STUDY ON SEEDLING DISEASES OF GUAVA (*Psidium guajava* L.) IN SELECTED AREA OF BANGLADESH

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STUDY ON SEEDLING DISEASES OF GUAVA (*Psidium guajava* L.) IN SELECTED AREA OF BANGLADESH

BY

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CERTIFICATE

This is to certify that thesis entitled, **"STUDY ON SEEDLING DISEASES OF GUAVA (*Psidium guajava* L.) IN SELECTED AREA 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. NAZRUL ISLAM, Registration No. 05-01745,** 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

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DEDICATED

TO

MY BELOVED PARENTS

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ABSTRACT

Guava, the major fruit crops of Bangladesh, was surveyed during the period of July, 2010 to April, 2012. Three experiments were carried out to study the nursery diseases of guava and to observe the effect of temperature, relative humidity and rainfall on the occurrence of disease incidence and severity on seedlings. Important plant pathogens *Colletotrichum gloeosporioides*, *Pestalotiopsis* spp., *Pseudomonas syringae* pv. *syringae* were identified and the incidence and severity of anthracnose, scab and leaf blight of guava at seedling stage were studied. Significant variations in development of these diseases were observed in varied weather factors. Occurrence of seedling disease was correlated with temperature, rainfall and relative humidity. That is why there was great variation of disease incidence and severity of guava from one location to another as well as from one season to another season. These weather parameters should be critically addressed for each host-pathogen system to find out the most appropriate time to combat the disease at minimum effort.

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LIST OF SYMBOLS AND ABBREVIATIONS

FULL WORDS	ABBREVIATION
Percentage	%
Cultivar	cv.
Ton	t
Hector	ha
Exempli gratia (by way of example)	e.g.
(at ell)	*et al.*
Species	Spp.
Centimeter	cm
Metric ton	Mt
Bangladesh Agriculture Research Institute	BARI
Sher-e-Bangla Agricultural University	SAU
Journal	*J.*
Number	No.
variety	var.
Namely	viz.
Degrees of freedom	df.
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
Etcetera	etc.
Potato Dextrose Agar media	PDA
Degree Celsius	^{0}C
Gram	g
Bangladesh Bureau of Statistics	BBS
Analysis of variances	ANOVA
Kilogram	Kg
Bangladesh Institute of Nuclear Agriculture	BINA
Bangabandhu Sheikh Mujibur Rahman Agricultural University	BSMRAU
Bangladesh Agricultural University	BAU
Percentages of Co-efficient of Variance	CV%
Least Significant Difference	LSD
Science	Sci.

CHAPTER I
INTRODUCTION

Guava (*Psidium guajava* L.), is one of the most common fruits in tropical and sub-tropical regions of the world. The tropical guava is best adapted to a warm climate, thriving in both humid and dry climates. It is adaptable over a wide range of climatic and soil conditions (Purseglove, 1984). It can be used as an important resource for local communities with potential for commercialization; boosting food and nutritional security. In rural areas, guava is used to supplement the daily diet or substitute exotic fruits. Guava has been found to be beneficial for people suffering from Asthma, high blood pressure, oral ulcers, scurvy, congestion of the lungs, bacterial infection etc. Guava can improve the texture of skin and help avoid skin problems. For the purpose, we can eat it raw or make wash your skin with a decoction of its immature fruits leaves. Juice of raw immature guavas decoction of guava leaves is known to bring relief in cough and cold. Bangladesh produces less than 30% of the fruits needed to meet the minimum daily requirements for its population. The importance of fruits in human diet can not be over emphasized. They are the chief sourch of some vitamins, mineral salts and also possess high medicinal values (Kamaluddin, 1994). About 80% of families in the country consume less than the minimum recommended daily requirement of fruits. As a consequence widespread nutritional deficiencies in vitamin 'A' and 'C' iron and other nutrients cause debilitating illness among the population (HKI, 2005). So, we can improve this situation by growing guava fruit trees and increasing the production of guava which is very important to fulfill the requirements of people in Bangladesh.

Bangladesh produces 182 thousand metric tons of guavas annually (BBS, 2010). Quantity and quality of guava in this country is far below the world standard. There are several factors responsible for low yield and poor quality of guava in Bangladesh, where diseases infestation is most important of them. It has been estimated that the production could be increased at least by 28% if the crop could be protected against various seedling diseases (Chowdhury, 2009). The climate of Bangladesh harbors plant pathogens and provide luxuriant environment for the

growth and reproduction of large number of plant pathogens which causes hundreds of different diseases of crops (Fakir, 2001).

Healthy seedlings are prime need and basic raw material for establishment of orchard for the production of guava. Seedling diseases are an important consideration for guava production. Seedling is frequently affected by physical and physiological disorders as well as diseases caused by fungi, bacteria and viruses (Mittal and Mathur, 1990). Seed borne pathogens affect nursery seedlings and reduce seedling vigor (Abdelmonem and Rasmi, 2003). So, seedling diseases of guava are one of the important problems in the tropics. Although a huge number of nurseries are engaged in producing seedlings, they fail to produce quality seedlings due to lack of their knowledge about diseases. Seed after germination are liable to attack by different soil borne organisms. Even after emergence of the seedling, it could be attacked by different diseases which may produce distinct symptoms in the nursery bed or it may carry the organisms when it is transplanted in the orchard or any selected place. In severe cases, diseases cause mortality of many seedlings after plantation. For this reasons, seedlings are to be reared up with proper care in order to avoid the diseases and to ensure quality guava production and increasing yield. Thus production of healthy seedlings ensures good plantation and save money, labor and energy of guava gardener.

Seedling of guava are affected by diseases such as wilt (*Fusarium oxysporium*), anthracnose (*Colletotrichum gloeosporioides*), seedling blight, fruit rot, *Phoma* rot, *Rhizopus* rot, collar rot, *Pestalotia* leaf spot, *Cercospora* leaf spot, stem canker , sooty mold, die back (Rahman *et al*., 2003).

The existing technology of cultivation of horticultural crops in the country is in a stage that needs to be upgraded for successful guava production in order to meet up the national demand. So, studies on the seedling disease of guava are an urgent need in the country. Therefore, attempts were taken to study the prevalence of various disease occuring on guava seedlings in some selected nurseries of Dhaka,

Gazipur, Barisal and Khagrachari and the effect of temperature, relative humidity and rainfall on incidence and severity of nursery disease of guava.

Considering the above facts, the present research work designed with the following objectives :

i) Survey on the prevalence of seedling diseases of guava in some selected nurseries of Dhaka, Gazipur, Barisal and Khagrachari.

ii) To identify the pathogen(s) associated with the disease.

iii) To study the effect of temperature, relative humidity and rainfall on incidence and severity of nursery diseases of guava.

CHAPTER II

REVIEW OF LITERATURE

Guava is considered as a popular and nutritious fruit species in Bangladesh. And, from a research and development point of view, it is found to be attacked by different diseases. The diseases of guava seedlings have been studied in Bangladesh to a limited extent. In this chapter an attempt has been made to review

the available literature about symptoms of nursery diseases of guava, their causal organisms, diseases status and their epidemiology.

Chowdhury *et al.*, (2011) studied the seedling diseases of guava and 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 the 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.

Hossain, (2011) made an extensive survey on the incidence and severity of nursery diseases of guava in different locations of major fruit growing areas of Bangladesh. In addition, they were working on isolation and identification of disease causal organisms. Moreover management of nursery diseases was their important task of work.

Chowdhury, (2009) studied on the effect of weather factors on the incidence and severity of anthracnose of guava seedling. Significant variations of the incidence and severity of different diseases of guava seedlings due to variations of the temperature, relative humidity and rainfall were observed in different data recording times. In case of anthracnose diseases of guava seedlings, the highest incidence (20.00%) and severity (16.19%) were recorded in July, 2007 at temperature, relative humidity and rainfall of 28.87°C, 85.67% and 62.60 cm, respectively. On the other hand, no incidence (0.00%) was recorded in January,

2008 at temperature, relative humidity and rainfall of 18.10°C, 75.33% and 2.73 cm, respectively.

Marques *et al*., (2007) studies guava bacterial blight due to *Erwinia psidii*; incidence levels and epidemiological aspects. The objectives of this study were to investigate the spread of bacterial blight of guava caused by *Erwinia psidii* in Distrito Federal, Brazil, and the optimum temperature for the in vitro multiplication of *E. psidii*; develop a simple and effective method for pathogenicity testing; and evaluate in vitro bacterial survival in different substrates. The disease was detected in 56% of the orchards, and a correlation of 81.9% between the presence of symptoms and positive disease diagnosis in the laboratory was recorded. The optimum temperature range for *E. psidii* growth was 24-33 degrees C, and short term preservation (up to 120days) in water suspension was superior. The inoculation of the pathogen to detached leaves or stems allowed symptom development in 7 days; this method appeared to be a rapid and reliable means of testing isolate pathogenicity.

Keith *et al*., (2006) conducted a survey on scab disease at the USDA/ARS Tropical Plant Genetic Resource Management Unit in Hilo, HI, where more than 50 accessions of guava are grown. Gray/light brown lesions surrounded by dark brown borders on leaves and brown, raised, corky, necrotic lesions on the exocarp of fruit which progressed on matured fruits were observed. Seventeen isolates from infected fruit, six isolates from lesions on leaves, and nine isolates from additional crops surrounding the guava trees were collected. The main fungi *Pestalotiopsis* spp were consistently isolated from symptomatic leaves and fruit and their morphology, colony characteristics, and pathogenicity was examined as potential sources of host resistance were identified for germplasm characterization studies. Molecular methods were used to identify four *Pestalotiopsis* taxa (*P. clavispora*, *P. Microspora*, *P.* Sp. GJ-1, and *P. disseminata*) on guava in Hawaii. To our knowledge, this is the first report of traditional and molecular methods of identification and characterization being used for fungal pathogens of guava in Hawaii.

Misra, (2004) studied guava diseases-their symptoms, causes and management. Guava (*Psidium guajava* L.), an important fruit of sub-tropical countries that affected by about 177 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 organisms and disease management practices.

Lim and Manicom, (2003) studied diseases of guava including distribution, importance and control of guava (*Psidium guajava*) diseases, together with characteristics and production of the fruit. Importance diseases include the bacterium *Erwinia psidii*, rust (*Puccinia psidii*), anthracnose (*Glomerella cingulata*), damping off fungus (*Rhizoctonia solani*), and guava wilt disease (caused by *Fusarium oxysporum f.*sp. *psidii* among others) and the gall forming nematode, *Meloidogyne* spp. Postharvest rots can be caused by a variety of microorganisms including *Cylindrocladium, Lasiodiplodia*, *Mucor* and *Rhizopus* species.

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 worlds.

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

Meah and Khan, (1987) recorded five disease of guava in the orchards where anthracnose was found in high intensity in some parts of the country.

Pathak, (1986) reported association of *Colletotrichum gloeosporioides* causing anthracnose on leaf of guava.

Pathak, (1980); Singh, (1998) and Ploetz *et al.*, (1998) found that in guava anthracnose, infected leaves developed irregular shaped black necrotic spots that coalesced and formed large necrotic areas. The margin of attacked leaves gradually turned dark brown and the black necrotic areas extended backward causing die back. The affected seedlings began to die back from the tip of the branch.

CHAPTER III

MATERIALS AND METHODS

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

i) Survey on the seedling diseases of guava in some selected nurseries of Bangladesh.
ii) Identification of causal organisms of the seedling diseases of guava.
iii) Epidemiological survey on the disease prevelance of seedling diseases of guava.

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

3.1.1. Location of survey area

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

3.1.2. Selection of Nursery

The eight nurseries of four districts are 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 table 1.

Table 1. Age of the guava 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 (July,2010 to July,2011)**	**Total number of seedlings (October,2010 to October,2011)**	**Total number of seedlings (January,2011 to January,2012)**	**Total number of seedlings (April,2011 to April,2012)**
Green orchid nursery, Agargaon, Dhaka	1	40	60	80	45
Barisal nursery,Savar, Dhaka	1	70	100	100	100
Gazipur	1	80	100	90	80

nursery,Gazipur					
Laxmipur nursery, Gazipur	1	80	60	80	60
Sarchina nursery, Barisal	1	60	60	70	60
Riyad nursery, Barisal	1	50	50	50	50
Hill Research Center, Khagrachari	1	60	50	80	70
Ramghar nursery, Ramghar, Khagrachari	1	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 guava 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 was made by two methods as follows:

3.2.2.1. Moist blotter method

The pathogen associated with the diseased plant parts (Leaves) were cut into several pieces by scissors and placed on the moist filter paper (Whatman no.1).

Three pieces of filter paper were moistened by dipping in sterile water. The petridishes 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 = 1000ml) plates aseptically. The plates were incubated at 28°±1°C for several days and examined daily for any fungal growth.

3.2.3. Preparation of Nutrient Agar (NA) media

Nutrient agar (28g) was taken in the Erlenmeyer flask containing 1000 ml distilled water. For mixing properly the nutrient agar was shaken thoroughly for few minutes. Flask was then plugged with cotton and wrapped with a piece of brown paper and tied with thread. It was then autoclaved at 121°C under 15 lbs pressure for 15 minutes. After autoclaving the media was picked out from the autoclave and allowed to cool at room temperature in Lamina flow cabinet until the temperature reached at approximately 50°C (feel warm in touch). Then the media was poured into sterilized glass petridishes for making NA plate and allowed to cool for solidification.

3.2.4. Bacteria isolation and identification

The bacteria strains isolated and collected from guava leaf, samples were identified using the following tests:

3.2.4.1. Potassium hydroxide solubility test

On glass slide a loop full of bacteria from a well-grown colony was mixed with a drop of 3% KOH aqueous solution. Mixing was continued for less than 10 seconds. A toothpick was used for picking bacteria from a colony as well as for sticking it. The toothpick was raised a few centimeters from the glass slides. Strands of viscid material showed the bacterium Gram-negative. Repeated strokes of the toothpick, which did not produced any strand, were Gram-positive (Mortensen, 1997).

3.2.4.2. Potato soft rotting test

The soft rotting test was done using well-washed, firm potatoes. The surface of the potatoes were sterilizes with rectified spirit, then cut into slices (3.5cm long and 7-8mm thick) aseptically with sharp sterile knife and places in sterile petridishes, the bottom of which was lined with moist filter paper (Whatman filter paper no.1). Two slices were then inoculated with loop full of 24 hours bacterial colony previously grown on a NA media. Petridishes were then incubated at room temperature (in darkness at 25°C) for 24-48 hours for the detection of soft rot. A control for each isolate was maintained using loop full of sterile water instead of bacteria (Lelliot and Stead, 1987).

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 guava 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. The disease incidence of guava seedling was determined by the following formula (Rai and Mamatha, 2005):

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

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

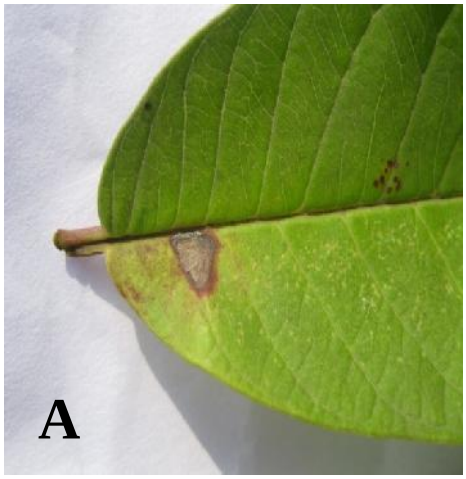
4.1. Survey on nursery diseases of guava

Three different diseases viz. anthracnose, scab and bacterial leaf blight 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 guava

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 A&B).



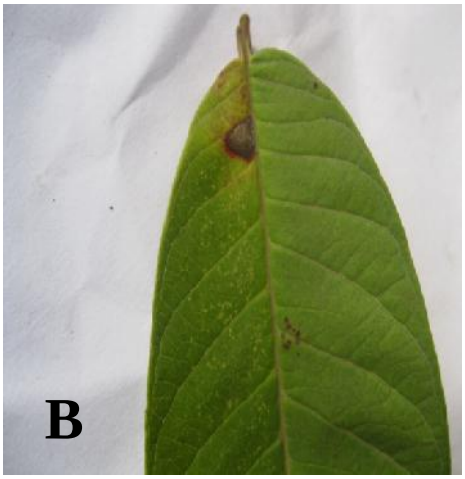


Plate 1. A & **B** showing symptoms of anthracnose of guava

The pathogen isolated from the diseased symptom was identified as *Colletotrichum gloeosporioides* (Plate 1 C&D) by observing the conidia were dark coloured, single cell barrel shaped characteristics.

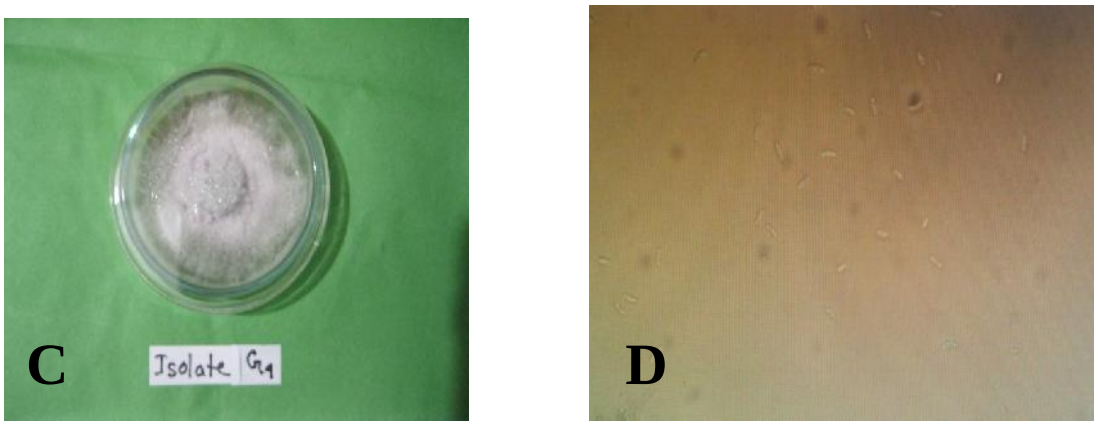


Plate 1. C. Pure culture of *Colletotrichum gloeosporioides* (Penz.), **D.** Conidia of *Colletotrichum gloeosporioides* (Penz.) produce in culture.

4.2.2. Scab of guava

Symptoms on leaves began as small dark brown spots that expanded to become gray or light brown circles surrounded by a dark brown border. In severe cases, lesions developed on large portions of a single leaf. Lesions were also observed on stems of fruit (plate 2 A & B).

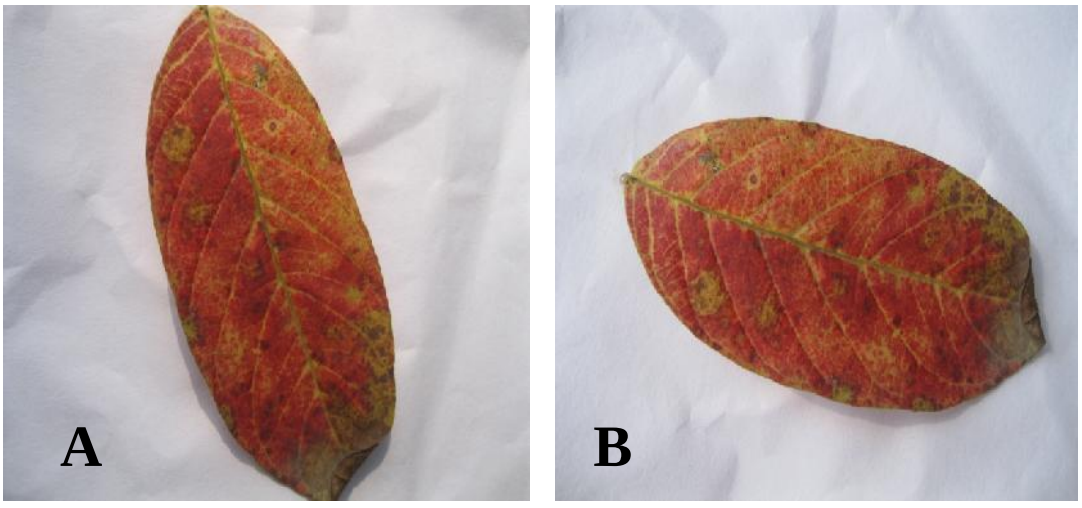


Plate 2. A & **B** showing symptoms of scab of guava leaf

The main fungi consistently isolated from symptomatic leaves that are *Pestalotiopsis* spp. (plate 2 C&D). *Pestalotiopsis* a complex genus that is characterized by spores having mostly four-euseptate and pigmented median

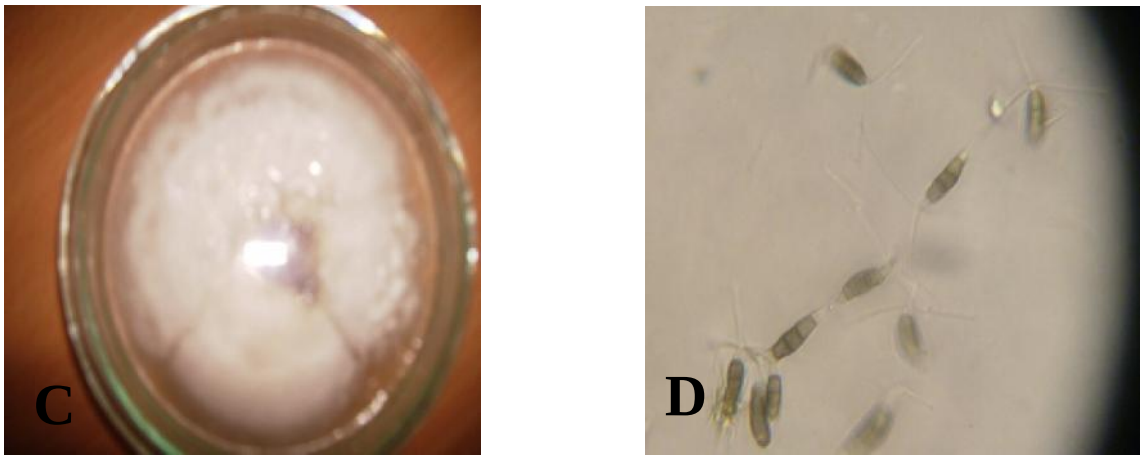


Plate 2. C. Pure culture of *Pestalotiopsis* spp., **D.** Conidia of *Pestalotiopsis* spp.

cells with two to four apical appendages arising as tubular extensions from the apical cell and a centric basal appendage (Jeewon *et al*., 2002)

4.2.3. Bacterial leaf blight of guava

Minute water soaked lesions appeared in groups towards the tip of the blade that turned brown to black in color and surrounded by chlorotic halos. They were surrounded by the veins and hence angular in shape. Large necrotic patches were formed by coalescing of several lesions. The patches sometimes dried up, often rough and raised due to heavy bacterial exudates (Plate 7 A&B). Petioles and tender stems were also infected and longitudinal cracks developed on the petiole.

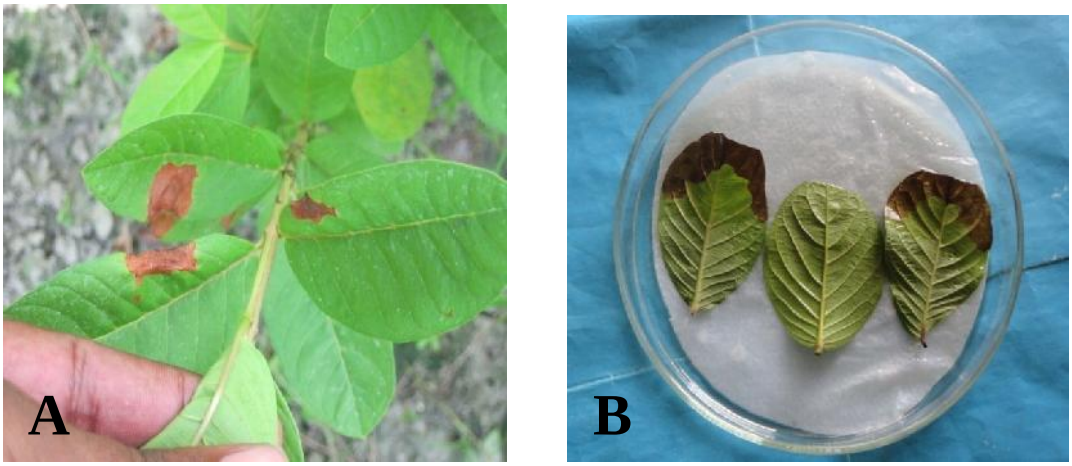


Plate 3. A & **B** showing symptoms of leaf blight of guava

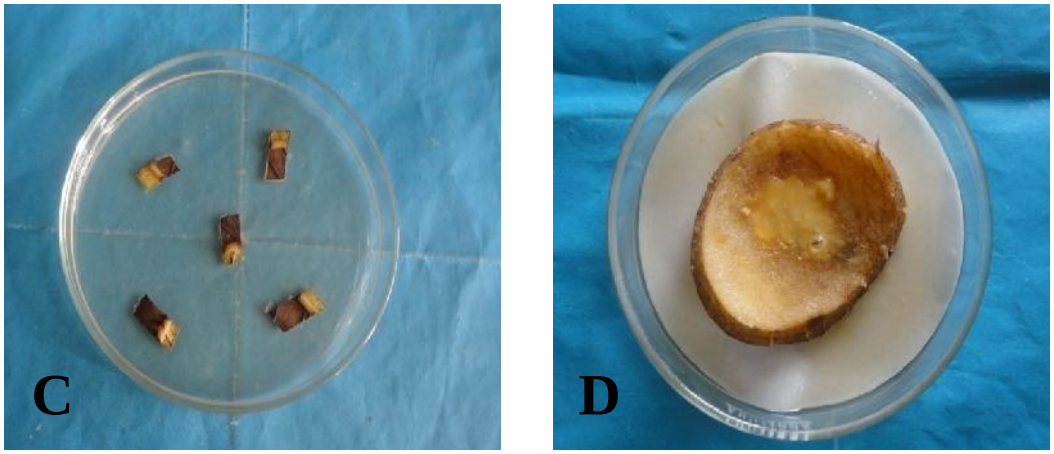


Plate 3. C. Isolation of bacteria by tissue culture method, **D**. Pectolytic test for *Pseudomonas syringae* pv. *syringae* isolate showing positive reaction producing rot on potato.

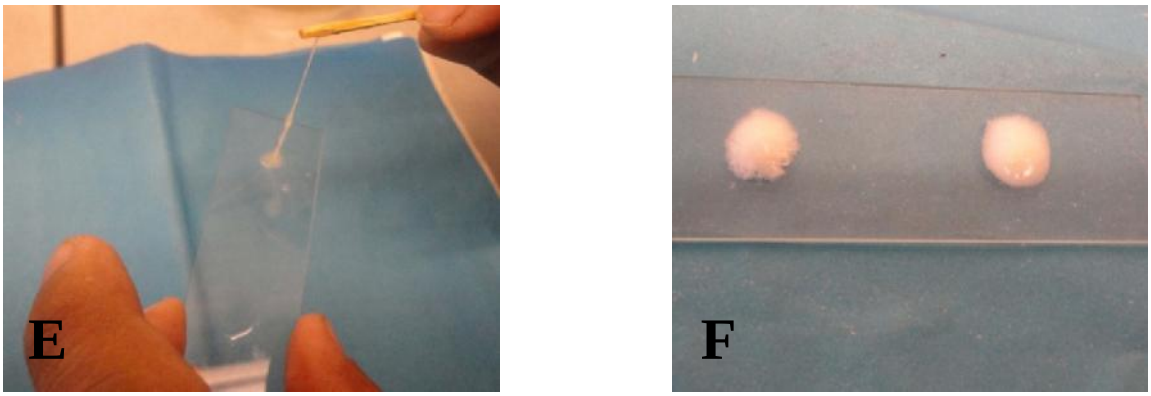


Plate 3. E. Potassium hydroxide solubility test showing positive reaction as indicated by the elastic thread or viscous material with *Pseudomonas syringae* pv. *syringae* isolate., **F.** Levan test showing positive reaction with *Pseudomonas syringae* pv. *syringae* isolate and producing distinctive domed shaped colonies in NA medium containing 5% sucrose.

Plate 3. G. Pure culture of *Pseudomonas syringae* pv. *syringae* on NA medium

The bacterial strains isolated and collected from guava leaf samples were used for potato soft rotting test or Pectolytic test (Plate 3 D), potassium hydroxide solubility test (Plate 3 E), and Levan test (Plate 3 F) that showing positive reaction with *Pseudomonas syringae* pv. *syringae* isolate and producing distinctive domed shape colonies in NA medium containing 5% sucrose. In the potassium hydroxide solubility test, (Plate 3 E) a strand of viscid material was found that indicated that the bacterium was Gram-negative. The isolated bacterium from the blighted leaf was *Pseudomonas* sp. (plate 3 G).

4.3. Epidemiology of disease incidence and severity

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

Incidence of anthracnose of guava varied from location to location and year to year that ranged from 25.53-22.50% in 2010-2011 and 43.93-24.38% in 2011-2012 (Table 2). The highest incidence was recorded at Khagrachari and the lowest was recorded at Gazipur in both the years. The severity of anthracnose of guava also varied from location to location and year to year that ranged from 19.73-15.82% in 2010-2011 and 26.46-14.62% 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 guava at different locations of Bangladesh from July, 2010 to April, 2012**

Location	anthracnose			
	Incidence (%)		Severity (%)	
	2010-2011	2011-2012	2010-2011	2011-2012
Dhaka	25.18 a	31.61 b	19.73 a	18.13 c
Gazipur	22.50 b	24.38 c	17.95 b	14.62 d
Barisal	23.72 b	30.14 b	15.82 c	23.16 b
Khagrachari	25.53 a	43.93 a	18.15 b	26.46 a
$LSD_{(p\geq 0.05)}$	1.381	1.600	1.009	1.766
CV%	3.57	4.27	4.82	6.95

Each data represents the mean value of three nurseries.

4.3.1.2. Incidence and severity of anthracnose of guava during July, 2010 to April, 2012

Incidence of anthracnose of guava varied from July, 2010 to April, 2012 and that ranged from 33.19-15.57% in 2010-2011 and 43.93-24.38% in 2011-2012 (Table 3). The highest incidence was recorded in July, and the lowest was recorded in January, in both the years. The severity of anthracnose of guava also varied from year to year that ranged from 25.98-10.47% in 2010-2011 and 37.73-9.77% in 2011-2012. The highest severity was recorded in July, in both the years and the lowest was recorded in January, in both the years.

Table 3. Incidence and severity of anthracnose of guava during July, 2010 to April, 2012

Time of data collection	anthracnose			
	Incidence (%)		Severity (%)	
	2010-2011	2011-2012	2010-2011	2011-2012
July	33.19 a	47.90 a	25.98 a	37.73 a

October	27.34 b	41.19 b	21.67 b	22.27 b
January	15.57 d	16.30 d	10.47 d	9.77 d
April	20.83 c	24.67 c	13.53 c	12.59 c
$LSD_{(p\geq 0.05)}$	1.459	2.339	1.455	2.412
CV%	3.57	4.27	4.82	6.95

Each data represents the mean value of three nurseries.

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

Incidence of anthracnose of guava varied significantly from season to season as well as location to location and that ranged from 35.75-12.96% in 2010-2011 and 64.25-10.40% in 2011-2012 (Table 4). The highest (35.75% and 64.25%) incidence of anthracnose of guava recorded in the month of July, 2010 and July, 2011 at Khagrachari respectively. The lowest (12.96% and 10.40%) incidence was observed in the month of January, in both the years at Barisal respectively. The severity of anthracnose of guava also varied significantly from season to season as well as location to location and that ranged from 27.63-9.40% in 2010-2011 and 52.08-5.737% in 2011-2012. The highest (27.63% and 52.08%) severity of anthracnose of guava observed in the month of July, 2010 at Dhaka and July, 2011 at Barisal, while the lowest (9.40% and 5.737%) was recorded in the month of January, 2011 at Dhaka and January, 2012 at Barisal respectively.

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

Location	Data recording time(month)	**anthracnose**			
		Incidence(%)		Severity(%)	
		2010-2011	2011-2012	2010-2011	2011-2012
Dhaka.	July	32.82 b	44.18 d	27.63 a	27.63 c
	October	29.14 c	35.49 e	21.18 d	22.17 d
	January	16.45 g	19.66 hi	9.40 i	9.960 g
	April	22.32 f	27.09 g	14.40 e	12.75 f
Gazipur	July	32.74 b	34.21 ef	23.08 c	19.59 e
	October	25.08 e	25.63 g	15.63 e	13.29 f

	January	15.86 g	16.18 j	11.81 fg	13.64 f
	April	21.21 f	21.50 h	12.76 f	11.94 fg
Barisal	July	31.44 b	48.94 c	27.26 ab	52.08 a
	October	28.48 c	44.00 d	22.69 c	22.84 d
	January	12.96 h	10.40 k	9.653 hi	5.737 h
	April	17.12 g	17.22 ij	12.18 fg	11.98 fg
Khagrachari	July	35.75 a	64.25 a	25.96 b	51.64 a
	October	26.66 d	59.62 b	27.18 ab	30.77 b
	January	17.02 g	18.97 i	11.00 gh	9.767 g
	April	22.68 f	32.87 f	14.79 e	13.68 f
$LSD_{(p\geq 0.05)}$		1.459	2.339	1.455	2.412
CV(%)		3.75	4.27	4.82	6.95

Each data represents the mean value of three nurseries.

4.3.1.4. Effect of weather components on the incidence and severity of anthracnose of guava seedling during July, 2010 to April, 2012

In different growing seasons of guava seedlings, the highest incidence (33.19% and 47.90%) and the highest severity (25.98% and 37.73%) of anthracnose disease were recorded in July, in both the years which average temperature, relative humidity and rainfall were 29.65°C, 81.40% and 7.55 cm, and 30.50°C, 83.50%, 5.50 cm, respectively. On the other hand, lowest incidence (15.57% and 16.30%) and the lowest severity (10.47% and 9.77%) were recorded in January, in both the years which average temperature, relative humidity and rainfall were 16.88°C, 73.80% and 0.52 cm, and 18.46°C, 76%, 0.60 cm, respectively (Fig. 1&2).

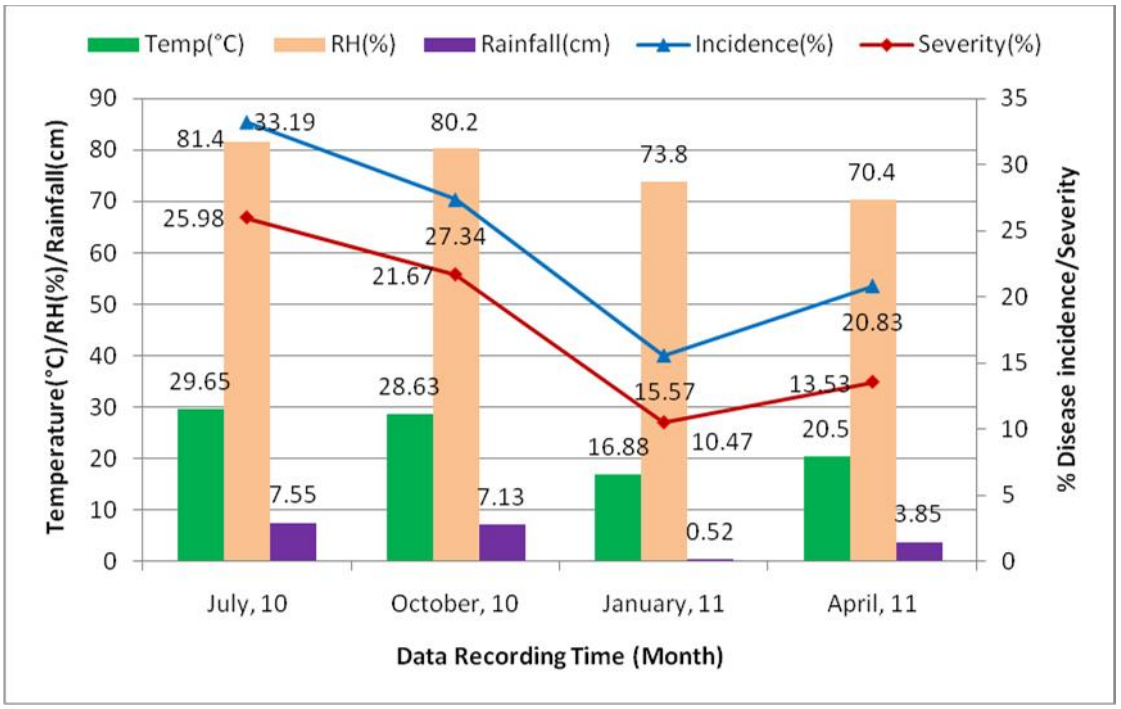


Fig. 1. Effect of different weather factors on the incidence and severity of anthracnose of guava seedling during July, 2010 to April, 2011

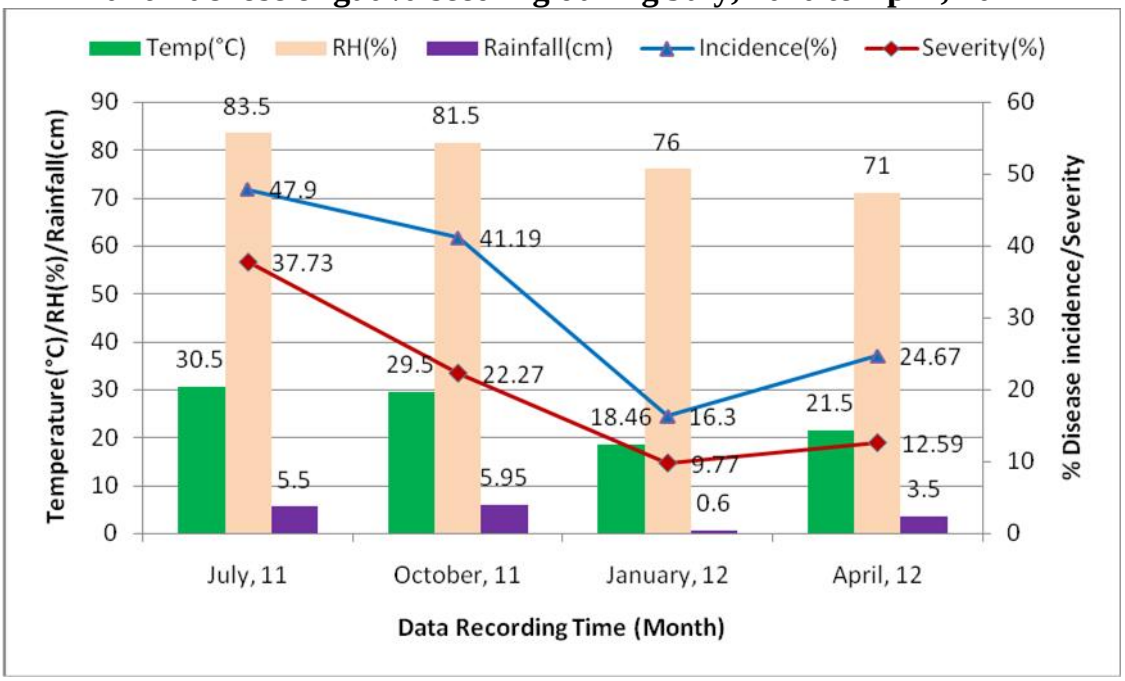


Fig. 2. Effect of different weather factors on the incidence and severity of anthracnose of guava seedling during July, 2011 to April, 2012

3.4.1.5a. Relation between anthracnose disease incidence as well as severity of guava seedlings and temperature.

A positive correlation between incidence and severity of anthracnose disease with temperature was observed in both the years. The relationship between disease incidence and temperature could be expressed by the equation $Y=1.191x-4.270$, ($R^2=0.935$) and $Y=2.437x-28.38$, ($R^2=0.984$), where x=temperature and y=disease

incidence. Here, the R^2 value indicates that the contribution of temperature to the incidence of anthracnose of guava. On the other hand, the relationship between disease severity and temperature could be expressed by the equation Y=1.129x−9.094, (R^2=0.964) and Y=1.901x−26.91, (R^2=0.798), where x=temperature and y=disease severity. Here, the R^2 value indicates that the contribution of temperature to the severity of anthracnose of guava.

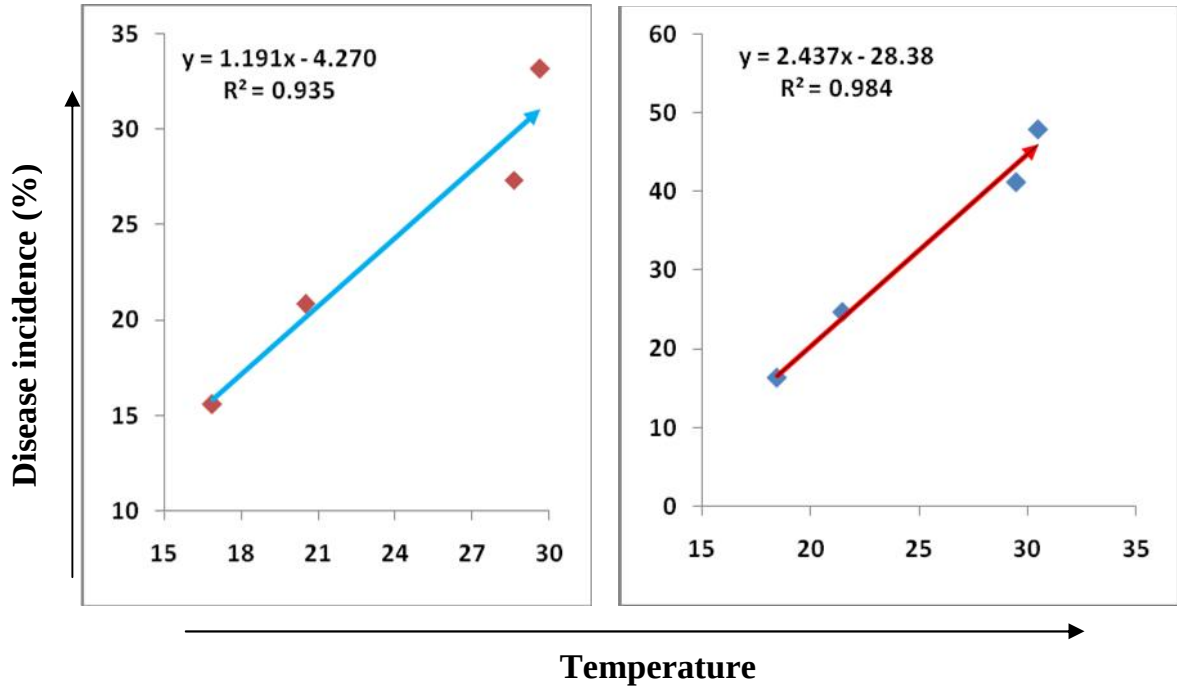
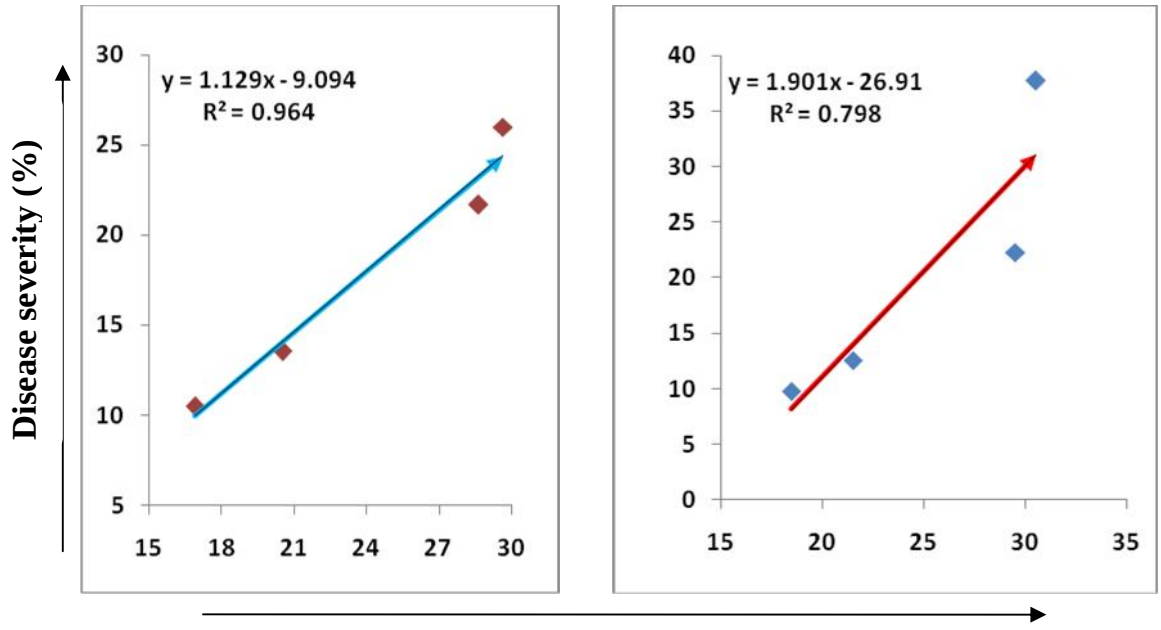


Fig. 3. Linear regression analysis of the effect of temperature on incidence of anthracnose of guava during July, 2010 to April, 2012



Temperature

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

3.4.1.5b. Relation between anthracnose disease incidence as well as severity of guava seedlings and relative humidity.

A positive correlation between incidence and severity of anthracnose disease with relative humidity was observed in both the years. The relationship between disease incidence and relative humidity could be expressed by the equation Y=1.211x–68.35, (R^2=0.682) and Y=2.118x–132.7, (R^2=0.673), 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 guava. On the other hand, the relationship between disease severity and relative humidity could be expressed by the equation Y=1.219x–75.34, (R^2=0.795) and Y=1.861x–124.6, (R^2=0.692), 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 guava.

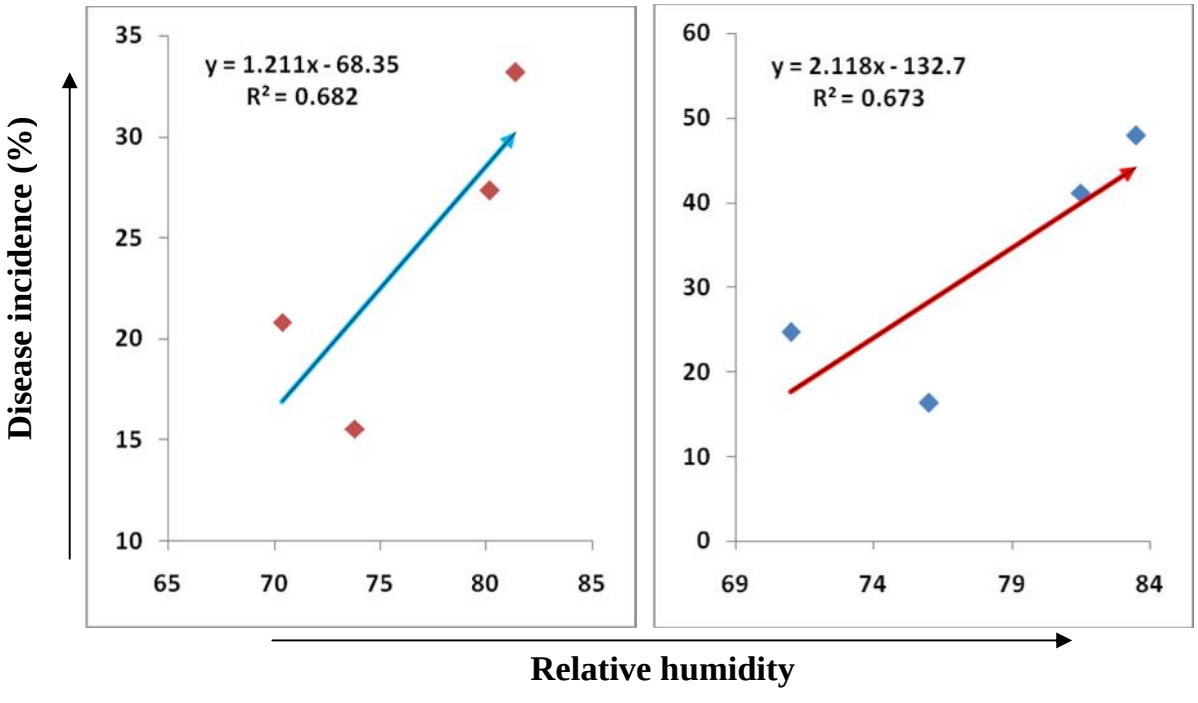


Fig. 5. Linear regression analysis of the effect of relative humidity on

incidence of anthracnose of guava during July, 2010 to April, 2012

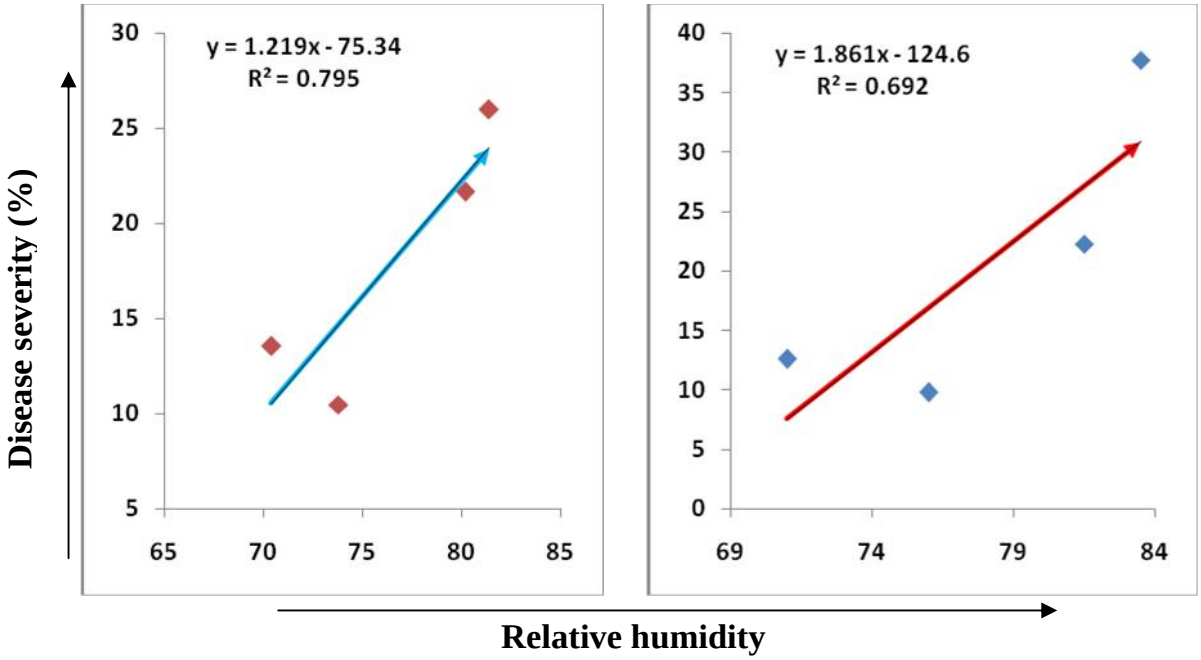


Fig. 6. Linear regression analysis of the effect of relative humidity on severity of anthracnose of guava during July, 2010 to April, 2012

3.4.1.5c. Relation between anthracnose disease incidence as well as severity of guava seedlings and rainfall.

A positive correlation between incidence and severity of anthracnose disease with rainfall was observed in both the years. The relationship between disease incidence and rainfall could be expressed by the equation Y=2.241x+13.55, (R^2=0.916) and Y=5.560x+10.89, (R^2=0.865), where x= rainfall and y=disease incidence. Here, the R^2 value indicates that the contribution of rainfall to the incidence of anthracnose of guava. On the other hand, the relationship between disease severity and rainfall could be expressed by the equation Y=2.079x+8.011, (R^2=0.905) and Y=3.917x+5.361, (R^2=0.572), where x=rainfall and y=disease severity. Here, the R^2 value indicates that the contribution of rainfall to the severity of anthracnose of guava.

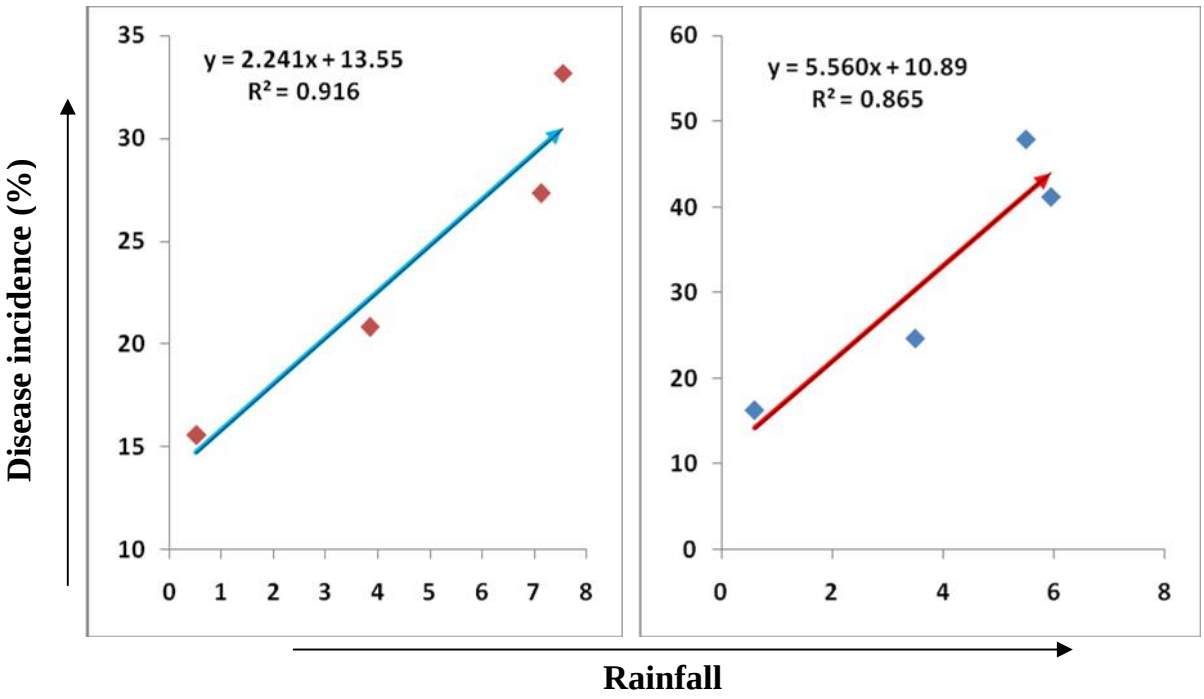


Fig. 7. Linear regression analysis of the effect of rainfall on incidence of anthracnose of guava during July, 2010 to April, 2012

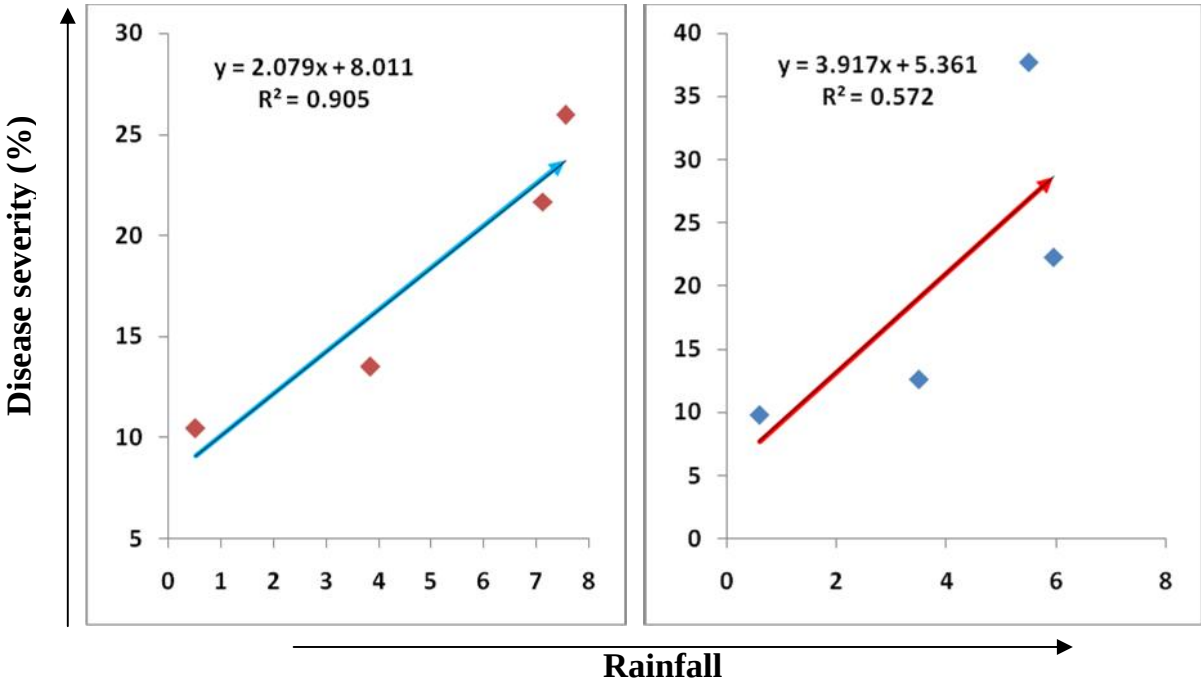


Fig. 8. Linear regression analysis of the effect of rainfall on severity of anthracnose of guava during July, 2010 to April, 2012

4.3.2.1. Incidence and severity of scab of guava at different locations of Bangladesh from July, 2010 to April, 2012

Incidence of scab of guava varied from location to location and year to year that ranged from 71.21-31.48% in 2010-2011 and 78.78-44.44% in 2011-2012 (Table 2). The highest incidence was recorded at Khagrachari and the lowest was recorded at Gazipur in both the years. The severity of scab of guava also varied from location to location and year to year that ranged from 56.45-26.74% in 2010-2011 and 66.15-37.18% in 2011-2012. The highest severity was recorded at Khagrachari in both the years and the lowest was recorded at Gazipur in 2010-2011 and Barisal in 2011-2012.

Table 5. Incidence and severity of scab of guava at different locations of Bangladesh from July, 2010 to April, 2012

Location	scab			
	Incidence (%)		Severity (%)	
	2010-2011	2011-2012	2010-2011	2011-2012
Dhaka	50.83 b	60.88 b	43.60 b	52.69 b
Gazipur	31.48 d	44.44 d	26.74 d	39.21 c
Barisal	37.19 c	47.81 c	32.85 c	37.18 c
Khagrachari	71.21 a	78.78 a	56.45 a	66.15 a
$LSD_{(p\geq 0.05)}$	1.600	3.105	1.249	2.153
CV%	1.63	2.71	1.70	3.54

Each data represents the mean value of three nurseries.

4.3.2.2. Incidence and severity of scab of guava during July, 2010 to April, 2012

Incidence of scab of guava varied from July, 2010 to April, 2012 and that ranged from 50.30-42.56% in 2010-2011 and 66.84-55.92% in 2011-2012 (Table 3). The

highest incidence was recorded in January and July and the lowest was recorded in month of October, in both the years. The severity of scab of guava also varied from year to year that ranged from 43.17-33.85% in 2010-2011 and 56.19-39.28% in 2011-2012. The highest severity was recorded in January and the lowest was recorded in October, in both the years.

Table 6. Incidence and severity of scab of guava during July, 2010 to April, 2012

Time of data collection	scab			
	Incidence (%)		Severity (%)	
	2010-2011	2011-2012	2010-2011	2011-2012
July	47.75 b	66.84 a	41.67 b	56.19 a
October	42.56 c	51.73 c	33.85 c	39.28 d
January	50.30 a	55.92 b	43.17 a	47.53 c
April	50.11 b	57.42 b	40.97b	52.22 b
$LSD_{(p\geq0.05)}$	1.312	2.651	1.143	2.915
CV%	1.63	2.71	1.70	3.54

Each data represents the mean value of three nurseries.

4.3.2.3. Incidence and severity of scab of guava during July, 2010 to April, 2012 of different experimental locations of Bangladesh

Incidence of scab of guava varied significantly from season to season as well as location to location and that ranged from 86.01-27.79% in 2010-2011 and 93.76-37.80% in 2011-2012 (Table 4). The highest (86.01% and 93.76%) incidence of scab of guava recorded in the month of January, in both the years, at Khagrachari

respectively. The lowest (27.79% and 37.80%) incidence was observed in the month of January, in 2010-2011 at Gazipur and April, 2011-2012 at Barisal respectively. The severity of scab of guava also varied significantly from season to season as well as location to location and that ranged from 66.50-22.74% in 2010-2011 and 87.31-30.60% in 2011-2012. The highest (66.50% and 87.31%) severity of scab of guava observed in the month of January, in both the years at Khagrachari, while the lowest (22.74% and 30.60%) was recorded in the month of January, in 2010-2011 at Gazipur and January, in 2011-2012 at Barisal.

Table 7. Incidence and severity of scab of guava during July, 2010 to April, 2012 of different experimental locations of Bangladesh.

Location	Data recording time (month)	scab			
		Incidence(%)		Severity(%)	
		2010-2011	2011-2012	2010-2011	2011-2012
Dhaka.	July	52.26 e	68.07 e	45.04 e	67.00 b
	October	48.85 f	55.03 f	38.61 g	40.27 ef
	January	46.11 g	46.04 h	39.56 g	37.91 fg

	April	56.11 d	74.37 d	51.19 d	65.60 b
Gazipur	July	34.84 k	55.43 f	31.73 j	48.00 c
	October	31.45 m	43.47 h	26.07 l	37.00 gh
	January	27.79 n	38.73 i	22.74 m	34.31 hi
	April	31.85 lm	40.14 i	26.44 l	37.51 fg
Barisal	July	38.05 i	56.60 f	33.83 i	44.00 d
	October	32.92 l	51.70 g	28.94 k	33.14 ij
	January	41.30 h	45.14 h	35.07 h	30.60 j
	April	36.49 j	37.80 i	33.57 i	40.97 e
Khagrachari	July	65.87 c	87.25 b	56.07 c	65.77 b
	October	57.00 d	56.73 f	41.77 f	46.70 cd
	January	86.01 a	93.76 a	66.50 a	87.31 a
	April	75.97 b	77.39 c	61.49 b	64.81 b
$LSD_{(p\geq0.05)}$		1.312	2.651	1.143	2.915
CV(%)		1.63	2.71	1.70	3.54

Each data represents the mean value of three nurseries.

3.4.2.4. Effect of weather components on the incidence and severity of scab disease of guava seedling

In different growing seasons of guava seedlings, the highest incidence (50.30% and 66.84%) and the highest severity (43.17% and 56.19%) of scab disease were recorded in January, in 2010-2011 and in July, in 2011-2012 which average temperature, relative humidity and rainfall were 16.88°C, 73.80% and 0.52 cm, and 30.50°C, 83.50%, 5.50 cm, respectively. On the other hand, lowest incidence (42.56% and 51.73%) and the lowest severity (33.85% and 39.28%) were recorded in October, in both the years which average temperature, relative humidity and rainfall were 28.63°C, 80.20% and 7.13 cm, and 29.50°C, 81.50%, 5.95 cm, respectively (Fig. 9&10).

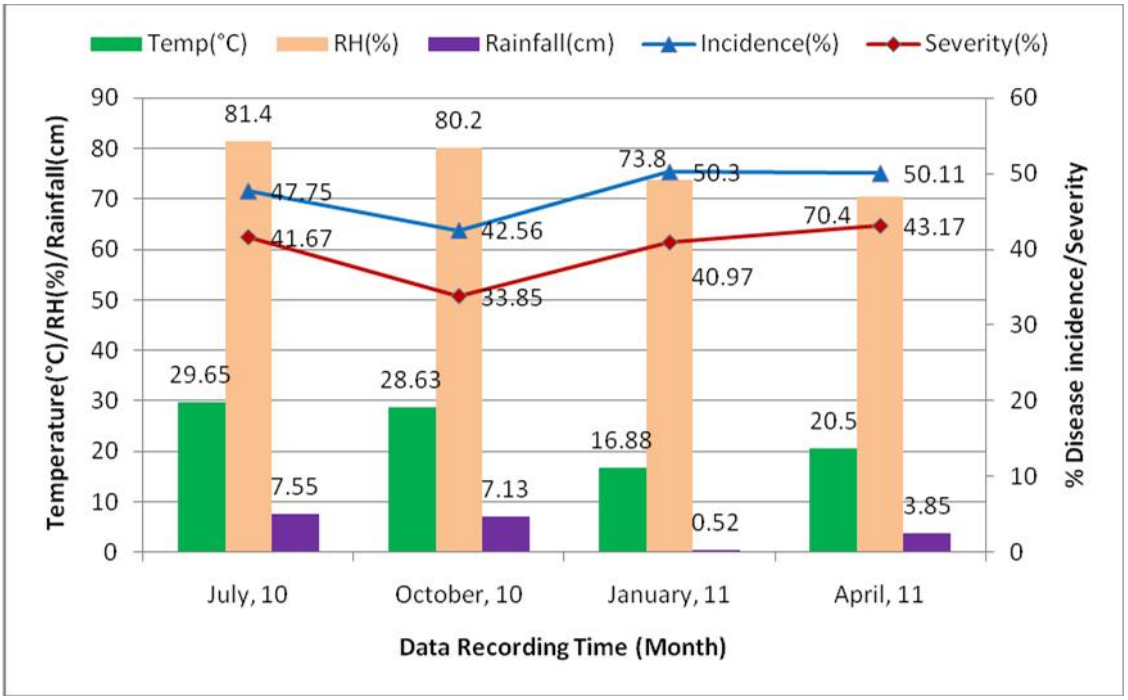


Fig. 9. Effect of different weather factors on the incidence and severity of scab of guava seedling during July, 2010 to April, 2011

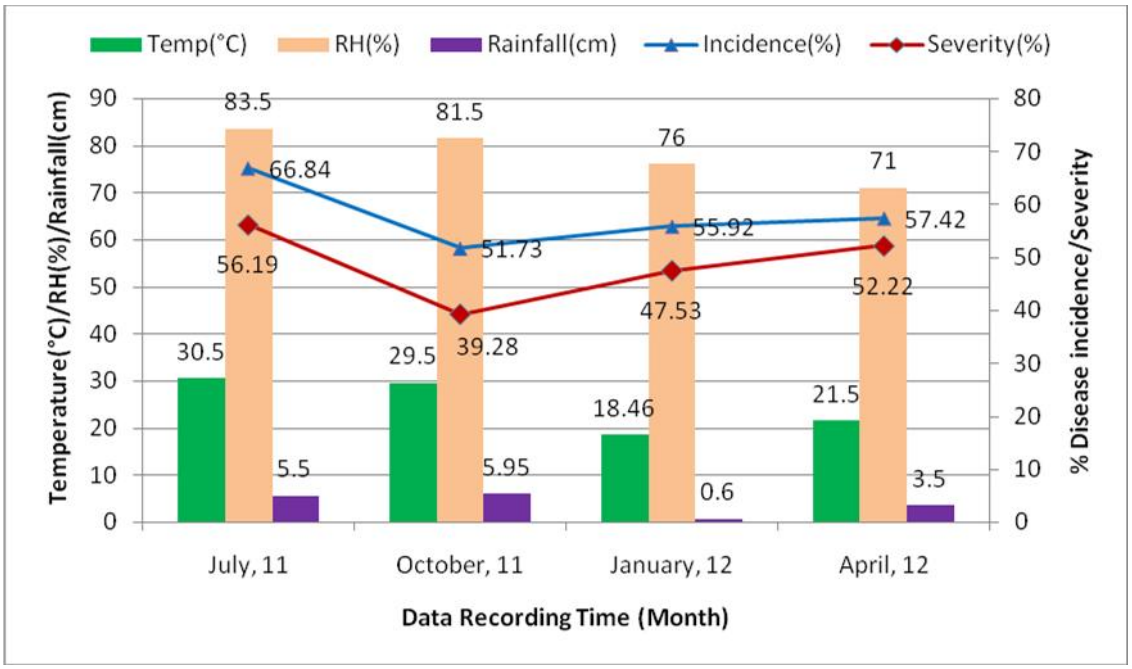


Fig. 10. Effect of different weather factors on the incidence and severity of scab of guava seedling during July, 2011 to April, 2012

4.3.2.5a. Relation between scab disease incidence as well as severity of guava seedlings and temperature.

A negative correlation between incidence and severity of scab disease with temperature was observed in 2010-2011 and a positive correlation with incidence as well as negative correlation with severity of scab disease was observed in 2011-2012. The relationship between disease incidence and temperature could be

expressed by the equation Y=−0.434x+58.06, (R^2=0.561) and Y=0.341x+49.44, (R^2=0.100), where x=temperature and y=disease incidence. Here, the R^2 value indicates that the contribution of temperature to the incidence of scab of guava. On the other hand, the relationship between disease severity and temperature could be expressed by the equation Y=−0.318x+47.53, (R^2=0.229), and Y=0.055x+50.19, (R^2=0.002), where x=temperature and y=disease severity. Here, the R^2 value indicates that the contribution of temperature to the severity of scab of guava.

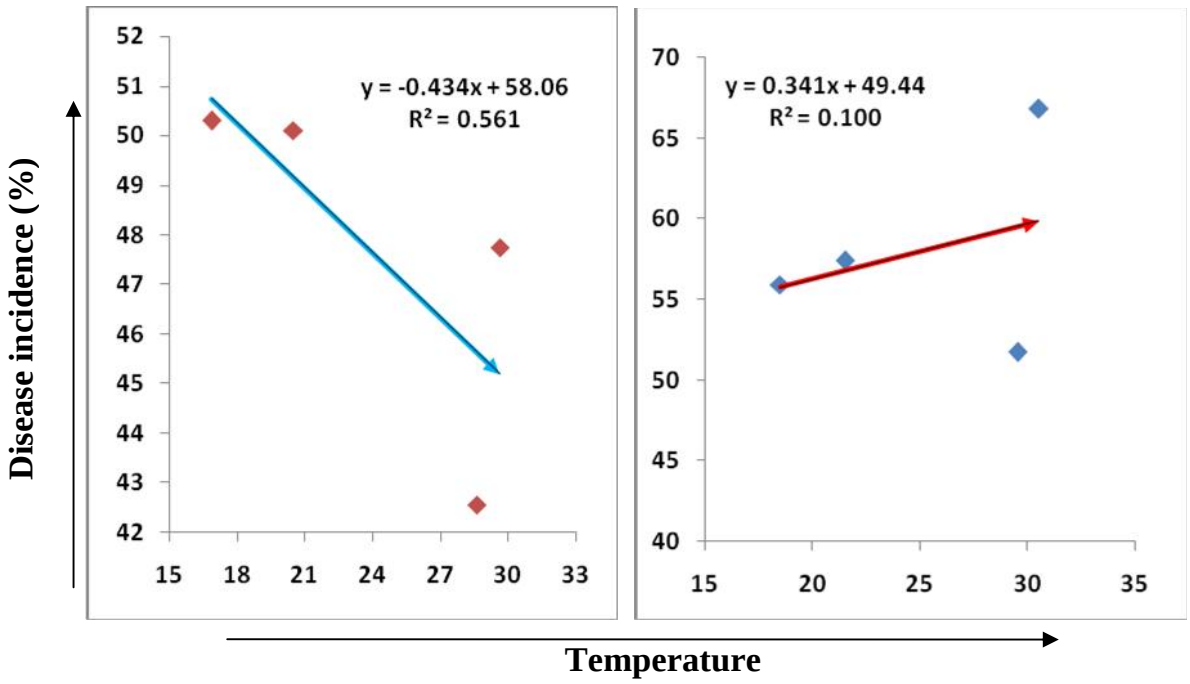
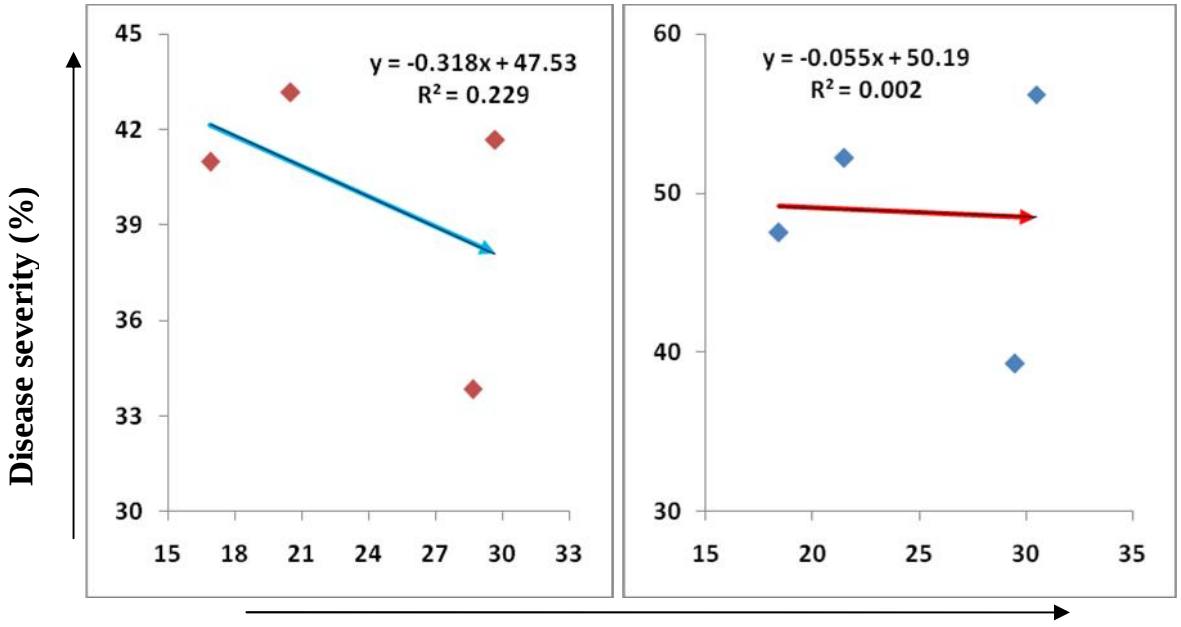


Fig. 11. Linear regression analysis of the effect of temperature on incidence of scab of guava during July, 2010 to April, 2012



Temperature

Fig. 12. Linear regression analysis of the effect of temperature on severity of scab of guava during July, 2010 to April, 2012

4.3.2.5b. Relation between scab disease incidence as well as severity of guava seedlings and relative humidity.

A negative correlation between incidence and severity of scab disease with relative humidity was observed in 2010-2011 and a positive correlation with incidence as well as negative correlation with severity of scab disease was observed in 2011-2012. The relationship between disease incidence and relative humidity could be expressed by the equation Y=−0.492x+85.35, (R^2=0.511) and Y=0.365x+ 29.47, (R^2=0.104), where x= relative humidity and y=disease incidence. Here, the R^2 value indicates that the contribution of relative humidity to the incidence of scab of guava. On the other hand, the relationship between disease severity and relative humidity could be expressed by the equation Y=−0.444x+73.90, (R^2=0.325), and Y=−0.147x+60.30, (R^2=0.013), where x=relative humidity and y=disease severity. Here, the R^2 value indicates that the contribution of relative humidity to the severity of scab of guava.

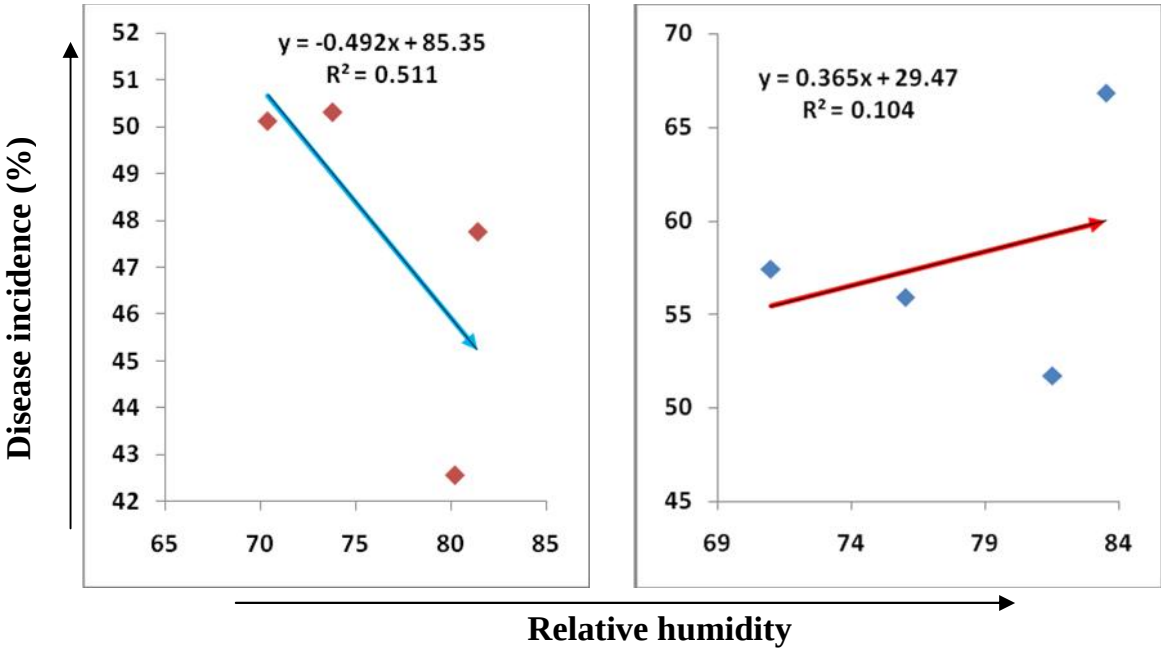


Fig. 13. Linear regression analysis of the effect of relative humidity on incidence of scab of guava during July, 2010 to April, 2012

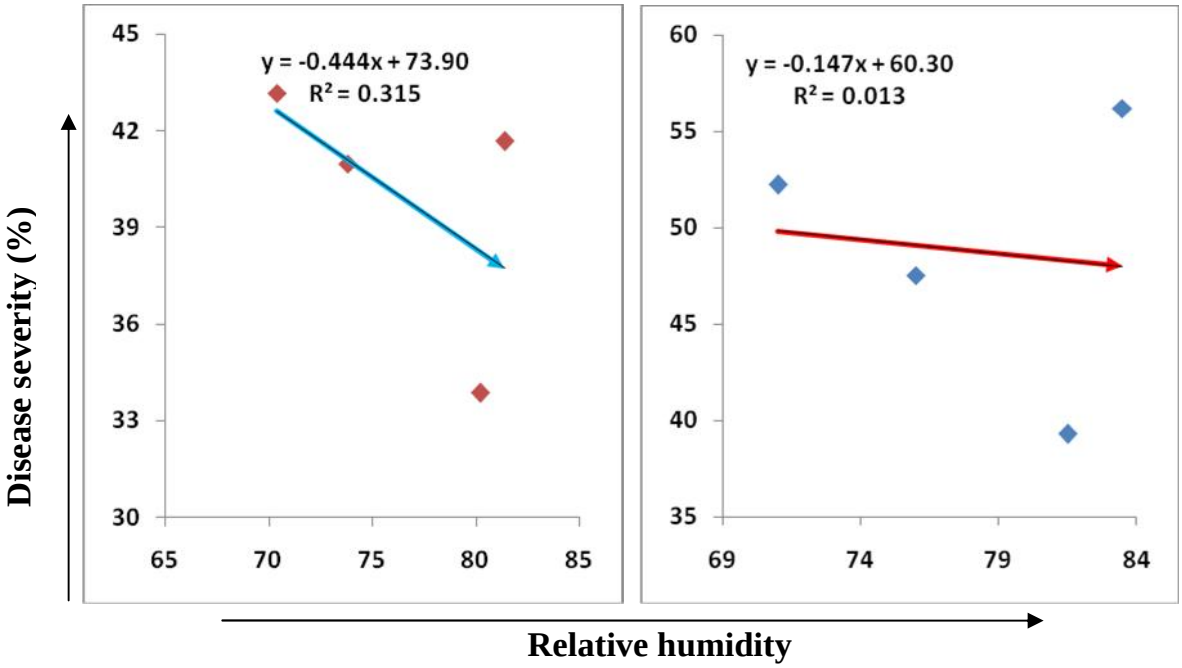


Fig. 14. Linear regression analysis of the effect of relative humidity on severity of scab of guava during July, 2010 to April, 2012

4.3.2.5c. Relation between scab disease incidence as well as severity of guava seedlings and rainfall.

A negative correlation between incidence and severity of scab disease with rainfall was observed in 2010-2011 and a positive correlation with incidence as well as negative correlation with severity of scab disease was observed in 2011-2012. The relationship between disease incidence and rainfall could be expressed by the equation $Y=-0.784x+51.41$, ($R^2=0.508$) and $Y=0.470x+56.14$, ($R^2=0.032$), where x= rainfall and y=disease incidence. Here, the R^2 value indicates that the contribution of rainfall to the incidence of scab of guava. On the other hand, the relationship between disease severity and rainfall could be expressed by the equation $Y=-0.525x+42.41$, ($R^2=0.172$), and $Y=-0.273x+49.86$, ($R^2=0.008$), where x= rainfall and y=disease severity. Here, the R^2 value indicates that the contribution of rainfall to the severity of scab of guava.

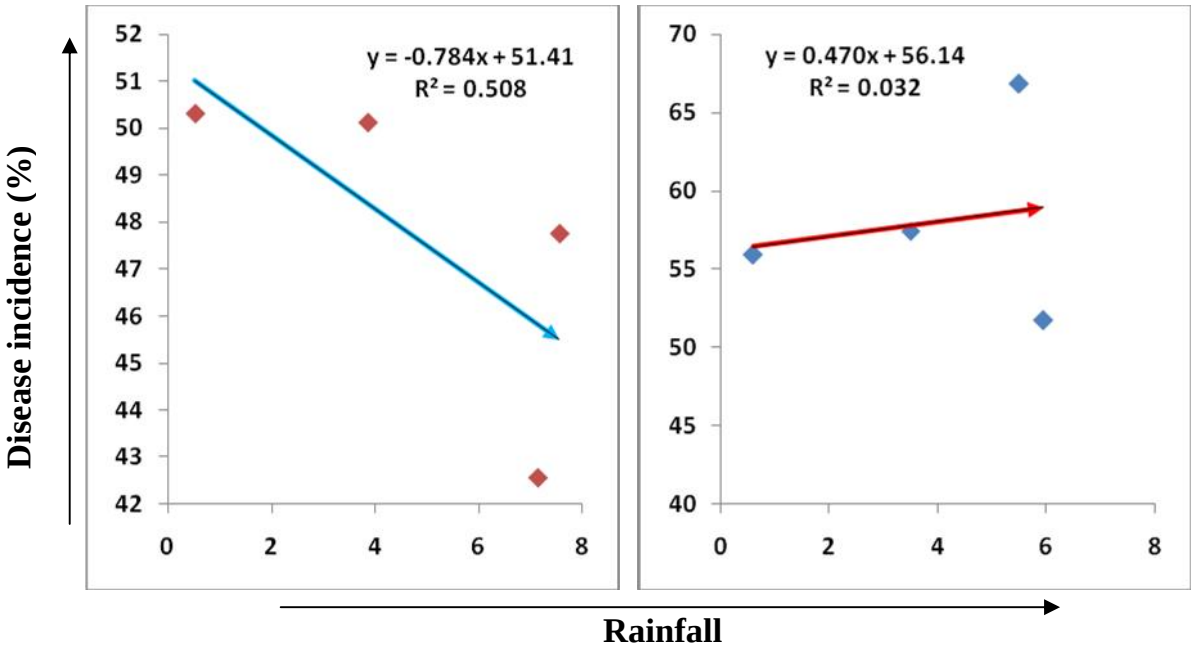


Fig. 15. Linear regression analysis of the effect of rainfall on incidence of scab of guava during July, 2010 to April, 2012

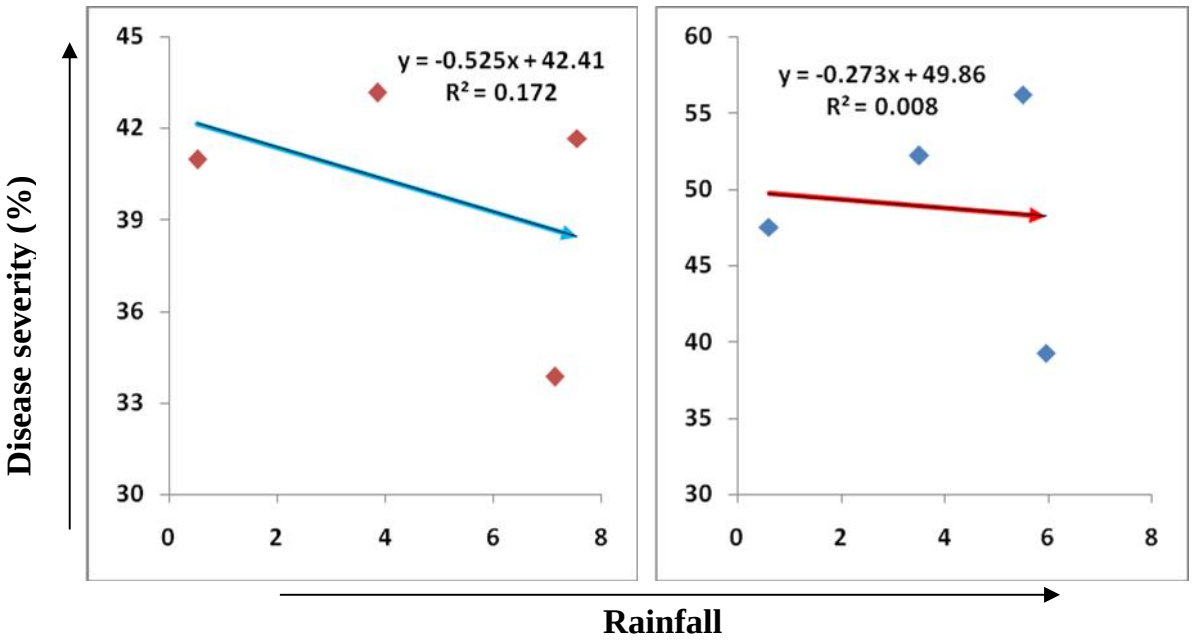


Fig. 16. Linear regression analysis of the effect of rainfall severity of scab of guava during July, 2010 to April, 2012

4.3.3.1. Incidence and severity of leaf blight of guava at different locations

of Bangladesh from July, 2010 to April, 2012

Incidence of leaf blight of guava varied from location to location and year to year that ranged from 39.93-23.48% in 2010-2011 and 42.54-26.75% in 2011-2012 (Table 2). The highest incidence (39.93%) was recorded at Gazipur in 2010-2011 and (42.54%) at Barisal in 2011-2012. The lowest incidence was recorded at Khagrachari in both the years. The severity of leaf blight of guava also varied from location to location and year to year that ranged from 33.65-19.05% in 2010-2011 and 38.54-25.62% in 2011-2012. The highest severity (33.65%) was recorded at Gazipur in 2010-2011 and (38.54%) at Barisal in 2011-2012. The lowest severity was recorded at Khagrachari in 2010-2011 and at Dhaka in 2011-2012.

Table 8. Incidence and severity of leaf blight of guava at different locations of Bangladesh from July, 2010 to April, 2012

Location	leaf blight			
	Incidence (%)		Severity (%)	
	2010-2011	2011-2012	2010-2011	2011-2012
Dhaka	32.40 b	38.70 ab	22.74 c	25.62 c
Gazipur	39.93 a	34.63 b	33.65 a	31.15 b
Barisal	31.48 b	42.54 a	24.81 b	38.54 a
Khagrachari	23.48 c	26.75 c	19.05 d	28.07 bc
$LSD_{(p\geq 0.05)}$	1.626	4.350	0.6921	3.093
CV%	2.49	5.36	2.90	4.68

Each data represents the mean value of three nurseries.

4.3.3.2. Incidence and severity of leaf blight of guava during July, 2010 to April, 2012 in Bangladesh

Incidence of leaf blight of guava varied significantly from July, 2011 to April, 2012 and that ranged from 42.47-20.32% in 2010-2011 and 54.75-21.86% in 2011-2012 (Table 3). The highest incidence (42.47% and 54.75%) was recorded in July, in both the years. And the lowest (20.32% and 21.86%) was observed in the month of January, in both the years. The severity of leaf blight of guava, varied significantly from July, 2011 to April, 2012 and that ranged from 35.77-15.31% in 2010-2011 and 50.88-14.27% in 2011-2012. The highest severity (35.77% and 50.88%) was recorded in the month of July, in both the years. And the lowest (15.31% and 14.27%) was observed in the month of January, in both the years.

Table 9. Incidence and severity of leaf blight of guava during July, 2010 to April, 2012 in Bangladesh

Time of data collection	leaf blight			
	Incidence (%)		Severity (%)	
	2010-2011	2011-2012	2010-2011	2011-2012
July	42.67 a	54.75 a	35.77 a	50.88 a
October	36.14 b	36.42 b	30.81 b	39.06 b
January	20.32 d	21.86 d	15.31 d	14.27 d
April	28.18 c	29.60 c	18.36 c	19.17 c
$LSD_{(p\geq0.05)}$	1.335	3.223	1.227	2.431
CV%	2.49	5.36	2.90	4.68

Each data represents the mean value of three nurseries.

4.3.3.1. Incidence and severity of leaf blight of guava during July, 2010 to April, 2012 of different experimental locations of Bangladesh.

Incidence of leaf blight of guava varied significantly from season to season as well as location to location and that ranged from 55.55-13.15% in 2010-2011 and 67.22-19.25% in 2011-2012 (Table 4). The highest incidence (55.55% and

67.22%) was recorded in the month of July, in 2010-2011 at Gazipur and July, in 2011-2012 at Barisal respectively. The lowest incidence (13.15% and 19.25%) was observed in the month of January, at Khagrachari respectively. The severity of leaf blight of guava also varied significantly from season to season as well as location to location and that ranged from 47.41-10.73% in 2010-2011 and 65.62-11.66% in 2011-2012. The highest severity (47.41% and 65.62%) was observed in the month of July, in 2010-2011 at Gazipur and July, in 2011-2012 at Barisal, while the lowest (10.73% and 11.66%) was recorded in the month of January, 2010-2011 at Khagrachari and January, 2011-2012 at Dhaka respectively.

Table 10. Incidence and severity of leaf blight of guava during July, 20 to April, 2012 of different experimental locations of Bangladesh.

Location	Data recording time (month)	**leaf blight**			
		Incidence(%)		Severity(%)	
		2010-2011	2011-2012	2010-2011	2011-2012
Dhaka.	July	42.56 c	62.82 b	34.37 c	48.74 c
	October	37.67 e	43.30 d	27.92 e	26.70 f

	January	21.68 k	20.65 g	12.66 l	11.66 j
	April	27.71 h	28.03 f	16.02 jk	15.38 i
Gazipur	July	55.55 a	55.48 c	47.41 a	46.49 c
	October	45.14 b	35.21 e	41.86 b	52.63 b
	January	23.23 j	20.75 g	20.72 h	12.06 j
	April	35.81 f	27.08 f	24.61 g	13.41 ij
Barisal	July	41.18 d	67.22 a	35.38 c	65.62 a
	October	35.35 f	41.50 d	31.65 d	43.90 d
	January	23.20 j	26.79 f	17.11 ij	21.09 h
	April	26.17 i	34.64 e	15.08 k	23.56 g
Khagrachari	July	31.37 g	33.47 e	25.92 f	42.67 d
	October	26.39 hi	25.66 f	21.81 h	33.00 e
	January	13.15 l	19.25 g	10.73 m	12.26 j
	April	23.01 jk	28.63 f	17.73 i	24.33 fg
$LSD_{(p\geq0.05)}$		1.335	3.223	1.227	2.431
CV(%)		2.49	5.36	2.90	4.68

Each data represents the mean value of three nurseries.

4.3.3.4. Effect of weather components on the incidence and severity of leaf blight of guava seedling during July, 20 to April, 2012

In different growing seasons of guava seedlings, the highest incidence (42.67% and 54.75%) and the highest severity (35.77% and 50.88%) of leaf blight disease were recorded in July, in both the years which average temperature, relative humidity and rainfall were 29.65°C, 81.40% and 7.55 cm, and 30.50°C, 83.50%, 5.50 cm, respectively. On the other hand, lowest incidence (20.32% and 21.86%) and the lowest severity (15.31% and 14.27%) were recorded in January, in both the years which average temperature, relative humidity and rainfall were 16.88°C, 73.80% and 0.52 cm, and 18.46°C, 76%, 0.60 cm, respectively (Fig. 17&18).

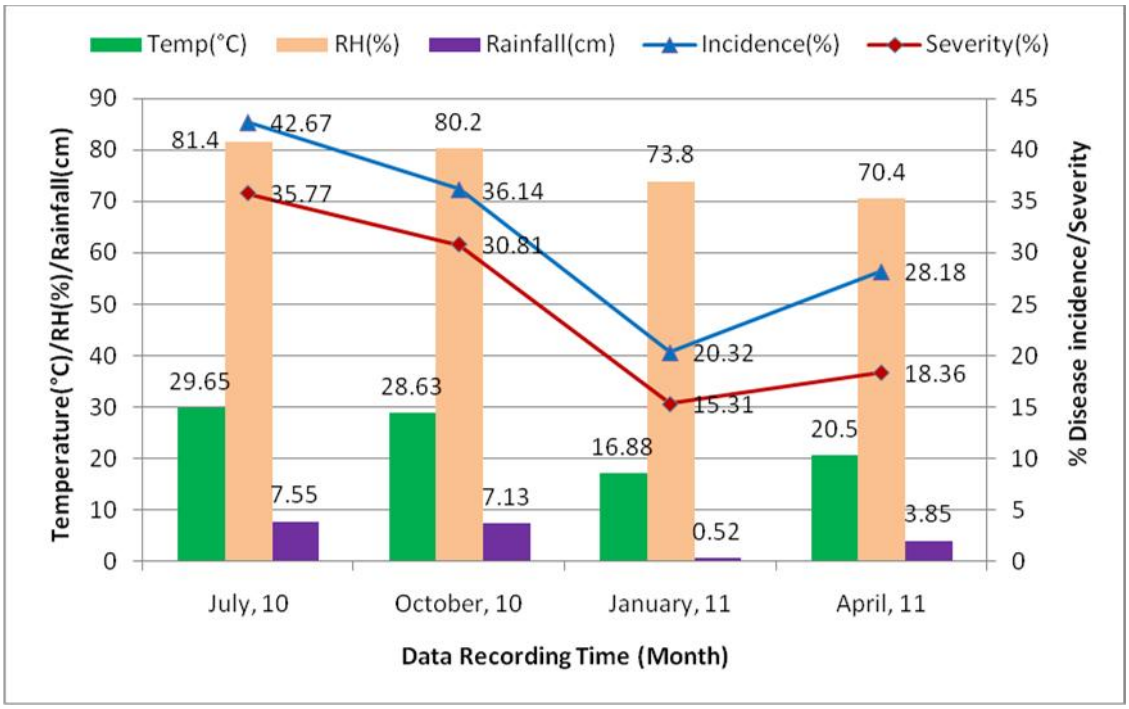


Fig. 17. Effect of different weather factors on the incidence and severity of leaf blight of guava seedling during July, 2010 to April, 2011

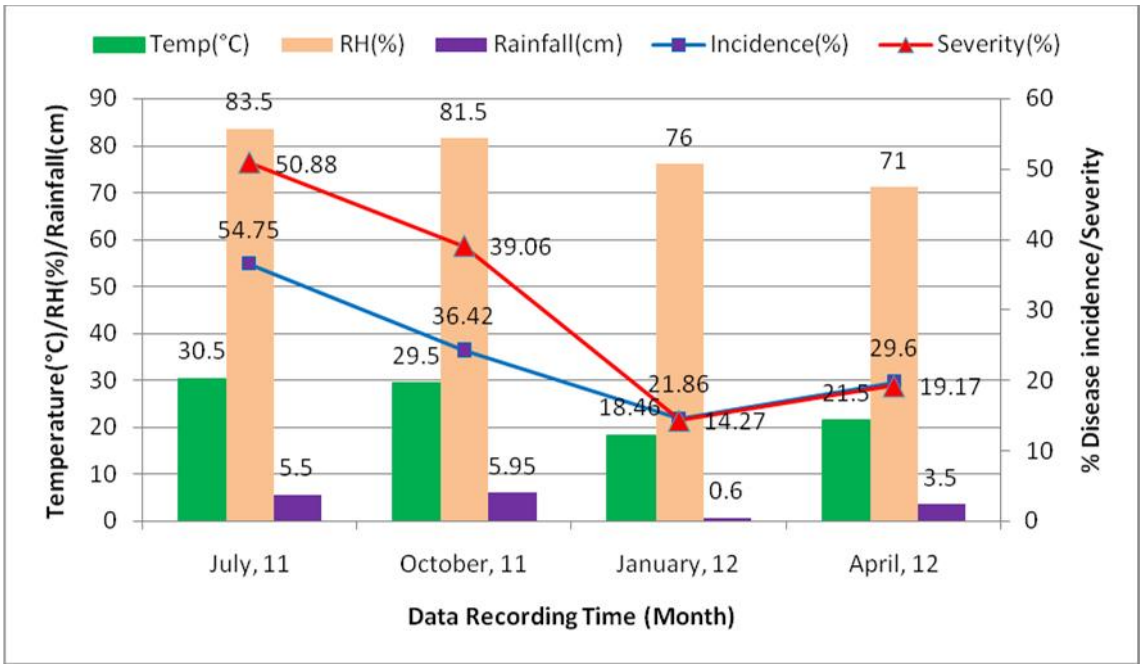


Fig. 18. Effect of different weather factors on the incidence and severity of leaf blight of guava seedling during July, 2011 to April, 2012

4.3.3.5a. Relation between leaf blight disease incidence as well as severity of guava seedlings and temperature.

A positive correlation between incidence and severity of leaf blight disease with temperature was observed in both the years. The relationship between disease

incidence and temperature could be expressed by the equation Y=1.513x–4.365, (R^2=0.944) and Y=0.2.083x–16.41, (R^2=0.773), where x=temperature and y=disease incidence. Here, the R^2 value indicates that the contribution of temperature to the incidence of leaf blight of guava. On the other hand, the relationship between disease severity and temperature could be expressed by the equation Y=1.548x–11.96, (R^2=0.968), and Y=2.809x– 39.35, (R^2 = 0.946), where x=temperature and y=disease severity. Here, the R^2 value indicates that the contribution of temperature to the severity of leaf blight of guava.

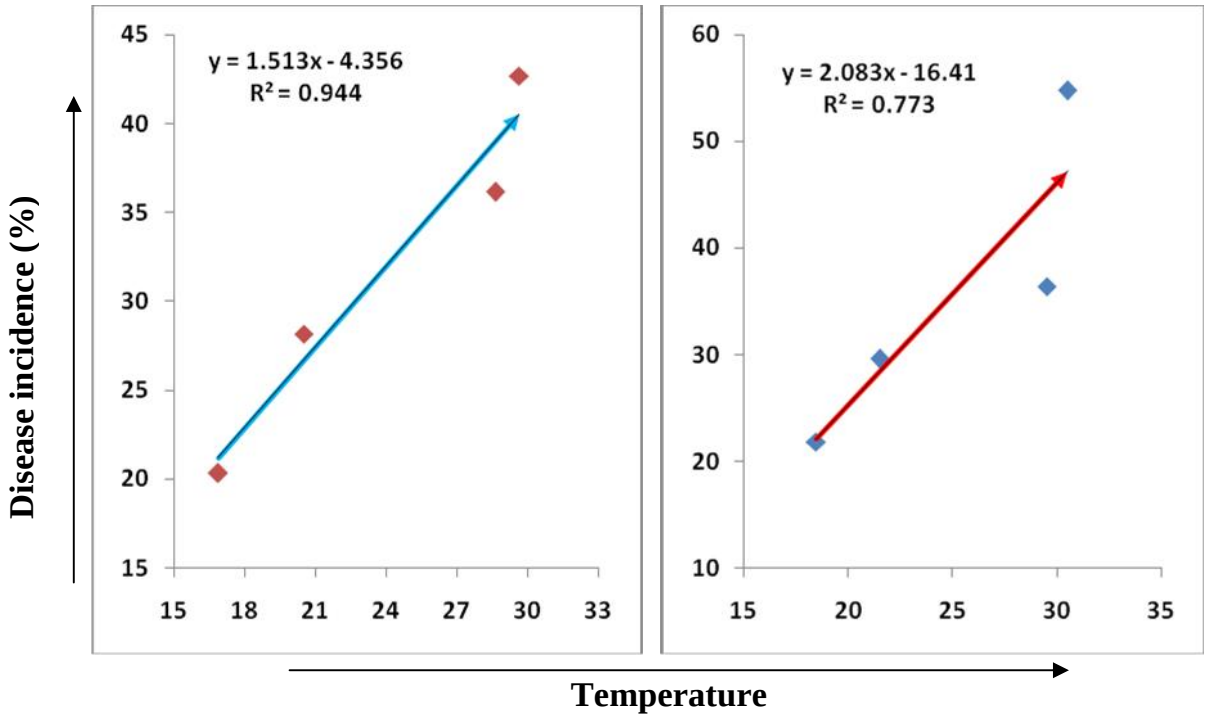


Fig. 19. Linear regression analysis of the effect of temperature on incidence of leaf blight of guava during July, 2010 to April, 2012

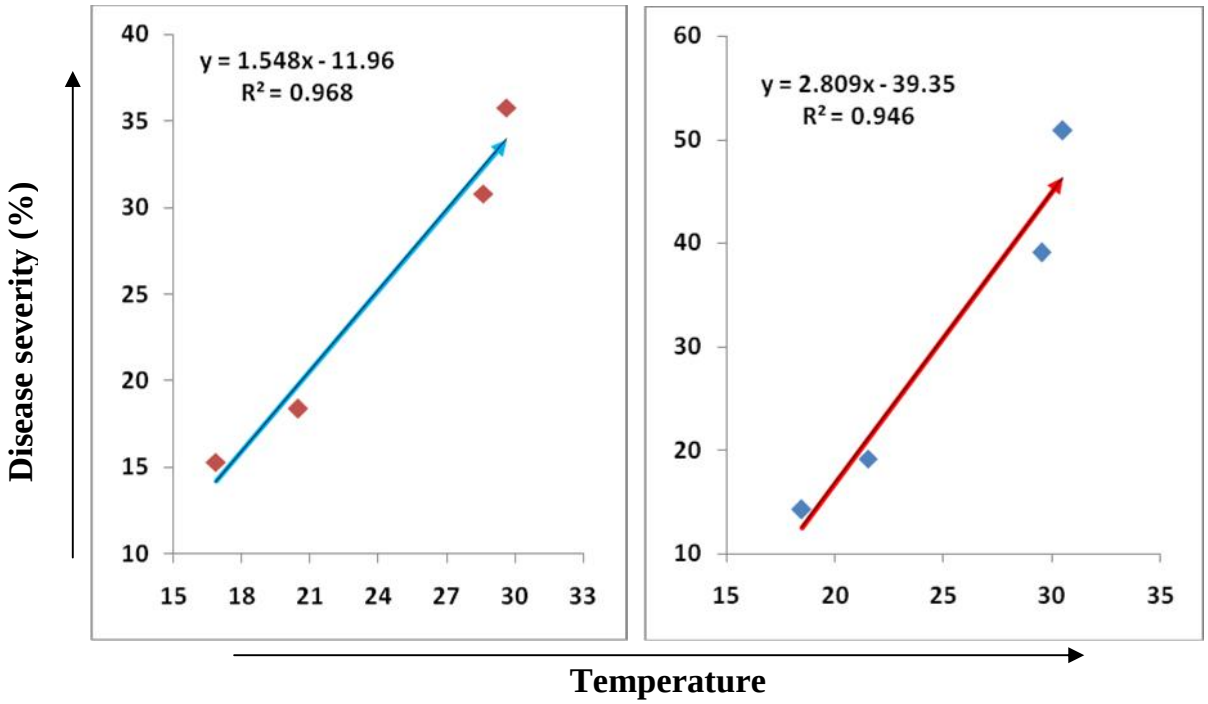


Fig. 20. Linear regression analysis of the effect of temperature on severity of leaf blight of guava during July, 2010 to April, 2012

4.3.3.5b. Relation between leaf blight disease incidence as well as severity of guava seedlings and relative humidity.

A positive correlation between incidence and severity of leaf blight disease with relative humidity was observed in both the years. The relationship between disease incidence and relative humidity could be expressed by the equation Y=1.489x–82.02, (R^2 = 0.645) and Y=1.860x–109.4, (R^2=0.558), 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 blight of guava. On the other hand, the relationship between disease severity and relative humidity could be expressed by the equation Y=1.714x–106, (R^2=0.840), and Y=2.657x–176.4, (R^2 = 0.766), 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 blight of guava.

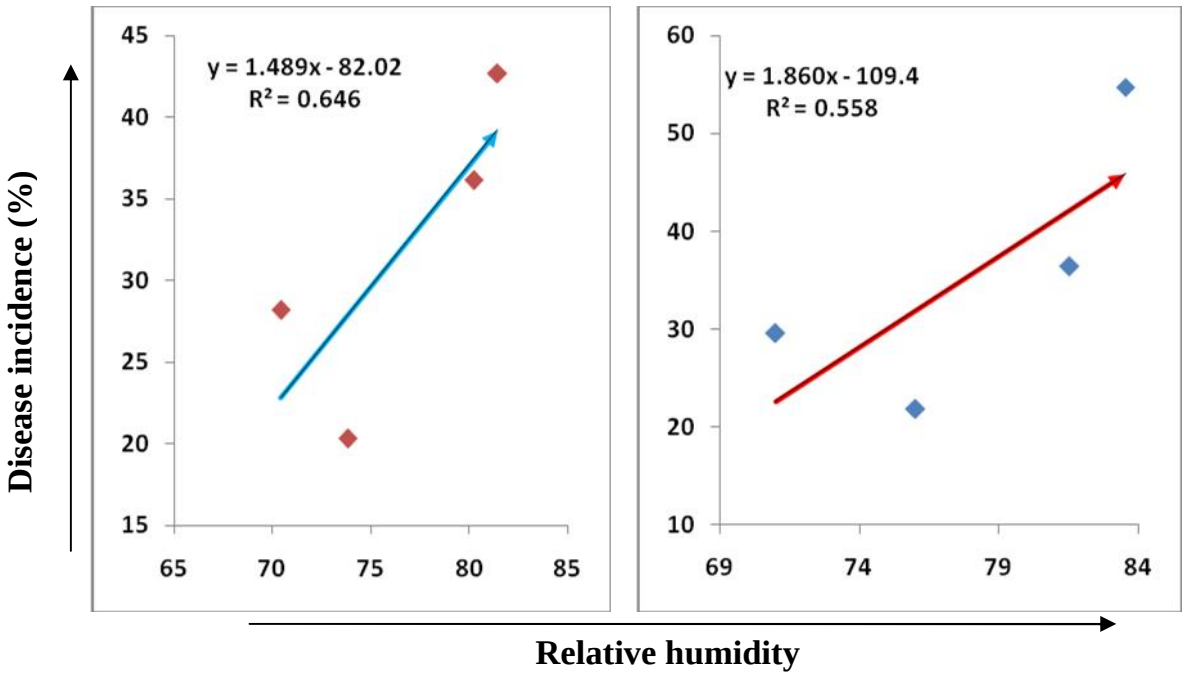


Fig. 21. Linear regression analysis of the effect of relative humidity on incidence of leaf blight of guava during July, 2010 to April, 2012

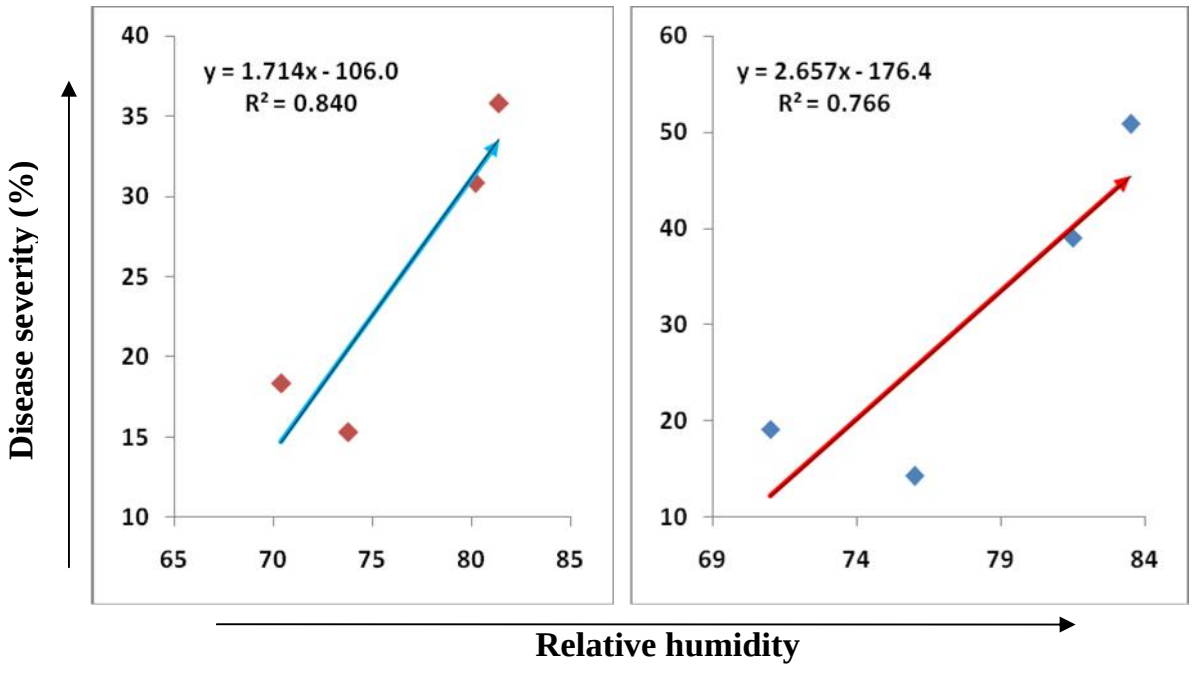


Fig. 22. Linear regression analysis of the effect of relative humidity on severity of leaf blight of guava during July, 2010 to April, 2012

4.3.3.5c. Relation between leaf blight disease incidence as well as severity of guava seedlings and rainfall.

A positive correlation between incidence and severity of leaf blight disease with rainfall was observed in both the years. The relationship between disease incidence

and rainfall could be expressed by the equation Y=2.874x+18.13, (R^2=0.944) and Y=4.495x+18.18, (R^2=0.607), where x= rainfall and y=disease incidence. Here, the R^2 value indicates that the contribution of rainfall to the incidence of leaf blight of guava. On the other hand, the relationship between disease severity and rainfall could be expressed by the equation Y=2.823x+11.61, (R^2=0.892), and Y=6.078x+7.216, (R^2=0.747), where x=rainfall and y=disease severity. Here, the R^2 value indicates that the contribution of rainfall to the severity of leaf blight of guava.

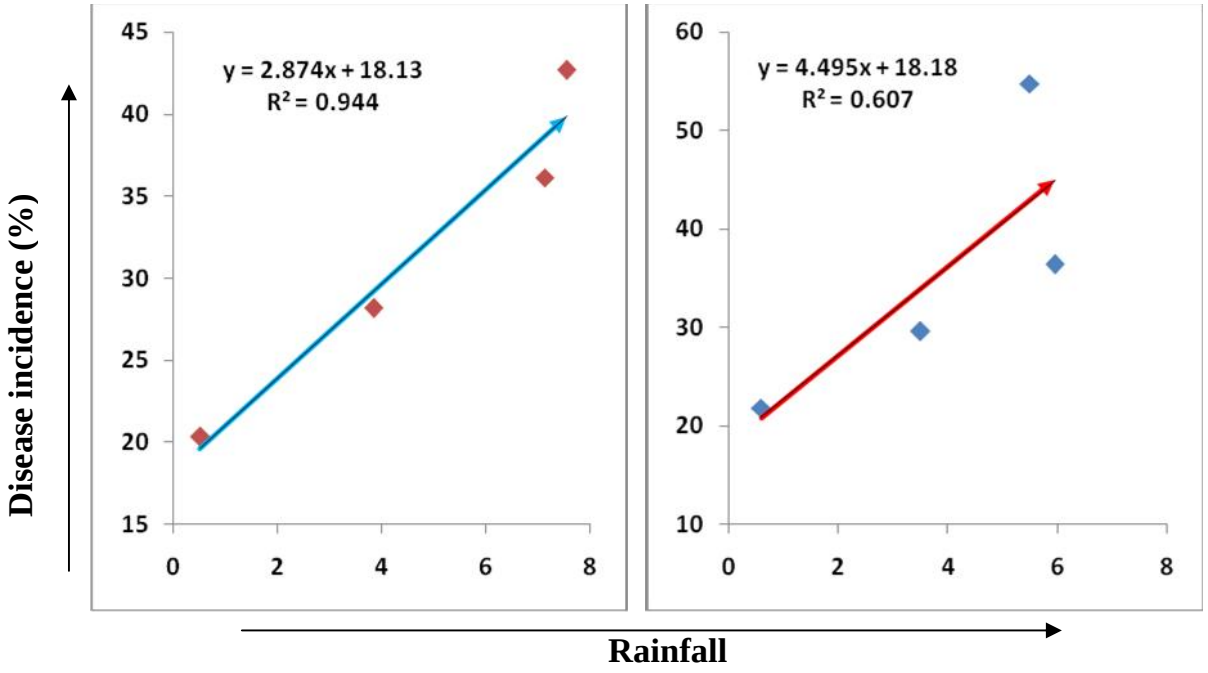
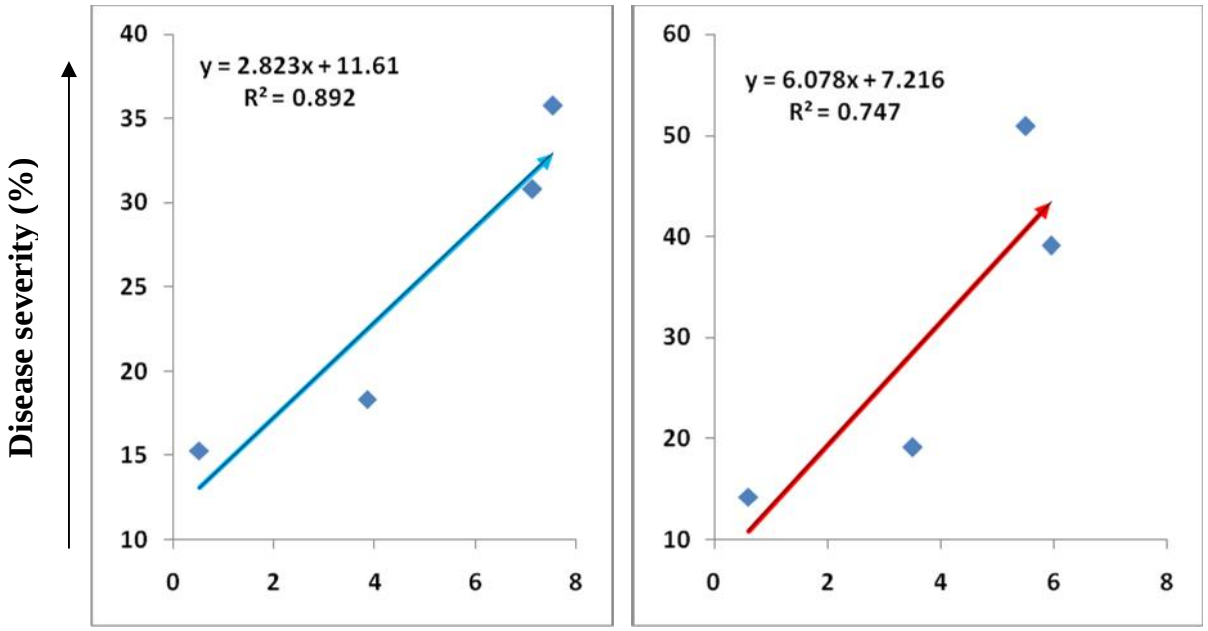


Fig. 23. Linear regression analysis of the effect of rainfall on incidence of leaf blight of guava during July, 2010 to April, 2012



Rainfall

Fig. 24. Linear regression analysis of the effect of rainfall on severity of leaf blight of guava during July, 2010 to April, 2012

4.3.5. Average temperature, relative humidity and rainfall 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 the following table:

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

Month	Average Temperature	Average Relative humidity	Average Rainfall
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

Guava, one of the major fruit crops of Bangladesh, was surveyed during the research period of July, 2010 to April, 2012. The survey was designed to study the nursery diseases of guava and to observe the effect of temperature, relative humidity and rainfall on the occurrence of disease incidence and severity on seedlings. Altogether three diseases of guava viz. anthracnose, scab, and leaf blight were recorded in all the locations during the survey in the eight nurseries. The nurseries were Green orchid nursery, Barisal nursery, Gazipur nursery, Laxmipur nursery, Sarchina nursery, Riyad nursery, Hill Research Center, and Ramghar nursery under four districts of Bangladesh. These diseases were recorded as a common disease in all the growing areas. The diseases recorded in the present study have also been reported on guava seedlings from different countries of the world by (Chowdhury, 2009; Chowdhury *et al.,* 2011; Hossain, 2011; Keith *et al*., 2006 and Marques *et al*., 2007). The diseases were identified by observing the symptoms on the seedlings during survey and determination of presence of fungi were made either directly by preparation of slides and examining them under compound microscope or indirectly by isolation to agar culture following keys outline by (Singh, 1978; Pathak, 1980; Peterson, 1986; Singh, 1998 and Ploetz *et al.*, 1998).

In the investigation, *Colletotrichum gloeosporioides* were isolated from anthracnose diseased leaf. Anthracnose in guava seedling caused by *Colletotrichum gloeosporioides* were reported by researcher from many parts of the world (Gupta and Rai 1973; Pathak, 1986; Rahman *et al*., 2003 and Awasthi *et al*., 2005). Observed symptom of the present study corroborates with the description of (Coutinho *et al.,* 1998). However, presence of fungus, *Botryodiplodia theobromae* (Hossain and Meah, 1992 and Rahman *et al*., 2003) and *Pestalotiopsis psidii* (Hossain and Meah, 1992; Rahman *et al*., 2003; Lin *et al.,* 2003; Keith *et al*., 2006), *Gloeosporium psidii* (Gupta *et al.,* 1984) in anthracnose of guava fruits have also been reported. *Pestalotiopsis psidii* was isolated from the scab symptom of guava leaf. In similar studies, *Pestalotiopsis* spp. has been

reported as causal pathogen of leaf spot of guava (Hossain *et al.,* 1992; Lin *et al.,* 2003; Keith *et al*., 2006). The bacteria *Pseudomonas* was isolated from the blighted leaf of guava. (Marques *et al.,* 2007) reported the presence of *Pseudomonas* from leaf of guava. Leaf blight by *Psuedomonas* in litchi fruit plants is reported by (Bultreys *et al*., 2010).

The prevalence of the recorded three diseases on guava varied in respect of nursery, location and time. Similar variation in prevalence of seedling diseases in respect of nursery location and time was recorded by (Chowdhury, 2009) in different guava growing regions. Regarding incidence of the three diseases recorded in the present study, anthracnose, scab, and leaf blight were the most predominant. It was also observed that the incidence and severity of anthracnose, scab, and leaf blight of guava varied from location to location. These variations may be due to effect of environment of different agro-ecological zone. The highest prevalence (incidence & severity) of anthracnose of guava was recorded at Khagrachari and the lowest prevalence (incidence & severity) was recorded at Gazipur in both the years. The highest prevalence (incidence & severity) of scab of guava was recorded at Khagrachari and the lowest prevalence (incidence & severity) was recorded at Gazipur in both the years. The highest prevalence (incidence & severity) of leaf blight of guava was recorded at Gazipur and the lowest prevalence was recorded at Khagrachari in both the years. In most of the cases highest incidence and severity were found in Khagrachari and lowest in Gazipur except for leaf blight of guava. This variation in the 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 guava 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 citrus. (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 (Chowdhury, 2009; Chowdhury *et al.,* 2011; Hossain, 2011; Keith *et al*., 2006 and Marques *et al*., 2007).

In the epidemiological study, the diseases were recorded eight times during the period of twenty month survey from July, 2010 to April, 2012.The prevalence (Incidence and severity) of anthracnose of guava was found to be increased in the month of July and October while the disease decreased in the month of January and April in both the years. Correlation analysis of prevalence of anthracnose 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 anthracnose with temperature, relative humidity and rainfall. With the increase of temperature, relative humidity and rainfall both the incidence and severity increased significantly. In a similar study on anthracnose of guava seedlings, (Chowdhury, 2009) recorded the highest incidence (20.00%) and severity (16.19%) in July, 2007 at temperature, relative humidity and rainfall of 28.87°C, 85.67% and 62.60 cm, respectively while no disease was recorded in the month of January. The finding of present study is in accordance with the results of (Chowdhury *et al.,* 2011; Koushik *et al.,* 1972 and Tandon and Singh, 1969). The prevalence (Incidence and severity) of scab of guava was found to be increased in the month January and July while the disease decreased in the month of October in both the years. A negative correlation between prevalence of scab disease with temperature, relative humidity and rainfall were observed. These also occurring due to variations of the temperature, relative humidity and rainfall that are supported by (Keith *et al*., 2006). The prevalence (Incidence and severity) of leaf blight of guava was found to be increased in the month of July and October while the disease decreased in the month of January and April in both the years. A positive correlation was observed between prevalence of leaf blight of guava with temperature, relative humidity and rainfall. With the increase of temperature, relative humidity and rainfall both the

incidence and severity increased significantly. The finding of present study collaborates with the finding of (Hossain, 2011). (Chowdhury, 2009) identified this disease and did not mention any causal organism. (Marques *et al*., 2007) also detected this disease in 56% of the orchards, and a correlation of 81.9% between the presence of symptoms and positive disease diagnosis in the laboratory was recorded. The optimum temperature range for *E. psidii* growth was 24-33 degrees C, and short term preservation (up to 120days) in water suspension was superior. The inoculation of the pathogen to detached leaves or stems allowed symptom development in 7 days; this method appeared to be a rapid and reliable means of testing isolate pathogenicity.

The present study on the occurrence of seedling diseases of guava in different nurseries reviles that all the diseases studied are related to the temperature, relative humidity and rainfall and have a profound effect over the occurrence of the diseases. These weather parameters should be critically observed for each host-pathogen system to find out the most appropriate time to combat the disease at minimum effort.

CHAPTER VI
SUMMARY AND CONCLUSION

Guava (*Psidium guajava* L.), is considered as the popular fruits of Bangladesh. It suffers from various diseases but least concrete information regarding their distribution, prevalence and epidemiology is available in Bangladesh. Therefore, the present study has been designed to study the occurrence and prevalence of seedling diseases of guava and to study the correlation of disease development with environmental parameters in eight nurseries in four selected districts namely, Dhaka, Gazipur, Barisal and Khagrachari.

Three experiments were carried out throughout the study period from July, 2010 to April, 2012. The diseases were identified based on matching the observed

symptoms in the infected plants with the symptoms. The disease also 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 (Singh, 1978; Pathak, 1980; Peterson, 1986; Singh, 1998 and Ploetz *et al*., 1998).

Three different diseases of guava viz. anthracnose, scab, and leaf blight 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 observed. Incidence and severity of anthracnose, scab, and leaf blight of guava varied from location to location. Significant variations were observed in the incidence and severity under the variation of weather parameters. The intermittent addition and defoliation of leaves during different period of year responsible for reduction of disease incidence and severity. Different degrees of correlation were observed among the seedling diseases of guava with temperature, relative humidity and rainfall. All the diseases were found to be influenced by the weather parameters.

The highest prevalence (incidence & severity) of anthracnose of guava was recorded at Khagrachari and the lowest prevalence (incidence & severity) was recorded at Gazipur in both the years. The highest prevalence (incidence & severity) of scab of guava was recorded at Khagrachari and the lowest prevalence (incidence & severity) was recorded at Gazipur in both the years. The highest prevalence (incidence & severity) of leaf blight of guava was recorded at Gazipur and the lowest prevalence was recorded at Khagrachari in both the years. The highest prevalence (incidence & severity) of anthracnose of guava was recorded in July, and lowest in January in both the years. The highest prevalence (incidence & severity) of scab of guava was recorded in January and July and the lowest prevalence (incidence & severity) was recorded in month of October, in both the years. The highest prevalence (incidence & severity) of leaf blight of guava was recorded in July, and lowest in January in both the years.

Therefore, the findings on the occurrence of seedling diseases of guava in different nurseries reviles 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 and microclimatic parameters should be critically observed for each host-pathogen system to find out the most appropriate time to combat the diseases at minimum effort.

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APPENDICES

Appendix I. Map showing the experimental site under study