# STUDY ON SEEDLING DISEASES OF CITRUS (*Citrus spp.*) IN SOME SELECTED NURSERIES OF RAJSHAHI



**KHALED MD. SYFULLAH**
**REGISTRATION NO. 00891/2000-2001**

**MASTER OF SCIENCE (M.S.)**
**IN**
**PLANT PATHOLOGY**




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



**June, 2008**

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*A Thesis*

*Submitted to the Faculty of Agriculture,*
*Sher-e-Bangla Agricultural University, Dhaka-1207*
*in partial fulfilment of the requirements for the degree of*

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## CERTIFICATE

This is to certify that thesis entitled **"STUDY ON SEEDLING DISEASES OF CITRUS (*Citrus spp.*) IN SOME SELECTED NURSERIES OF RAJSHAHI"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfilment 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 Khaled Md. Syfullah, Registration No. 00891/2000-2001 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 been duly been acknowledged.



**Dated:**
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*Dedicated to*

*My Beloved Parents*

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# STUDY ON SEEDLING DISEASES OF CITRUS (*Citrus*) IN SOME SELECTED NURSERIES OF RAJSHAHI

by
Khaled MD. Syfullah

## THESIS ABSTRACT

Two experiments were carried out throughout the study period in order to study the seedling diseases of citrus. Five diseases were recorded on citrus seedling in four selected nurseries located in Rajshahi and the recorded diseases were citrus scab, citrus sooty mould, die back, citrus canker and yellowing of citrus plant were common in all the surveyed locations. The symptoms of scab appeared as on leaves branches, thrones and twigs. In severe cases the plants withered and died. The incidence and severity varied from nursery to nursery and month to month. In case of citrus scab the highest disease incidence and disease severity (67.08%) and (62.00%) respectively observed in the month of July and the lowest disease incidence and disease severity was observed in the month of March. So far, for the disease development the temperature was 15.50-29.50$^0$C and relative humidity was 75-85% while in case of citrus sooty mould the highest disease incidence and disease severity was observed in the month of March that was 18.80% and 14.13% respectively, the lowest disease incidence and disease severity was observed in the month of January. So far, for the disease development the temperature was 15.00-25.00$^0$C and relative humidity was 65-75%. Therefore citrus scab was the most prominent disease encountered on citrus seedling in Rajshahi.

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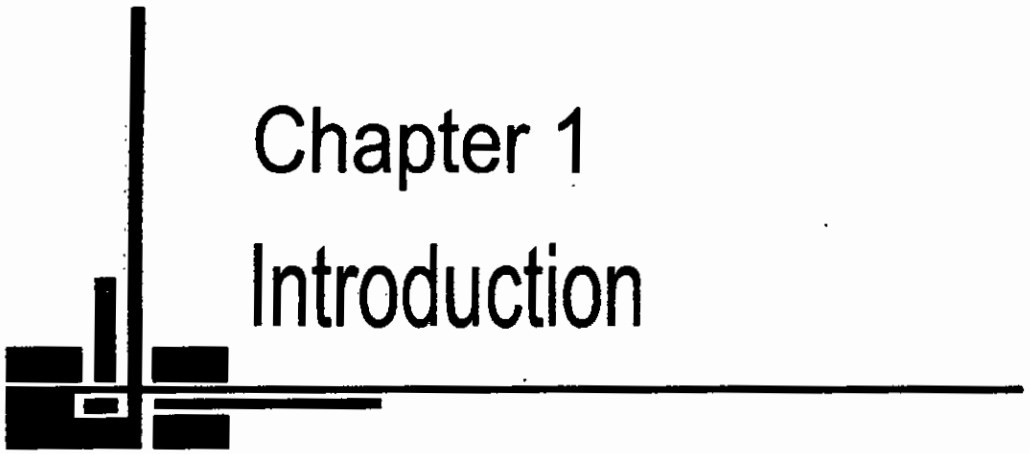
# LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| **%** | = | Percent |
| **°C** | = | Degree Centigrade |
| **Anon.** | = | Anonymous |
| **BARI** | = | Bangladesh Agricultural Research Institute |
| **BAU** | = | Bangladesh Agricultural University |
| **BBS** | = | Bangladesh Bureau of Statistics |
| **cv.** | = | Cultivar(s) |
| **DMRT** | = | Duncan's Multiple Range Test |
| **e.g.** | = | For example |
| ***et al.*** | = | And Others |
| **etc.** | = | Etcetera |
| **FAO** | = | Food and Agriculture Organization |
| **hr** | = | Hour(s) |
| **LSD** | = | Least Significant Difference |
| **no.** | | Number |
| **SAU** | = | Sher-e-Bangla Agricultural University |
| **T** | = | Treatment |
| **Viz.** | = | **example** |



# Chapter 1
# Introduction

CHAPTER-I

# INTRODUCTION

Citrus (*Citrus spp.*), belongs to the family Rutaceae, is one of the important fruit crops in the world as well in Bangladesh. It is thought to be originated in Indian subcontinent because of maximum genetic diversity are grown in this region (Sohi and Kapoor, 1990). It has a great demand due to its nutritive value, flavor and tastes. Many people of our country are suffering from the deficiency of some limiting vitamins like vitamin A and C and some other minerals like calcium and iron in their daily diet. It is observed that 93% people of Bangladesh are suffering from the deficiency of vitamin C (Anonymous, 1980). Citrus serves as a potential source of vitamins and minerals (Alam *et al.*, 2003). As vitamin C cannot be stored in human body like others and it is needed to be taken with daily diet. Thus citrus fruits play an important role in human health. Slices of lemon are served as a garnish on fish or meat or with iced or hot tea. Lemon juice is primarily used for flavoring cakes, cookies, cake icings, puddings, sherbet, confectionery, preserves and pharmaceutical products. It is the source of lemon oil, pectin and citric acid. It is much used as a flavoring agent for hard candies.

Considering the multipurpose use, the demand of fruit (citrus) is increasing day by day. In Bangladesh citrus is cultivated in about 15,008 ha of land with a total production of 31750 metric tons per annum (BBS, 2007). Eight species of citrus fruits are grown in Bangladesh. Among them, three species viz. Elachi lemon

(*Citrus limon* L.), Kagzi lime (*Citrus awrantifolia* Swing), and Pummelo (*Citrus grandis* L.) are commonly cultivated in our country. In citrus growing area, Kagzi lime and Elachi lemon occupy 6,388.66 ha of land of the country (BBS 2007). As the hilly and high land remains fallow round the year, there is a great opportunity to extend citrus cultivating area in the country.

Various factors are responsible for lowering the yield of citrus. Among the factors, plant diseases play an important role in lowering yield as well as citrus decline. Citrus plants are very much prone to the attack of numerous diseases. Different species of citrus grown in the world suffers from more than 100 diseases (Klotz, 1973). In Bangladesh, twelve diseases are known to occur in different species of citrus seedlings. Among these diseases; scab, die-back, sooty mould and canker yellowing, citrus greening and gummosis are considered as major diseases in Bangladesh (Alam, 2003).

Use of resistant variety is the most acceptable method for controlling these diseases. But no such citrus variety is available in Bangladesh. On the other hand, healthy and disease free seedlings are of basic raw material and prime need for establishment of orchards as well as production of citrus. But seedling diseases are one of the important problems in the tropics as well as in Bangladesh. Although huge numbers of nurseries are producing seedlings but quality seedlings production is not ensured due to attack of different plant diseases. For protection from these diseases, seedlings are to be reared up with proper care in order to

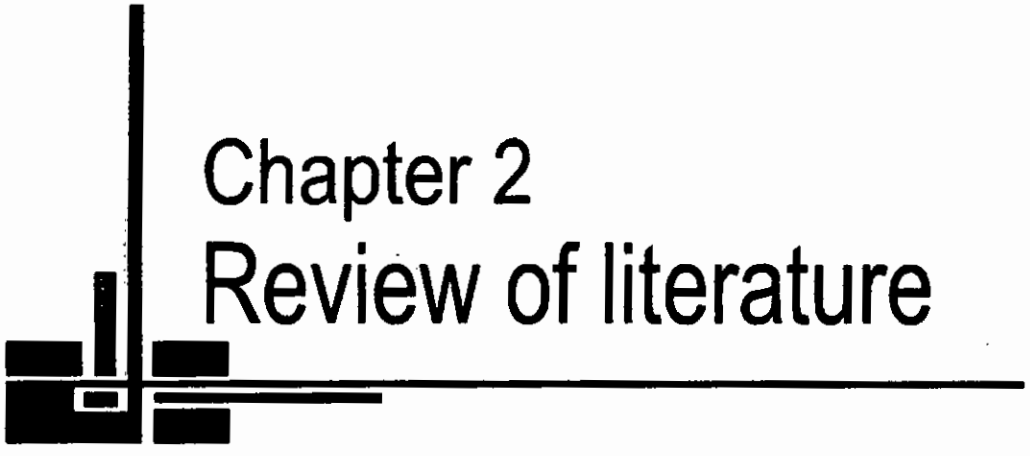
ensure the establishment of quality citrus orchard and finally increasing production.

Least concrete information regarding citrus seedling diseases, their distribution, incidence, severity and epidemiology is available. Therefore, an attempt has been made to study the prevalence of various diseases occurring on citrus seedlings in selected nurseries of Rajshahi.

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

i) Survey on the nursery diseases of citrus in the selected nursery of Rajshahi.

ii) To study the epidemiology especially in relation to the effect of temperature and relative humidity on incidence and severity of nursery diseases of citrus.



# Chapter 2
# Review of literature

CHAPTER-II

# REVIEW OF LITERATURE

Citrus plants are prone to the attack of many diseases at all stages of growth. These diseases are widely occurring throughout the citrus growing countries in the world. The diseases of citrus plants as well as fruits have been studied in Bangladesh but little attention has been paid to the nursery diseases. Many researchers in their survey found these diseases with epidemic condition. Therefore, for precise presentation only the related literatures on disease symptoms and epidemic nature are presented here.

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

According to Fawcett (1936) *Capnodium citri* Berk and Desm is principally associated with sooty mould disease. In Darjeeling district *Capnodium citri* is disseminated by 17 species of Coccids .



Naik (1949) observed that the sooty mould fungus develops and detach in 23°C and 50-60% relative humidity.

Bose (1953) and Hays (1957) in Kumaon much damage was caused by *Chaetothyrium citri* Fisher associated with white fly and winged fly.

Ramakrishnan (1954a) reported that citrus seedlings are greatly affected by sooty mould. Low humidity (50-65%), temperature between 20°-26°C is more favorable for the incidence of the disease.

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

Chowdhury (1955a) mentioned that in Assam sooty mould is mostly caused by *Capnodium citri* Berk and Desm., *Meliola butleri* Syd., and *Acrithecium lunatum* Wak. were also associated.

Chowdhury (1955b) remarked that the fruits of sooty mould affected plants did not ripe and the color was often uneven. In dry condition the sooty growth gets detached and blown of by the wind. The fungal growth is partly washed off with downpour of rain or sprays also.

Chowdhury (1955c) observed that sooty mould was more in shaded trees than those well exposed to sun. In India sooty mould is common in all citrus growing regions.

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

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

Reddy amd Murti (1990) reported that Canker infected leaves, twigs and branches constitute the source of inoculam to spread the disease from season to season. Since the infected leaves drop off early and the bacteria perish rapidly in the soil. Nirvan (1963) considered that leaves do not severe as carriers of inocula.

Tripathi and Srivastava (1992) observed that citrus scab caused by *Elsinoe fawcettit* on leaves and fruits appeared during the summer (April-June), little progress was observed during these months. With the onset of the rainy season (July-September), the infection progressed well and was seldom exposed to severe conditions, progressed to tip wards slowly and caused wilt, turned yellow and dropped. Twigs and branches appeared to have been scorched by fire. When twigs

were dry, minute brown to black, slightly raised, clumped pustules were observed. Under humid conditions, a pink slimy material appeared on dead bark and twigs. This symptom has also been observed on seedlings of citrus rootstocks in greenhouses in Morocco.

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

Gottwald (1995) observed that Cataibl significantly affected the spatiotemporal dynamics of citrus scab epidemics by reducing both inoculum production and providing protection to susceptible new leaves.

Rawal and Saxana (1997) reported that anthracnose attacks the young leaves, shoots, blossoms and fruits of small acid limes. Young foliage and blossoms are blighted and distinct lesions formed on leaves and fruits. Affected fruits frequently drop prematurely. Wither tip is characterized by shedding of leaves and die-back of twigs. Leaves show light green spots which turn brown. On dead twigs, black dot like acervuli appear in concentric rings. The stem end of immature fruits results in fruit drop. In severe cases, branches show die-back and the tree dies in a few years.

Rawal and Saxana (1997) reported that symptoms of anthracnose appear on leaves, young shoots and tender fruits. On leaves, the necrotic spots show acervuli arranged in concentric rings. Dead parts of the twigs assume silvery grey

appearance. Twigs show a slight gumming and a sharp line of separation between healthy and dead tissues. Affected buds fail to develop and affected fruits drop off. Often, the infected fruits develop reddish brown stain on the rind. The fungus has also been held responsible for nisseting and tears staining of rind. This leads to the blight of twig. The infected hyphae produced by appresorium remain latent even after the fruit mature and produce anthracnose in oranges and grape fruit, if the peal is injured or fruits are over matured.

Singh *et al.* (1997a) conducted a survey at Panjab in India and disease incidence recorded on 3 citrus species viz. rough lemon (*Citrus jambhiri*) 76.5-80,1%, sweet orange (*C. sinensis*) 10.8-20.3% and kinnow (*C. nobilus* × *C. deiiciosa*) 46.25-81.07%. The highest disease incidence was recorded in the sitb-mounlarnous zone on rough lemon (80.1%) and kinnow (80.07%) and the lowest incidence was recorded on sweet orange 10.8% in the arid irrigated zone.

Singh *et al.* (1997b) identified the causal organism of citrus scab as *Elsinoe fawcettii* on the basis of spore morphology and pathogenicity test on rough lemon seedling.

Janghoon *et al.* (1998) reported that citrus scab caused by *Elsinoe ftwcettii* cause warty and scabby lesions on the surface of leaves, twigs and fruits of mandarin cv. Satsuma. Warty lesions were mainly developed before July but scabby lesions developed during the summer season in Cheju Island, Korea Republic.

Singh *et al.* (1998a) reported that scab is primarily a disease of Sastuma, orange, tangerine, grape fruit, lemon, sour orange and trifoliate orange root stock. It does not attack the sweet orange.

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

Huang (1999) reported that citrus scab (*Elsinoe fawcettii*) attacked the expanded leaves of spring shoots of mandarin and started to attack the fruit lets in mid-late May in Jiangxi, China. During the autumn, if the temperature and humidity are favorable, it attacks the young shoots and fruit lets causing up to 65.9-72.2% fruit-let drop.

Malcolm (1999) reviewed that the common name *Capnodium citri* to represent several species of sooty mold fungi. Analysis of sooty mold specimens from Citrus in Florida found the species *Antennariella californica* and *Chaetobolisia falcata* with spherical fruit bodies and *Caldariomyces fumago* and *Polychaeton citri* with elongate fruit bodies. It is recommended that use of the name *Capnodium citri* for sooty mold on Citrus and ornamental plants are to be avoided because of its use for a number of species and on nomenclatural grounds.

Sooty mold looks a lot on plant's twigs, branches or leaves. Plant parts may be covered in grimy black soot. It looks like someone may have dumped ashes or may have even caught the plant on fire. Most plants affected by this plant mold, may also have some sort of pest problem (Anonymous , 2000).

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

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

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

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

Hyun *et al.* (2001) reported that two scab diseases were recognized currently on citrus: (i) citrus scab caused by *Elsinoe fawcettii*, which has several pathotypes and (ii) Sweet orange scab caused by *E. anstralis*.

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

Amador (2002b) reported that small lesions appear as translucent dots that later become pustules in citrus scab. As the disease progresses, the pustules turn into warts, consisting of amass of corky tissue pale tan in color. The leaves become twisted and distorted and the entire young branch may be affected.

Amador (2002c) reported that citrus scab caused by the fungus *Elsinoe fawcettii*, is an important disease in Texas. The disease is more severe on lemons, sometimes troublesome on grapefruit and seldom a problem on sweet orange. Sour orange is highly susceptible, thus nursery stocks may become infected before young sour orange trees are budded. Because citrus tissue is susceptible to scab only while young, the disease is mainly confined to new growth.

Huang and Huang (2002) reported that approximately 50% of fruits from Nanfengmiju trees were damaged by citrus scab (*Elsinoe fawcettii*). The main reasons were identified as unfavorable weather conditions (Much rainfall, high humidity and frost damage.

Alam (2003) conducted a survey in the commercially citrus growing areas of Moulavibazer, Sylhet and Chittagong in Bangladesh and listed scab (*Elsinoe fmvcettii*), canker (*Xanthomonas citri*) and die back (*Colletotrichum gloeosponoides*) are the major diseases of citrus in Bangladesh.

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

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

Gopal and Kumar (2003a) reported that only young tissues are affected by citrus scab. Leaves are more susceptible to infection just after emergence from the bed. The grown up mature leaves are immune. Fruit remain susceptible for about three months after petal fall.

Gopal and Kumar (2003b) reported that the main symptom is small, grayish-brown corky scabs which develop on the twigs, young leaves and fruit. The fruits are infected when they are very young; the scabs are larger and warty. These lesions are particularly large on fruits. The scabs on fruit which are infected later are slightly raised above the surface of the rind. The numbers of lesions may join together to form large scabby areas. These may develop cracks as the fruit grows.

Gopal et al. (2003c) observed that die-back of acidlime seedlings in Rayalaseema region of Andhra Pradesh was found to be caused by combined infection of *Colletotrichum gloeospodoides* and bacterial canker pathogen *Xanthomonas axonopodis* Pv. *citri.* Of the 10 chemical treatments tested, spray treatments involving streptomycin sulphate carbendazim 0.1% + streptomycin sulphate 100 ppm followed by bordeaux mixture 1% + streptomycin sulphate 100 ppm were found effective in reducing the disease by about 81 and 76 per cent, respectively.

Leaves, fruit and sometimes branches have a black, moldy appearance. The fungi causing sooty mold do not actually infect the plant; instead they grow on the sugary exudates of insects such as aphids, brown soft scale, black flies and whiteflies. A heavy sooty mold coating on the fruit can result in a lower grade of fruit, while a heavy coating of fungi on the leaves retard photosynthesis as well as growth, causing lighter flowering and reduced yields (Anonymous, 2005a).

The disease sooty mold is caused by fungus (*Capnodium citri*), which is not a parasitic organism. It does not penetrate the tissue of the plant but grows superficially on the honeydew excretions of white flies, aphids, mealy bugs and scale insects. Sooty mold can cause damage by preventing the sunlight from reaching the leaf and by making the fruit black and unattractive. Fruit covered by sooty mold is smaller and does not color well (Anonymous, 2005b).

Millet (2005) reported the white spots on the tree's leaves certainly are not Sooty Mold. Sooty Mold is (as the name applies) a black mold like growth that can cover the major portion of the leaf surface.

Amador (2006) reported that sooty mould is not a true disease because the several fungi associated with it do not feed on the tissues of citrus trees. Rather, the fungi feed on rich honeydew excreted by insects such as aphids, brown soft scale and whiteflies. The amount of sooty mold is directly proportionate to the number of honeydew-excreting insects present. Heavy leaf coating can retard growth by interfering with photosynthesis and other physiological functions of the leaf. Light fruit set and reduced yields often result.

# Chapter 3
# Materials and Methods

CHAPTER III

# MATERIALS AND METHODS

Two experiments were carried out throughout the study period in order to study the seedling diseases of citrus.

## 3.1. Experiment I: Survey on the nursery diseases of citrus in selected nursery of Rajshahi

### 3.1.1. Survey on the nursery diseases of citrus

Prevalence of diseases occurring on citrus seedlings raised in the selected nursery was surveyed.

### 3.1.2. Location of survey

The survey was carried out in different nurseries of Rajshahi Division. The nurseries were located in AEZ 3. The characteristic features of this AEZ are shown in Appendix 1.

### 3.1.3. Selection of Nursery

Four nurseries were selected for survey of citrus seedling diseases. These nurseries were BARI Fruit Research Center Nursery, Rajshahi Sadar, DAE horticulture center, Rajshahi, Lamyia Nursery, Katakhali, Motihar, Rajshahi and Hena Agro Nursery, Mohendra, Poba, Rajshahi. The age of the seedlings (years) and total number of seedlings are given in Table 1.

Table 1. Age of the citrus seedlings and total number of seedlings in selected four nurseries from July to March

| Nursearies | Age of the seedlings (Years) | Total number of seedlings (January) | Total number of seedlings (March) | Total number of seedlings (July) | Total number of seedlings (October) |
|---|---|---|---|---|---|
| Fruit Research Center Nursery, Rajshahi Sadar | 1 | 600 | 400 | 650 | 700 |
| Hena Agro Nursery, Rajshahi Sadar | 1.3 | 1500 | 1200 | 1450 | 2000 |
| DAE horticulture center, Rajshahi, | 1.2 | 1000 | 1400 | 1350 | 1500 |
| Lamyia Nursery, Katakhali, Motihar, Rajshahi | 1 | 450 | 460 | 580 | 750 |

### 3.1.4. Observation of the symptoms

In the four selected nurseries more or less similar kinds of diseases were observed Symptoms of the diseases were studied by visual observation. Sometimes 10x hand lens were 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. Beside this, the symptom of the diseases were recorded following the description of Reddy and Murti, 1990; Rajput and Haribabu, 1985 Identification of all the fungal diseases was finally confirmed by identification of the associated fungal organisms through isolation.

### 3.2. Experiment II: Epidemiology of disease incidence and severity

#### 3.2.1. Survey period

Survey was made during the period from January '07 to October '07. First survey was made in January '07 second survey was made in March '07 third survey was made in July '07 and forth survey was made in October '07.

#### 3.2.2. Methods of Survey

Each of the selected nurseries was surveyed once a month to find out the occurrence of each of citrus seedling diseases. For calculation of incidence of nursery citrus seedling diseases every seedling were counted in the nursery, and also counted the infected seedlings and then expressed in percentage. The disease incidence of nursery citrus seedling was determined by the following formula.

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

In each nursery 10 infected plants were randomly selected for determining disease incidence and disease severity. For disease incidence of foliar diseases of citrus seedling, 10 infected plants were randomly selected. For one plant every leaf were observed to record the disease incidence, in the mean time disease leaves were also counted for disease incidence and finally it was expressed in percentage. The disease incidence of foliar diseases was determined by the following formula.

$$\text{Disease Incidence (Leaves)} = \frac{\text{No. of diseased leaves}}{\text{No. of total leaves}} \times 100$$

In case of disease severity 10 infected plants were randomly selected from each nursery for foliar diseases of citrus seedling, for each plant randomly 3 leaves were selected, disease severity was determined by the following formula.

$$\text{Disease Severity (Leaves)} = \frac{\text{Leaves area diseased}}{\text{Total Leaves area}} \times 100$$

Leaf area diseased was measured by eye estimation following disease rating scales and then summations of each leaf area diseased in each plant were made. Total area of a leaf was considered as 100%.

$$\text{Disease Severity} = \frac{\text{Sum of total rating} \times 100}{\text{No. of total observation} \times \text{highest grade of the scale}}$$

Where as, Sum of total rating = No. of observation × Grade

The following rating scales were used for the foliar disease scab, sooty mould

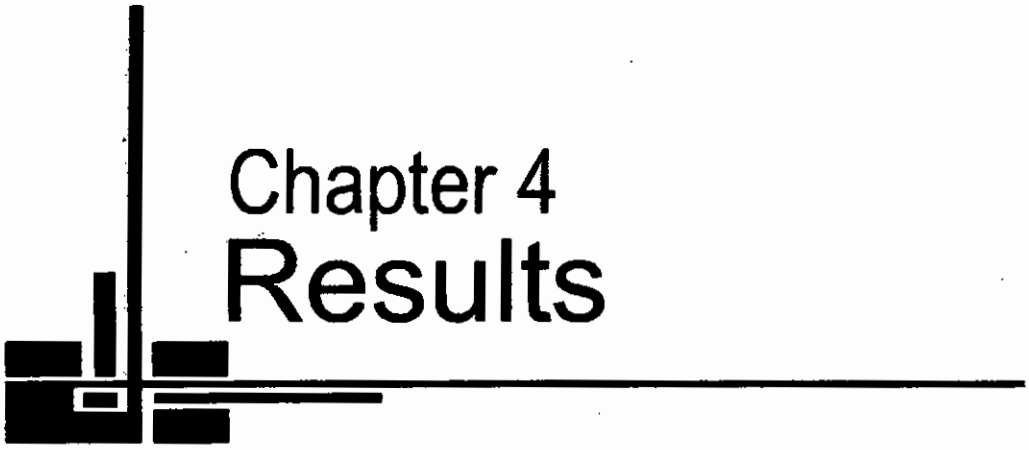
| Criteria | Ratings |
|---|---|
| No visible symptoms | 0 |
| 1-5% leaf area diseased | 1 |
| 5.1-12% leaf area diseased | 2 |
| 12.1-25% leaf area diseased | 3 |
| 25.1-50% leaf area diseased | 4 |
| >50% leaf area diseased | 5 |

### 3.3. Metrological data collection

Metrological data were collected from regional metrological station.

### 3.3. Statistical analysis

The collected data on different parameters were analyzed statistically by using MSTAT-C package program. The means for all the treatments were compared by DMRT (Duncan Multiple Range Test). The significance of the difference among the means was calculated by LSD test (Least Significance Difference).



# Chapter 4
# Results

CHAPTER IV

# RESULTS

## 4.1. Survey of Nursery diseases of citrus

In Rajshahi two nurseries having citrus seedling were surveyed, in order to determine the incidence of different diseases. Altogether two different diseases viz. citrus scab and citrus sooty mold were recorded (Plate 1-6). The symptoms of different diseases as observed in nurseries were as follows:

### 4.1.1. Scab

On leaves, lesions usually found on the lower surface and were circular to somewhat angular and dark brown to black. During rainy weather lesions were olive tan. As lesions enlarged, they became white to gray with narrow, dark borders. The affected leaves became significantly distorted, wrinkled, stunted and miss shaped and prematurely shed. In nurseries in case of susceptible varieties, twigs also get infected, the lesion on the shoots being more or less similar to those on the leaves (Plate 1).

### 4.1.2. Sooty Mould

The disease was recognized in the field by the presence of a black velvety covering on the leaf surface and twigs. The entire leaf surface was covered by black mould in patches on the leaf the mould formed a thin membranous covering over the affected parts. The covering rubbed easily from the leaf surface. Under dry condition the affected leaves curl and shrivel up. The plant presents a sticky appearance. The intensity and extend of sooty growth is proportional to the intensity of insect infestation (Plate 2).

### 4.1.3. Canker:

The disease appears on the leaves, twigs, petioles, branches and thrones. To start with canker lesions appear as yellowish spots which gradually enlarge 2 to 4 mm in diameter and appear as rough raised brownish pustules. These pustules are surrounded by a characteristic yellow halo. The size of the pustules varies in size and shape in variety to variety. The yield eventually lowered (Plate 3-4).

### 4.1.4. Die Back:

This disease is caused due to different reason. In the preliminary stage of the disease the young and small branches of the plants dies from top to backward. The leaves become yellowish. As the disease develops small mottling and chlorosis appears on the leaves. The leaves decrease in size and number. The plants may wilts prematurely. The branches of the plants dried up backward and eventually the plants died (Plate 5).

### 4.1.5. Yellowing:

The leaves of the plants become yellow. Sometimes the whole leaves appear yellow in color. Sometimes yellow area on the side of the midrib extends to the margin of the leaves. The plant gets stunted. In some cases only the midrib become yellow but the other portion of the leaves remain green. In severe cases the plants may withered and died (plate 6.)

Plate 1. Citrus scab

Plate 2. Citrus sooty mold

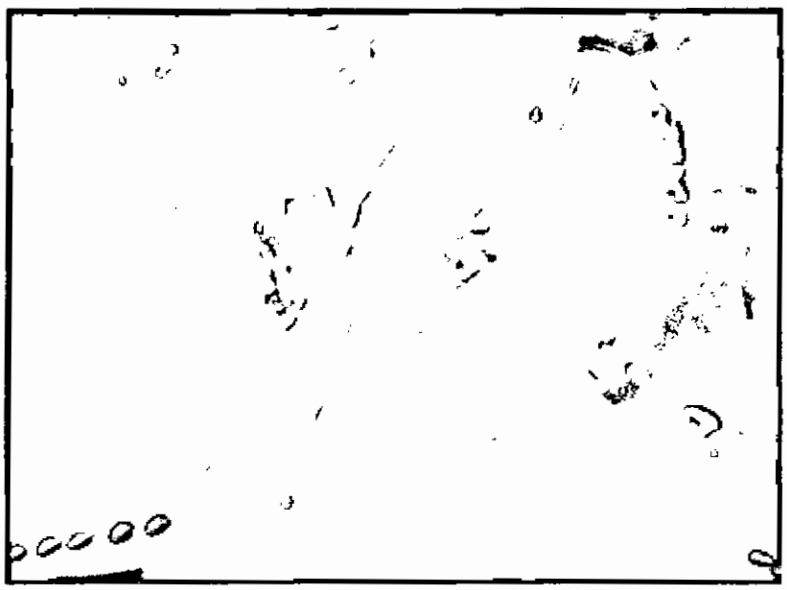


Plate 3. Canker on lemon seedlings

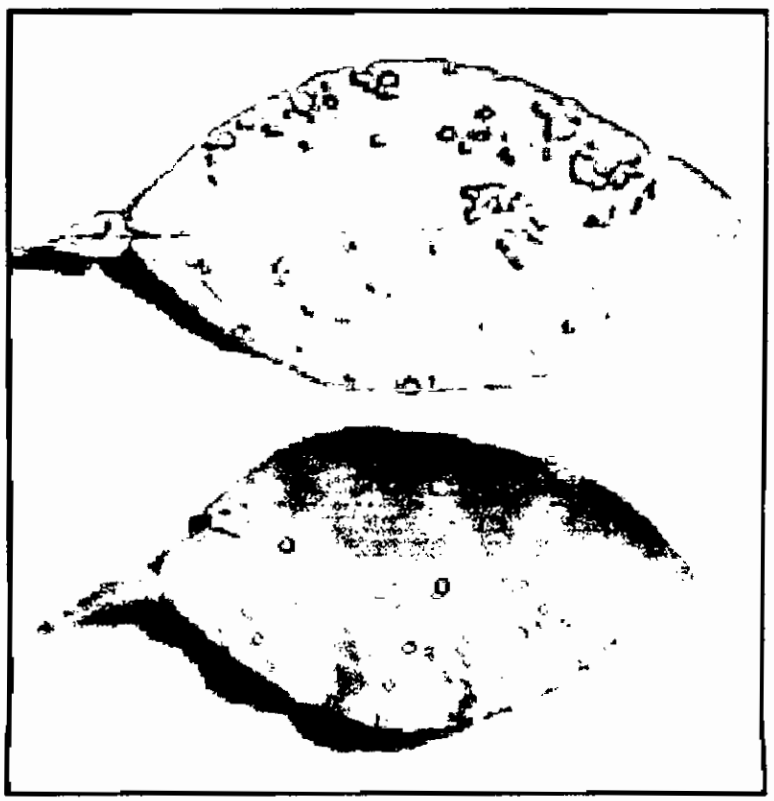


Plate 4. Citrus Canker

Plate 5. Twig dieback of citrus seedling

Plate 6. Yellowing of citrus leaf

### 4.2. Average disease incidence and severity of the two diseases recorded in four nurseries from January to October'2007

The average disease incidence of citrus scab, citrus sooty mould, citrus canker, die-back and yellowing was observed from January to October were 44.25%, 12.67%, 9.875%, 7.685% and 4.587% respectively and average disease severity observed from January to October were 36.33%, 9.097%, 7.894%, 6.879% and 4.546 % respectively.

**Table 2.** Average disease incidence and severity of the two diseases recorded in four nurseries from January to October'2007

| Name of the Diseases | % Disease Incidence | % Disease Severity |
|---|---|---|
| Citrus scab | 44.25 | 36.33 |
| Citrus sooty mould | 12.67 | 9.097 |
| Citrus canker | 9.875 | 7.894 |
| Die-back | 7.685 | 6.879 |
| Yellowing | 4.587 | 4.546 |

### 4.3. Epidemiology of disease incidence and severity

#### 4.3.1. Incidence and severity of scab of citrus

In the month of January, 2007 the incidence of scab of citrus varied significantly from 27.57- 32.81% with respect to nurseries surveyed(Table.3). The highest incidence (32.81%) was recorded at Lamyia Nursery, Kataakhali, Motihar, Rajshahi followed by BARI Fruit Research Center (28.64%). The lowest incidence (27.57%) was observed in Hena Agro Nursery, Mohendra, Poba, Rajshahi (Table 3). The severity of scab of citrus varied significantly from 23.22-28.40% with respect to nurseries. The highest severity (28.40%) was recorded DAE Horticulture center and the lowest severity (23.22%) was observed Lamyia Nursery, Kataakhali, Motihar, Rajshahi (Table 3).

In the month of March, 2007 the incidence of scab of citrus varied significantly from 33.23-52.73% with respect to nurseries surveyed. The highest incidence (52.73%) was recorded at Lamyia Nursery, Katakhali, Motihar, Rajshahi followed by BARI Fruit Research Center (35.26%). The lowest incidence (33.23%) was observed in Hena Agro Nursery, Mohendra, Poba, Rajshahi (Table 3). The severity of scab of citrus varied significantly from 25.33-35.56% with respect to nurseries. The highest severity (35.56%) was recorded at Lamyia Nursery, Kataakhali, Motihar, Rajshahi followed by BARI Fruit Research Center (25.33%). The lowest severity (25.00%) was observed DAE Horticulture center (Table 3).

In the month of July, 2007 the incidence of scab of citrus varied significantly from 46.96-67.08% with respect to nurseries surveyed. The highest incidence (67.08%) was recorded at Lamyia Nursery, Kataakhali, Motihar, Rajshahi followed by BARI Fruit Research Center (52.57%). The lowest incidence (46.96%) was observed in Hena Agro Nursery, Mohendra, Poba, Rajshahi (Table 3). The severity of scab of citrus varied significantly from 43.94-62.00% with respect to nurseries. The highest severity (62.00%) was recorded at Lamyia Nursery, Kataakhali, Motihar, Rajshahi and the lowest severity (43.94%) was observed DAE Horticulture center (Table 3).

In the month of October, 2007 the incidence of scab of citrus varied significantly from 42.40-57.37% with respect to nurseries surveyed. The highest incidence (57.37%) was recorded Lamyia Nursery, Kataakhali, Motihar, Rajshahi followed by BARI Fruit Research Center (47.95%). The lowest incidence (42.40%) was observed in DAE Horticulture center (Table 3). The severity of scab of citrus varied significantly from 37.03-43.33% with respect to nurseries. The highest severity (43.33%) was recorded at Lamyia Nursery, Kataakhali, Motihar, Rajshahi and the lowest severity (37.03%) was observed DAE Horticulture center (Table 3).

Table 3. Incidence and severity of citrus scab in four different surveyed nurseries of Rajshahi from January 2007 to October 2007

| Name of the Nursery | January | | March | | July | | October | |
|---|---|---|---|---|---|---|---|---|
| | Disease Incidence (%) | Disease Severity (%) | Disease Incidence (%) | Disease Severity (%) | Disease Incidence (%) | Disease Severity (%) | Disease Incidence (%) | Disease Severity (%) |
| Hena Agro Nursery, Mohendra, Poba, Raj | 27.57b | 26.67ab | 33.23c | 29.56ab | 46.96c | 45.06b | 57.20a | 38.04b |
| BARIFruit Research Center, | 28.64b | 23.22b | 35.26c | 25.33b | 52.57bc | 46.31b | 47.95b | 39.91ab |
| DAE Horticulture center | 28.87b | 28.40a | 41.20b | 25.00b | 56.16b | 43.94b | 42.40c | 37.03b |
| Lamyia Nursery, Kataakhali, Motihar, Rajshahi | 32.81a | 27.25a | 52.73a | 35.56a | 67.08a | 62.00a | 57.37a | 43.33a |
| CV% | 6.48 | 6.62 | 4.66 | 13.59 | 3.79 | 3.18 | 3.07 | 5.45 |
| LSD | 3.813 | 3.492 | 5.732 | 7.836 | 6.391 | 4.748 | 4.759 | 4.312 |
| Level of significance | * | * | ** | * | * | ** | ** | * |

Means followed by same letter significantly different at 1% or 5% level of significance.

### 4.3.2. Effect of temperature and relative humidity on the incidence and severity of scab of citrus

The incidence of citrus scab was influenced by temperature and relative humidity. The incidence of citrus scab observed in the month of January was 40.65% when the temperature and relative humidity were 18.45°C and 68% respectively. The incidence of citrus scab observed in the month of March was 29.47% when the temperature and relative humidity were 25.50°C and 54% respectively. In the month of July the incidence of citrus scab was 56.73% when the temperature and relative humidity were 28.50°C and 84% respectively and in the month of October the incidence of citrus scab was 51.23% while the temperature and relative humidity were 27.60°C and 78% respectively (Figure 1).The severity of citrus scab was influenced by average temperature and average relative humidity. The severity of citrus scab observed in the month of January was 28.86% when the temperature and relative humidity were 16.9°C and 75% respectively. The severity of citrus scab observed in the month of March was 26.38% when the temperature and relative humidity were 24.1°C and 66% respectively. In the month of July the severity of citrus scab was 49.33% when the temperature and relative humidity were 28.95°C and 87% respectively and in the month of October the severity of citrus scab was 39.57% while the temperature and relative humidity were 27.55°C and 84% respectively (Figure 1).

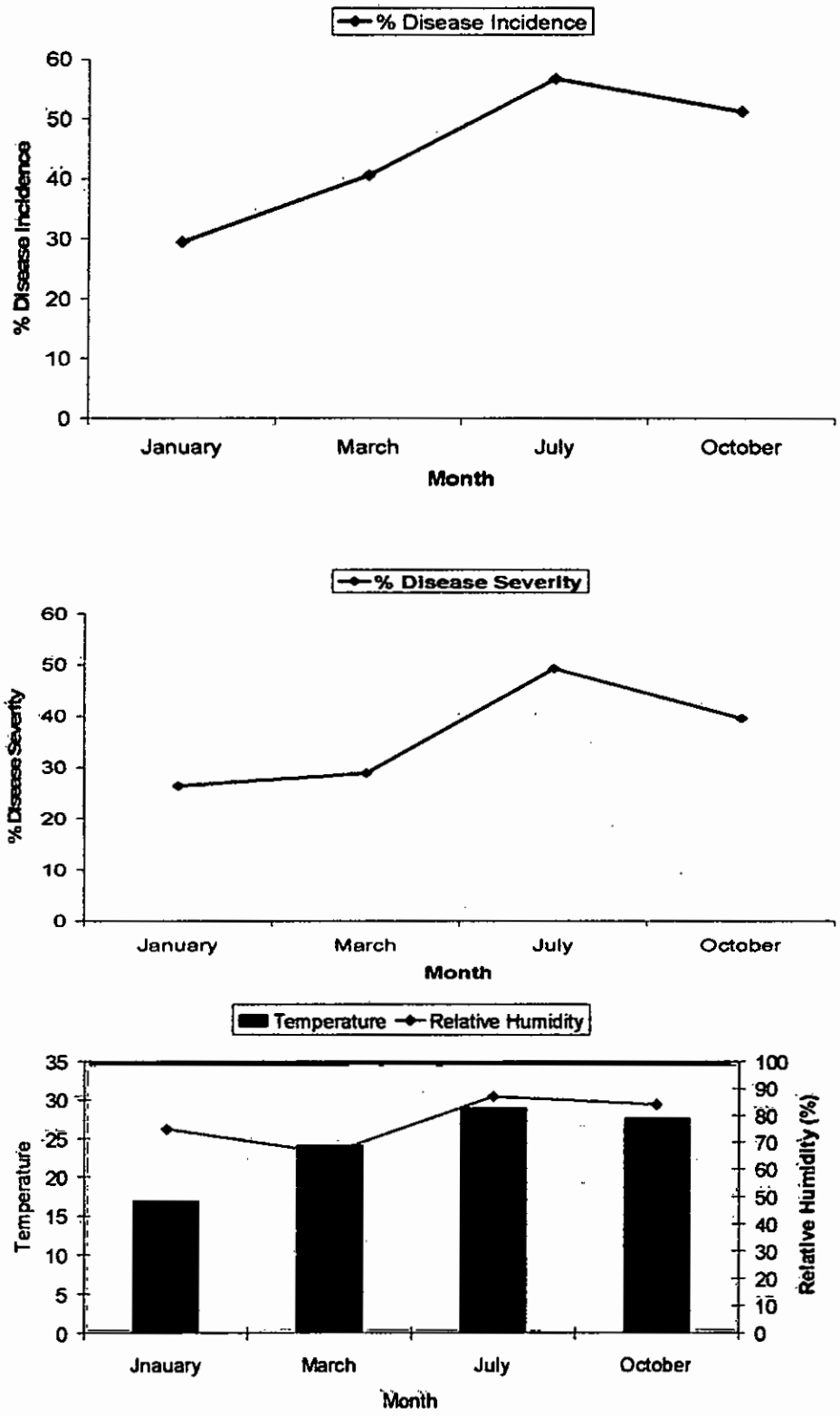



**Fig1. Effect of Temperature and Relative Humidity on the Incidence and Severity of Citrus Scab**

#### 4.3.3.1. Correlation between disease incidence and temperature of citrus scab

A positive correlation between disease incidence and temperature was observed (Figure 2) in case of citrus scab. The relationship between disease incidence and temperature could be expressed by the equation y = 2.1934x -8.9545 ($R^2$ = 0.9597) where y = disease incidence and x = temperature. The $R^2$ value indicated that contribution of temperature were 95.97% on the incidence of citrus scab (*Elsinoe fawcetti*).

#### 4.3.3.2. Correlation between disease severity and temperature of citrus scab

A positive correlation between disease severity and temperature was observed (Figure 3) in case of citrus scab. The relationship between disease severity and temperature could be expressed by the equation y = 1.6806x - 4.9314 ($R^2$ = 0.736*) where y = disease severity and x = temperature. The $R^2$ value indicated that contribution of temperature were73.60% on the severity of citrus scab (*Elsinoe fawcetti*).

#### 4.3.3.3. Correlation between disease incidence and relative humidity of citrus scab

A positive correlation between disease incidence and relative humidity was observed (Figure 4) in case of citrus scab. The relationship between disease incidence and relative humidity could be expressed by the equation y = 1.2685x – 54.433 ($R^2$ = 0.9966**) where y = disease incidence and x = relative humidity. The $R^2$ value indicated that contribution of relative humidity were 99.66% on the incidence of citrus scab (*Elsinoe fawcetti*).

#### 4.3.3.4. Correlation between disease severity and relative humidity of citrus scab

A negative correlation between disease severity and relative humidity was observed (Figure 5) in case of citrus scab. The relationship between disease severity and relative humidity could be expressed by the equation y = 1.10304x – 44.332 ($R^2$ = 85.88**) where y = disease severity and x = relative humidity. The $R^2$ value indicated that contribution of relative humidity were 85.88% on the severity of citrus scab (*Elsinoe fawcetti*).

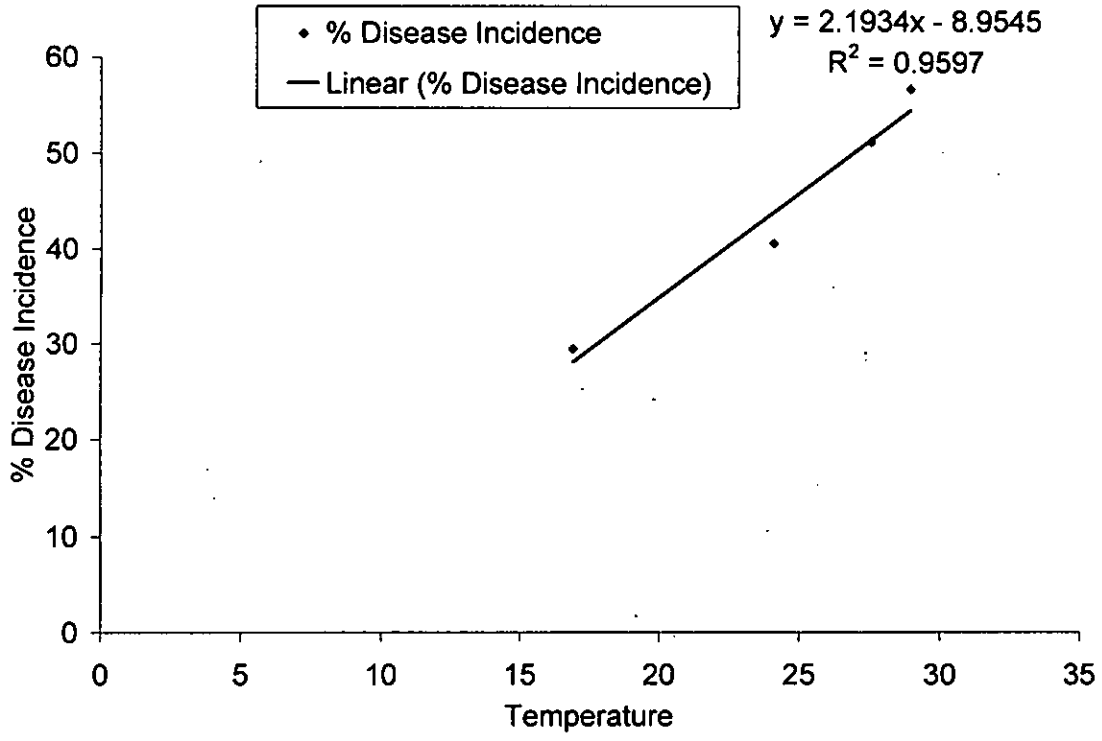



**Fig 2. Liner regression analysis of monthly average temperature of investigated four months on incidence of citrus scab**

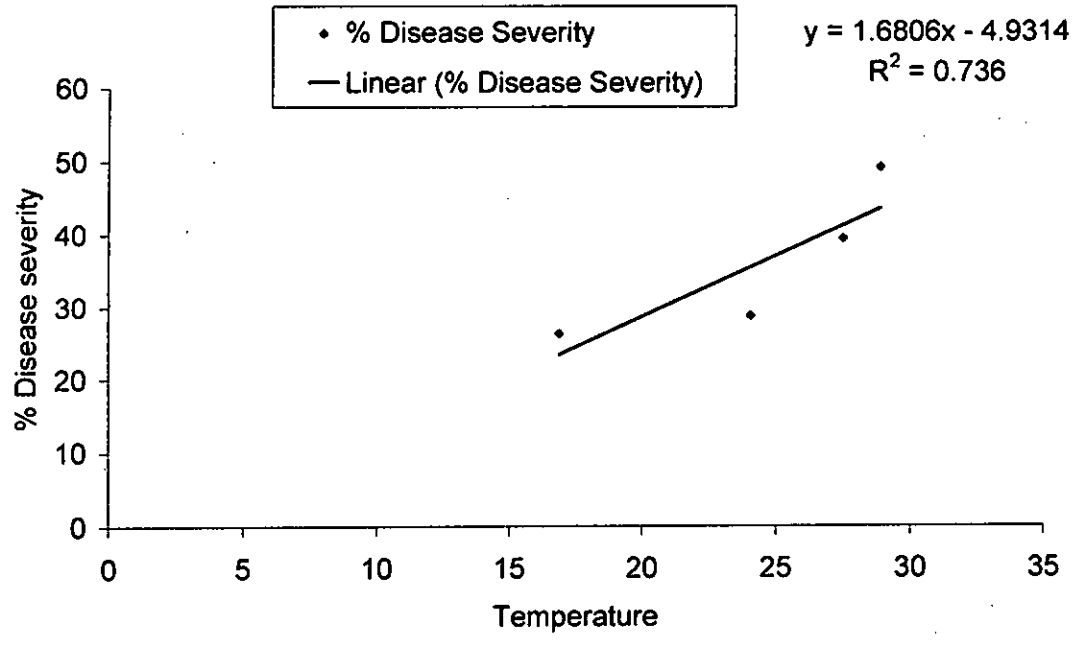



**Fig 3. Liner regression analysis of monthly average temperature of investigated four months on severity of citrus scab**

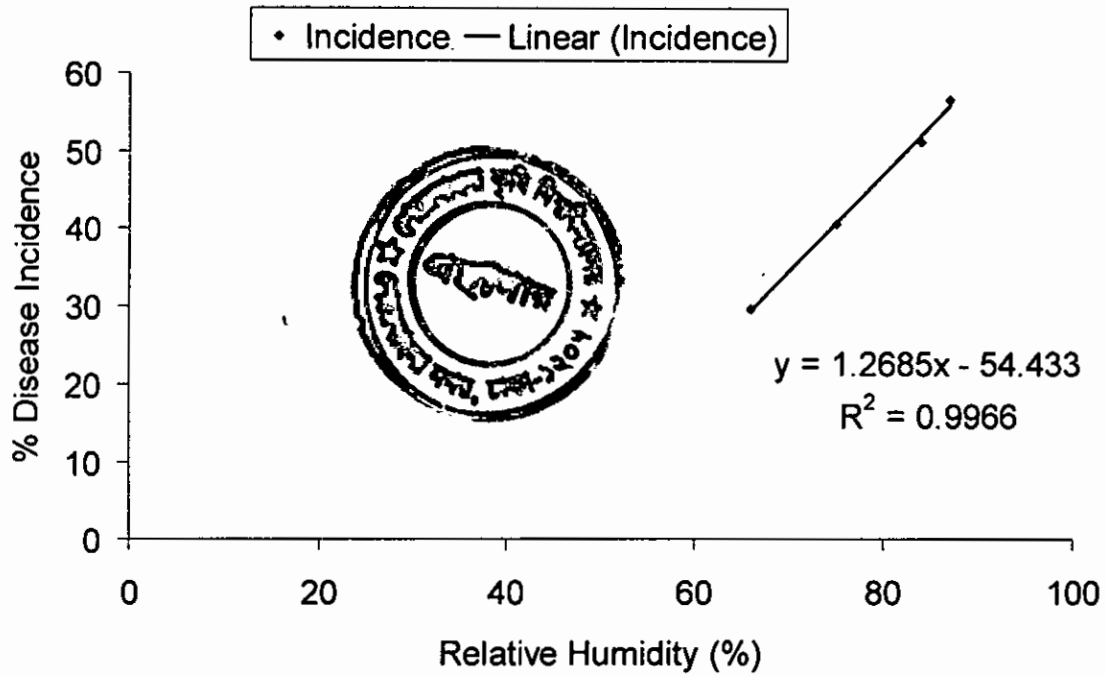



**Fig 4. Liner regression analysis of monthly average relative humidity of investigated four months on incidence of citrus scab**

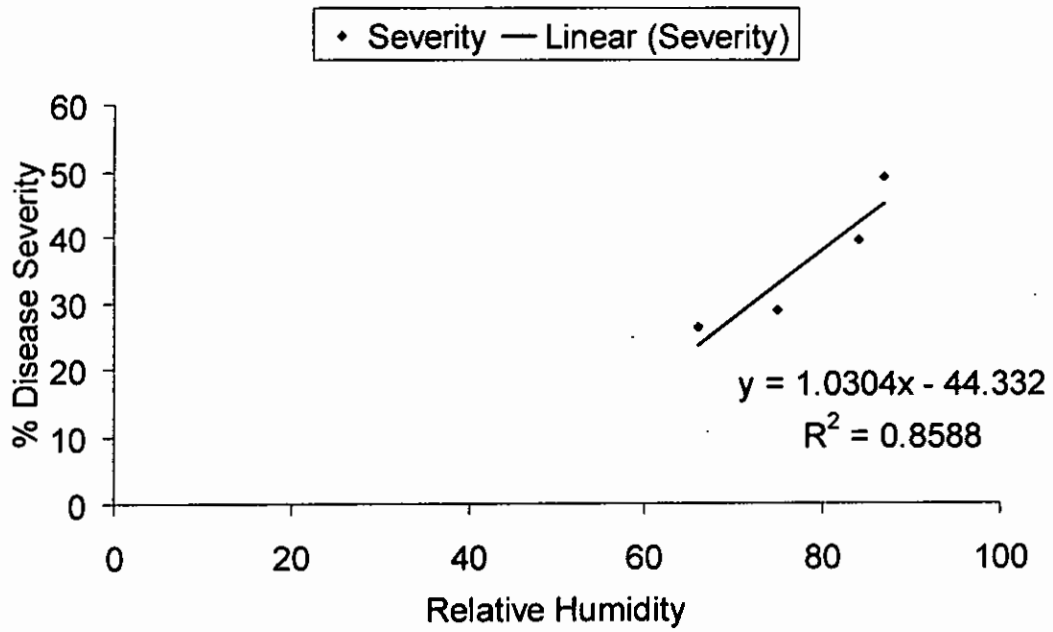



**Fig 5. Liner regression analysis of monthly average relative humidity of investigated four months on severity of citrus scab**

### 4.3.4. Incidence and severity of sooty mould of citrus

In the month of January, 2007 the incidence of sooty mould of citrus varied significantly from 7.32-9.48% with respect to nurseries surveyed. The highest incidence (9.48%) was recorded at DAE Horticulture center, Rajshahi followed by Hena Agro Nursery, Mohendra, Poba, Rajshahi (7.99%). The lowest incidence (7.32%) was observed in Lamyia Nursery, Kataakhali, Motihar, Rajshahi (Table 4). There was no significant statistical difference found in term of severity of sooty mould of citrus in the nurseries surveyed. The severity of sooty mould of citrus varied from 5.87-6.61% with respect to nurseries surveyed. The highest severity (6.607%) was recorded at DAE Horticulture center, Rajshahi; followed by Hena Agro Nursery, Mohendra, Poba, Rajshahi (6.466%). The lowest severity (5.857%) was observed in BARI Fruit Research Center, Rajshahi (Table 4).

In the month of March, 2007 the incidence of sooty mould of citrus varied significantly from 15.87-18.80% with respect to nurseries surveyed. The highest incidence (18.80%) was recorded at DAE Horticulture center, Rajshahi; followed by Hena Agro Nursery, Mohendra, Poba, Rajshahi (18.33%). The lowest incidence (15.87 %) was observed in BARI Fruit Research Center, Rajshahi (Table 3). The severity of sooty mould of citrus varied significantly from 10.38-14.13% with respect to nurseries. The highest severity (14.13%) was recorded at Lamyia Nursery, Kataakhali, Motihar, Rajshahi, followed by Hena Agro Nursery, Mohendra, Poba, Rajshahi (11.99%). The lowest severity (10.38%) was observed in BARI Fruit Research Center (Table 4).

Table 4. Incidence and severity of sooty mould of citrus in four different surveyed nurseries of Rajshahi from January 2007 to October 2007

| Name of the Nursery | January | | March | | July | | October | |
|---|---|---|---|---|---|---|---|---|
| | Disease Incidence (%) | Disease Severity (%) | Disease Incidence (%) | Disease Severity (%) | Disease Incidence (%) | Disease Severity (%) | Disease Incidence (%) | Disease Severity (%) |
| Hena Agro Nursery, Mohendra, Poba, Rajshahi | 7.994b | 6.466a | 18.33a | 11.99ab | - | - | - | - |
| BARIFruit Research Center, Rajshahi | 7.398b | 5.857a | 15.87b | 10.38b | - | - | - | - |
| DAE Horticulture center, Rajshahi | 9.482a | 6.607a | 18.80a | 11.45b | - | - | - | - |
| Lamyia Nursery, Kataakhali, Motihar, Rajshahi | 7.318b | 5.893a | 16.15b | 14.13a | - | - | - | - |
| CV% | 5.35 | 6.83 | 3.87 | 9.13 | - | - | - | - |
| LSD | 0.8593 | 0.8476 | 1.336 | 2.186 | - | - | - | - |
| Level of significance | * | * | * | * | - | - | - | - |

Means followed by same letter significantly different at 1% or 5% level of significance.

### 4.3.5. Effect of temperature and relative humidity on the incidence and severity of sooty mould of citrus

The incidence of sooty mould of citrus was influenced by temperature and relative humidity. The incidence of sooty mould of citrus observed in the month of January was 8.48% when the temperature and relative humidity were 16.9°C and 75% respectively. The incidence of sooty mould of citrus observed in the month of March was 17.29% when the temperature and relative humidity were 24.1°C and 66% respectively. No disease was observed in the month of July and October (Figure 6). The severity of sooty mould of citrus was influenced by average temperature and average relative humidity. The severity of sooty mould of citrus observed in the month of January was 6.21% when the temperature and relative humidity were 16.9°C and 75%, respectively. The severity of sooty mould of citrus observed in the month of March was 11.273% when the temperature and relative humidity were 24.1°C and 66%, respectively. No disease was observed in the month of July and October (Figure 6).

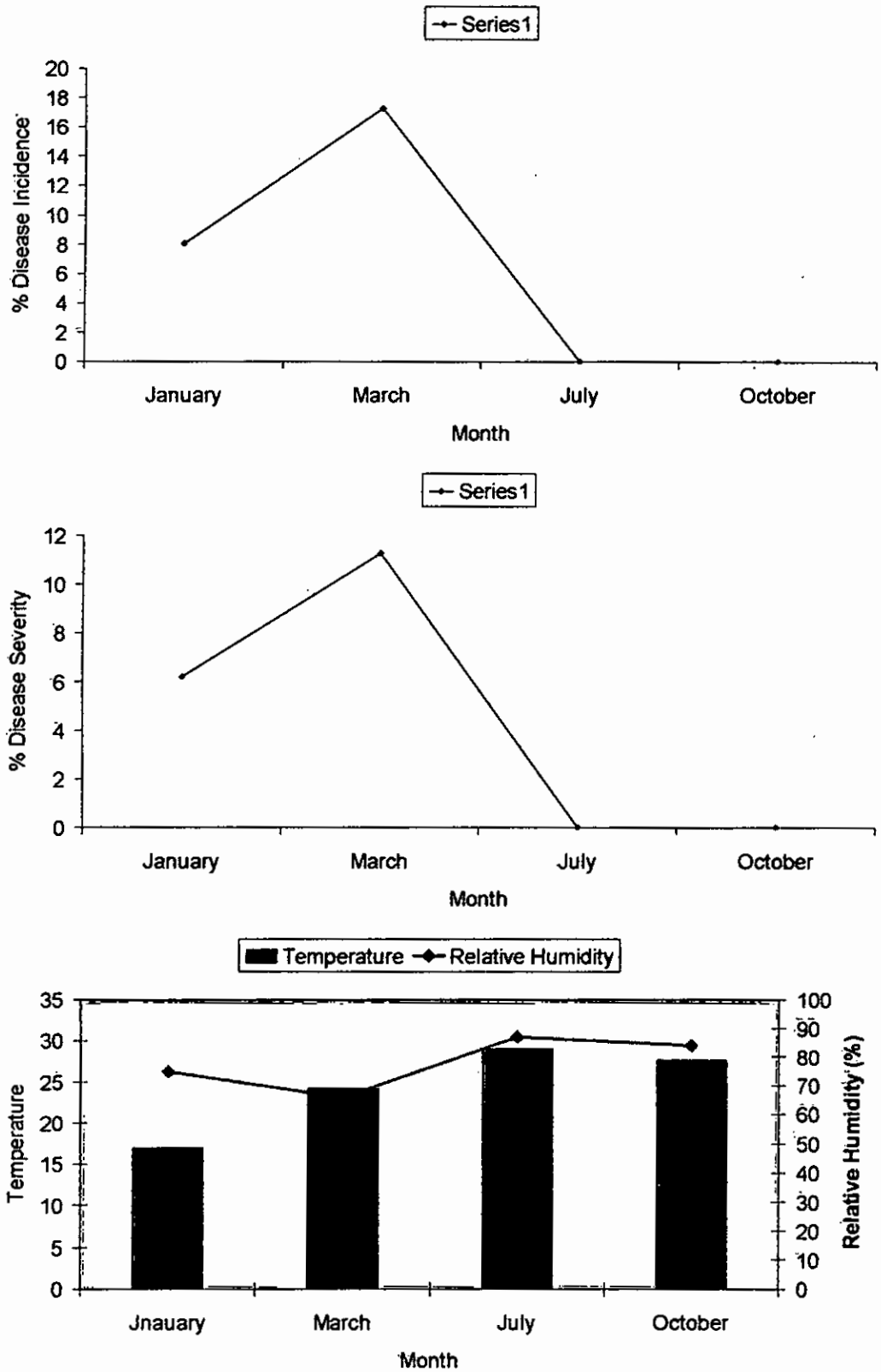



**Fig 6. Effect of Temperature and Relative Humidity on the Incidence and severity of Citrus sooty mould**

#### 4.3.6.1. Correlation between disease incidence and temperature of sooty mould of citrus

A negative correlation between disease incidence and temperature was observed (Figure 7) in case of sooty mould of citrus. The relationship between disease incidence and temperature could be expressed by the equation y = -0.7464x + 24.529 ($R^2$ = 0.2385) where y = disease incidence and x = temperature. The $R^2$ value indicated that contribution of temperature were 23.85% on the incidence of sooty mould of citrus (*Capnodium citri*).

#### 4.3.6.2. Correlation between disease severity and temperature of sooty mould of citrus

A negative correlation between disease severity and temperature was observed (Figure 8) in case of sooty mould of citrus. The relationship between disease severity and temperature could be expressed by the equation y = -0.5691x + 18.241($R^2$ = 0.3157) where y = disease severity and x = temperature. The $R^2$ value indicated that contribution of temperature were 31.57% on the severity of sooty mould of citrus (*Capnodium citri*).

#### 4.3.6.3. Correlation between disease incidence and relative humidity of sooty mould of citrus

A significant negative correlation between disease incidence and relative humidity was observed in case of sooty mould of citrus (Figure 9). The relationship between disease incidence and relative humidity could be expressed by the equation y = -0.08578x + 73.239 ($R^2$ = 0.9778**) where y = disease incidence and x = relative humidity. The $R^2$ value indicated that contribution of relative humidity were 23.85% on the incidence of sooty mould of citrus (*Capnodium citri*).

#### 4.3.6.4. Correlation Study between disease severity and relative humidity of sooty mould of citrus

A significant negative correlation between disease severity and relative humidity was observed (Figure 10) in case of sooty mould of citrus. The relationship between disease severity and relative humidity could be expressed by the equation $y = -0.57x + 48.829$ ($R^2 = 0.9832^{**}$) where y = disease severity and x = relative humidity. The $R^2$ value indicated that contribution of relative humidity were 98.32% on the severity of sooty mould of citrus (*Capnodium citri*).

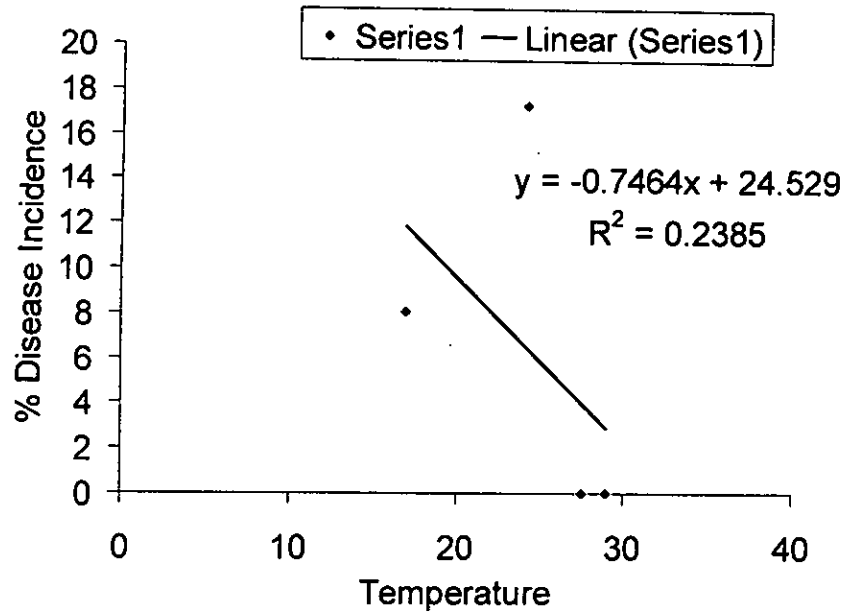



**Fig 7. Liner regression analysis of monthly average temperature of investigated four months on incidence of sooty mould**

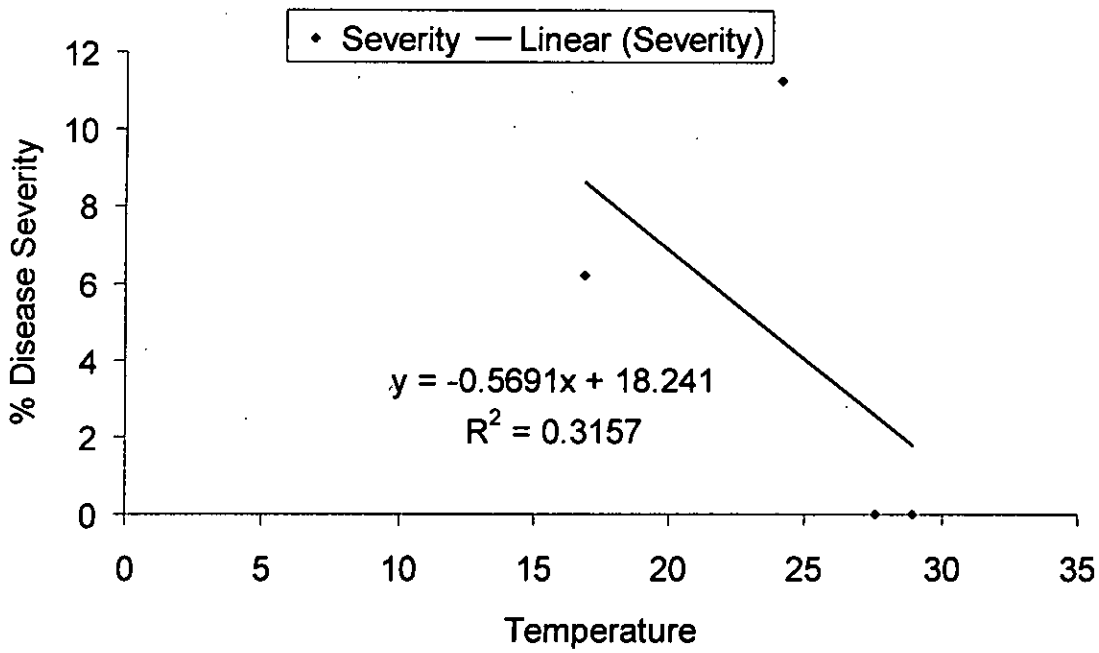



**Fig 8. Liner regression analysis of monthly average temperature of investigated four months on severity of sooty mould**

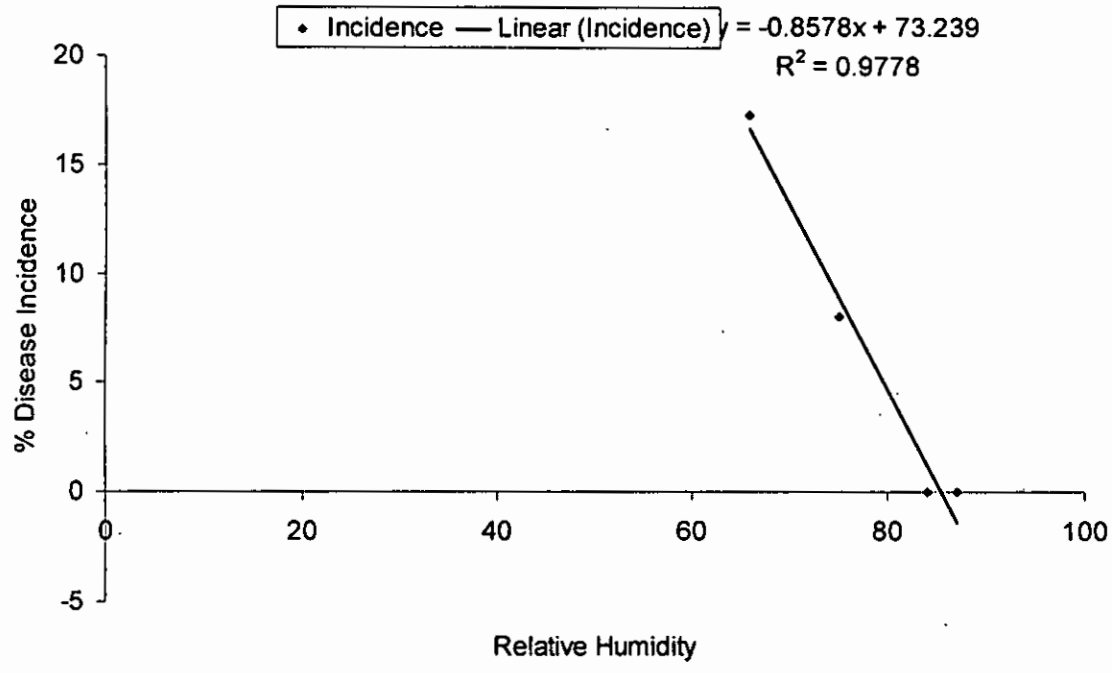



**Fig 9. Liner regression analysis of monthly average relative humidity of investigated four months on incidence of sooty mould**

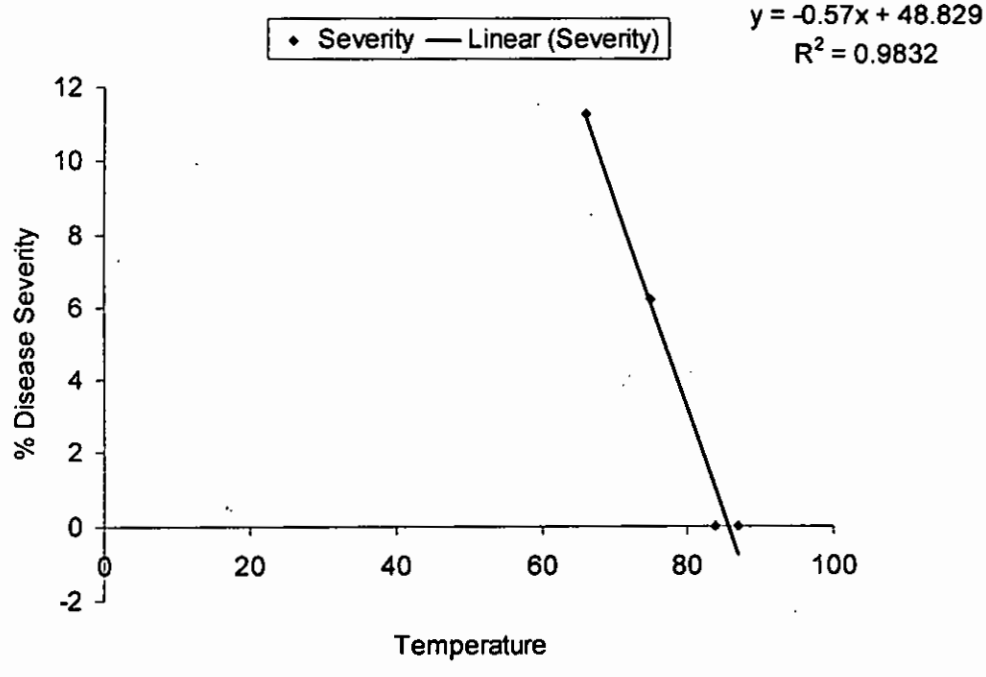



**Fig 10. Liner regression analysis of monthly average relative humidity of investigated four months on severity of sooty mould**

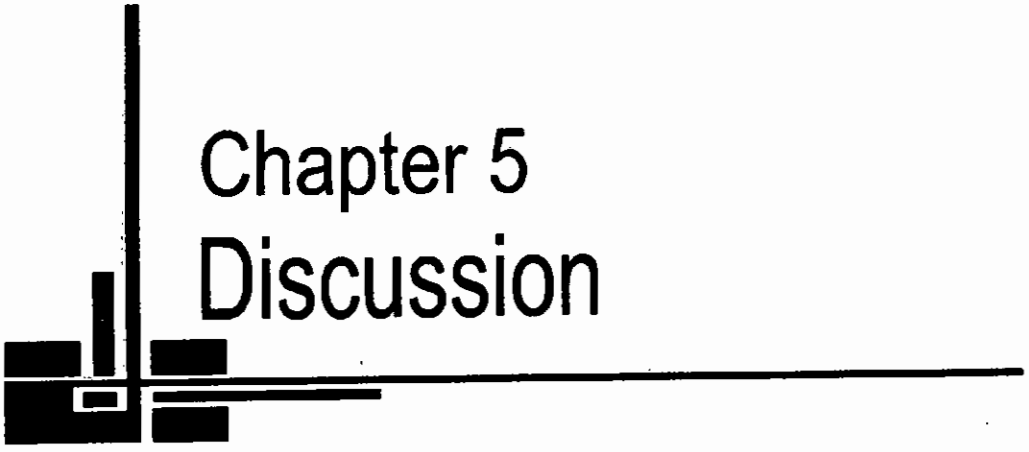
### 4.4. The average temperature and relative humidity of Rajshahi in the month of January'07 to October '07

In the month of January the maximum temperature was 24.4°C and the minimum temperature was 9.4°C, so the average temperature observed in the month of January was 16.9°C. In the month of March the maximum temperature was 31.1°C and the minimum temperature was 17.1°C, so the average temperature observed in the month of March was 24.1°C. In the month of July the maximum temperature was 32.4°C and the minimum temperature was 26.0°C, so the average temperature observed in the month of July was 28.95°C. In the month of October the maximum temperature was 31.9°C and the minimum temperature was 23.2°C, so the average temperature observed in the month of October was 27.55°C (Table 6).

In the month of January the average relative humidity was 75%. In the month of March the average relative humidity was 66%. In the month of July the average relative humidity was 87% and in the month of October the average relative humidity was 84% (Table 6).

**Table 5. The average temperature and relative humidity of Rajshahi in the month of January'07 to October '07**

| Month | Maximum Temperature ($^0$C) | Minimum Temperature ($^0$C) | Average Temperature ($^0$C) | Average Relative Humidity (%) |
|---|---|---|---|---|
| January | 24.4 | 9.4 | 16.9 | 75 |
| March | 31.1 | 17.1 | 24.1 | 66 |
| July | 32.4 | 26.0 | 28.95 | 87 |
| October | 31.9 | 23.2 | 27.55 | 84 |



# Chapter 5
# Discussion

CHAPTER V

# DISCUSSION

In the present study five diseases namely citrus scab, citrus sooty mould, die back, citrus canker and yellowing of citrus plant were recorded in four nurseries under Rajshahi district of there diseases two were fungal viz. citrus scab and citrus sooty mould, one bacterial- citrus canker, one viral-yellowing and the other is the result of various complex factors. This diseases recorded in the present study have also been reported on citrus seedlings from different countries of the world (Chowdhury,(1955a); Klotz, (1973); Nirvan, (1961); Reddy and Murti, (1985); Anonymous, (1990). Alam (2003).

In Bangladesh twelve diseases including five observed by the present author, were recoded by Alam (2003), in the citrus growing areas of Bangladesh on grown plants the disease were identified based only on symptoms developed on the seedlings. No attempt was made by the present author to isolate the causal organism of the diseases and prove its pathogenisity. Since the symptoms was so conspicuous that those need not be isolated for their confirmation. The pathogens of the five diseases encounter in the present study were identified as the causes by workers from different citrus growing countries of the world. Therefore further critical studies are needed to determine the cause(s) of the seedling diseases of citrus recorded in Bangladesh.

Of the five diseases two diseases viz. citrus scab and citrus sooty mould were found to occur in all the four nurseries at Rajshahi. On the other hand citrus canker were not found in DAE Horticulture center, Lamyia Nursery, Kataakhali, located

in the Rajshahi district similarly die-back of citrus could not be recorded in BARI Fruit Research Center, DAE Horticulture center and also citrus yellowing was not be recorded from Hena Agro Nursery and Lamyia Nursery.

The prevalence of the recorded five diseases varied independently of each other with respect to nursery and its location. Similar variation in prevalence of seedling diseases was recorded by Fraser, 1959; McClean, 1960 and Nirvan, 1961 in different citrus growing regions.

Regarding incidence of the five diseases recorded in the present study, citrus scab was the most pre-dominant (44.25%) while citrus sooty mould (12.67%) and yellowing (4.546%) had the least occurrence. While disease severity was concerned, citrus scab (36.33%) was the prevalent disease and citrus yellowing (4.546%) had the lowest prevalence. Singh *et al.* (1997a) conducted a survey at Panjab in India and found the highest disease incidence of scab on rough lemon (80.1%) and kinnow (80.07%) and the lowest incidence were recorded on sweet orange 10.8% in the arid irrigated zone.

In the present study the diseases were recorded four times during the period of ten month survey from January to October. During the survey period prevalence (Incidence and Severity) of citrus scab was found to increase with the increase in time. The highest disease incidence and disease severity were observed in the month of July (67.08% and 62.00%) and the lowest prevalence (disease incidence and disease severity) observed in the month of March (27.57% and 23.22%) respectively (Table 2). The result of the present study corroborates with the study of Nirvan (1961) who found that the scab was negligible in colder season than that

of warmer season.

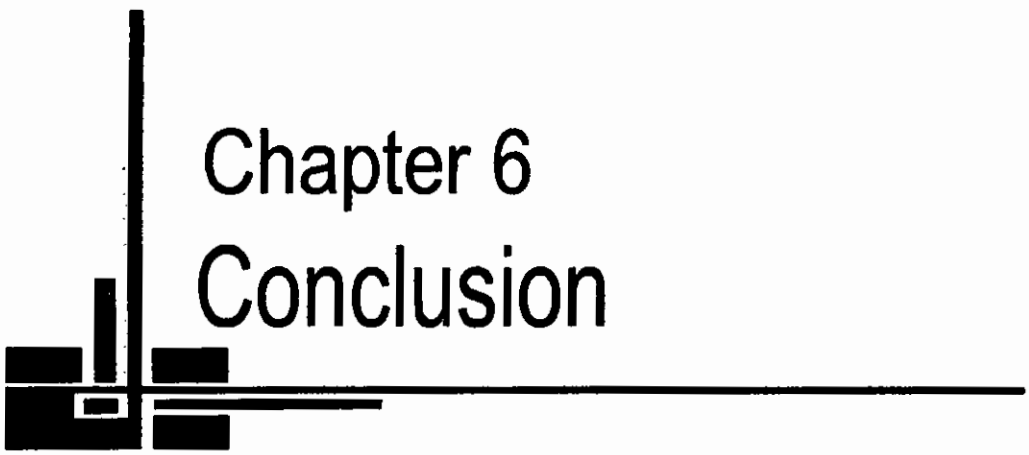
A positive correlation was observed between prevalence of scab and relative humidity. With the increase of temperature and relative humidity in the month of January to July the incidence and severity both increased significantly. In the month of October the incidence and severity both reduced due to flashing of new leaves. Statistical analysis shows that the contribution of temperature and relative humidity collectively around 97%. The other factor may influence the prevalence of the disease due to rainfall, hour of rainfall or relative humidity. The present study also supported by the previous workers (Chowdhury, (1955b); Reddy and Murti, (19900; Singh *et al.*, (1997). Chowdhury (1955c) reported that humidity and rainfall played more important role in the development of scab than by temperature. Reddy and Murti (1990) found that scab prevails in the regions where temperature and humidity remains low.

The highest prevalence of sooty mould of citrus observed in the month of March while the temperature and relative humidity were 24.10°C and 66% respectively. In Bangladesh, almost similar temperature and relative humidity remains in the month of January and February and the temperature starts to raise and reach as high as 28°C in the month of March, April and May almost similar relative humidity of around 68-70%. June, July and August are characterized by monsoon rain, high humidity and relatively high temperature around 30°C. As the sooty mould thrives well in low humidity and temperature, the high incidenceand severity was observed in the months of January, February and March. No diseases was found in the month of July to October. It may be due to non-conducive

atmosphere for the pathogen sooty mould. The result of the present study keeps in with the findings of the previous workers (Naik, 1949; Ramakrishnan, 1954a). Naik (1949) observed that the sooty mould fungus develops and detach in 23°C and 50-60% relative humidity. Also another factor of prevalence of insects namely aphids, scaly insects etc. known to be responsible for secreting honey dew which in facts acts as substrates for harboring sooty mass. Anonymous (2005a) found the fungi causing sooty mould grow on the sugary exudates of insects such as aphids, brown soft scale, black flies and white flies. Anonymous (2005b) reported that sooty mould grows superficially on the honeydew excretions of white flies, aphids, mealy bugs and scaly insects.

Thus may be described by pattern of rainfall of our country, since total amount of rainfall a negative trend of prevalence of sooty mould was observed. This high rainfall may washout the superficially attached sooty mass on the leaves. The present findings also match with the findings of Chowdhury (1955) who reported that the disease occurs in cold weather and in low relative humidity. The fungal growth is washed off downpour of rain.

The occurrence of the diseases in the nursery reveals that scab and sooty mould diseases are present in the nursery from January to March and scab is most pre-dominant disease of citrus.



# Chapter 6
# Conclusion

## CHAPTER VI

# CONCLUSION

Citrus seedlings are suffer from various diseases in Bangladesh , but least concrete information regarding their distribution, incidence, severity and epidemiology is available. Therefore, an attempt has been made to study the occurrence and prevalence of seedling diseases of citrus and to study the correlation of temperature and relative humidity with the development of diseases in selected nurseries of Rajshahi.

Two experiment were carried out throughout the study period from January, 2007 to October, 2007. A total of 4950 seedlings in four selected nurseries were surveyed. The disease were identified based on matching the observed symptoms in infected plants with symptoms in infected plants with symptoms published in citrus diseases and their control by Reddy and Murti (1990) and Citriculture by Rajput and Hari babu (1985). The epidemiological study especially the effct of temperature and relative humidityon the disease prevalence (Incidence and Severity) was studied.

Five different diseases viz. citrus scab, citrus sooty mould, die back, citrus canker and yellowing of citrus seedlings were recorded during the survey period in four selected nurseries of Rajshahi.

The prevalence of recorded five diseases varied independently from each other with respect to nursery and its location. Regarding the incidence of five diseases recorded in the present study, Citrus scab was the most pre-dominant (44.23%) followed by Sooty mould (12.67%), Canker(9.87%), Die-back (7.68%) and yellowing (4.54%). When disease severity wad concerned, Citrus scab(36.33%) was the most prevalent disease followed by Sooty mould (9.09%), Canker (7.89%) and Die-back (6.87%), yellowing (4.54%) had the lowest prevalence. The correlation of prevalence of diseases with temperature and relative humidity recorded from January to October, 2007. The prevalence of Sooty mould was highest in the month of July to October.

Therefore, the present study on the occurrence of seedling diseases in the nursery relies that Citrus Scab and Sooty mould studied were highly related to the temperature and relative humidity. Other parameters of epidemiology viz. total amount of rainfall in the growing period, leaf wetness period, vapor presser deficit, sunshine hour, microclimatic parameters including canopy temperature, relative humidity etc. should be critically evaluated to have better understanding of disease development, Further, these parameters 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 appropriate time to combat the disease at minimum effort.

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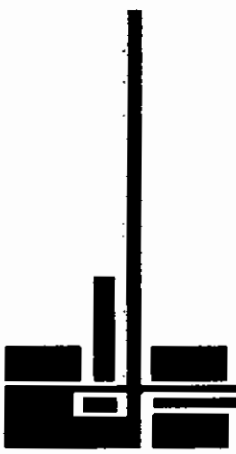
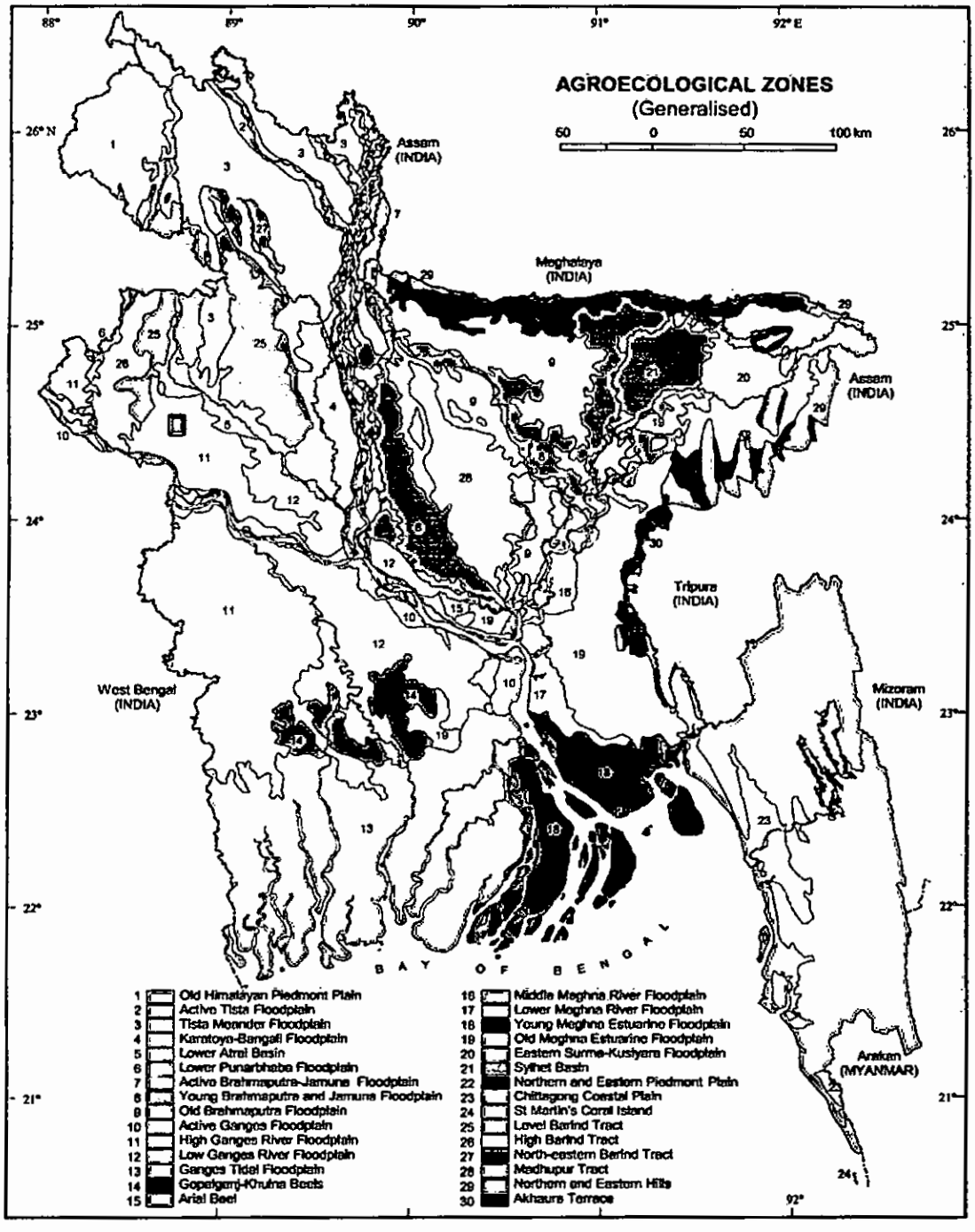


# Appendiecs

Appendix 2. Location of the experimental site under study




**Study Location** ▯