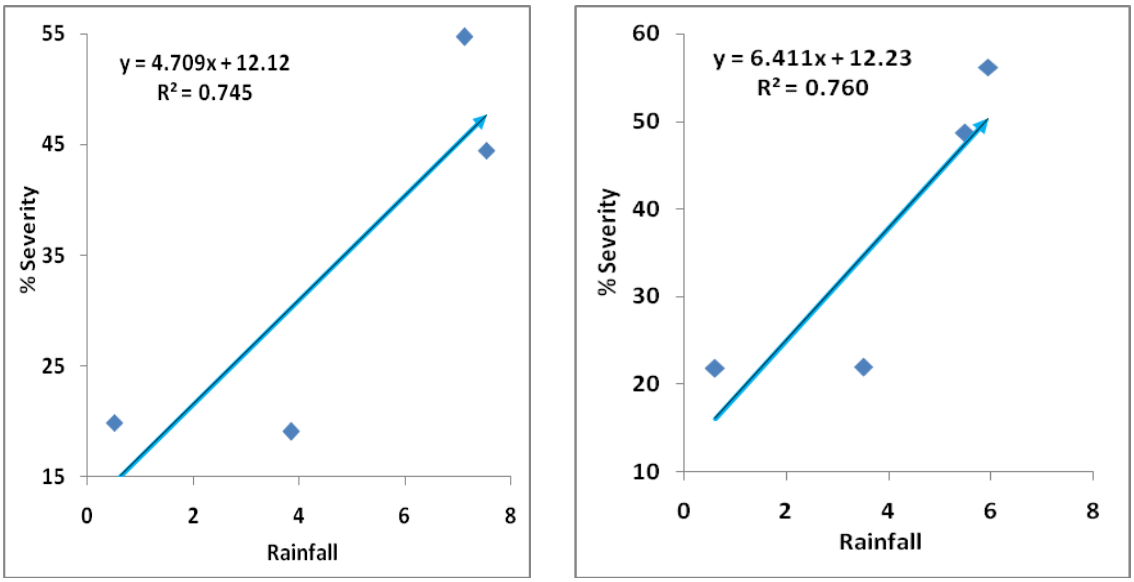


Figure 16. Linear regression analysis of the effect of rainfall on severity of leaf spot of mango during July, 2010 to April, 2012

4.3.3.1. Incidence and severity of sooty mould of mango at different locations of Bangladesh from July, 2010 to April, 2012

Incidence of sooty mould of mango varied from location to location and year to year that ranged from 11.80-14.39% in 2010-2011 and 13.77-17.24% in 2011-2012 (Table 8). The highest incidence (14.39%) was recorded at Dhaka in both years. The lowest incidence was recorded at Gazipur in both the years. The severity of sooty mould of mango also varied from location to location and year to year that ranged from 8.458-10.68% in 2010-2011 and 9.447-12.58% in 2011-2012. The highest severity (10.68 %) was recorded at Dhaka in 2010-2011 and (12.58%) at Khagrachari in 2011-2012. The lowest severity was recorded at Barisal in 2010-2011 and Gazipur in 2011-2012.

Table 8. Incidence and severity of sooty mould of mango at different locations of Bangladesh from July, 2010 to April, 2012

Location	Sooty mould			
	Incidence (%)		Severity (%)	
	2010-2011	2011-2012	2010-2011	2011-2012
Dhaka	13.52 a	17.24 a	10.68 a	11.25 a
Barisal	11.80 a	16.05 a	8.458 a	11.32 a
Gazipur	11.90 a	13.77 a	9.071 a	9.447 a
Khagrachari	14.39 a	18.89 a	9.574 a	12.58 a
$LSD_{(p\geq 0.05)}$	7.386	9.244	4.294	8.642
CV%	6.94	9.83	4.90	4.72

Each data represents the mean value of three nurseries

4.3.3.2. Incidence and severity of sooty mould of mango during July, 2010 to April, 2012 in Bangladesh

Incidence of sooty mould of mango varied significantly from July, 2011 to April, 2012 and that ranged from 9.413-18.90% in 2010-2011 and 13.57-24.18% in 2011-2012 (Table 9). The highest incidence (18.90%) and (24.18%) was recorded in January, for both the years. and the lowest (9.413%) in July in 2010-2011 and (13.57%) in October in 2011-2012. The severity of sooty mould of mango, varied significantly from July, 2011 to April, 2012 and that ranged from 7.467-11.14% in 2010-2011 and 10.32-12.08% in 2011-2012. The highest severity (11.14%) in April and (12.08%) in January was recorded for both the years. and the lowest (7.467%) in July in 2010-2011 and (10.32%) in October in 2011-2012.

Table 9. Incidence and severity of sooty mould of mango during July, 2010 to April, 2012 in Bangladesh

Time of data collection	Sooty mould			
	Incidence (%)		Severity (%)	
	2010-2011	2011-2012	2010-2011	2011-2012
July	9.413 c	13.80 b	7.467 b	11.40 ab
October	10.40 c	13.57 b	8.350 b	10.32 c
January	18.90 a	24.18 a	10.83 a	12.08 a
April	12.90 b	14.40 b	11.14 a	10.78 bc
$LSD_{(p\geq0.05)}$	1.508	1.363	1.565	0.8853
CV%	6.94	9.83	4.90	4.72

Each data represents the mean value of three nurseries.

4.3.3.3. Incidence and severity of sooty mould of mango during July, 2010 to April, 2012 of different experimental locations of Bangladesh .

Incidence of sooty mould of mango varied significantly from season to season as well as location to location and that ranged from7.833-20.78% in 2010-2011 and 11.50-28.43% in 2011-2012 (Table10.). The highest incidence (20.78%) and (28.43%) was recorded in the month of January, at Khagrachari for both years. The lowest incidence (7.833%) in July at Barisal and (11.50%) was observed in the month of April, at Gazipur, respectively. The severity of sooty mould of mango also varied significantly from season to season as well as location to location and that ranged from 6.167-13.33% in 2010-2011 and 7.293-14.18% in 2011-2012. The highest severity (13.33%) and (14.18%) was observed in the month of April, 2010-2011 at Dhaka and January, 2011-2012 at Khagrachari. while the lowest (6.167%) and (7.293%) was recorded in the month of July, 2010-2011 at Gazipur and April, 2011-2012 at Gazipur respectively.

Table 10. Incidence and severity of sooty mould of mango during July, 20 to April, 2012 of different experimental locations of Bangladesh .

Location	Data recording time(month)	Sooty mould of mango			
		Incidence(%)		Severity(%)	
		2010-2011	2011-2012	2010-2011	2011-2012
Dhaka.	July	11.33 de	13.55 hi	8.733 de	10.33 ef
	October	10.33 ef	14.33 gh	9.000 de	9.667 f
	January	19.67 a	25.91 b	11.67 bc	12.33 bc
	April	12.77 d	15.17 fg	13.33 a	12.67 b
Barisal	July	7.833 h	13.41 hi	6.400 fg	11.44 cd
	October	9.70 efg	13.66 hi	7.767 efg	10.70 de
	January	17.50 b	23.50 c	8.633 de	12.18 bc
	April	12.17 d	13.63 hi	11.03 c	10.93 de
Gazipur	July	8.410 gh	12.33 ij	6.167 g	11.37 cd
	October	9.500 fg	12.37 ij	8.00 ef	9.50 f
	January	17.67 b	18.90 d	12.97 ab	9.623 f
	April	12.04 d	11.50 j	9.15 de	7.293 g
Khagrachari	July	10.08 ef	15.89 f	8.567 de	12.47 b
	October	12.07 d	13.92 gh	8.633 de	11.42 cd
	January	20.78 a	28.43 a	10.06 cd	14.18 a
	April	14.63 c	17.30 e	11.03 c	12.23 bc
$LSD_{(p\geq 0.05)}$		1.508	1.363	1.565	0.8853
CV(%)		6.94	9.83	4.90	4.72

Each data represents the mean value of three nurseries.

4.3.3.4. Effect of weather components on the incidence and severity of sooty mould of mango seedling during July, 20 to April, 2012

In different growing seasons of mango seedlings, the highest incidence (18.90%) and (24.18%) and the highest severity (11.14%) and (12.08%) of Sooty mould disease were recorded in January, for both the years;Fig (17 and 18),when average temperature, relative humidity and rainfall were 16.88°C, 73.80% and 0.52cm, and 18.46°C, 76%, 0.6cm, respectively. On the other hand, lowest incidence (9.413%) and (13.57%) and the lowest severity (7.467%) and (10.32%) were recorded in July in 2010-2011 and in October in 2011-2012; having average temperature, relative humidity and rainfall 29.65°C, 81.40% and 7.55cm, and 29.50°C, 81.50%, 5.95cm, respectively (Fig.17&18).

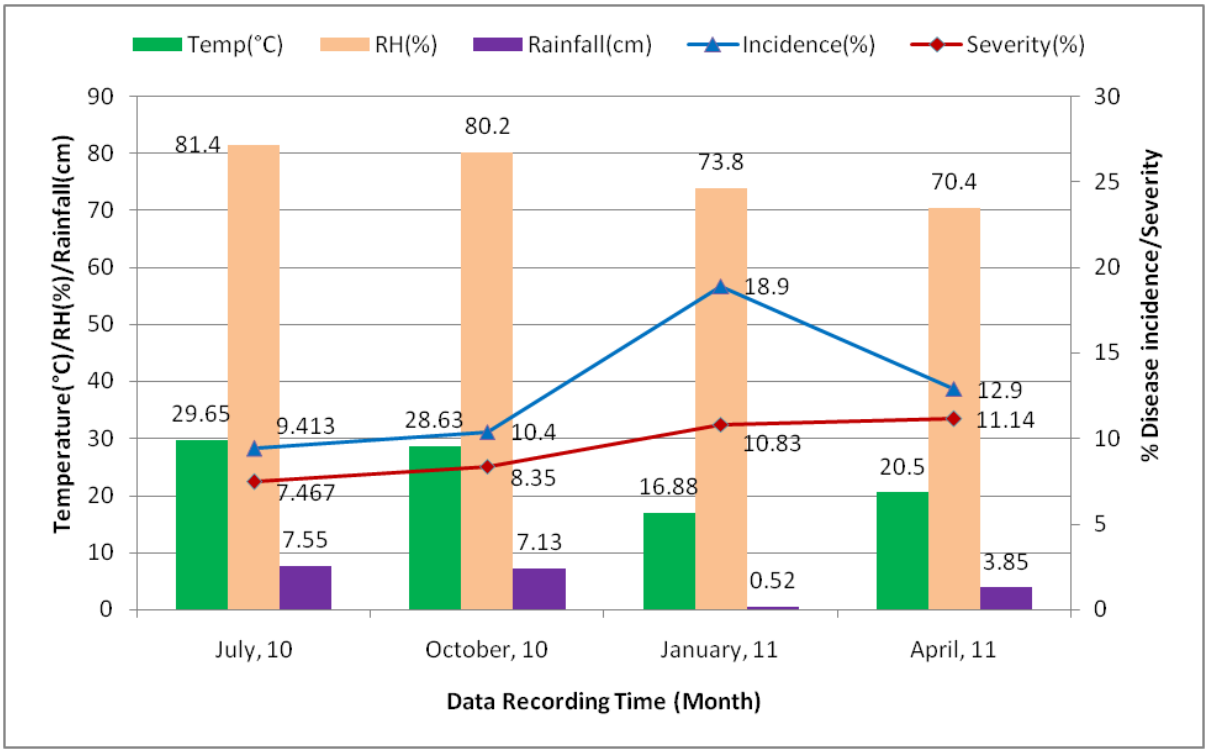


Figure 17. Effect of different weather factors on the incidence and severity of sooty mould of mango seedlings during July, 2010 to April, 2011

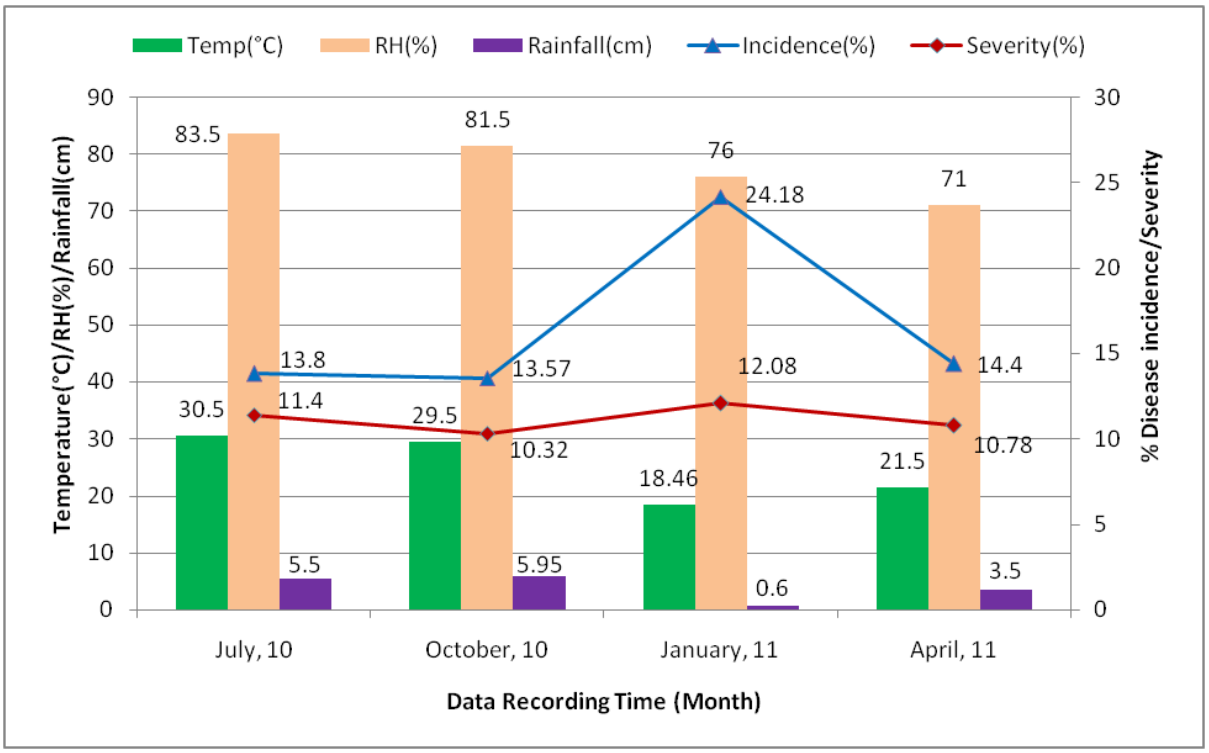
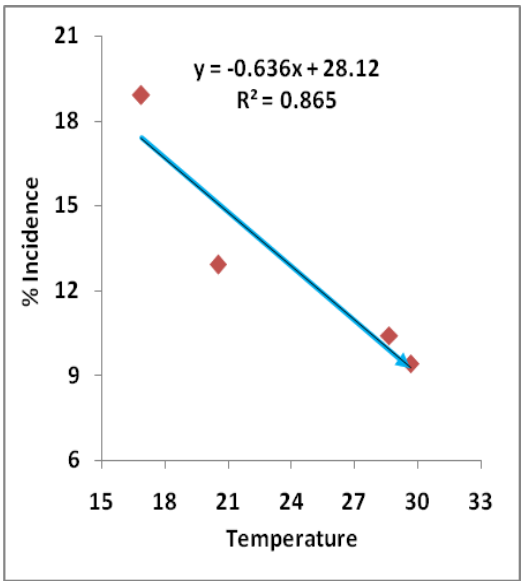


Figure 18. Effect of different weather factors on the incidence and severity of Sooty mould of Mango seedling during July, 2011 to April, 2012

4.3.3.5a. Relation between sooty mould disease incidence as well as severity of mango seedlings and temperature.

A significant negative correlation between sooty mould disease incidence as well as severity and temperature were observed for both the years, Fig (19and20). The relationship between disease incidence and temperature could be expressed by the equation Y= -0.636x + 28.12, (R^2 = 0.865) and Y= -0.672x + 33.28, (R^2=0.601), where x=temperature and y=disease incidence. Here, the R^2 value indicates that the contribution of temperature to the incidence of sooty mould of mango. On the other hand, the relationship between disease severity and temperature could be expressed by the equation Y = -0.275x + 16.03, (R^2=0.891), and Y= -0.067x + 12.83, (R^2 = 0.276), where x=temperature and y=disease severity. Here, the R^2 value indicates that the contribution of temperature to the severity of sooty mould of mango.



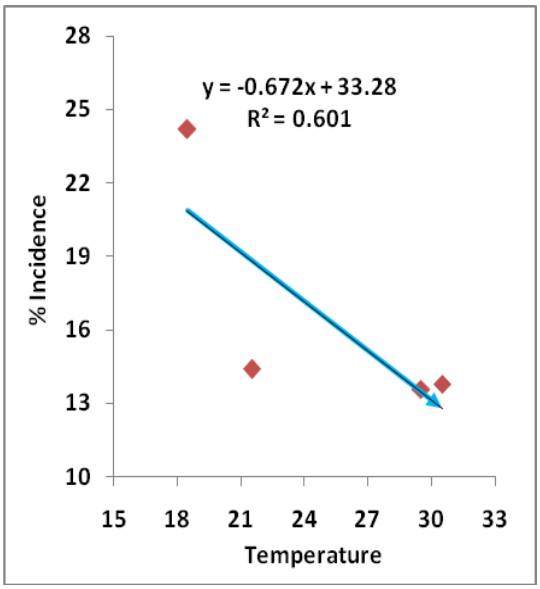
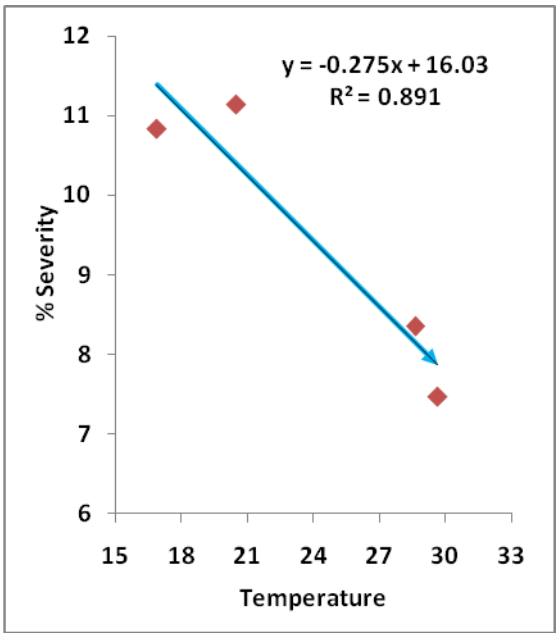


Figure 19. Linear regression analysis of the effect of temperature on incidence of sooty mould of mango during July, 2010 to April, 2012



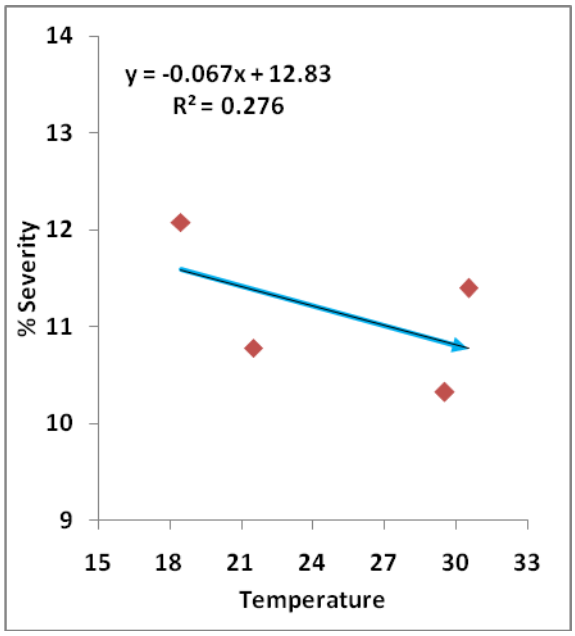


Figure 20. Linear regression analysis of the effect of temperature on severity of sooty mould of mango during July, 2010 to April, 2012

4.3.3.5b. Relation between sooty mould disease incidence as well as severity of mango seedlings and relative humidity.

A significant negative correlation between sooty mould disease incidence as well as severity and relative humidity were observed for both the years Fig 21 and 22. The relationship between disease incidence and relative humidity could be expressed by the equation Y= -0.517x + 52.46, (R^2 = 0.404) and Y= -0.269x + 37.53, (R^2=0.087), where x= relative humidity and y=disease incidence. Here, the R^2 value indicates that the contribution of relative humidity to the incidence of sooty mould of mango. On the other hand, the relationship between disease severity and relative humidity could be expressed by the equation Y = -0.338x + 35.32, (R^2=0.951), and Y= -0.008x + 11.79, (R^2 = 0.003), where x= relative humidity and y=disease severity. Here, the R^2 value indicates that the contribution of relative humidity to the severity of sooty mould of mango.

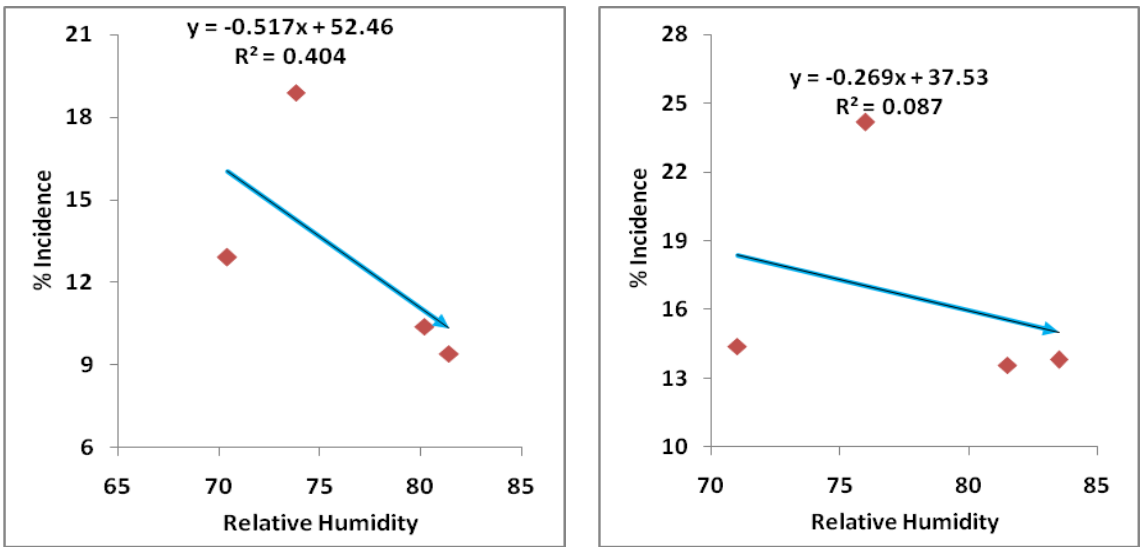


Figure 21. Linear regression analysis of the effect of relative humidity on incidence of sooty mould of mango during July, 2010 to April, 2012

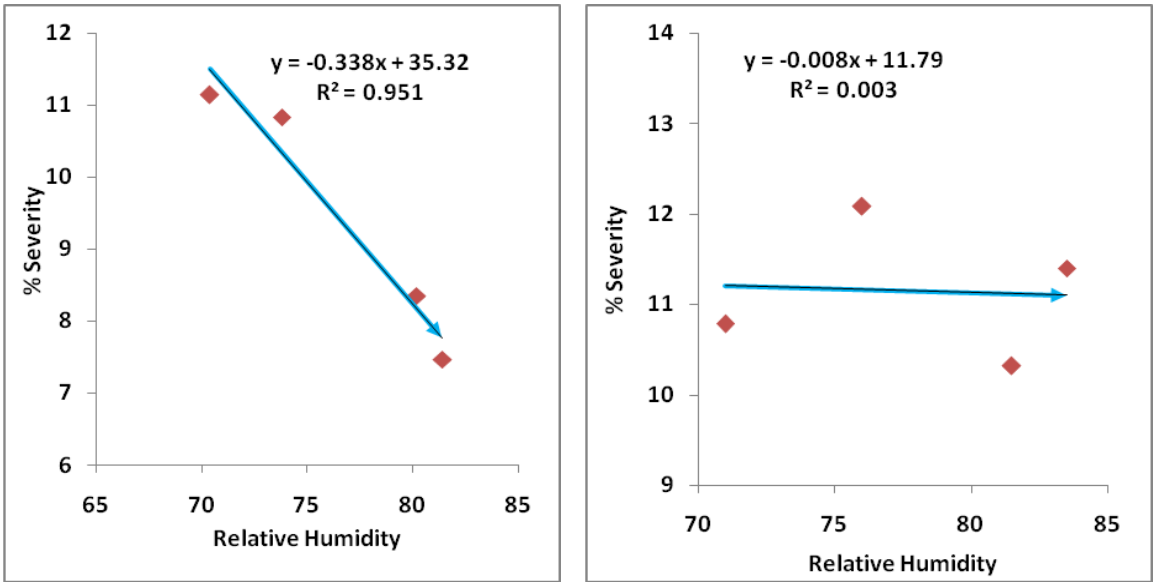


Figure 22. Linear regression analysis of the effect of relative humidity on severity of sooty mould of mango during July, 2010 to April, 2012

4.3.3.5c. Relation between sooty mould disease incidence as well as severity of mango seedlings and rainfall.

A significant positive correlation between sooty mould disease incidence as well as severity and rainfall were observed for both the years (Fig 23 and 24). The relationship between disease incidence and rainfall could be expressed by the equation Y= -1.275x + 18.98, (R^2 = 0.963) and Y= -1.955x + 24.09, (R^2=0.859), where x= rainfall and y=disease incidence. Here, the R^2 value indicates that the contribution of rainfall to the incidence of sooty mould of mango. On the other hand, the relationship between disease severity and rainfall could be expressed by the equation Y = -0.482x + 11.74, (R^2=0.756), and Y= -0.237x + 12.06, (R^2 = 0.571), where x= rainfall and y=disease severity. Here, the R^2 value indicates that the contribution of rainfall to the severity of sooty mould of mango.

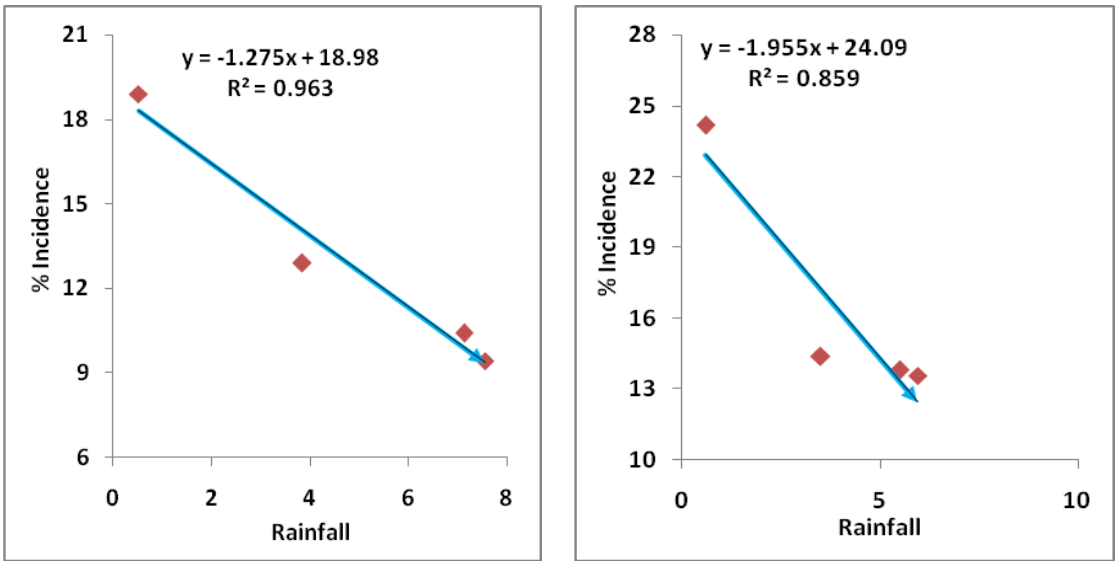


Figure 23. Linear regression analysis of the effect of rainfall on incidence of sooty mould of mango during July, 2010 to April, 2012

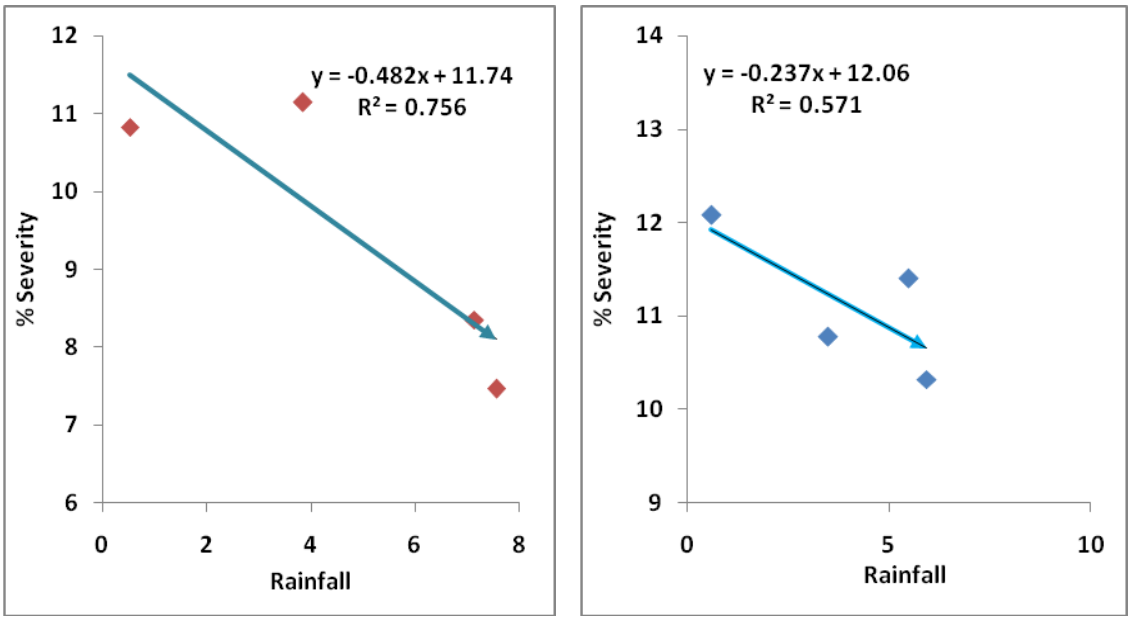


Figure 24. Linear regression analysis of the effect of rainfall on severity of sooty mould of mango during July, 2010 to April, 2012

4.3.4. Average temperature, relative humidity and rainfa ll of Dhaka, Gazipur, Barisal and Khagrachari from July, 2010 to April, 2012

The average temperature , relative humidity and rainfall of each month during the experimental period have been recorded and presented in table 11.

Table 11. Average temperature, relative humidity and rainfall of Dhaka , Gazipur, Barisal and Khagrachari from July , 2010 to April, 2012

Month	Average Temperature (^oC)	Average Relative humidity	Average Rainfall (mm)
July,2010	29.65	81.40	7.55
October,2010	28.63	80.20	7.13
January,2011	16.88	73.80	0.52
April,2011	20.50	70.43	3.85
July,2011	30.50	83.50	5.50
October,2011	29.50	81.50	5.95
January,2012	18.46	76.0	0.60
April,2012	21.50	71.0	3.50

CHAPTER V
DISCUSSION

A survey was conducted in eight nurseries under four district of Bangladesh viz. Green orchid nursery, Barisal nursery, Gazipur nursery, Laxmipur nursery, Sarchina nursery, Riyad nursery, and Hill Research Center and Ramghar nursery during the period of July, 2010 to April, 2012. In the present study three diseases of mango were recorded namely anthracnose, leaf spot and sooty mould of mango.The recorded diseases were fungal diseases. Mango anthracnose and sooty mould were found in most regions in the world. On the other hand, Leaf spot of mango were found less in the observation area in Bangladesh. In Bangladesh the leaf spot disease of mango were found severe under high temperature and high rainfall condition. The leaf spot disease incidence and severity were found highly in Khagrachari District during the observation period of July 2010 to April 2012. The diseases recorded in the present study had also been reported on mango seedlings from different countries of the world Chowdhury (2009); Singh (1968); Fitzell and Peak (1984), Peterson (1986); Mortuza (1990); Ploetz *et al.* (1994); Reza and Kader (1996); Conde *et al.* (1997). Again, in Bangladesh eighteen diseases including three observed in the present study were recorded by Dey *et al* (2007); Sarkar, S. R (2008) and Chowdhury (2009) in the mango growing areas of Bangladesh. These diseases were recorded as a common disease in all the growing areas surveyed.

The diseases in the present study were identified by observing the symptoms on the seedlings during survey and determination of presence of fungi was made either directly by preparation of slides and examining them under compound microscope or indirectly by isolation to agar culture following keys outline by Akhtar *et al.* (1999); Ploetz *et al*. (1998); Okigbo and Osuinde (2003) and Freeman *et al.* (2004). Anthracnose of mango was identified based on visual symptom following the description of Sarkar, S. R. (2008); Chowdhury (2009).

In the present study the pathogen isolated from mango anthracnose was *Colletotrichum gloeosporioides*. The pathogen has been reported by many researchers throughout the world [Singh (1968) and Xie and Xie.(1999)]. Pletz *et al.* (1994) reported leaf spot (*Pestalotiopsis mangiferae*) as the major problem in the nursery. Anthracnose in the seedling was caused by *Colletotrichum gloeosporioides.* The conidial stage of (*Colletotrichum gloeosporioides*) which is in accordance with Ploetz *et al* (1994). Anthracnose of mango caused by *Colletotrichum gloeosporiodes* have also been reported by many researchers throughout the world [Awasthi *et al* (2005) and Chowdhury, (2009)]. The presence of *Pestalotiopsis mangiferae* has also been reported by others [Singh, (1968); Pathak, (1980); Ploetz *et al* (1994).; Okigbo and Osuinde (2003) Dey *et al*. (2007); and Choudhory, (2009).Sooty mould of mango caused by *Capnodium roseum,* has been reported by Misra (2001) Awasthi *et al* (2005) Sarkar, S. R. (2008) and Chowdhury (2009).

The prevalence of the recorded three diseases on mango varied in respect of nursery and location. Similar variation in prevalence of seedling diseases in respect of nursery and location was recorded by Meah and Khan (1987) Pathak (1980); Peterson (1986) Mortuza (1990); Tiwari *et al.*(2006) Sarkar, S. R, (2008) and Chowdhury, (2009) in different mango growing regions. Regarding incidence of the three diseases recorded in the present study, mango anthracnose and sooty mould were the most predominant while leaf spot of mango had the least occurrence. In case of disease severity, mango anthracnose and mango sooty mould were the prevalent diseases while the prevalence of leaf spot had the least occurrence.

Occurrence and severity of various diseases of mango throughout the year in the orchards of Nawabganj and Rajshahi (Kajia) were recorded (Annonymous, 1990). Anthracnose, leaf spot and sooty mold diseases were observed in the orchards of the surveyed area. The highest incidence of anthracnose was observed in the variety Aswina (37.16%) and Gootee (37.8%) in Nawabganj district and the lowest in the variety Kuapahari in the same district. In the present study, it was also

observed that the incidence and severity of anthracnose, leaf spot and sooty mould of mango varied from location to location. These variations may be due to effect of environment of different agro-ecological zone. The highest incidence and severity of anthracnose, leaf spot and sooty mould was recorded at Khagraachari. The Khagraachari is a south eastern hilly district of Bangladesh. This high prevalence may be due to environmental effect of that particular agro-ecological zone.

The effects of temperature, rainfall and relative humidity on the incidence and severity of noted diseases of mango in selected location were observed. The climate of Bangladesh is characterized by high temperature, heavy rainfall, and often excessive humidity with fairly marked seasonal variations (Anonymous, 1995). Anovas, correlation and linear regression analysis were performed to determine the relationship between different components of climatic factor (temperature, relative humidity and rainfall) and the incidence as well as severity of seedling disease of mango. Gilling (1986) observed that anovas has been the fundamental method used by plant pathologist to determine the correlation between the prevalence and environmental parameters. Determining the effects of temperature, rainfall and relative humidity on the incidence and severity of disease in different pathosystems has been focused by many researchers worldwide [(Meah and Khan (1987); Bitancourt and Jenkins (1943); Fitzell and Peak, (1984); Mortuza (1990); Ploetz *et al.,* 1994; Reza and Kader (1996) ; Jeger *et al* (1988);Xie and Xie(1999); Misra(2001); Colon *et al* (2002); Awasthi *et al* (2005); Tiwari et *al.*(2006); Sarkar, S. R. (2008); *Chowdhury*, 2009; and Hossain, 2011)].

In the present study diseases were recorded eight particular times during the period of two years survey from July, 2010 to April, 2012. Prevalence (Incidence and severity) of mango anthracnose and leaf spot were found to be increased in the month of April and July while the disease decreased in the month of January and October. Correlation regression analysis of prevalence of anthracnose and leaf spot disease along with generalized environmental parameters revealed that this increase

and decrease were due the effect of temperature, relative humidity and rainfall. A positive correlation was observed between prevalence of leaf spot with temperature, relative humidity and rainfall. With the increase of temperature, relative humidity and rainfall both the incidence and severity increased significantly. The result of the present study corroborates with the study of Bal and Dhiman (2005) who found that mango leaf spot was found to build up during the first week of June with the onset of rains. They also observed that highest incidence of mango leaf spot was recorded during the second week of September and the diseases showed a positive correlation with temperatures, relative humidity and rain and hence the period from July to September was identified as the most conducive for the development of mango leaf spot. Ploetz *et al.* (2007) reported that mango leaf spot occurs primarily in tropical and sub-tropical climates where considerable rainfall accompanies warm temperatures but it can also occur in drier climates.

The highest prevalence (Incidence and disease severity) of mango anthracnose was observed in the month of July and April and the lowest prevalence (Incidence and severity) observed in the month of January and October. A positive correlation was observed between prevalence of anthracnose with temperature, relative humidity and rainfall. With the increase of temperature, relative humidity and rainfall both the incidence and severity increased significantly. The result of the present study corroborates with the study of Singh (1968) who found that the anthracnose was negligible in colder season than that of warmer seasons. The present study also supported by the previous workers Chowdhury, (1955); (Meah and Khan(1987); Bitancourt and Jenkins (1943); Fitzell and Peak, (1984); Mortuza (1990); Ploetz *et al.*, 1994; Reza and Kader (1996) ; Jeger *et al* (1988); Xie and Xie(1999); Misra (2001); Colon *et al* (2002); Awasthi *et al* (2005); Tiwari *et al* (2006); Sarkar, S. R (2008); Chowdhury, 2009; and Hossain, 2011.

Meah and Khan (1987) found that anthracnose prevails in the regions where temperature and humidity remains low. Chowdhury (2009) reported that humidity and rainfall played more important role in the development of anthracnose than by temperature. The prevalence of (Incidence and severity) of sooty mould of mango was recorded in the months July and October but no disease was found in the month of January and April. A positive correlation was observed between prevalence of sooty mould with temperature, relative humidity and rainfall. The present study also supported by the (Meah and Khan(1987);Bitancourt and Jenkins (1943); Fitzell and Peak, (1984); Mortuza (1990); Ploetz *et al.* (1994); Reza and Kader (1996); Jeger *et al* (1988); Xie and Xie (1999); Misra (2001); Colon *et al* (2002); Awasthi *et al* (2005); Tiwari et all(2006);Sarkar, S. R (2008); Chowdhury, (2009); and Hossain, (2011).

CHAPTER VI

SUMMARY AND CONCLUSION

Mango seedlings are vulnerable to attacked by various diseases in Bangladesh, but least concrete information regarding their distribution, incidence, severity, epidemiology and management is available. Therefore, the present study has been designed to study the occurrence and prevalence of seedling diseases of mango and to study the correlation of disease development with environmental parameters in eight nurseries in four selected districts namely, Dhaka, Gazipur, Barisal and Khagrachari in Bangladesh.

Four experiments were carried out throughout the study period from July, 2010 to April, 2012. The diseases were identified based on the observed symptoms in the infected plants following the description of Reddy and Murti, (1990); Rajput and Haribabu, (1985). The disease were also identified by observing the symptoms as well as the presence of fungi on the infected parts of plant by preparation of slides and examining them under compound microscope or by isolation to agar culture following keys outline by Sing (1978), Pathak (1980), Peterson (1986), Sing (1998) and Ploetz *et al*. (1998).

Three different diseases viz. leaf spot, anthracnose and sooty mould of mango on mango seedlings were recorded during the survey period under four different geographical location viz. Dhaka, Gazipur, Barisal and Khagrachari and the effect of temperature, relative humidity and rainfall on incidence and severity of noted diseases were studied. Incidence and severity of leaf spot, anthracnose, and sooty mould of mango varied from location to location. Significant variations were observed on the incidence and severity under the variation of weather parameters. The intermittent addition and defoliation of leaves during different period of year responsible for significant reduction of disease incidence and severity.

Different degrees of correlation were observed among the seedling diseases of mango with temperature, relative humidity and rainfall. All the diseases were found to be influenced by the epidemiological parameters.

Prevalence of anthracnose, leaf spot, and sooty mould of mango varied from season to season. The highest incidence of anthracnose was recorded in October and the lowest was recorded in January in both the years. The highest severity was recorded in October in both the years, and the lowest was recorded in January in both the years. In different growing seasons of mango seedlings, the highest incidence (60.28%) and (66.79%) and the highest severity (50.5%) and (55.13%) of anthracnose disease were recorded in October, for both the years ;(Fig.1 and 2) and lowest incidence (24.3%) and (25.5%) and the lowest severity (17.39%) and (16.14%) were recorded in January, for both the years.

The highest incidence of leaf spot was recorded in October for both the years. And the lowest was recorded in month of January, for both the years. The highest severity was recorded in October, for both the years. And the lowest was recorded in April in 2010-2011 and in January in 2011-2012. In different growing seasons of mango seedlings, the highest incidence (62.40%) and (65.84%) and the highest severity (54.72%) and (56.21%) of leaf spot disease were recorded in October for both the years (Fig 9 and 10) and the lowest incidence (26.76%) and (31.28%) and the lowest severity (19.12%) and (21.81%) were recorded for both the years.

The highest incidence (18.90%) and (24.18%) of sooty mould was recorded in January, for both the years. and the lowest (9.413%) in July in 2010-2011 and (13.57%) in October in 2011-2012. The highest severity (11.14%) in April and (12.08%) in January was recorded for both the years. and the lowest (7.467%) in July in 2010-2011 and (10.32%) in October in 2011-2012.

Therefore, the present study on the occurrence of seedling disease in the nursery revealed that all the diseases studied are related to the temperature, relative humidity and rainfall. Other parameters of epidemiology viz. leaf wetness period, vapor presser deficit, sunshine hour, microclimatic parameters including canopy

temperature, relative humidity etc, should be critically evaluated to have profound effects on over wintering; formation, germination and development of inoculam in different pathosystem and these should be critically studied for each host-pathogen system to find out the most appropriate time to combat the disease at minimum effort.

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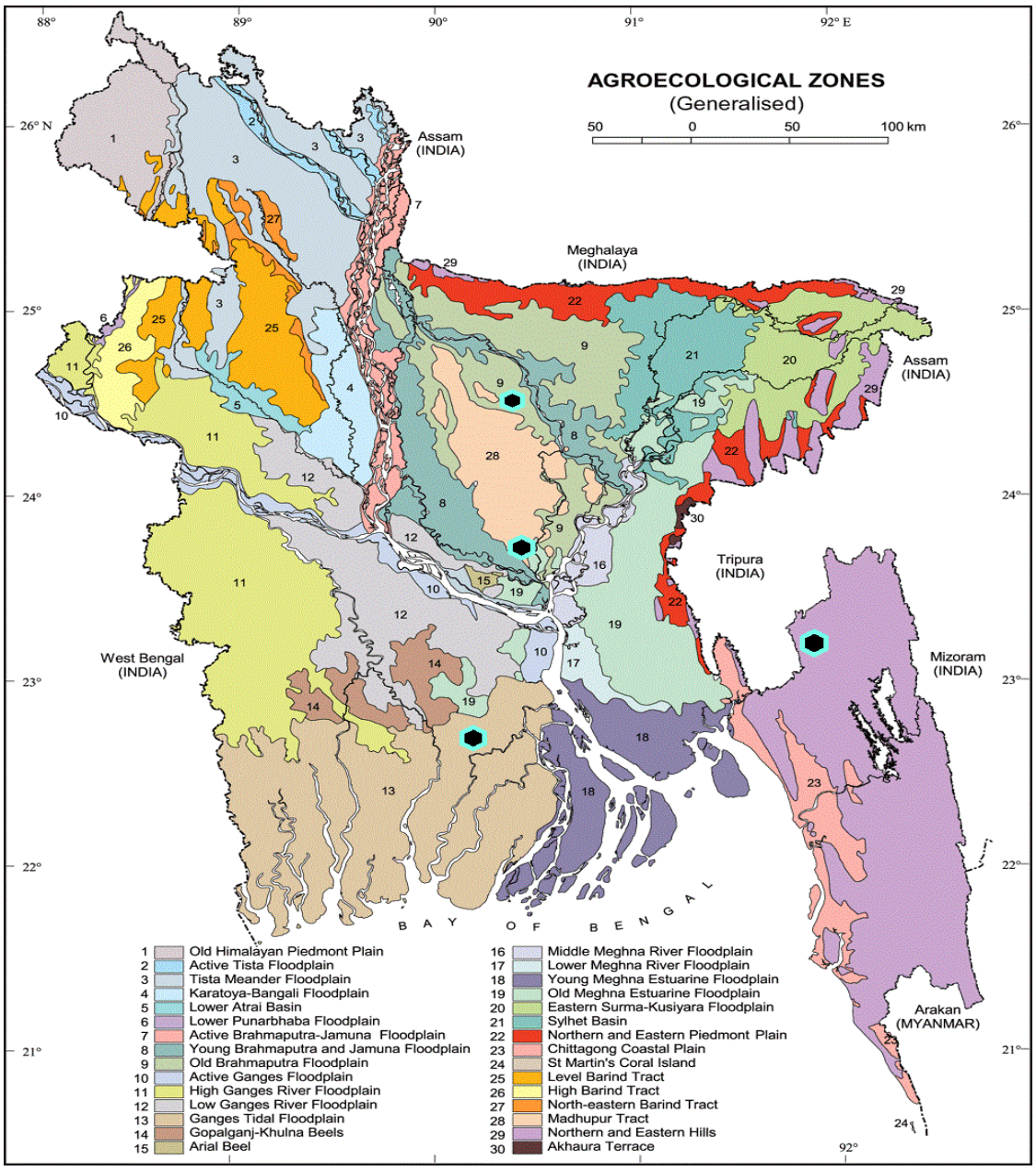
APPENDICES

Appendix I. Map showing the experimental site under study



⬣ Position of experimental site