EPIDEMIOLOGICAL SURVEY ON THE INCIDENCE AND SEVERITY OF PURPLE BLOTCH OF ONION IN BANGLADESH

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CERTIFICATE

This is to certify that the thesis entitled "*EPIDEMIOLOGICAL SURVEY ON THE INCIDENCE AND SEVERITY OF PURPLE BLOTCH OF ONION IN 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 bona fide research work carried out by *Khan Md. Nuruddin Faysal, Registration No. 00904,* under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

I further certify that any help or sources of information as has been availed of during the course of this inquire have been duly acknowledged and the contents & style of the thesis have been approved and recommended for submission.

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

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Dhaka, Bangladesh

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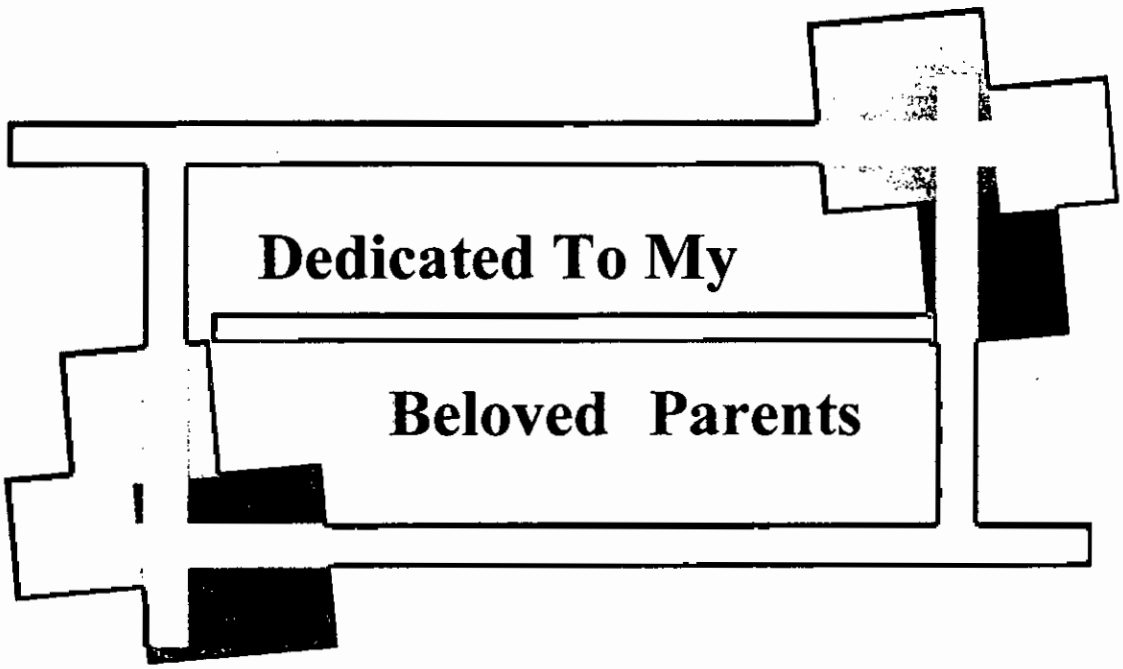

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ABSTRACT

An epidemiological survey on the incidence and severity of purple blotch of onion was conducted during onion growing seasons of the year 2007-08, 2008-09 and 2009-10 (Winter- September to March) in the major onion growing areas viz. Vasanchar (Faridpur), Jitka (Manikgonj), Sayedpur (Comilla), Nandina (Jamalpur), Kesobpur (Jessore), BARI (Gazipur), SAU campus (Dhaka), Hathazari (Chittagong), Dhamrai (Dhaka), Taherpur (Rajshahi) of the country. Data were collected on % Plant infection, % Leaf infection, % LAD (Leaf Area Diseased), % SAD (Stalk Area Diseased), Soil pH, Soil temperature, Soil moisture, Air temperature and Air humidity (% RH). The disease incidence and severity of purple blotch of onion varied with locations, and environmental factors. The plant infection and leaf infection ranged from 87 % - 36 % and 62 % - 20 %, respectively while the percent leaf area diseased (% LAD) and percent stalk area diseased (% SAD) ranged from 36.67 % - 9.00 % and 39.00 % - 11.00 %, respectively. The highest disease incidence and severity during the consecutive 3 growing seasons of the year 2007-08, 2008-09 and 2009-10 was recorded at Sayedpur (Comilla) where average air temperature, air humidity and pH were 24.08^{0}C, 75.17% and 4.72 respectively. The lowest incidence and severity was recorded at BARI (Gazipur) where average air temperature, air humidity and pH were 23.99^{0}C, 85.44% and 5.30 respectively. Soil pH (4.6 -5.17), air temperature (23^{0}C) and air humidity (75 % ± 2) had influential effect on the incidence and severity of purple blotch of onion.

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ABBREVIATIONS USED

AEZ	=	Agro-Ecological Zone
@	=	At the rate
ANOVA	=	Analysis of variance
Anon.	=	Anonymous
AM	=	Ante meridiem
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
BBS	=	Bangladesh Bureau of Statistics
cm	=	Centimeter
CMI	=	Commonwealth Mycological Institute
CV	=	Co-efficient of variance
cv.	=	Cultivar
D	=	Day
DMRT	=	Duncan's Multiple Range Test
eg.	=	Example
Fe	=	Iron
g	=	Gram
FAO	=	Food and Agricultural Organization
ha	=	Hectare
$HgCl_2$	=	Mercuric chloride
hr	=	Hour
i.e.	=	That is
ISTA	=	International Seed Testing Association
IDM	=	Integrated Disease Management
K	=	Potassium
Kg / ha	=	Kilogram per hectare
LAD	=	Leaf Area Diseased
lb	=	Pound
LSD	=	Least Significant Difference

m	=	Meter
mm	=	Millimeter
P	=	Phosphorus
PM	=	Post meridiem
PDA	=	Potato Dextrose Agar
PDI	=	Percent Disease Index
ppm	=	Parts per million
q/ha	=	Quintal per hectare
RCBD	=	Randomized Complete Block Design
RH	=	Relative Humidity
S	=	Sulphur
SAD	=	Stalk Area Diseased
SAU	=	Sher-e-Bangla Agricultural University
T	=	Treatment
t / ha	=	Ton per hectare
VPD	=	Vapor Pressure Deficit
wt.	=	Weight
w/v	=	weight per volume
Zn	=	Zinc
$ZnSO_4$	=	Zinc Sulfate
^0C	=	Degree Centigrade
%	=	Percent

CHAPTER – 1

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the family Alliaceae, is a popular medicinal and widely grown spice in Bangladesh as well as in the world and has got multifarious uses; such as spice vegetables, salad-dressing etc. It is also used as condiments for flavoring a number of foods and medicines (Vohora *et al.* 1974). On the other hand, raw onion is being used and given protection to human beings from sun stroke, normally is consumed green as well as in mature stages almost by every one, by different means.

It grows extensively during winter season in Bangladesh but at present it grows in the summer season also. Its commercial cultivation is concentrated in the greater districts of Faridpur, Comilla, Jessore, Pabna, Rajshahi, Dinajpur, Mymensingh, Dhaka and Rangpur (BBS, 2006). Recently, bunching onion (*Allium fistulosum*) is coming up as a popular vegetable too. It does not form bulbs but grow in clusters with long white stems. (Benoit and Coustermans, 1987). Now-a-days, onion regarded as a cash crop to the farmers which provides them continuous harvesting both winter and summer season and financial assistance.

In terms of global vegetable production nearly 28 million tons per annum, next to tomatoes and cabbages bears importance (FAO, 1991). In Bangladesh, the present production of onion is around nearly 7,69,000 tons from 115742 hectares of land (BBS, 2006). The annual yield is only 6.644 tons / ha in Bangladesh (BBS, 2006) which is quite low compared to other onion growing countries of the world. Our requirement of onion per year is around 14,00,000 tons/year (BBS, 2006).

Among the 23 districts of onion growing areas of the country viz. Faridpur, Comilla, Manikganj, Dinajpur, Jessore, Pabna, Rajshahi, Mymensingh, Jamalpur, Patuakhali, Kishorganj, Tangail, Borishal, Bandarban, Khagrachari, Sylhet, Bogra, Rangamati, Kustia, Dhaka, Chittagong and Rangpur, the highest yield 2,08,935 metric ton was in Faridpur from 78,695 acre of land. (BBS, 2007).

In Bangladesh, the local varieties namely Faridpuri and Taherpuri are commonly grown extensively. The high yielding variety, such as- BARI 1, BARI 2, and BARI 3 also are now famous for cultivation in Bangladesh. In Bangladesh, the demand of bulb onion as well as the onion seeds is increasing every year and the price of the true seeds remains fairly high in each season.

As per the world literatures, onion is attacked by about 66 diseases including 38 fungal, 10 bacterial, 6 nematode, 3 viral, 1 mycoplasmal, 1 parasitic plant and 7 miscellaneous diseases and disorders.

Onion suffers from several diseases caused by various pathogens (Meah and Khan, 1987; Ahmed and Hossain, 1985; Munoz *et al.*, 1984). Seven diseases were reported as seed borne viz. purple blotch, seed rot, germination reduction, black mould, germination failure and white rot. Among them purple blotch of onion caused by *Alternaria porri* (Ellis) Cif. is the most important fungal disease (Munoz *et al.*, 1984; Bose and Som, 1986). This disease commonly known as leaf blotch and is noted as the major disease throughout the world including Bangladesh (Ahmed and Hossain, 1985; Munoz *et al.*, 1986; Meah and Khan, 1987; Bose and Som, 1986 and Castellanos-Linares *et al.*, 1988).

The purple blotch of onion is considered as a serious problem for seed production in tropical countries like Bangladesh (Rahman *et al.*, 1988; Anonymous, 1985). In primary stage the symptoms appear on leaves or seed stalks as small water-soaked lesion that quickly develops white centre. As lesions enlarge, they become zonate and brown to purple, and are surrounded by a yellow zone. The lesion extends upward for some distance.

A few large lesions have formed in a leaf or seed stalk, which may coalesce and girdle the leaf or seed stalk and tissues distal to the lesions will die.

Seed production is severely affected because the disease causes damage of foliage and breaking of floral stalks (Munoz *et al.*, 1984). The infected seed stalks break at the point where the blotch lesion is developed (Singh, 1987). Under favorable environmental conditions, complete failure of the crop may take place if proper control measures are not employed (Sharma, 1986). Bulb and seed yields of onions cv. "Nasik Red" were significantly reduced as a result of purple blotch caused by *Alternaria porri* (Gupta and Pathak, 1988). About 20 to 25 % losses in seed yield have been recorded in India (Thind and Jhooty, 1982) and 41-44 % in Bangladesh (Hossain and Islam, 1993; Fakir, 2002). In Bangladesh, both the cultivars Faridpuri and Taherpuri are susceptible to the disease (Rahman *et al.*, 1988). The cultivation area of onion is increasing but its rate of production per unit area in Bangladesh is gradually decreasing due to disease problem (BBS, 2006). As a result Bangladesh has to import a large quantity of onion every year to fulfill the national demand at the cost of foreign currency.

Temperature, humidity and host nutrition play an important role for infection of onion caused by *Alternaria porri* (Gupta *et al.*, 1993; Everts and Lacy, 1990; Lacy, 1990; Mondol *et al.*, 1989; Khare and Nema, 1981).

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Basic environmental conditions such as temperature, moisture, sunlight, air humidity and physical and chemical characteristics of soil can greatly affect the physiology of the crop plant and subsequent disease development (Larkin *et al.*,2002). Thus, an epidemiological survey is necessary to have a clear picture about the microclimate and the prone areas of the country regarding purple blotch disease for onion cultivation. But no such work has been under taken in Bangladesh.

Under the scenario discussed above, the present study was undertaken to achieve the following objectives:

1) To determine the incidence and severity of purple blotch of onion in major onion growing areas of Bangladesh
2) To record the soil temperature, air temperature, soil moisture, air humidity (RH) in onion growing season of major onion growing areas of the country.
3) To determine the effect of environmental factors on incidence and severity of purple blotch of onion

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CHAPTER 2

REVIEW OF LITERATURE

Purple blotch of onion, incited by *Alternaria porri* is the most important disease of onion in Bangladesh and all over the most growing region of the world. Researchers have been carrying out their investigations on the purple blotch of onion, its epidemiology and transmission of the pathogen for the management of this disease. Epidemiological parameters viz. soil temperature, air temperature, soil moisture, air humidity and soil pH is being explored in many countries of the world. Literature in relation to Epidemiology of purple blotch of onion is presented in this chapter.

Lakra (1999) conducted an experiment at the Choudhury Charan Singh Haryana Agricultural University, Hisar, India and found numerous purple spots / blotchs on older leaves and scapes when fortnightly dew fall was >1.0 mm, mean maximum relative humidity > 75 % and mean maximum temperature 20-30°C with > 18 hr favourable temperature (10-30°C) duration. Exposure of leaf and / or escape to wetness for 8 hr was a pre-requisite for conidial germination with increasing disease intensity, every yield component was adversely affected; the most severe infection reduced the number of escapes /plant, the height of scape, the number of umblets /umbel, the number of seeds /umblet, 1000-grain weight, number of

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seeds / plant and the seed yield / plant by 28.7, 74.5, 89.9, 41.7, 35.7, 95.7 and 97.3 % respectively compared with healthy plants.

On the basis of 5 years of the survey (1988-93) Srivastava *et al.*, (1994) reported the higher incidence (2.5-87.8 %) of purple blotch (*Alternaria porri*) in both the kharif and rabi onions, when high humidity prevailed.

Hossain *et al.* (1993) reported 41-44 % loss of seed crop in Bangladesh due to purple blotch of onion. Under favorable environmental conditions of the disease, complete failure of onion seed crop was observed (Sharma, 1986). The disease causes 20-25 percent loss in seed yield in India (Thind and Jhooty, 1982).

Chawda and Rajasab (1992) conducted a field and laboratory experiment on *Colletotrichum gloeosporioides* (*Glomerella cingulata*) and *Alternaria porri*. Conidia of *Alternaria porri* were readily dispersed by air currents.

Rodriguez *et al.* (1991) studied that the intensity and dynamics of *Alternaria porri* conidial germination at 5, 10, 15, 20, 25, 30, 35, 37.5 and 40°C and RH 76-100 %. Conidia developed at 5 - 37.5°C, with an optimum temperature of 30°C. Germination started within 1 h of incubation at 20-

35°C and in 4 hr. 50 % of the conidia had germinated. The min. threshold for RH at 20°C was between 76-78 %.

Everts and Lacy (1990) conducted a study to determine the influence of weather variables on conidial concentration of *Alternaria porri* in air of an onion field for two years (1986-87). Weather instruments and a spore trap were placed in the centre of an unsprayed 15×30 m plot of field. In both the years, the natural logarithm of numbers of airborne conidia sampled during the current day (D) was positively correlated with (1) the max. hourly vapor pressure deficit (VPD) (saturation-ambient vapor pressure) on D, and (2) the logarithm of the conidial concentration sampled on D-1. A regression equation was developed to predict relative conidial concentration on day D in 1987 that explained 59 % of the variability. Purple blotch lesions were counted weekly at the same site in 1986 and 1987. In 1987, counts of lesions were also made on onion trap plants placed in the field plot at weekly intervals. Large concentration of conidia of *Alternaria porri* did not always precede increases in lesions.

Evert and Lacy (1990) examined formation of conidia by *Alternaria porri* under variable dew duration and controlled relative humidity (RH). Viable conidia produced on lesions after 9 hrs of dew to 38 hrs and conidia formed during 16 hrs of dew duration caused typical lesions. Conidia were formed at all RHs tested (75-100 %); numbers were very low at 75-85 % RH

but increased with increasing RH. Conidia formed on lesions on senescent leaves when incubated in dew chamber at 25°C and conidia formed repeatedly (up to eight cycles) on lesions to alternating low RH (35-50 %) and high (100 %) RH.

Ahmed and Hossain (1985) recorded purple blotch of onion from all onion growing regions of Bangladesh. Ashrafuzzaman and Ahmed (1976) also reported that the damage of foliage and breaking of floral stalks due to the disease resulting in failure of seed production are common.

Among the factors reducing yield and limiting the production of onion seed in Cuba, breaking of floral stalks due to injuries caused by *Alternaria porri* was reported by Munoz *et al.* (1986).

Khare and Nema (1982) also reported that the temperature ranged between 22°C to 25°C was not only suitable for growth and sporulation of *Alternaria porri* but also optimum for spore germination as well as for infection in onion. They also argued that spore germination on leaves decreased with the increase of nitrogen doses to the host. They also reported that temperature, humidity and nutrients seemed to play important roles for ensuing infection of *Alternaria porri* in onion. Cent percent (100 %) spore germination occurred in vitro within 4 hrs at 22°C, while maximum germination was recorded within 6 hrs at 25°C on the host surface.

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Khare and Nema (1981) studied sporulation of conidia of *Alternaria porri* on host and its dispersal. Maximum sporulation of *Alternaria porri* in the field was at 8 a.m. and mostly occurred immediately after the rains. In the laboratory sporulation was best at 22°C and 90 % RH. Most conidia were trapped at 12 hours noon and the least at 8 am. (mean temp.>18°C).

Attack by Thrips tabaci predisposed plants to infection by Alternaria porri and severe purple blotch occurred on plants in which the insects were uncontrolled reported by Thind and Jhooty (1982).

Wu (1979) surveyed the seed-borne diseases of vegetables. Results of the survey on onion showed that *Alternaria porri* and *Stemphylium botryosum* (*Pleospora herbgrum*) reduced germination of onion seeds

Alves *et al.*, (1983) studied the incidence of purple spot (*Alternaria porri* Ell. Cif.) on onion cultivars and hybrids in Manaus, Amazonia. Plants were divided into five classes on the basis of natural infection in the field. Incidence was 30-50 % (class III) in most cases; only the hybrid P×76 having plants in class I (0-10 %).

Miller (1983) reported that the leaf damage levels were significantly lower on younger than older leaves. Leaves emerging 9, 8, 7, 6 and 5 week before bulbing maturity required 51/2, 5, 41/2, 31/2 and 21/2 weeks respectively to reach 50% damage within 2 weeks.

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Gupta *et al.*, (1996) stated that Stemphylium blight (*Stemphylium vesicarium*) and purple blotch (*Alternaria porri*) are important diseases causing considerable damage to onion crops in India. Diseases are found severe during the rainy season especially when thrips are also associated with the crop.

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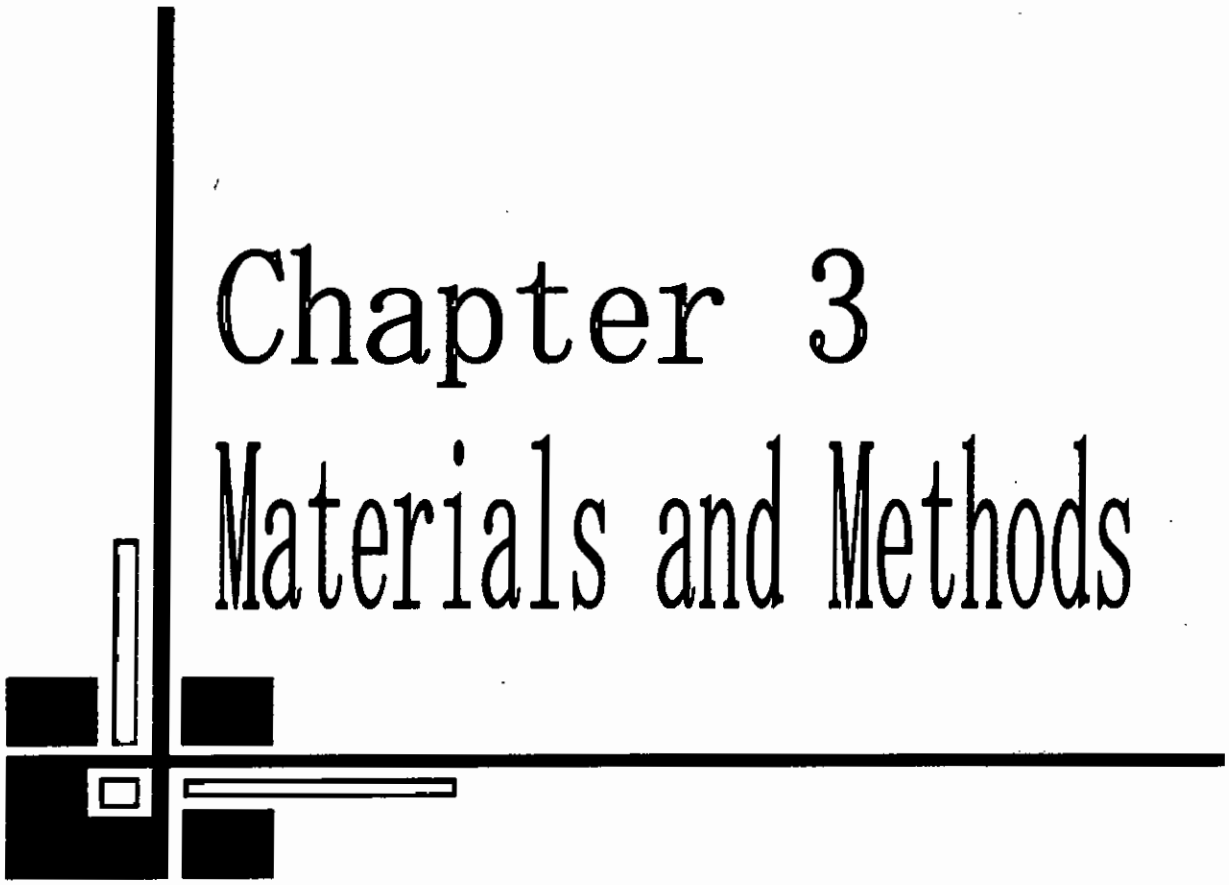
2.1 Morphology of *Alternaria porri*

Raju and Mehta (1982) demonstrated an experiment on certain nutritional aspects of *Alternaria porri* (Ellis) Ciferri on onion in vitro and summarized that potato dextrose agar having pH 6 was best to culture the fungus. Temperature ranging 22-25°C was optimum for mycelial growth and sporulation of *Alternaria porri*.

Sixty-days-old onion plants (cv. Nasik Red) were most susceptible to the purple blotch pathogen (*Alternaria porri*) (Gupta and Pathak, 1986). Plants inoculated at high RH (100 %) for 120 hours resulted in maximum disease severity and shortest incubation period.

Ariosa-Terry and Herrera-Isla (1986) measured the damage of onion due to purple blotch caused by *Alternaria porri*. The first symptoms appeared 50 days after sowing and disease intensity was the highest at 110 days. White onions were more affected than red onions.

Everts and lacy (1996) studied the factors influencing infection of onion leaves by *Alternaria porri* and subsequent lesion expansion. Conidia deposited on onion leaves formed single to several germ tubes and appressoria and often penetrated at more than one locus under conditions favorable. After 3 hrs in the dew chamber at 24°C following



Chapter 3
Materials and Methods

CHAPTER – 3

MATERIALS AND METHODS

3.1. Field experiments

The in vitro work was conducted at the Seed Health Laboratory of the Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, Bangladesh. The epidemiological surveys were conducted in the major onion growing areas viz. Vasanchar (Faridpur), Jitka (Manikgonj), Sayedpur (Comilla), Nandina (Jamalpur), Kesobpur (Jessore), BARI (Gazipur), SAU campus (Dhaka), Hathazari (Chittagong), Dhamrai (Dhaka), Taherpur (Rajshahi) of the country. (Fig.1)

3.2. Experimental period

The experiment were conducted during onion growing seasons of the year 2007-08, 2008-09 and 2009-10 (Winter- September to March).

Experiments :

I. Epidemiological survey on the incidence and severity of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2007-2008.

II. Epidemiological survey on the incidence and severity of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2008-2009.

III. Epidemiological survey on the incidence and severity of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2009-2010.

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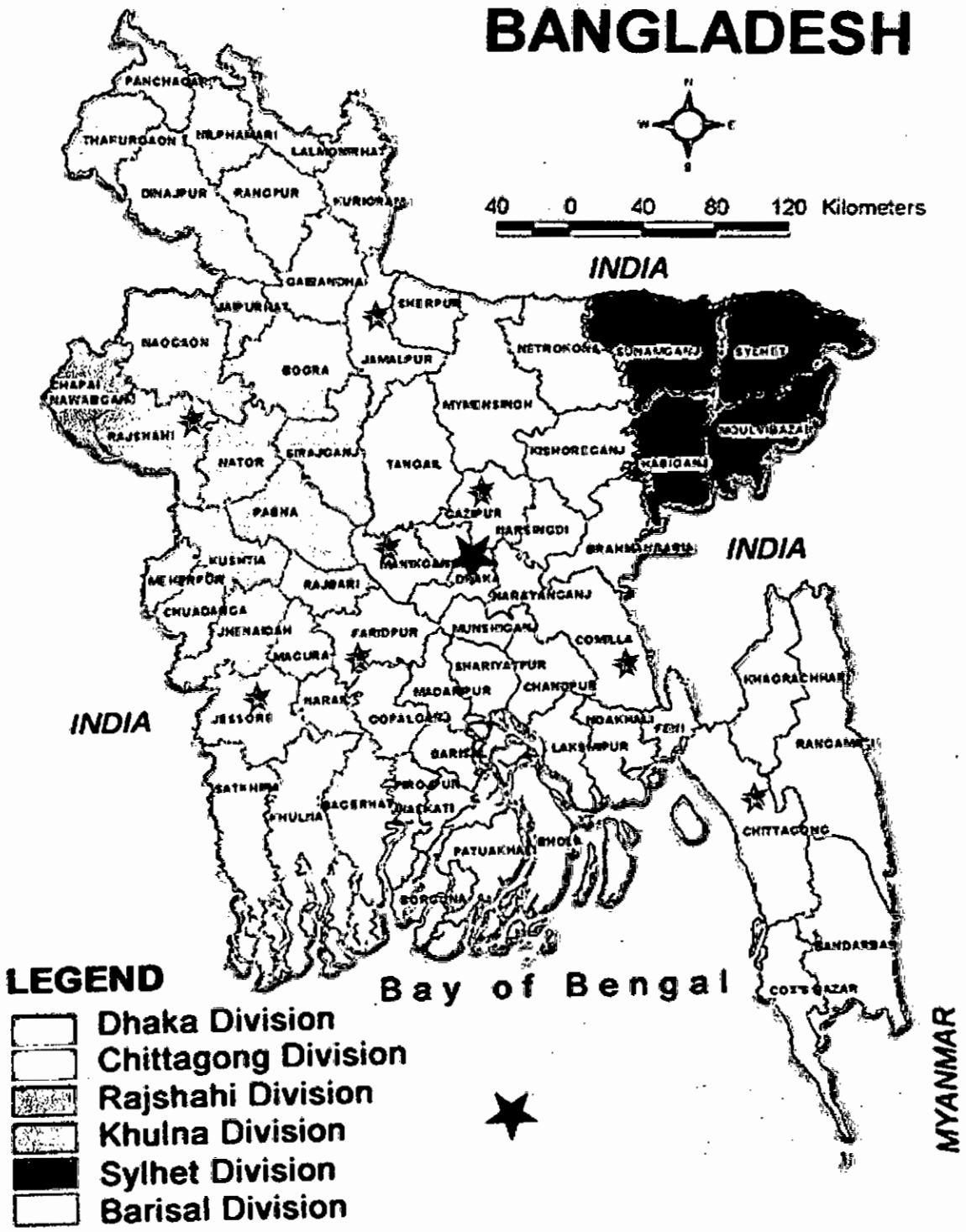

Fig.1. Map showing the survey site under the study

Non- Government Organizations. In each growing area, three (3) spots were randomly selected for inspection. Each spot covered an area of 0.5 acres or above. All farmers' plots and all cultivars of onion available in those spots were considered for inspection. Visits to each spot were made during the main winter growing season of the year. Data were collected on the following parameters:

I. % Plant infection

II. % Leaf infection

III. % LAD (Leaf Area Diseased)

IV. % SAD (Stalk Area Diseased)

V. Soil pH, temperature and moisture

VI. Air temperature and Humidity (% RH)

Recording of Soil and Atmospheric parameters

Soil pH and soil moisture were determined in situ with the help of soil pH and soil moisture meter (DEMETRA E.M. System Soil tester, Japan). Soil temperature was determined with SISEDO Multi-Thermometer. Air temperature and Air humidity were determined by Digital Thermo hygrometer.

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%LAD and %SAD was calculated using following formula:

$$\%\ \text{LAD / SAD} = \frac{\text{Area infected leaf / stalk}}{\text{Total number of inspected leaf / stalk}} \times 100$$

3.2.1 Isolation and Identification of Pathogens

Isolation and identification pathogen were made in two ways-

a) By direct observation
b) By inoculating diseased tissues on Potato Dextrose Agar (PDA) medium.

3.2.1.a. By direct observation1000

The diseased leaves of onion plants were collected and kept in polythene bags and tagged. The samples were than taken to the Seed Health Laboratory of the Department of Plant Pathology, SAU, Dhaka. Then slides were prepared from the diseased samples, observed under stereo microscope and identify the pathogen according to Commonwealth Mycological Institute (CMI) description. Vol. no. 338.

3.2.1.b. By growing on Potato Dextrose Agar (PDA) medium

The diseased leaves (plate 1) were cut into pieces (5mm diameter) and surface sterilized with $HgCl_2$ (1: 1000) for 30 seconds. Then the cut pieces were washed in sterile water thrice and were placed on to acidified PDA medium in petridish. The plates containing leaf pieces were incubated at room temperature (25°C±1)for seven days. When the fungus grew well and sporulated, the organism was re-cultured by single spore or tip culture method to obtain pure culture (Plate 2). Then slides were prepared from pathogenic structures and was observed under microscope and identified with the help of relevant literature (CMI Description). (Plate 3)

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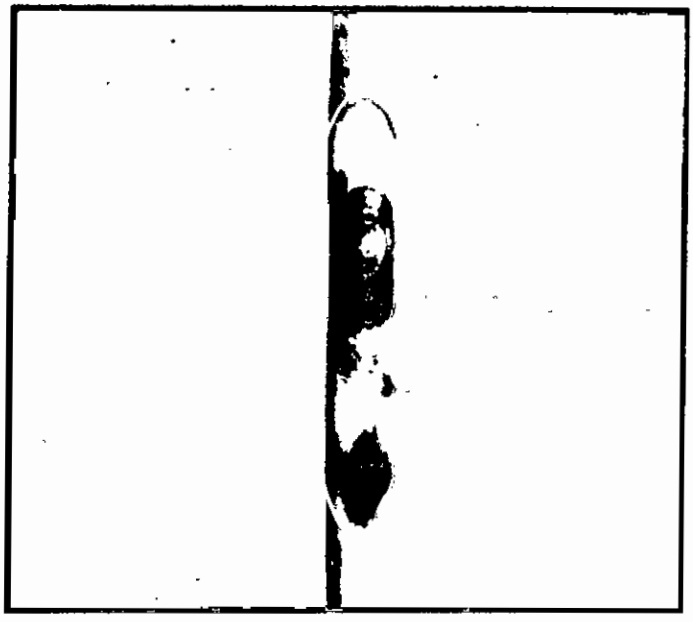

Plate 1. A stalk showing purple blotch symptom

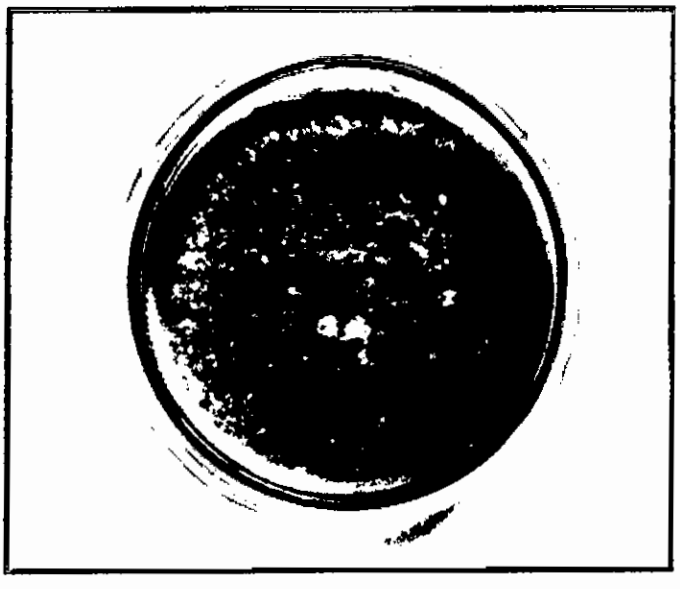

Plate 2. Pure culture of *Alternaria porri*

Plate 3. Conidia of *Alternaria porri* (x 40)

3.3. Data collection

Plants were selected randomly for each region and tagged for data collection. Data collection was started after the onset of the disease symptoms. Data were collected on the following parameters:

3.3.1. No. of plant infection / plant

Number of infected leaf per plant was recorded and used for calculation of disease incidence. The leaf with characteristic purple colored spot blotch or blighted tip was denoted as diseased leaf.

Calculation of disease incidence

The percent disease incidence was calculated using the following formula (Wheleer, 1969):

$$\% \text{ Leaf / plant infection} = \frac{\text{Number of infected leaf / plant}}{\text{Total number of leaf / plant}} \times 100$$

3.3.2. Leaf Area Diseased (LAD)

Leaf area diseased of the ten selected plants in every region under each treatment were measured and recorded by conversion to percentage.

3.3.3. Number of infected seed stalk /area

Number of infected seed stalk/plot was recorded at different days after planting and used for calculation of disease incidence (Wheleer, 1969):

$$\% \text{ stalk infection} = \frac{\text{Number of infected stalk}}{\text{Total area of inspected stalk}} \times 100$$

3.3.4. Stalk Area Diseased (SAD)

Stalk Area Diseased of the selected plants in every region under each treatment were measured and recorded by conversion to percentage.

$$\% \text{ LAD} / \% \text{ SAD} = \frac{\text{Area infected of leaf / stalk}}{\text{Total number of inspected leaf / stalk}} \times 100$$

Percent LAD (Leaf Area Diseased) and SAD (Stalk Area Diseased) were measured by eye estimation. Area of a single leaf / stalk was considered as 100%. Deducting the healthy area, the diseased area was estimated. Average of %LAD / %SAD was then calculated dividing the total number of inspected leaf / stalk. (Islam *et al.*,2001).

3.3.5. Estimation of PDI

Diseased scoring scale '0 – 5' was used to estimate the disease severity (PDI) of purple blotch of onion for each unit plot under each treatment (Plate

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0 = No disease symptoms

1 = A few spots towards the tip, covering less than 10% leaf/stalk area

2 = Several dark purplish brown patches covering 10% to less than 20% leaf/stalk area

3 = Several patches with paler outer zone, covering 20% to 40% leaf/stalk area

4 = Long streaks covering 40% to 75% leaf/stalk area or breaking of leaf / stalk

5 = Complete blotching of leaf / stalk

The Percent Disease Index (PDI) was calculated using the following formula:

$$\text{PDI (Leaf/Stalk)} = \frac{\text{Total sum of numerical ratings}}{\text{No. of observation} \times \text{Maximum disease rating in the scale}} \times 100$$

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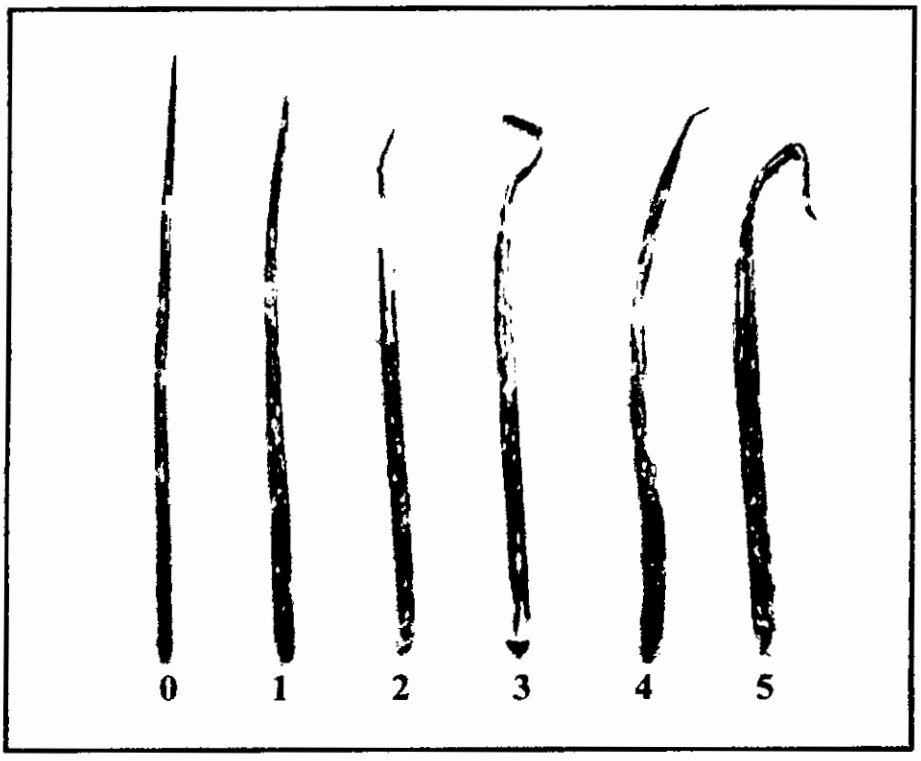

Plate 4. Purple blotch severity of onion leaf showing '0-5' rating scale

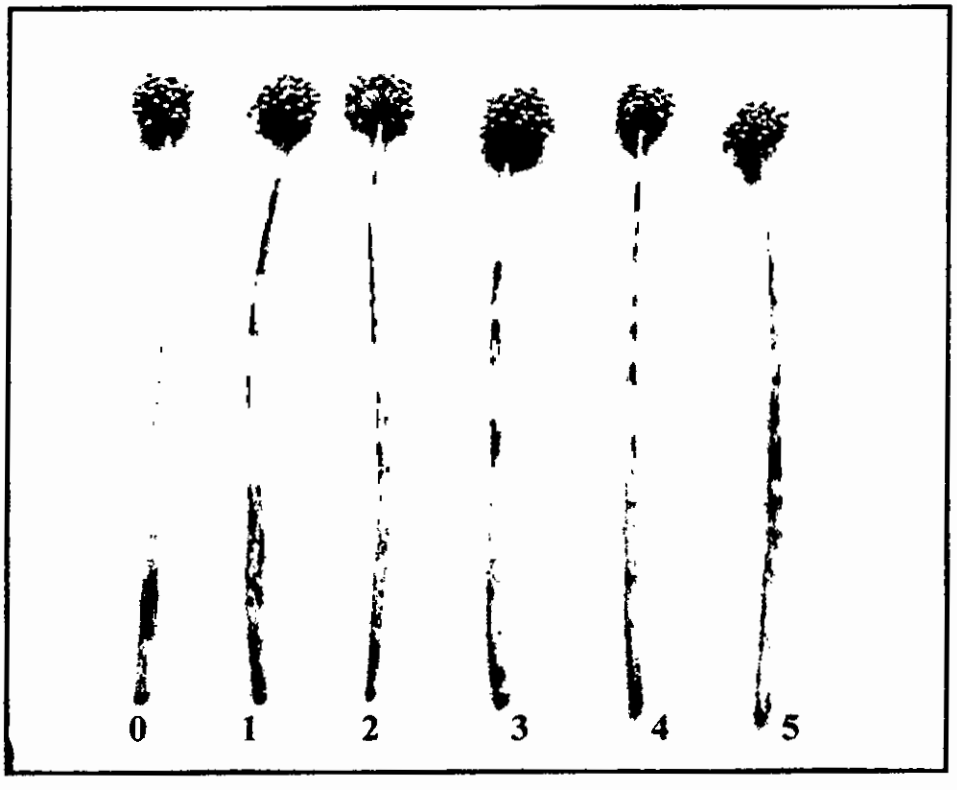

Plate 5. Purple blotch severity of onion seed stalk showing '0-5' rating scale

3.4. Correlation and regression study

The correlation and regression study was performed taking the weather parameter like air temperature, air humidity, soil moisture and soil pH in X-axis and disease incidence and severity in Y-axis.

3.5. Analysis of Data

Data were analyzed statistically using MSTAT Computer Program. Data were transformed, whenever necessary, following Arcsine transformation. Means of treatment were separated using Duncan's Multiple Range Test (DMRT), (Gomez and Gomez, 1983).

Chapter 4
Results and Discussion

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RESULTS AND DISCUSSIONS

This Chapter includes the experimental results and discussions. The epidemiological survey on purple blotch of onion caused by *Alternaria porri* and *Stemphylium botryousum* was assessed based on percent plant infection, percent leaf infection, percent leaf area diseased (% LAD), percent Stalk area diseased (% SAD).

4.1 Epidemiological Survey

Disease incidence (% plant infection and % leaf infection) and severity (% LAD and %SAD) of purple blotch of onion varied with locations, and environmental factors like soil temperature, air temperature, soil moisture, air humidity and soil pH.

4.1.1 Effect of Locations

The highest percent plant infection during the cropping seasons 2007-08 was recorded at Sayedpur, Comilla (83.00%), Nandina, Jamalpur (75.00%) and Jitka, Manikgong (70.00%) followed by SAU campus, Dhaka (67.00%), Vasanchar, Faridpur (65.00%), Kesobpur, Jessore (65.00%), and Dhamrai, Dhaka (65.00%). The lowest plant infection recorded at BARI, Gazipur (36.00%) preceded by Taherpur, Rajshahi (45.00%) and Hathazari, Chittagong (55.00%) (Table. 1)

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Table 1: Epidemiological survey on the incidence and severity of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2007-2008

Location	% Plant Infection	% Leaf Infection	%LAD	%SAD
Vasan Char (Faridpur)	65.00 bc	45.00 bc	23.00 bc	24.00 bc
Jitka, (Manikgonj)	70.00 b	48.00 bc	25.00 bc	26.00 bc
Sayedpur Comilla	83.00 a	57.00 a	34.00 a	36.00 a
Nandina Jamalpur	75.00 ab	52.00 ab	29.00 ab	31.00 ab
Kesobpur Jessore	65.00 bc	44.00 bc	22.00 c	23.00 c
BARI Gazipur	36.00 e	20.00 d	9.00 e	11.00 e
SAU Campus Dhaka	67.00 b	46.00 bc	24.00 bc	26.00 bc
Hathazari Chittagong	55.00 cd	39.00 c	20.00 cd	21.00 cd
Dhamrai Dhaka	65.00 bc	45.00 bc	23.00 bc	25.00 bc
Taherpur Rajshahi	45.00 de	25.00 d	14.00 de	16.00 de
CV (%)	9.46	11.48	16.02	15.71
LSD (0.05)	10.16	8.288	6.129	6.441

In case of leaf infection, the highest percent leaf infection during the cropping seasons 2007-08 was recorded at Sayedpur, Comilla (57.00%), Nandina, Jamalpur (52.00%) and Jikka, Manikgong(48.00%) followed by SAU campus, Dhaka (46.00%), Vasanchar, Faridpur (45.00%), Kesobpur, Jessore (44.00%) and Dhamrai, Dhaka (45.00%). The lowest plant infection recorded at BARI, Gazipur (20.00%) proceeded by Taherpur, Rajshahi (25.00%) and Hathazari, Chittagong (39.00%). (Table. 1)

Similar trend of disease incidence and disease severity was observed in the growing season 2008 - 09. The highest percent plant infection was recorded at Sayedpur, Comilla (85.67%), Nandina, Jamalpur (76.33%) and Jitka, Manikgong (72.00%) followed by SAU campus, Dhaka (68.67%), Vasanchar, Faridpur (67.33%), Kesobpur, Jessore (66.330%) and Dhamrai, Dhaka (66.33%). The lowest plant infection recorded at BARI, Gazipur (37.67%) preceded by Taherpur, Rajshahi (47.33%) and Hathazari, Chittagong (57.00%). (Table. 2)

In case of leaf infection, significantly the highest percent leaf infection during the cropping seasons 2008-09 was recorded at Sayedpur, Comilla (60.33%), Nandina, Jamalpur (54.33%) and Jitka, Manikgong (51.33%) followed by SAU campus, Dhaka (49.33%), Vasanchar, Faridpur (46.67%), Kesobpur, Jessore (46.67%), Dhamrai, Dhaka (47.33%).

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Table 2: Epidemiological survey on the incidence and severity of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2008-2009

Location	% Plant Infection	% Leaf Infection	% LAD	% SAD
Vasan Char (Faridpur)	67.33 bc	46.67 bc	25.67 bc	26.67 bc
Jitka, (Manikgonj)	72.00 bc	51.33 b	27.00 bc	28.00 bc
Sayedpur Comilla	85.67 a	60.33 a	35.33 a	37.67 a
Nandina Jamalpur	76.33 b	54.33 ab	31.33 ab	32.67 ab
Kesobpur Jessore	66.33 c	46.67 bc	24.33 c	26.67 bc
BARI Gazipur	37.67 f	21.33 d	11.33 d	13.33 e
SAU Campus Dhaka	68.67 bc	49.33 bc	25.67 bc	28.67 bc
Hathazari Chittagong	57.00 d	41.67 c	21.67 c	23.33 cd
Dhamrai Dhaka	66.33 c	47.33 bc	25.00 bc	27.67 bc
Taherpur Rajshahi	47.33 e	27.33 d	15.33 d	18.00 de
CV (%)	7.98	9.29	14.48	15.87
LSD (0.05)	8.822	7.117	6.028	7.152

The lowest plant infection recorded at BARI, Gazipur (21.33%) proceeded by Taherpur, Rajshahi (27.33%) and Hathazari, Chittagong (41.67%). (Table. 2). A similar trend of results was also observed on the disease incidence and severity of purple blotch of onion was in different onion growing region during the cropping season 2009 - 10 (Table 3). The variation of disease incidence and severity of purple blotch of onion in different growing areas of the country might be due to the variation of environmental factors and varietal variations. Lakra (1999) reported that purple blotch severity increase while relative humidity laid around 75% and temperature ranged from 20 - 30^{0}C. Rodriguez *et al.* (1991) also reported that higher % RH favored the conidial germination of *Alternaria porri*.

4.1.2 Effect of Soil pH

Soil pH had significant effect on the incidence and severity of purple blotch of onion. Soil pH varied from 4.6 - 6.5 and disease incidence (leaf infection) and severity (leaf area diseased) varied from 20.0 - 57.0 % and 9.0 34.0 %, respectively in the growing season 2007- 08 (Table 4). Soil pH ranged from 4.67-6.60 and plant infection and leaf infection varied from 37.67 – 85.67 % and 21.33 – 60.33 %, respectively in the growing season 2008- 09 (Table 5). The disease severity (% LAD and % SAD) varied from 12.67 - 36.67 % and 15.00 - 39.00, respectively while the pH ranged from 4.9 - 6.67 in the cropping season 2009 - 10.

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Table 3: Epidemiological survey on the incidence and severity of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2009-2010

Location	% Plant Infection	% Leaf Infection	% LAD	% SAD
Vasan Char (Faridpur)	68.67 c	48.33 cd	27.00 cd	29.00 cd
Jitka, (Manikgonj)	74.33 bc	54.67 bc	28.67 bc	30.67 bc
Sayedpur Comilla	87.00 a	62.00 a	36.67 a	39.00 a
Nandina Jamalpur	77.33 b	56.33 ab	32.67 ab	35.00 ab
Kesobpur Jessore	67.67 c	50.33 b-d	26.33 cd	29.00 cd
BARI Gazipur	39.67 f	23.33 e	12.67 e	15.00 f
SAU Campus Dhaka	68.67 c	51.33 b-d	27.33 cd	31.33 bc
Hathazari Chittagong	58.67 d	44.67 d	23.00 d	25.00 d
Dhamrai Dhaka	67.00 c	50.00 b-d	26.33 cd	29.00 cd
Taherpur Rajshahi	49.00 e	29.33 e	17.00 e	20.33 e
CV (%)	6.63	7.60	10.44	9.37
LSD (0.05)	7.478	6.130	4.613	4.555

The soil pH varied from 4.9 - 6.67 during the cropping season 2009 - 2010 and the disease incidence and severity increased or decreased maintaining the similar trends of the previous two years. Low soil pH (4.6 - 5.17) had influential effect on the incidence and severity of the disease. Higher level of plant and leaf infection remained concentrated at this pH range. Plant infection and leaf infection were the highest (87.00% and 62.00%, respectively) while pH was noted 4.9 in growing season 2009 - 2010. Similarly the disease severity (% LAD and % SAD) recorded the highest (36.67 % and 39.00 %, respectively) while pH also noted 4.6 (Table 6). Previous reports on the effect of soil pH on the incidence and severity of purple blotch of onion in Bangladesh are not available in the literature. However, some reports on the growth and sporulation of *Alternaria porri* in *in vitro* are available (Raju and Mehta, 1982; Hossain *et al.*, 1997). They reported that pH ranged from 6.0 - 7.0 in PDA medium favored the growth and sporulation of *Alternaria porri* that does not match with the present findings. In the present findings, soil pH ranged from 4.6 - 5.17 favored the disease incidence and severity. Soil pH 4.6 – 5.17 might have the adverse effect on the plant nutritional health that indirectly favored the pathogen increasing disease incidence and disease severity.

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4.1.3 Effect of Air Temperature

The disease incidence (percent plant infection and leaf infection) and disease severity (% Leaf area diseased and % Stalk area diseased) were greatly influenced by varied air temperature. The highest level of incidence occurred while the air temperature lies around 23.0°C in all the cropping seasons. In the year 2007-08, the highest plant infection (83 %) and leaf infection (57 %) was recorded at 23.0°C temperature at Jitka, Manikgonj which were statistically similar with Sayedpur, Comilla at same temperature. The highest LAD (34 %) and SAD (36 %) were also recorded at 23.0°C air temperature in Jitka, Manikgonj that was also statistically identical with Sayedpur, Comilla at same temperature. The temperature above or below the range 19.5-25.9°C markedly decreased the disease incidence and severity.

The trend of disease incidence and severity regarding air temperature in the following cropping seasons 2008-09 and 2009-10 were found more or less similar with 2007-08 with some extent. The highest incidence and severity were found centered at the temperature ranged from 23.0 - 23.13°C and 23.07 - 23.10°C, respectively in the growing seasons 2008-09 and 2009-10 (Table 5 &6). Khare and Nema (1982) reported that the temperature range between 22 - 25^0 C was suitable for growth, sporulation and conidial

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Table 4: Epidemiological data on the incidence and severity of purple blotch of onion in major growing a as of Bangladesh during the cropping seasons 2007-2008

Location	Soil Temperature (0C)	Air Temperature (0C)	Soil Moisture (%)	Air Humidity (%)	Soil PH	% Plant Infection	% Leaf Infection	% LAD	%SAD
Vasan Char Faridpur	26.0	24.5	60	70	6.5	65.00 bc	45.00 bc	23.00 bc	24.00 bc
Jitka, (Manikgonj)	25.4	23.5	65	68	5.9	70.00 b	48.00 bc	25.00 bc	26.00 bc
Sayedpur Comilla	25.8	23.4	65	75	4.6	83.00 a	57.00 a	34.00 a	36.00 a
Nandina Jamalpur	24.2	20.2	55	72	4.8	75.00 ab	52.00 ab	29.00 ab	31.00 ab
Kesobpur Jessore	27.0	25.5	55	60	5.5	65.00 bc	44.00 bc	22.00 c	23.00 c
BARI Gazipur	25.0	23.5	65	63	5.1	36.00 e	20.00 d	9.00 e	11.00 e
SAUCampus Dhaka	25.9	23.8	60	73	5.3	67.00 b	46.00 bc	24.00 bc	26.00 bc
Hathazari Chittagong	27.7	25.9	50	70	5.9	55.00 cd	39.00 c	20.00 cd	21.00 cd
Dhamrai Dhaka	25.5	23.4	60	65	5.6	65.00 bc	45.00 bc	23.00 bc	25.00 bc
Taherpur Rajshahi	21.0	19.5	57	55	6.5	45.00 de	25.00 d	14.00 de	16.00 de

Table 6: Epidemiological data on the incidence and severity of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2009-2010

Location	Soil Temperature (0C)	Air Temperature (0C)	Soil Moisture (%)	Air Humidity (%)	Soil PH	% Plant Infection	% Leaf Infection	% LAD	% SAD
Vasan Char Faridpur	26.77	25.53	64.67	72.33	6.67	68.67 c	48.33 cd	27.00 cd	29.00 cd
Jitka, (Manikgonj)	26.00	24.73	67.33	70.00	6.13	74.33 bc	54.67 bc	28.67 bc	30.67 bc
Sayedpur Comilla	26.10	24.70	66.00	74.00	4.90	87.00 a	62.00 a	36.67 a	39.00 a
Nandina Jamalpur	24.70	22.07	58.00	73.50	5.17	77.33 b	56.33 ab	32.67 ab	35.00 ab
Kesobpur Jessore	27.53	25.83	57.67	62.33	5.77	67.67 c	50.33 b-d	26.33 cd	29.00 cd
BARI Gazipur	25.47	24.40	66.67	63.67	5.50	39.67 f	23.33 e	12.67 e	15.00 f
SAUCampus Dhaka	26.00	24.17	63.00	74.00	5.63	68.67 c	51.33 b-d	27.33 cd	31.33 bc
Hathazari Chittagong	27.83	26.30	55.67	71.33	6.17	58.67 d	44.67 d	23.00 d	25.00 d
Dhamrai Dhaka	25.83	24.07	63.00	66.67	5.87	67.00 c	50.00 b-d	26.33 cd	29.00 cd
Taherpur Rajshahi	22.27	20.30	61.33	57.00	6.63	49.00 e	29.33 e	17.00 e	20.33 e

Table 5: Epidemiological data on the incidence and severity of purple blotch of onion in mjor growing areas of Bangladesh during the cropping seasons 2008-2009

Location	Soil Temperature (0C)	Air Temperature (0C)	Soil Moisture (%)	Air Humidity (%)	Soil pH	% Plant Infection	% Leaf Infection	% LAD	%SAD
Vasan Char Faridpur	26.53	25.30	63.00	71.00	6.60	67.33 bc	46.67 bc	25.67 bc	26.67 bc
Jitka, (Manikgonj)	25.63	24.07	66.67	69.00	6.07	72.00 bc	51.33 b	27.00 bc	28.00 bc
Sayedpur Comilla	25.93	24.13	66.00	76.50	4.67	85.67 a	60.33 a	35.33 a	37.67 a
Nandina Jamalpur	24.50	21.53	57.00	73.00	4.90	76.33 b	54.33 ab	31.33 ab	32.67 ab
Kesobpur Jessore	27.40	25.73	57.00	61.00	5.67	66.33 c	46.67 bc	24.33 c	26.67 bc
BARI Gazipur	25.30	24.07	65.67	63.33	5.30	37.67 f	21.33 d	11.33 d	13.33 e
SAUCampus Dhaka	25.90	23.83	61.33	74.00	5.43	68.67 bc	49.33 bc	25.67 bc	28.67 bc
Hathazari Chittagong	27.83	26.17	53.67	71.00	6.00	57.00 d	41.67 c	21.67 c	23.33 cd
Dhamrai Dhaka	25.73	23.73	61.67	66.67	5.73	66.33 c	47.33 bc	25.00 bc	27.67 bc
Taherpur Rajshahi	21.83	20.03	59.00	56.33	6.57	47.33 e	27.33 d	15.33 d	18.00 de

germination of *Alternaria porri* where cent percent spores were germinated at 22^{0}C. Similar finding was reported by Raju and Mehta (1982) that temperature ranging 22 – 25 ^{0}C was optimum for the mycelial growth and sporulation of *Alternaria porri.* Hossain *et al.* (1997) reported that the luxuriant mycelial growth was obtained within a temperature range of 20 - 30 ^{0}C. Cova and Rodriguez (2001) reported that 21 - 28 ^{0}C temperature was favors for the symptoms development of purple blotch of onion.

4.1.4 Effect of Soil Moisture

Soil moisture varied from 50 to 66.67% in different onion growing areas of the country recorded during growing season 2007-08, 2008-09 and 2009-10. The highest plant infection (83 %) was noted at 65 % soil moisture. The leaf infection (57 %), LAD (34 %) and SAD (36 %) were also recorded the highest at soil moisture of 83 % which were statistically similar with those at 58 % soil moisture. In growing season 2008-09, 2009-10, the trend of disease incidence and severity were found more or less similar with some extent. The highest plant infection (87 %) , leaf infection (62%), LAD (36.67%) and SAD (39 %) were recorded at 66 % soil moisture in Sayedpur, Comilla. (Table 4, 5 & 6). Previous research reports regarding the effect of soil moisture on purple blotch of onion are not available in the literature.

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4.1.5 Effect of Air Humidity

Air humidity (% RH) ranged from 55 - 76.50 % in the survey experiments during 2007-08, 2008-09, and 2009-10. The air humidity had remarkable influence in the incidence and severity of purple blotch of onion. The highest plant infection (83 %), leaf infection (57 %), LAD (34 %) and SAD (36 %) were found at 75 % RH in the location Sayedpur, Comilla during the cropping season 2007-08. During the growing season 2008-09, the highest plant infection (85.67 %), leaf infection (60.33 %), LAD (35.33 %) and SAD (37.67 %) were recorded at 76.50 % RH in Sayedpur, Comilla. The highest plant infection (87%), leaf infection (62%), LAD (36.67%) and SAD (39%) was recorded in Sayedpur, comilla at 74 % RH while the lowest plant infection (39.67%), leaf infection (23.33%) LAD (12.67%) and SAD (15 %) were recorded in BARI, Gazipur at 63.67%. (Table 2, 3 & 4). The present findings are in agreement with the findings of previous reports (Lakra, 1999; Rodriguez *et al.*, 1991; Evert and Lacy, 1990 and Cova-J and Rodriguez-D, 2001) who reported that high air humidity (%RH) favored the disease incidence and severity of purple blotch of onion. Lakra (1999) while working on the effect of relative humidity on the purple blotch of onion, reported that >75% RH favorable for the disease. Rodriguez *et al.* (1991) reported that the intensity and dynamics of *Alternaria porri* favored by 76 - 100% RH. Evert and Lacy (1990) reported that the formation of conidia of

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Alternaria porri enhanced by 75 - 100% RH. Cova - J and Rodriguez - D (2001) also reported that relative humidity ranged from 80 - 100% favored the symptoms development and sporulation of *Alternaria porri*.

4.2 Correlation and regression analyses

The correlation and regression study revealed that a positive and significant correlation exist between the environmental parameters (air temperature and air humidity) with disease incidence and severity, while the effect of soil pH was found significantly and negatively correlated with disease incidence and disease severity of purple blotch of onion. No sharp relationship between soil moisture and disease incidence and severity was noticed. (Fig. 2-17).

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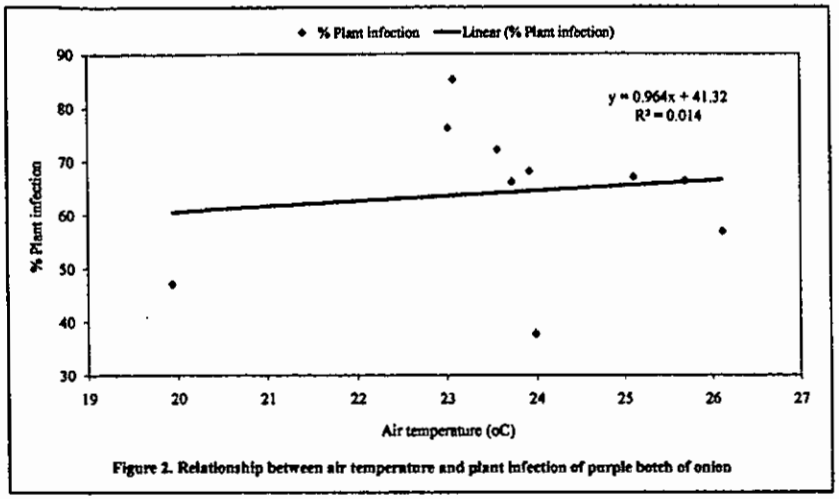


Figure 2. Relationship between air temperature and plant infection of purple botch of onion

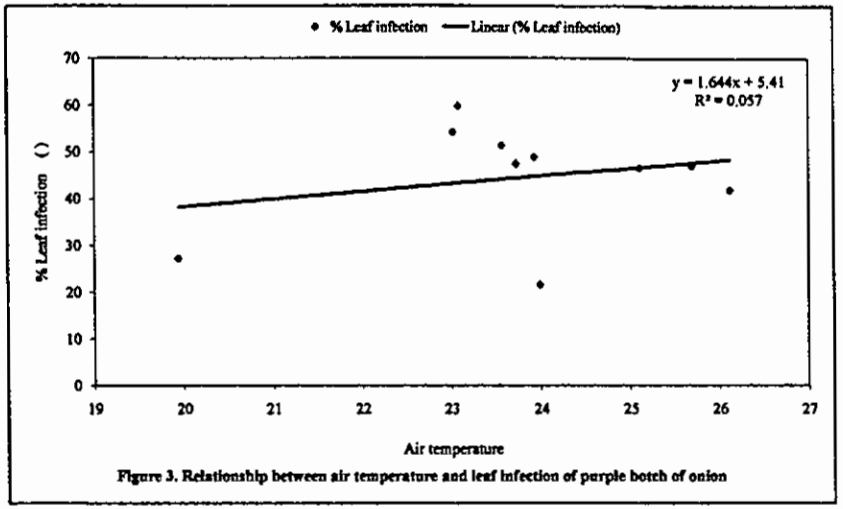


Figure 3. Relationship between air temperature and leaf infection of purple botch of onion

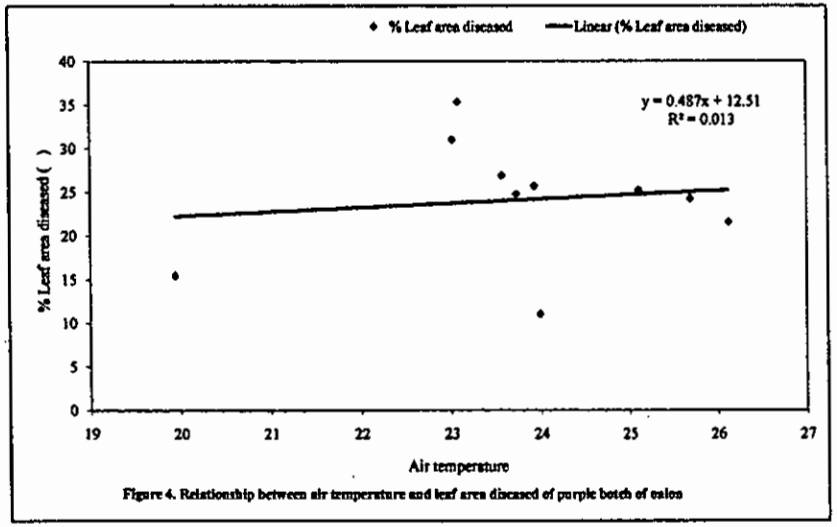


Figure 4. Relationship between air temperature and leaf area diseased of purple botch of onion

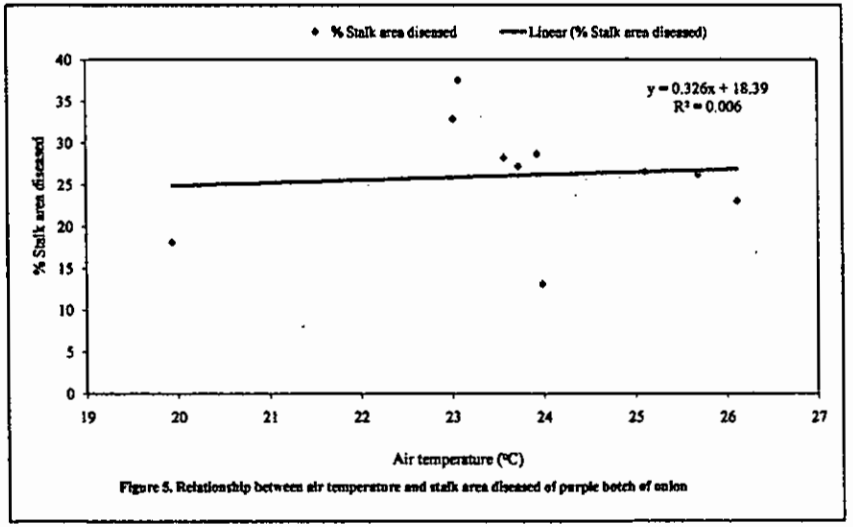


Figure 5. Relationship between air temperature and stalk area diseased of purple botch of onion

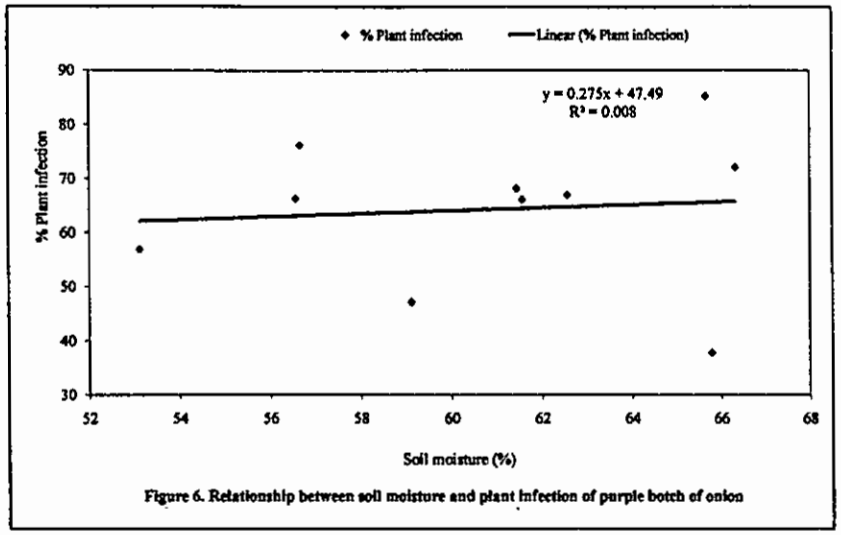


Figure 6. Relationship between soil moisture and plant infection of purple botch of onion

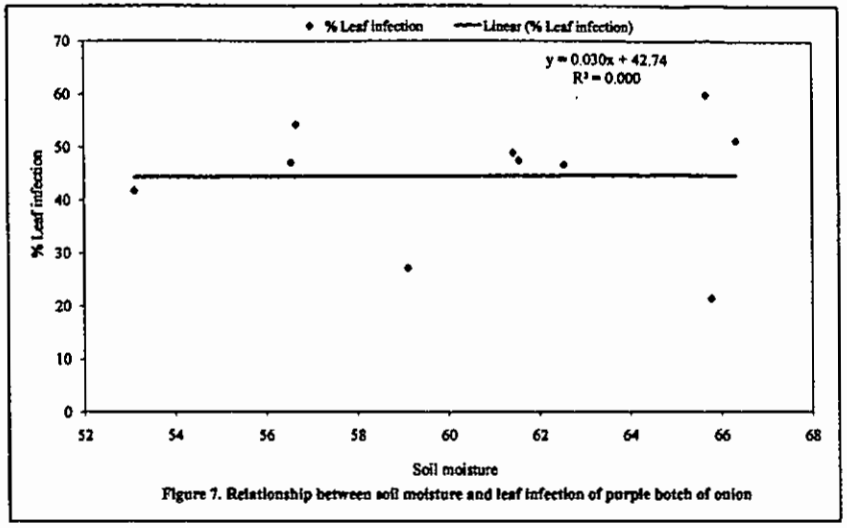


Figure 7. Relationship between soil moisture and leaf infection of purple botch of onion

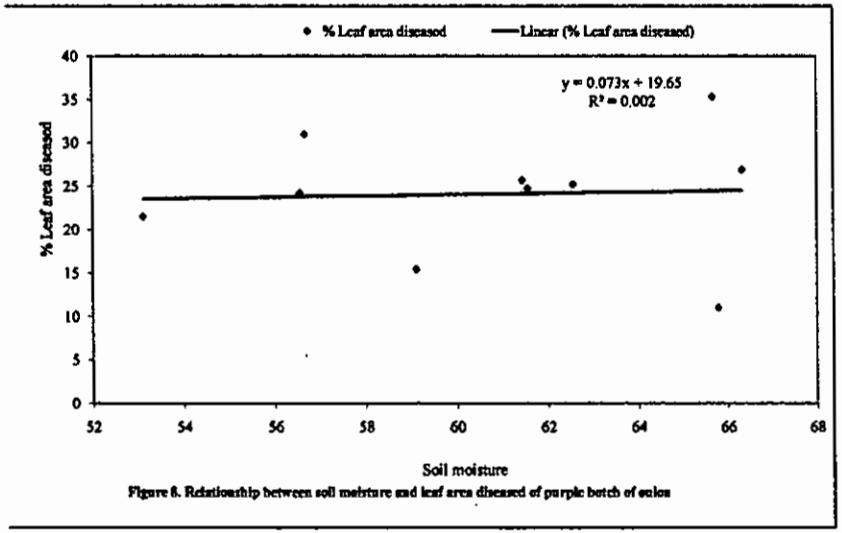


Figure 8. Relationship between soil moisture and leaf area diseased of purple botch of onion

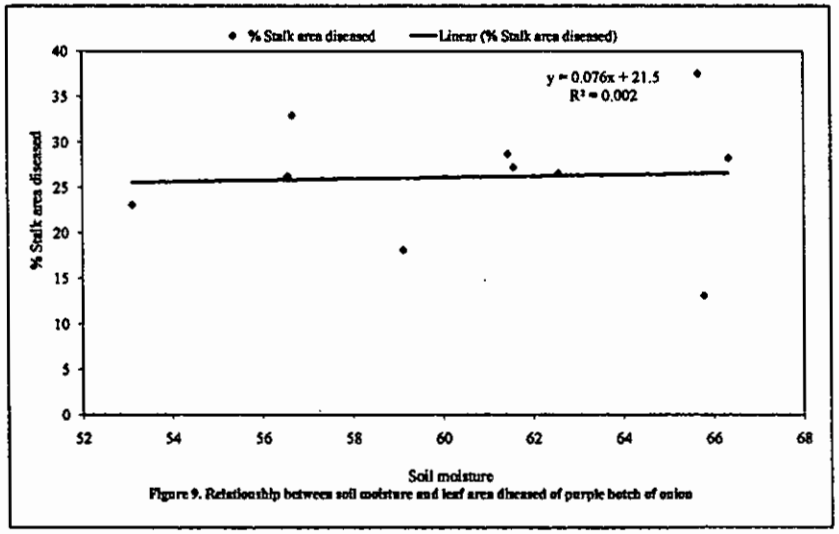


Figure 9. Relationship between soil moisture and leaf area diseased of purple botch of onion

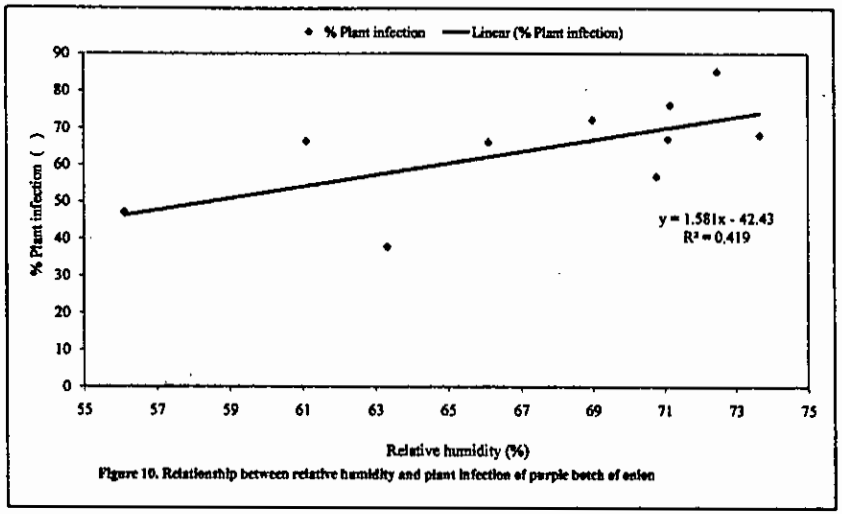


Figure 10. Relationship between relative humidity and plant infection of purple botch of onion

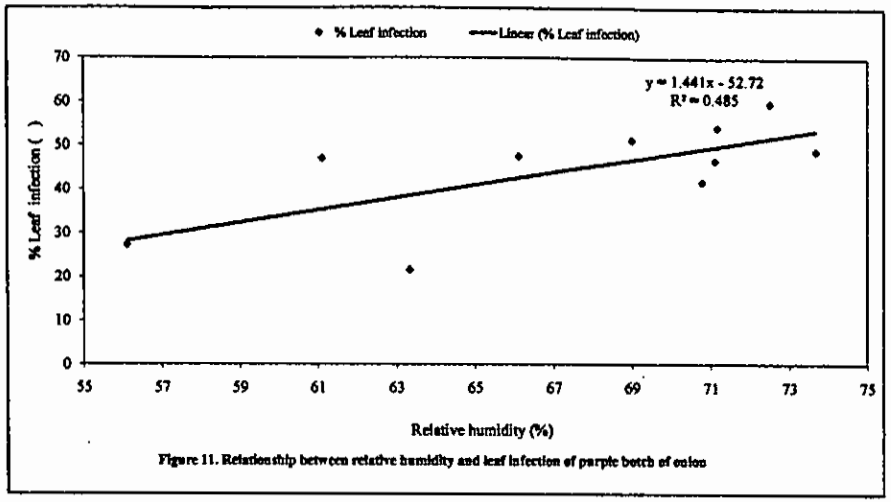


Figure 11. Relationship between relative humidity and leaf infection of purple botch of onion

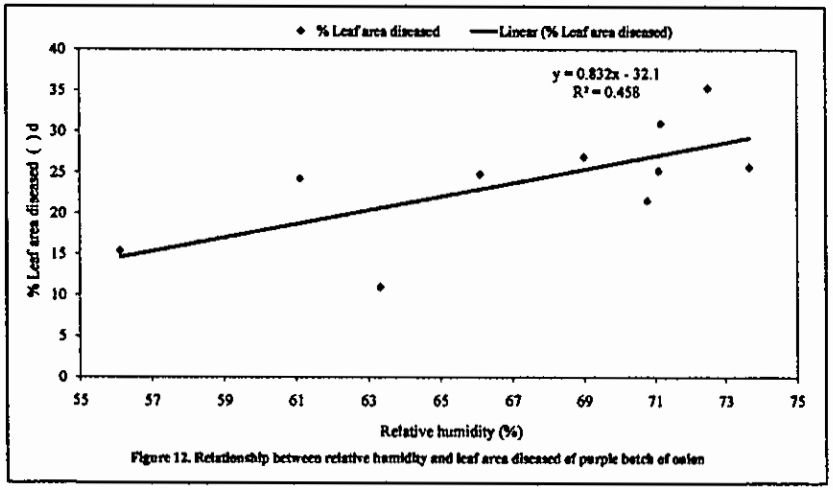


Figure 12. Relationship between relative humidity and leaf area diseased of purple botch of onion

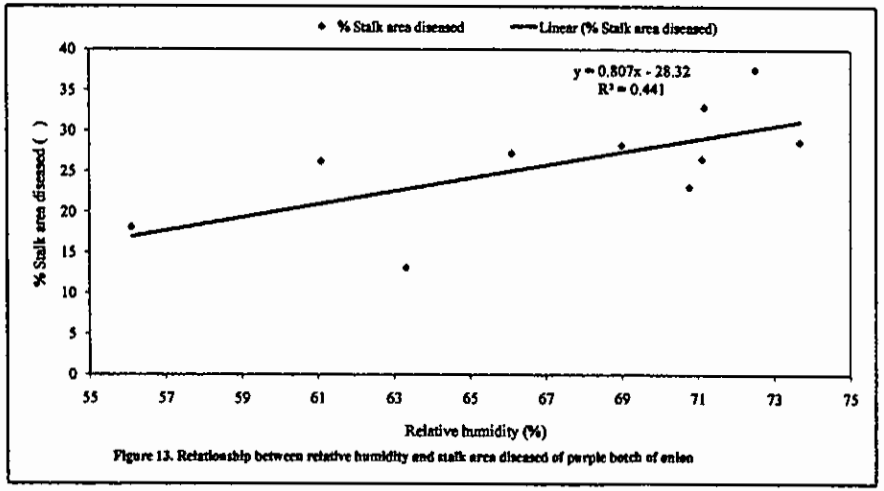


Figure 13. Relationship between relative humidity and stalk area diseased of purple botch of onion

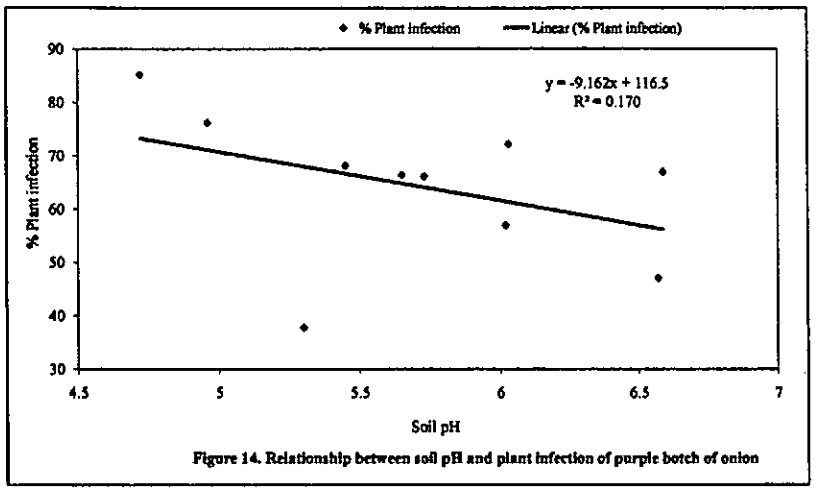


Figure 14. Relationship between soil pH and plant infection of purple botch of onion

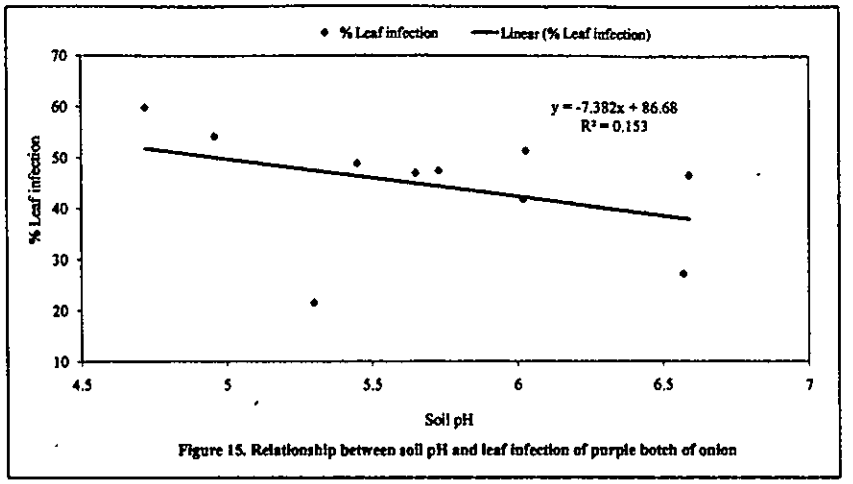


Figure 15. Relationship between soil pH and leaf infection of purple botch of onion

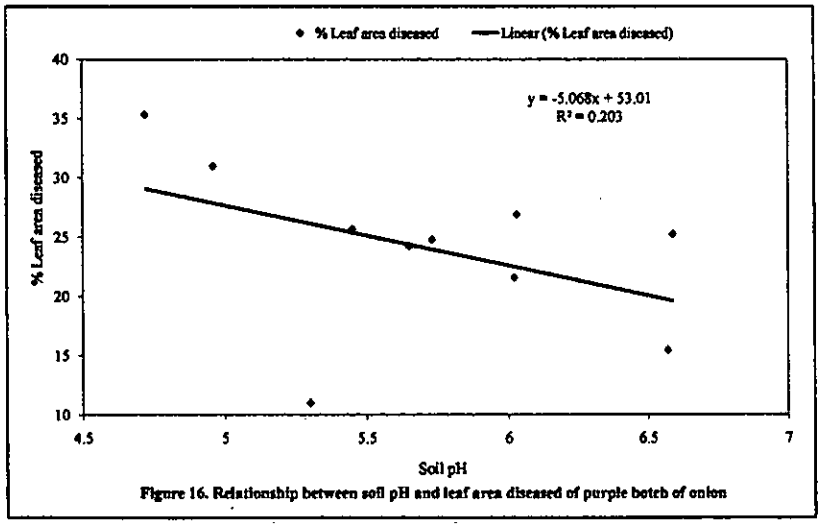


Figure 16. Relationship between soil pH and leaf area diseased of purple botch of onion

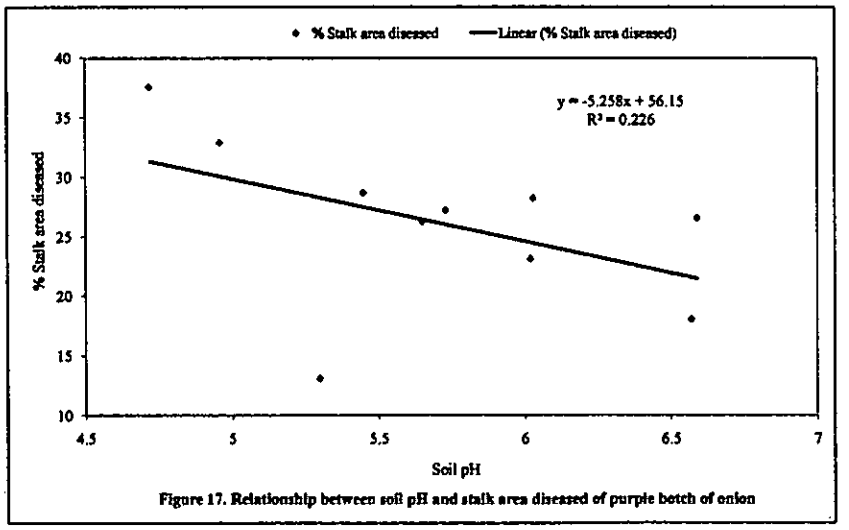
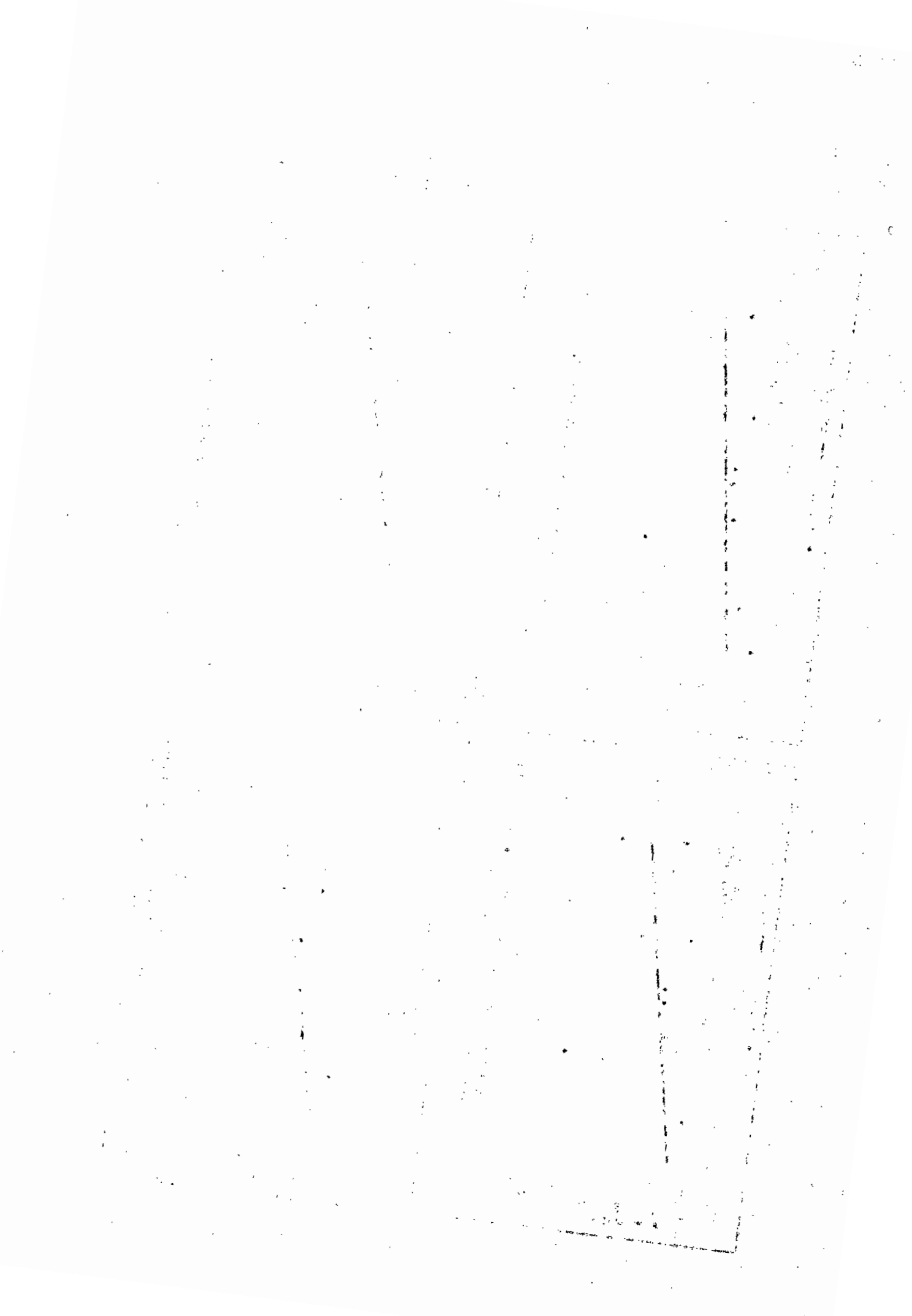
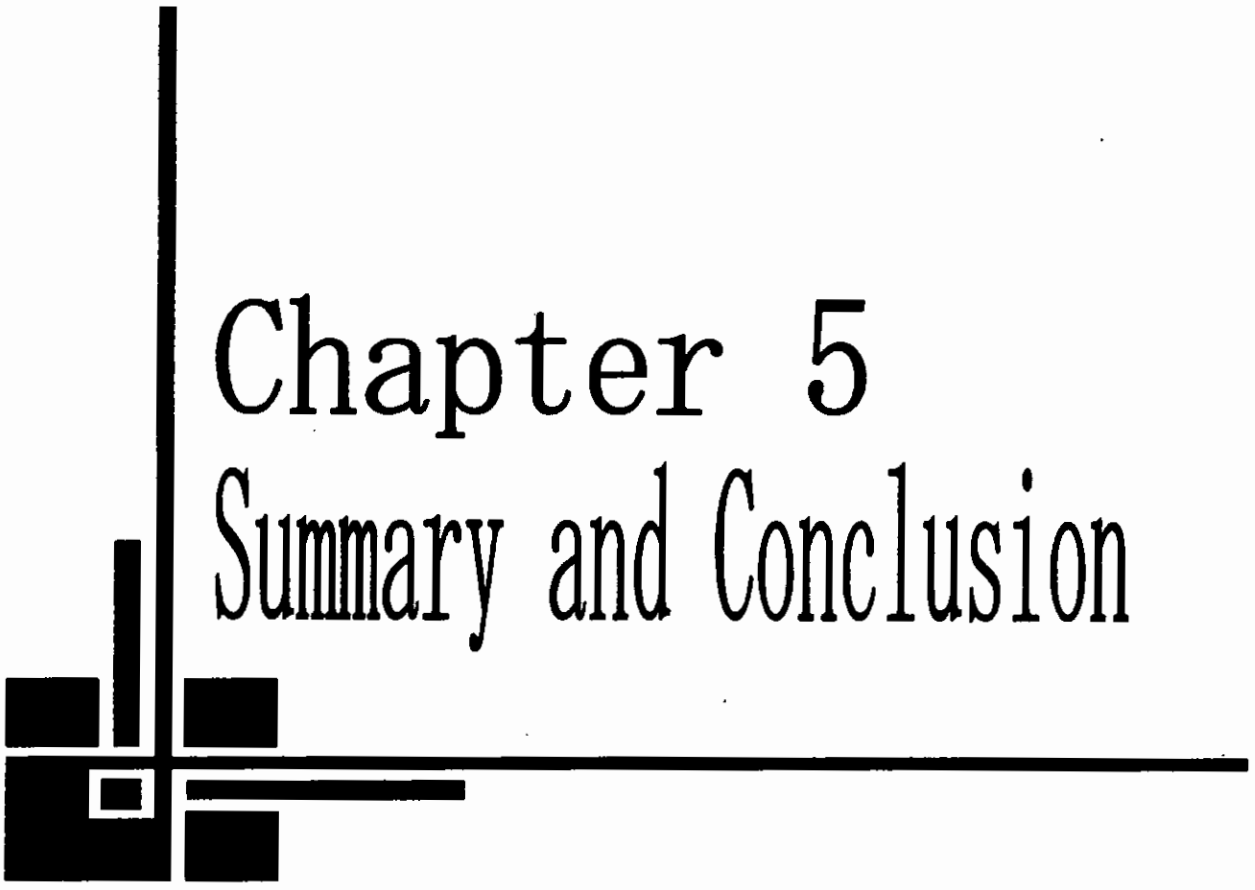


Figure 17. Relationship between soil pH and stalk area diseased of purple botch of onion





Chapter 5
Summary and Conclusion

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The epidemiological surveys were conducted during onion growing seasons of the year 2007-08, 2008-09 and 2009-10 (Winter- September to March) in the major onion growing areas viz. Vasanchar (Faridpur), Jitka (Manikgonj), Sayedpur (Comilla), Nandina (Jamalpur), Kesobpur (Jessore), BARI (Gazipur), SAU campus (Dhaka), Hathazari (Chittagong), Dhamrai (Dhaka), Taherpur (Rajshahi) of the country. The in vitro works were conducted at the Seed Health Laboratory of the Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, Bangladesh. Ten (10) major onion growing areas of Bangladesh were identified and selected based on information gathered from different Government and Non- Government Organizations. In each growing area, three (3) spots were randomly selected for inspection. Each spot covered an area of 0.5 acres or above. All farmers' plots and all cultivars of onion available in those spots were considered for inspection. Visits to each spot were made during the main winter growing season of the year. Data were collected on % Plant infection, % Leaf infection, % LAD (Leaf Area Diseased), % SAD (Stalk Area Diseased), Soil pH, Temperature and moisture, Air temperature and humidity (% RH).

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SUMMARY AND CONCLUSIONS

The epidemiological surveys were conducted during onion growing seasons of the year 2007-08, 2008-09 and 2009-10 (Winter- September to March) in the major onion growing areas viz. Vasanchar (Faridpur), Jitka (Manikgonj), Sayedpur (Comilla), Nandina (Jamalpur), Kesobpur (Jessore), BARI (Gazipur), SAU campus (Dhaka), Hathazari (Chittagong), Dhamrai (Dhaka), Taherpur (Rajshahi) of the country. The in vitro works were conducted at the Seed Health Laboratory of the Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, Bangladesh. Ten (10) major onion growing areas of Bangladesh were identified and selected based on information gathered from different Government and Non- Government Organizations. In each growing area, three (3) spots were randomly selected for inspection. Each spot covered an area of 0.5 acres or above. All farmers' plots and all cultivars of onion available in those spots were considered for inspection. Visits to each spot were made during the main winter growing season of the year. Data were collected on % Plant infection, % Leaf infection, % LAD (Leaf Area Diseased), % SAD (Stalk Area Diseased), Soil pH, Temperature and moisture, Air temperature and humidity (% RH).

Result showed that the disease incidence and severity of purple blotch of onion varied with locations, and environmental factors like soil temperature, air temperature, soil moisture, air humidity and soil pH. The highest percent plant infection during the cropping seasons 2007-08 was recorded at Sayedpur, Comilla (83.00%), Nandina, Jamalpur (75.00%) and Jitka, Manikgong (70.00%) followed by SAU campus, Dhaka (67.00%), Vasanchar, Faridpur (65.00%), Kesobpur, Jessore (65.00%), and Dhamrai, Dhaka (65.00%). The lowest plant infection recorded at BARI, Gazipur (36.00%) preceded by Taherpur, Rajshahi (45.00%) and Hathazari, Chittagong (55.00%). In case of leaf infection, significantly the highest percent leaf infection during the cropping seasons 2007-08 was recorded at Sayedpur, Comilla (57.00%), Nandina, Jamalpur (52.00%) and Jikka, Manikgong(48.00%) followed by SAU campus, Dhaka (46.00%), Vasanchar, Faridpur (45.00%), Kesobpur, Jessore (44.00%) and Dhamrai, Dhaka (45.00%). The lowest plant infection recorded at BARI, Gazipur (20.00%) preceded by Taherpur, Rajshahi (25.00%) and Hathazari, Chittagong (39.00%). Similar trend of disease incidence and disease severity was observed in the growing season 2008 - 09. The highest percent plant infection was recorded at Sayedpur, Comilla (85.67%), Nandina, Jamalpur (76.33%) and Jitka, Manikgong (72.00%) followed by SAU campus, Dhaka (68.67%), Vasanchar, Faridpur (67.33%), Kesobpur, Jessore (66.330%) and

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Soil pH had significant effect on the incidence and severity of purple blotch of onion. Soil pH varied from 4.6 - 6.5 and disease incidence (leaf infection) and severity (leaf area diseased) varied from 20.0 - 57.0 % and 9.0 34.0 %, respectively in the growing season 2007- 08. Soil pH ranged from 4.67-6.60 and plant infection and leaf infection varied from 39.67 - 87.00 % and 23.33 - 62.00 %, respectively in the growing season 2008- 09. The disease severity (% LAD and % SAD) was varied from 12.67 - 36.67 % and 15.00 - 39.00, respectively while the pH ranged from 4.6 - 6.5 in the cropping season 2007 - 08. The soil pH varied from 4.9 - 6.67 during the

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cropping season 2009 - 2010 and the disease incidence and severity increased or decreased maintaining the similar trends of the previous two years. Low soil pH (4.6 -5.17) had influential effect on the incidence and severity of the disease. Higher level of plant and leaf infection remained concentrated at this pH range. Plant infection and leaf infection were the highest (87.00% and 62.00%, respectively) while pH was recorded 4.9 in growing season 2009 - 2010. Similarly the disease severity (% LAD and % SAD) recorded the highest (36.67 % and 39.00 %, respectively) while pH also 4.6.

The disease incidence and disease severity were greatly influenced by varied air temperature. The highest level of incidence occurred while the air temperature lies around 23.0°C in all the cropping seasons. In the year 2007-08, the highest plant infection (83 %) and leaf infection (57 %) was noted at 23.0°C temperature at Jitka, Manikgonj which was statistically similar with Sayedpur, Comilla at same temperature. The highest LAD (34 %) and SAD (36 %) were also recorded at 23.0°C air temperature in Jitka, Manikgonj that was also statistically identical with Sayedpur, Comilla at same temperature. The temperature above or below 19.5-25.9°C markedly decreased the disease incidence and severity. The trend of disease incidence and severity regarding air temperature in the following cropping seasons 2008-09 and 2009-10 were found more or less similar with 2007-08 with some extent.

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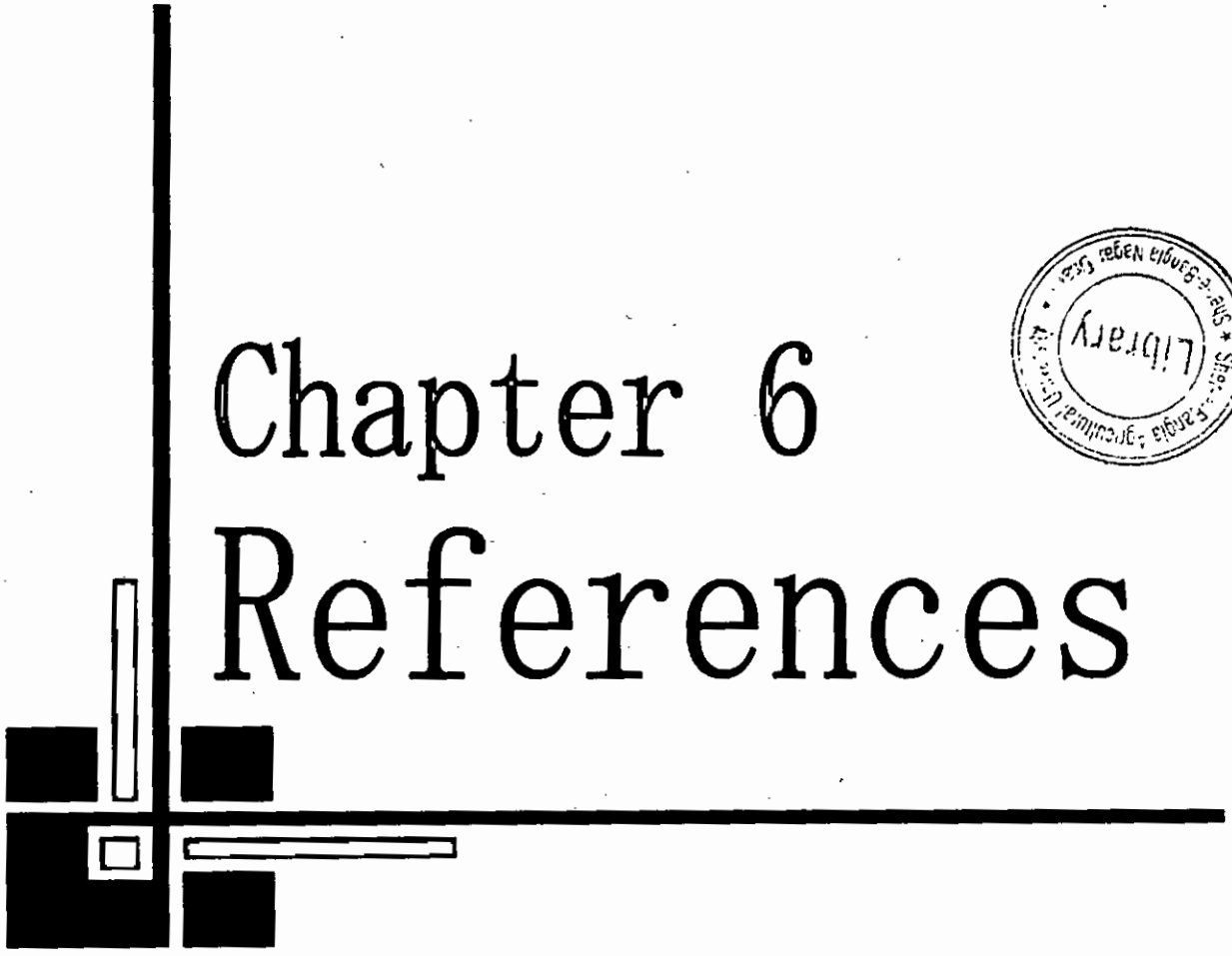
The highest incidence and severity were found concentrated at the temperature ranged from 23.0 - 23.13°C and 23.07 - 23.10°C, respectively in the growing seasons 2008-09 and 2009-10.

Soil moisture varied from 50 to 66.67% in different onion growing areas of the country recorded during growing season 2007-08, 2008-09 and 2009-10. The highest plant infection (83 %) was noted at 65 % soil moisture. The leaf infection (57 %), LAD (34 %) and SAD (36 %) were also recorded the highest at soil moisture of 83 % which were statistically similar with those at 58 % soil moisture. In growing season 2008-09 and 2009-10, the trend of disease incidence and severity were found more or less similar with some extent. The highest plant infection (87 %), leaf infection (62%), LAD (36.67%) and SAD (39 %) were recorded at 66 % soil moisture in Sayedpur, Comilla.

Air humidity (% RH) ranged from 55 - 76.50 % in the survey experiments during 2007-08, 2008-09, and 2009-10. The air humidity had remarkable influence in the incidence and severity of purple blotch of onion. The highest plant infection (83 %), leaf infection (57 %), LAD (34 %) and SAD (36 %) were found at 75 % RH in the location Sayedpur, Comilla during the cropping season 2007-08. During the growing season 2008-09, the highest plant infection (85.67 %), leaf infection (60.33 %), LAD (35.33 %) and SAD (37.67 %) were recorded at 76.50 % RH in Sayedpur, Comilla.

The highest plant infection (87%), leaf infection (62%), LAD (36.67%) and SAD (39%) was also recorded in Sayedpur, Comilla at 74 % RH while the lowest plant infection (39.67%), leaf infection (23.33%) LAD (12.67%) and SAD (15 %) were recorded in BARI, Gazipur at 63.67%.



Chapter 6
References

Castellanes-Linares, I. J.,Auchet-Jencens F. and Garcia-Correosa. I. (1988).Effect of *Alternaria porri.* (Ell.) Cif. on onion seed production under experimental condition in Cuba. In Rev. Pl. Pathol. 67:2730.

Chawda, H. T. and Rajasab, A. H. (1992). Epidemiological investigations on anthracnose and purple blotch of onion (*Allium cepa* L.). Onion Newsletter for the Tropics. Department of Post-graduate Studies and Research in Botany, Gulbarga University, Gulbarga 585 106, India. 4: 65-66.

Commonwealth Mycological Institute (CMI) description. Vol. no. 338.

Cova,-J and Rodriguez,-D. (2001). Effect of temperature and relative humidity on leaf blight in onion (*Allium cepa* L.). Interamerican Society for Tropical Horticulture , 45: 95-97.

Everts, K.L. and Lacy, M.L. (1990). The influence of dew duration, relative humidity, and leaf senescence on conditional formation and infection of onion by *Alternaria porri.* Phytopathology. 80 (11): 1203-1207.

Everts, K.L. and Lacy, M.L. (1996). Factors influencing infection of onion leaves by *Alternaria porri* and subsequent lesion expansion. Plant. Dis. 80 (3): 276-280.

Fakir, G. A. (2002). Estimation of yield loss of Major Crops of Bangladesh caused by diseases. Seed Pathology Centre, Dept. of plant pathology, BAU, Mymensingh.

Fancelli, M.I. and Kimati. H. (1991). Influence of culture media and fluorescent light on the sporulation of *Alternaria dauci.* P.P. 70 (10): 806.

FAO. (1991). Production Year Book for 1990. Food and Agricultural Organization, Rome.

Gomez, K. A. and Gomez, A. A. (1983). Statistical Procedures for Agril. Res. 2nd End. Intl. Res. Inst. Manila, Philippines. Pp.139-207.

Gupta, R.B.L. and Pathak, V.N. (1986). Effect of host of inoculum density and duration of high relative humidity on development of purple blotch of onion. Phytophylactia **18** (3) 151-152.

Gupta, R.B.L. and Pathak. V.N. (1988). Yield losses in onions due to purple blotch disease caused by *Alternaria porri*. Pl. Path. Lab. Sukhadia Univ. Agric. Res. Sta. Druagapura, Jaipur 302015, India. Phytophylactica (1988) **20** (1): 21-23.

Gupta, R. P., Srivastava and Pandey, U. B. (1993). Status of diseases and insect pests of onion in India. Abstracts of Oral Presentations International Symposium on Alliums for the Tropics, Bangkok. 15-19 Feb 1993.

Gupta,R.P., Srivastafa,P.K and Sharma,R.C. (1996). Efficacy of fungicides and their spray interval on the control of purple blotch and stemphylium blight diseases of onion. National-Horticultural-Research and Development-Foundation. **16** (3): 11-13.

Hossain, A. K. M. A. and Islam, M. Z. (1993). Onion improvement Programme in Bangladesh. International Symposium on Alliums for the Tropics, Bangkok. 15-19 Feb 1993.

Hossain,M.M; Khatun,F; Hossain,M.D; Meah,M.B. (1997). Effect of culture media, temperature, pH and nitrogen sources on growth and sporulation of *Alternaria porri*. *Bangladesh Journal of Plant Pathology*. **13**(1/2): 5-8

Hassan, M.H.A. and Hussein, M.A.M. (2004). New Disease Report. Plant Pathology Department, Faculty of Agriculture, Assiut University, 71526 Assiut, Egypt.

Islam, M.R.; Akhter, N.; Chowdhury, S. M.; Ali, M. and Ahamed, K. U. (2001). Evaluation of fungicides against *Alternaria porri* causing purple blotch of onion. *J. Agric. Sci. Tech.* **2** (1): 27-30

Khare, U.K and Nema. K.G. (1981). Studies on purple blotch of onion sporulation on host and dispersal of conidia. India Phytopath. **34**(2): 214-218.

Khare, U.K and Nema. K.G. (1982). Factors affecting germination of spores of *Alternaria porri* in vitro and in-vivo. Indian Phytopathol. **35**(1): 100-103.

Lacy, M. L. (1990). The influence of dew duration, relative humidity and leaf senescence on conidial formation and infection of onion by *Alternaria porri*. Phytopathology. **80**(11): 1203-1207.

Lakra, B. S. (1999). Development of purple blotch incited by *Alternaria porri* and its losses in seed crop of onion (*Allium cepa*). *Indian Journal of Agricultural Sciences*. 69: 2, 144-146.

Larkin, R.P. and Fravel, D. R. (2002). Effect of varying environmental conditions on biological control of Fusarium wilt of tomato by non-pathogenic *Fusarium spp.* Phytopathology **92**:1160-1166

Meah, B. and Khan, A.A. (1987). Checklist of vegetables and fruit diseases in Bangladesh. Department of Plant Pathology, BAU. Mymensingh. p.22.

Miller, M.E. (1983). Relationship between onion leaf age and susceptibility to *Alternaria porri*, Plant disease **67**(3): 283-286.

Mondal, M. F., Hossain, I., Bakshi, A. I. and Nasiruddin, K. M. (1989). Effects of nitrogen and phosphorous on purple blotch on onion seed crop. *Bangladesh J. Plant Path.* **5**(1&2): 37-39.

Munoz, D. C. L., Martinez, J. J. P. and Perez, A. P. (1984). Onion seed production under tropical conditions. Humbaldt Inst. Fund. Res. Trop. Agric. Acad. Sci. **10**(2): 42-45.

Munoz, D. C., L., Martinez, J. J. P. and Perez, A. P. (1986). Onion seed production under tropical conditions. Hort. Abs. 56: 4150.

Nuchnart- Jonglaekha, Witcha-Saatsut, Sombat Srichuwong. (1982). Studies on purple blotch of onion, garlic and fungicide tests for control. Chiang Mai University. Chiang Mai (Thailand). Dept. of Plant Pathology, Chiang Mai (Thailand).

Rahman, M. L., Ahamed, H. U. and Mian, I. H. (1988). Efficacy of fungicides in controlling purple blotch of onion. *Bangladesh J. Plant Path.* **4**(1&2): 71-72.

Raju, K.S. and Metha. B.K (1982). Certain nutritional aspects of *Alternaria porri* of onion. *India J. Mycal.* **12**(1): 96-98.

Rodriguez, F., Herrera, I. and Vinagera, E. (1991). Influence of the temperature and relative humidity on the germination of *Alternaria porri* conidia, causal agent of purple blotch of onion. 1:2, 53-61

Shandhu, K. S.; Gill, S. S. and Hari Singh. (1982). Effect of cultural practices in purple blotch disease in onion seed crop. *Journal of Research* **19**(2): 118-120.

Sharma, S.R. (1986). Effect of fungicidal sprays on purple blotch and bulb yield of onion. Indian Phytopath. **39**(1): 78-82.

Singh, R. S. (1987). Disease of vegetable crops. Oxford & IBH Pub. Co., New Delhi, India. p. 362.

Srivastava, P. K., Bhardwaj, B. S. and Gupta, R. P. (1994). Status of field diseases and insect pests of onion in India. **14**:(2), 11-14.

Srivastava, A. K, Borse, V.A, Gupta, R.P and Srivastava,P. K. (1996). News-letter- National- Horticultural- Research and Development Foundation.**16**:4, 9-11.

Thind, T. S. and Jhooty, J. S. (1982). Association of thrips with purple blotch infection on onion plants caused by *Alternaria porri*. Indian Phytopathol. 35: 696-698.

Vohora, S.B.; Rizman, M. and Khan, J.A. (1974). Medicinal uses of common Indian Vegetables. Planta Medica. **23**(4): 381-393.

Wheleer, B. E. J. 1969. An introduction of plant disease. John Wiley, London, U. K. pp. 298.

Wu, W. S. (1979). Survey on seed-borne fungi of vegetable. Plant Protection Bulletin, Taiwan, **21** (2): 206-219.

APPENDICES

Appendix 1. ANOVA for effect of % plant infection of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2007-2008

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	f value
Replication	2	90.600	45.300	1.2914
Treatment	9	5209.200	578.800	16.5005
Error	18	631.400	35.078	--

Appendix 2. ANOVA for effect of % leaf infection of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2007-2008

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	f value
Replication	2	9.800	4.900	0.2099
Treatment	9	3542.700	393.633	16.8620
Error	18	420.200	23.344	--

Appendix 3. ANOVA for effect of % LAD of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2007-2008

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	f value
Replication	2	16.200	8.100	0.6345
Treatment	9	1332.300	148.033	11.5953
Error	18	229.800	12.767	--

Appendix 4. ANOVA for effect of % SAD of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2007-2008

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	f value
Replication	2	16.200	8.100	0.5745
Treatment	9	1334.700	148.300	10.5177
Error	18	253.800	14.100	--

Appendix 5. ANOVA for effect of % plant infection of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2008-2009

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	f value
Replication	2	97.267	48.633	1.8388
Treatment	9	5242.133	582.459	22.0227
Error	18	476.067	26.448	--

Appendix 6. ANOVA for effect of % leaf infection of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2008-2009

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	f value
Replication	2	8.867	4.433	0.2576
Treatment	9	3822.300	424.700	24.6759
Error	18	309.800	17.211	--

Appendix 7. ANOVA for effect of % LAD of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2008-2009

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	f value
Replication	2	29.067	14.533	1.1770
Treatment	10	1314.533	146.059	11.8284
Error	20	222.267	12.348	--

Appendix 8. ANOVA for effect of % SAD of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2008-2009

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	f value
Replication	2	24.467	12.233	0.7038
Treatment	9	1278.533	142.059	8.1730
Error	18	312.867	17.381	--

Appendix 9. ANOVA for effect of % plant infection of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2009-2010

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	f value
Replication	2	86.600	43.300	2.2785
Treatment	9	5078.133	564.237	29.6909
Error	18	342.067	19.004	--

Appendix 10. ANOVA for effect of % leaf infection of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2009-2010

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	f value
Replication	2	11.467	5.733	0.4490
Treatment	9	3867.633	429.737	33.6511
Error	18	229.867	12.770	--

Appendix 11. ANOVA for effect of % LAD of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2009-2010

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	f value
Replication	2	8.467	4.233	0.5853
Treatment	9	1306.700	145.189	20.0722
Error	18	130.200	7.233	--

Appendix 12. ANOVA for effect of % SAD of purple blotch of onion in major growing areas of Bangladesh during the cropping seasons 2009-2010

Source of variation	Degrees of freedom	Sum of squares	Mean of squares	f value
Replication	2	5.067	2.533	0.3592
Treatment	9	1280.667	142.296	20.1786
Error	18	126.933	7.052	--