INVESTIGATION ON DIFFERENT DISEASES OF BETELVINE IN MAJOR GROWING AREAS OF BANGLADESH

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DHAKA-1207

JUNE, 2016

INVESTIGATION ON DIFFERENT DISEASES OF BETELVINE IN MAJOR GROWING AREAS OF BANGLADESH

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REGISTRATION NO. 15-06974

A Thesis

Submitted to the Faculty of Agriculture, Dept. of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

IN

PLANT PATHOLOGY

SEMESTER: JANUARY-JUNE, 2016

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This is to certify that the thesis entitled, "INVESTIGATION ON DIFFERENT DISEASES OF BETEL VINE IN MAJOR GROWING AREAS OF BANGLADESH" submitted to the Department of Plant Pathology, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE (MS) in PLANT PATHOLOGY embodies the result of a piece of bona fide research work carried out by ***MD. ZAKARIA MASUD*** *bearing Registration No.15-06974 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 acknowledged.

Dated:
Dhaka, Bangladesh

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DEDICATED

TO

MY BELOVED PARENTS

ACKNOWLEDGEMENT

All praises to almighty and kind 'Allah Rabbul Al-Amin' who enabled me to pursue my higher study and to complete the research work as well as to submit the thesis for the degree of Masters of Science in Plant Pathology from Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

It is a proud privilege to express the deepest gratitude, and sincere appreciation to my supervisor, Dr. Md. Rafiqul Islam, Professor , Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, for his valuable and, scholastic guidance, suggestions, constructive criticisms, continuous inspiration and encouragement, throughout the whole period of research work and in the preparation of this thesis.

I express my heartfelt thanks and sincere appreciation to my co-supervisor Abu Noman Faruq Ahmmed, Associate Professor, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, for his precious advice, instruction, inspiration and cordial help to complete the research work successfully.

The author pleased to convey cordial thanks to Chairman, Associate Professor Dr. Md. Belal Hossain, Department of Plant Pathology Sher-e-Bangla Agricultural University, Dhaka for their help and cooperation during the research work.

I am highly grateful to my honorable teachers of Department of Plant Pathology for their valuable teaching, direct and indirect advice, encouragement and co-operation during the whole study period.

The author is also thankful to Kbd Md. Hafizur Rahman for his helpful cooperation in compiling and analysis the data and for giving technical support to prepare this thesis paper.

Finally I thankful my parents, my wife and my brothers for their love and affection, valuable support, their sacrifice and consultant efforts for bringing my dreams come true. They were the never ending source of inspiration and encouragement in this critical period of my studies.

The Author

INVESTIGATION ON DIFFERENT DISEASES OF BETEL VINE IN MAJOR GROWING AREAS OF BANGLADESH

ABSTRACT

An Investigation was done on different diseases of betel vine in major gowing areas of five upazillas under five districts in Bangladesh. The upazilas were Gouronadi under Barisal district, Kaligonj under Jhenaidah district, Mirpur under Kustia district, Mohanpur under Rajshahi district and Sitakundo under Chittagong district. Three diseases namely leaf spot, leaf rot and foot and root rot was found prevalent in the surveyed areas. Leaf spot was found to be caused by *Colletotrichum piparis,* leaf rot caused by *Phytophthora parasitica* and foot and root rot caused by *Sclerotium rolfsii.* The highest disease incidence (41.60) and disease severity (21.86) of leaf rot disease were found in Mohanpur upazilla under Rajshahi district in the month of August. The highest disease incidence (57.44%) and disease severity (28.32%) of leaf spot of betel vine were also found in the month of August at Mohanpur upazilla under Rajshahi district. In case of foot and root rot the highest disease incidence (27.80%) was recorded in the month of Augustat at Gouranadi upazilla under Barisal district. The lowest disease incidence (4.24%) was recorded in Kaligong upazilla under Jhenaidah district while the lowest disease severity (2.83%) of leaf rot was found Gouronadi upazilla under Barisal district respectively. The minimum disease incidence (8.32%) and disease severity (2.72%) were recorded in the month of May in Sitakundo upazilla under Chittagong district. In case of foot and root rot the lowest disease incidence (6.00%) was also recorded in Sitakundo upazilla under Chittagong district. In respect of locations and period of survey it was revealed that leaf rot and leaf spot of betel vine were prevalent in the month of August at Mohanpur upazilla under Rajshahi district and foot and root rot of betel vine in Gouronadi upazilla under Barisal district.

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CHAPTER I

INTRODUCTION

Betel vine is a perennial rooted climber which belongs to the family Piperaceae. Its scientific name is *Piper betle* L. (Srichana *et al*., 2009). Betel vine having the heart-shaped deep green leaves is an important horticultural crop of aesthetic and commercial values, cultivated under shady areas. It is grown throughout the country. The betel leaf contains some vitamins, enzymes, thiamine, riboflavin, tannin, iodine, iron, calcium, minerals, protein and essential oil (Chopra *et al*. 1956; Khanna, 1997).

Leaves of betel vine are chewed along with areca nut as a masticator in many parts of the world. Betel chewing is considered to be a good and cheap source of dietary calcium (Anon, 1990). The betel vine is grown in conservation under shady and humid conditions necessary for the growth of plant.

This shady and moist atmosphere also flavors the development of many diseases, especially leaf spot disease that greatly affects the growth of plants and produce heavy losses to the farmers (Chattopadhayay and Maiti, 1990).

The betel vine cultivation is also found in anywhere of Myanmar. The production of betel vine leaves is commonly found in this study area. The betel vine consumption with areca nuts is used as important role in traditional ceremonies and also used as medicine in local people. But, the leaves are infected by the diseases of leaf spot, leaf rot, foot rot and anthracnose caused by various fungi. Thus the betel vine growers incurred huge loss due to different diseases of betel vine.

During cultivation, betel vine is very much affected by diseases and outcome of the farmer is big loss for betel vine cultivation. The most important diseases of betel vine plants are powdery mildew disease, leaf rot disease, foot rot disease and leaf spot disease. It occurs in a very powerful form and if not controlled, causes unlimited damage and even total demolition of the entire of betel vine plantations (Vijayakumar and Arumugam, 2014).

Among plant microbial pathogens like bacteria, fungi, viruses etc, fungi are the most important and prevalent pathogens, infecting a wide range of host plants and are responsible to cause economical losses of crops in the field and harvest during storage and transportation. Plant-based fungal pathogens are unsafe for consumption (Patel and Jasrai 2013).

The farmers are also encountered heavy loss in leaf yield every year. The leaf is a destructive disease causing substantial yield loss in all the growing area. The diseases cause severe damage to natural leaves in the field as well as during transit and unfavorable weather conditions. Betel leaf spot, leaf rot and foot and root rot are serious disease caused by various fungal pathogens. These pathogens are necessary to control and manage because betel leaves are one of the most important cash crops in our country. Moreover, the infected leaves of betel vine are sometimes become out of consumption and people are discouraged in it consumption. Thus, an investigation on betel vine diseases should be carried out.

There are about 100 betel leaf varieties found in the world of which 40 are recorded in India and 30 in west Bengal and Bangladesh (Guha, 1927; Maity, 1989; Samanta, 1994). 18 species are found in Sri Lanka and three are endemic (Dassanayake and Fosberg, 1981).

The cultivars of betel vine viz. Bangla, Sanchi, Mitha, Bhabna, etc. are found in Bangladesh. The climatic requirement needed for betel vine cultivation is low relative humidity and with high temperature (>40°C) in summer and low (<10°C) in winter, respectively (Guha, 1927). In Bangladesh, it has been cultivated mainly under artificially created structure, locally known as *Boroj*.

Bangladesh is the second largest betel vine growing country in the world. Anonymous (2006) total area about 14,100 hectares. Total annual production is about 72,570 tons and the average yield is 2.28 tons per acre. Barisal, Maulavi-Bazar, Satkhira, Cox's Bazar, Rajshahi, Jessore, Kushtia, Jhinidah, Pabna etc. are mainly the major betel vine cultivation area of Bangladesh. The betel vine is highly susceptible to diseases, pests and natural climates (Sayeeduzzaman, 1988).

Diseases are the most important problems for betel vine cultivation. Among the diseases of betel vine, leaf rot caused by *Phytophthora parasitica var. piperina*, betel vine foot and root rot caused by *Sclerotium rolfsii* and leaf spot caused by *Colletotrichum piparis* are the most devastating diseases, which decrease the production of betel vine crop to a great extent. Sixty percent of betel vine production was damaged due to foot and root rot disease in 3 upazillas under Rajshahi district (Islam, 2005).

Leaf rot of betel vine caused by *Phytophthora parasitica* disease is an endemic and cause serious problem all over the betel vine growing areas in Bangladesh (Chowdhury and Ahmed, 1985).

Betel vine foot and root rot (*Sclerotium rolfsii)* is a devastating soil borne fungus with a wide host range (Aycock, 1996). Southern part of Bangladesh specially Barisal, Jhinaidah, Kushtia, Rajshahi as well as Chittagong are the major betel vine

growing district in Bangladesh. Most of the marginal farmers are involved in betel vine cultivation. They grow betel leaf to meet up the national demand as well as to export. For continuous cultivation, the, different disease infestation seem to be alarming for inoculums potential. But recently they are in troubles to grow betel vine due to the various disease problem. Thus the investigation was urgently necessary to determine the prevalence of betel vine diseases in major growing areas of Bangladesh.

On the basis of above facts the present investigation was undertaken with the following objectives:

1. To survey on the diseases of betel vine prevalent in Bangladesh;
2. To isolate and identify the causal organisms of prevalent diseases of betel vine;
3. To determine the disease incidence (DI) and disease severity (DS) of prevalent betel vine diseases.

CHAPTER II

REVIEW OF LITERATURE

Betel vine (*Piper betle* L.) is susceptible to attack by many diseases at all growth stages. In Bangladesh the diseases of betel vine were studied to a limited extent. High humid and moist shaded conditions are for the growth of betel vine. This is also favorable to develop betel vine diseases. Foot and root rot of betel vine caused by *Sclerotium rolfsii* is a soil borne fungus with a wide range of agronomical and horticultural crops. *S. rolfsii* is also a facultative saprophytic fungus and can produce resting spore (sclerotium) under unfavorable Climate.

Aycock (1966) stated that *Sclerotium rolfsii,* produce foot rot or collar rot of many other crops with wide host range (Talukdar, 1974; Bhattacharrya *et al*., 1977). The pathogen is known to cause diseases of cereals, pulses, oil crops, betel vine, potatoes, vegetables, ornamentals and nursery seedlings of fruits and forest trees.

Chowdhury (1945) stated that the disease can be controlled by earthing up so as to cover the sclerotia to a depth of 75 cm and that similar results may be obtained by ploughing to a depth of 22-30 cm.

In Bangladesh, diseases caused by *Sclerotium rolfsii* in different crops have been reported among many others by Meah and Khan (2003).

Anthracnose caused by *Colletotrichum piperis* is one of the most important disease that in severe condition is lead to death of plants producing up to 25-905% losses to the crop in different part of India (Dastur, 1935; Chattopadhyay and Maiti, 1990).

Occurrence of anthracnose of betel vine was reported for the first time by Hasan and Ahmed (1963) from Bangladesh. Recent information on the diseases of betel vine in Bangladesh appears to be limited. Keeping all these views in mind, the present work was carried out to investigate the incidence of disease and its *in vitro* management of anthracnose pathogen(s) by using fungicides and antagonists.

The serious diseases viz. leaf rot, foot and root rot and leaf spot can complete damage of betel vine. Leaf rot caused by *Phytophthora parasitica* is the most common in betel vine and this disease is endemic and cause serious damage all over the betel vine growing areas in Bangladesh (Dasgupta and Sen, 1999).

The foot and root rot of betel vine was found worldwide including Indonesia, Myanmar, Sri Lanka (Paul, 1939) and Bangladesh (Roy, 1948; Turner, 1969) etc. Leaf rot disease caused by *P. parasitica* was first reported by Dastur (1926). *Phytophthora* sp. can attacked Stem portion of betel vine (Anonymous, 1928).

The highest intensity of foot and root rot and leaf rot has been recorded in West Bengal (Dasgupta and Sen, 1999).

The average losses by foot and root rot may vary from 30 – 100%. In case of leaf rot, 20 – 40% (Maiti and Sen, 1982; Dasgupta *et al.*, 2000).

High temperature, relative humidity and rainfall played an important role in betel vine diseases development (Anonymous, 2000-2006; Maiti and Sen, 1982).

In betel vines *Phytophthora* induced foot rot associated with wilting is common. The two types of spots are found in leaf rot disease of betel vine (Maiti and Sen, 1977).

The infection of foot and root rot of betel vine usually does not extend beyond one or two internodes because the plant dies before the disease progresses (Dastur, 1935).

A well-drained fertile sandy loam to sandy clay soil with pH 5.6 to 8.2 is suitable for betel vine cultivation under 2250-4750 mm rainfall, 40-80% relative humidity and 15-40°C temperature (CSIR, 1969; Guha and Jain, 1997).

In the lower rainfall areas (1500- 1700 mm) the crop can cultivated through irrigation with proper drainage system during rainy season (Jana, 1995).

The betel vine reported to attack *Phytophthora* sp. includes *P. nicotianae* var. *parasitica* (Mc Rae, 1934), *P. nicotianae* var. *piperina* (Dastur, 1927) and *P. parasitica*, /*P. palmivora* (Maiti and Sen, 1977).

Based on existing keys to *Phytophthora spp.* all the isolates from Assam were identified as *Phytophthora palmivora*.

Debnath (1979) the reaction of 12 cultivars of soybean to collar rot and root rot disease caused by *Sclerotium roifsii*, found, all varieties were susceptible this pathogen.

16 isolates of *Phytophthora parasitica* were identified from different betel vine growing areas of West Bengal (Mohanty, 2000).

Islam (2005) observed that 60% of betel leaf production decreased in three upazilas of Rajshahi due to foot and root rot disease.

Farr *et al*., (1989) found that, *Sclerotium roifsii* can attack all plant parts under favourable environmental conditions.

Ramkrishan *et al.* (1930) and Smith (1932) observed that *Sclerotium rolfsii* causing wilt; was common on Irish potatoes, sweet potatoes and all kinds of vegetables and flowers in Jamaica.

Chattopadhyay and Maiti (1990) observed that shady and humid conditions are favorable for the many betel vine diseases development.

Punja *et al.* (1988) found that temperature is the main limiting factor for geographic distribution of *Sclerotium rolfsii*. Rarely the disease occurs in average minimum winter temperature was below 0°C.

Bertus (1929) stated that *Sclerotium rolfsii* has the ability to cause damping off disease of seedlings in some plants when the pathogen was come into contact with stem of those plants, under high temperature and humidity. On the other hand different hosts like chilli, tomato, groundnut etc it caused collar rot disease of the plants.

Mollah (2012) found that 29^{0}C temperature and 85% RH, is needed for high disease incidence and severity of foot and root rot of betel vine in Satkhira district.

Al-Askar *et al.*, (2013) reported that sclerotial diseases caused by *Sclerotium rolfsii* primarily occur in hot and humid climates.

Mridha and Alamgir (1989) observed sclerotial wilt of betel vine in Chittagong. Plants showed decay at the collar region. The infected portion of stem was covered with white cottony mycelia strands with small, light to deep brown sclerotia on the stem as well as adjacent soil surface.

Palakshappa (1986) were observed 35 to 39 % disease incidence of *S. rolfsii* on *Piper betle* in different areas of Karnataka province during 1984-85.

Das *et al.* (2000) found that the foot and tuber rot of tuberose disease symptoms caused by *Sclerotium rolfsii* is appearance of prominent mycelial masses on leaf surfaces or near the collar region.

Giganate (1950) found that potatoes were occasionally attacked by *Sclerotium rolfsii* in northern and central Italy. The fungus cause collar rot disease, the plants become yellow and rapid wilting. Elliptical or irregular shape sclerotia were found in the infected part of tuber. This disease mostly occurred in sandy or clay soils with hot moist weather.

Mostofa (1973) reported that the any amount of *Sclerotium rolfsii* can produce collar rot and wilt disease of betel vines.

Dutta *et al.* (2002) found that initially *Sclerotium rolfsii* attacks collar region of tuberose plant and then to the tubers and petioles become infected to cause disease.

In Belgium severe foot or collar rot was observed in two month old wilted tomato (*Lycopersicum esculentum)* plants (Lievens *et al.*, 2004).

Siddaramaiah and Chandrapa (1988) proved the pathogenicity of *Sclerotium rolfsii* in pot culture on cardamom by inoculating 25 days old sclerotial cultures in sand corn meal medium and observed the symptoms one week after inoculation.

According to Islam (2008) 66.66 to 100%. infection was found in eggplants incase of *Sclerotium rolfsii* through artificial inoculation.

Potato Dextrose Agar (PDA) was found the best culture medium for *S. rolfsii* (Harinath Naidu, 2000, Amarsingh and Dhanbir Singh, 1994, Gupta and Ashu Sharma, 2004., Gaur *et al*., 2005 and Raoof *et al.,* 2006).

The incidence and severity of foot and root rot of betel vine is more or less highest and lowest throughout the year in Jamalpur region (Rahman *et al.,* 2011).

CHAPTER III

MATERIALS AND METHODS

3.1. Experimental site

The experiment was conducted at the M.S. Laboratory, Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), Dhaka- 1207.

3.2. Location of survey

Survey was conducted at different major betel vine growing locations in Bangladesh in five upazillas under five district viz. Gaurnadi, Kaligonj, Kushtia Sadar, Mohanpur, Sitakunda upazilla under Barisal, Jhenaidha, Kustia, Rajshahi and Chittagong district respectively were the survey area. Five borojes (betel vine garden) in an upazilla were considered for recording data.

3.3. Survey Period

January to December, 2016.

3.4. Survey experiments

The Survey was conducted to determine the percent disease incidence and severity of different betel vine diseases under survey areas.

3.5. Land topography

The experimental area was situated in the sub-tropical zone. It lies in AEZ No.11 (High Ganges River Floodplain), AEZ No.13 (Ganges tidal Floodplain) AEZ No.29 (Northern and Eastern Hills), AEZ No.11 (High Ganges River Floodplain) (AEZ-BARC/FAO/UNDP, 1988). Most areas have a broad and narrow ridge with inter-ridge depression, separated with smooth broad ridges and basins. The upper

parts of ridges above normal flood level, lower parts of ridges and basin margins are seasonally shallow flooded. General soil types predominantly dark grey calcareous and brown floodplain calcareous soils. Soils are moderately alkaline. The land type of the different upazillas are high to medium high, the soil is silty loam and clay in texture. pH 6.0 to 8.0. Dark grey to olive brown in color. Fertility level is low with low organic matter content in the brown ridge soils but higher in the dark grey soils.

3.6. Procedures of survey

During the survey, five betel vine garden (borojes) were selected in an upazilla. In each upazilla, five survey plots in a '*boroj*' randomly selected for data recording. Area of each spots was about 500 sqm. farmers plots. Three visits were made to each spot three times during the study period. Ten spots and ten plants in each spot randomly were selected in a *boroj*. Every selected plant was observed and the necessary data were recorded carefully.

Table 1. Betel vine diseases recorded under five Upazillas

Upazillas	Districts	Name of the disease
Gaurnadi	Barisal	Leaf rot, Foot and root rot and Leaf spot/Anthracnose of betel vine
Kaligonj	Jhenaidha	
Mirpur	Kustia	
Mohanpur	Rajshahi	
Sitakunda	Chittagong	

Data on following parameters were recorded

a) Number of plants/ spot

b) Infected plants/ spot

c) % Leaf area diseased

d) % Plant infection

e) % Disease incidence

e) % Disease severity

3.7. Disease incidence and severity assessment

Calculating disease incidence using following formula:

$$\% \text{ Plant infection} = \frac{\text{Number of diseased plants}}{\text{Number of plants inspected}} \times 100$$

Calculating disease severity using following formula:

$$\% \text{ Disease severity} = \frac{\text{Area of stem tissue infected}}{\text{Total stem area inspected}} \times 100$$

3.8. Isolation of causal pathogen

The disease infected parts were washed in tap water for 5 minutes. The leaves were cut into about 1 cm pieces. They were washed with distilled water and then dried on the sterilized filter paper for 15 minutes. Infected parts were placed on the PDA medium for one hour to obtain proper deposition of fungal spores from the infected parts. After that they were removed from the plate. The pathogenic spores were inoculated for 3 - 10 days in the room temperature. The pathogenic fungal colonies

developing on PDA medium. Then the organism were isolated by preparing slide under compound microscope and re-cultured to get pure culture of that organism.

3.9. Potato Dextrose Agar (PDA) medium preparation

At first, 200g potato was peeled and cut in a slice and boiled in 1 liter water. After 30 minute it was sieved. Then 20g dextrose, 18g Agar were mixed slowly with proper shaking to avoid coagulation. Adjusted the pH 6.5 with 1N NaOH. in a conical flask and sterilized the media through autoclave by adjusting 121^0C temperature at 15 PSI pressure for 30 minutes. The whole works were done under laminar air flow chamber.

3.10. Data analysis

The data were statistically analyzed by using computer software (MSTAT-C). The significant differences were compared by Duncan's Multiple Range Test (DMRT) of the treatment means.

CHAPTER IV

RESULTS

Surveyed were conducted at major betel vine growing areas of five upazillas viz., Gouronadi, Kaligonj, Mirpur, Mohanpur and Sitakunda under the district of Barisal, Jhenaidah, Kushtia, Rajshahi and Chittagong, respectively. Mainly local cultivars Jhalpaan, Sanchipaan, Bhabnapaan, Mithapaan, Banglapan, Mohanalipaan and Chalitagotipaan were found to cultivate in that area. The diseases and their symptoms as observed in five upazillas were as follows:

4.1. Betel vine leaf rot disease

The fungus attacks the vines at all stages of crop growth. Initial symptom is sudden wilting of vines. The affected vines show yellowing and drooping of the leaves from tip downwards. The leaves become dull due to loss of lustre. The affected plant dry up completely within 2 or 3 days. The succulent stem turns brown, brittle and dry as stick. The lower portion of the stem near the soil level shows irregular black lesions up to second or third inter-node. The diseased inter nodes undergo ‘wet rot’ and the tissue become soft, slimy with a fishy odor. The roots of the affected plants also show extensive discoloration and rotting.

In the young crop, the fungus produces ‘Leaf rot’ symptoms. The leaves near the soil region show circular to irregular water soaked spots, often starting from the edge. The spots rapidly enlarge and cover a part or whole of the leaf blade, which shows rotting. The leaves turn brown to dark brown or dirty black and defoliation occurs. The leaves within 2-3 feet height of the vine show the leaf rot symptom. (Plate-1 and 2).

4.2. Betel vine leaf spot disease

On the leaves the disease is characterized by the presence of spots which are usually circular with brownish-black centre and yellowish halo. These spots often coalesce to form large lesions. The infected regions gradually become thin and dry and do not undergo any rotting. When the spots are present on the margin of the leaves, the leaf blade tends to droop owing to the shrinkage of tissues. The infected leaves may fall off prematurely. Acervuli are produced in abundance on aerial stems and branches and sparsely on the leaves.

Under favorable conditions, the lesion may spread to the lower parts of the stem, ultimately involving the whole plant and killing it. Very often many parts of the stem may be infected simultaneously, resulting in quick death of the plant (Plate-3, 4 and 5).

4.3. Betel vine foot and root rot disease

The earliest symptom of the disease is darkening of the stem at the foot of the plant near ground level. The darkening starts developing from just below to about 1-2 mm above or occasionally higher up in different vines. The leaves soon turn yellow, become flac.id and drop off. Whole vine ultimately wilts and dries up. The darkened portion of the stern tends to shrink and becomes soft and slimy and the bark peels off easily. The color of the darkened portion ultimately becomes black. White, ropy, fan-shaped mycelial strands creeps over the stern portion, developing small light brown to dark-brown sclerotia on the infected portion. The sclerotial initials are white at first, later turn brown owing to age. The pathogen initially remains confined to the portion it colonizes so that if the healthy portion of the vine is neatly cut from the infected portion and planted, normal growth of the vine

is resumed. If healthy portion of the vine neatly cut from the infected portion is placed in water, the flaccid cells regain their normal shape. This shows that the wilting observed in the early stages of infection is due to, impairment of water translocation as a result of vascular injury at the point of infection (Plate-6, 7, 8 and 9).

4.4. Disease incidence (%) of betel vine leaf rot disease

Disease incidence of betel vine leaf rot in different upazillas found significantly different from one upazilla to another and one season to another (Table 2). Maximum disease incidences 17.60% to 41.60% were recorded in Mohanpur upazilla under Rajshahi district. The highest disease incidence were found in August (6.04% to 41.60%) and lowest in May (4.24% to17.60%).

Table 2. Disease incidence of betel vine leaf rot disease

Upazilla	**% Disease Incidence (Month wise)**		
	January	May	August
Gouranadi	14.40 c	7.68 bc	9.36 c
Kaligonj	21.44 b	4.24 c	34.48 ab
Mirpur	17.68 bc	17.60 a	34.24 b
Mohanpur	27.28 a	9.76 b	41.60 a
Sitakunda	14.88 c	6.96 bc	6.04 c
LSD	5.691	3.588	7.344
CV (%)	22.18	28.94	21.78

Plate 1. Leaf rot disease symptoms caused by *Phytophthora parasitica*.

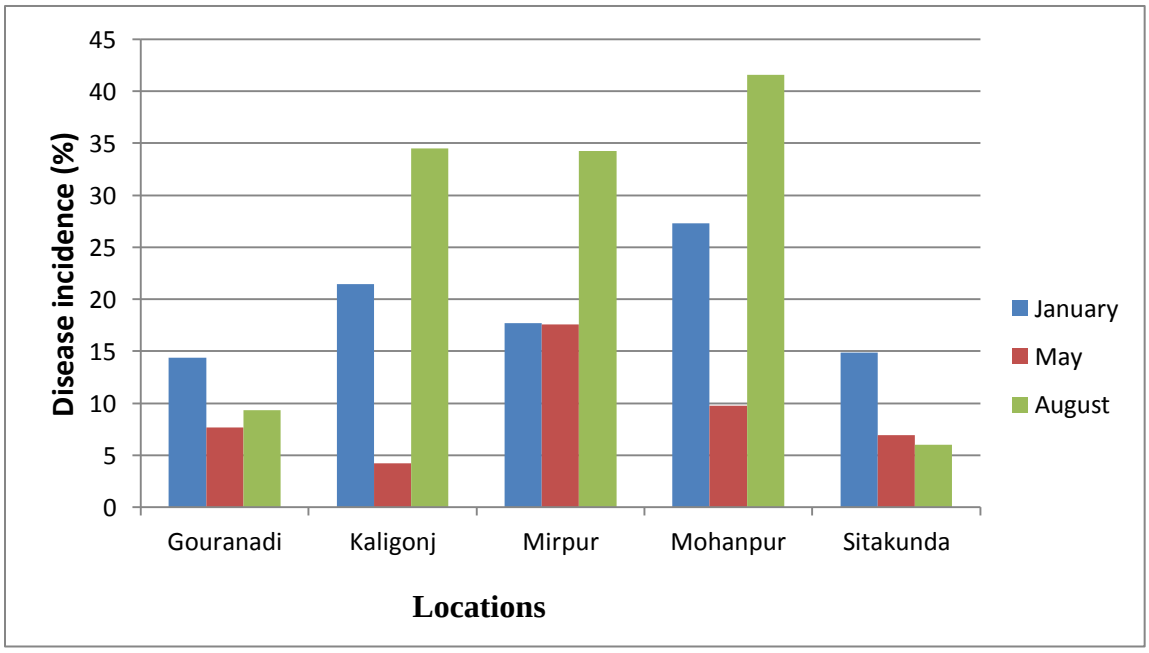

Figure 1: Mean disease incidence of betel vine leaf rot disease

4.5. Disease severity (%) of betel vine leaf rot disease

Disease severity of betel vine leaf rot under different upazillas found to vary significantly from one location to another and season to season (Table 3). The maximum disease severity 5.42% to 21.86% was observed in Mohanpur upazilla under Rajshahi district and the minimum disease severity 1.80% to 18.14% was found in Kaligonj upazilla under Zhenaidah district. The highest disease severity were found in August (5.34% to 21.86%) and lowest were found in May (1.80 to 8.08%).

Table 3. Disease severity of betel vine leaf rot disease

Upazilla	**% Disease Severity (Month wise)**		
	January	May	August
Gouranadi	7.63 b	2.83 c	5.34 c
Kaligonj	10.94 b	1.80 c	18.14 b
Mirpur	9.65 b	8.08 a	18.62 b
Mohanpur	14.58 a	5.42 b	21.86 a
Sitakunda	7.52 b	2.84 c	9.61 c
LSD	3.509	1.84	3.22
CV (%)	26.01	32.76	17.78

Plate 2. Sporangiophore with sporangium

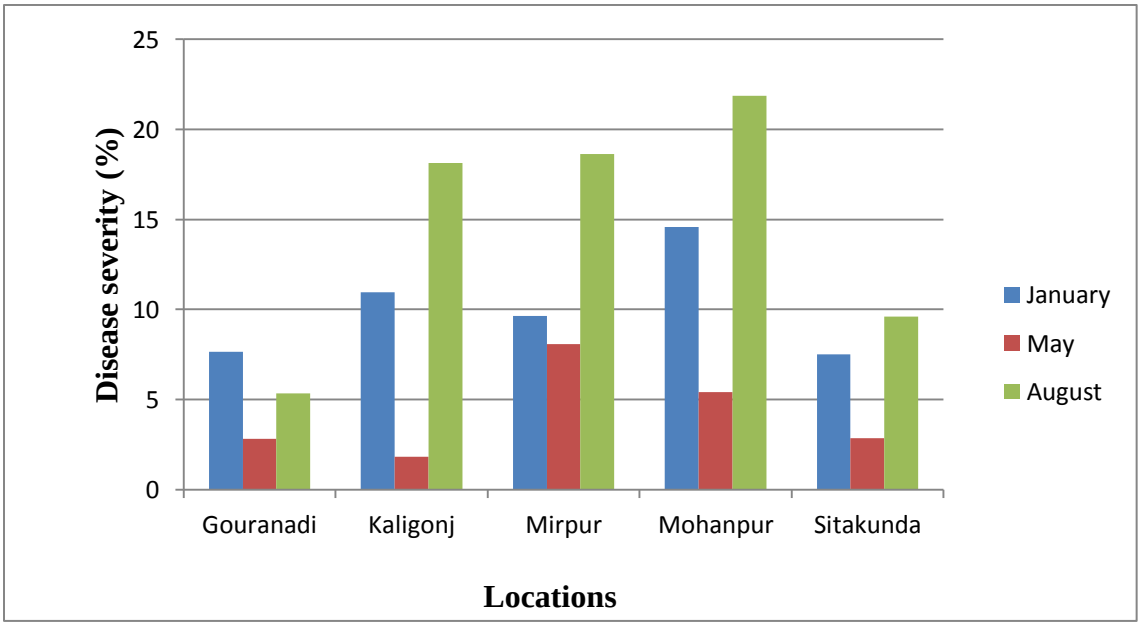

Figure 2: Mean disease severity of betel vine leaf rot disease

4.6. Disease incidence (%) of betel vine leaf spot disease

Disease incidence of betel vine leaf spot disease under different upazillas found significantly different from location to location (Table 4). The maximum disease incidences 11.64% to 57.44% were found in Mohanpur upazilla. The highest disease incidence were found in August (13.92% to 57.44%) and lowest in May (8.32% to11.64%).

Table 4. Disease incidence of betel vine leaf spot disease

Upazilla	**% Disease Incidence (Month wise)**		
	January	May	August
Gouranadi	12.28 d	8.96 c	14.40 d
Kaligonj	20.88 a	10.36 b	40.40 c
Mirpur	20.04 a	10.80 ab	50.40 b
Mohanpur	18.24 a	11.64 a	57.44 a
Sitakunda	20.16 a	8.32 c	13.92 d
LSD	3.212	1.088	6.048
CV (%)	13.08	8.11	17.77

Plate 3. Leaf spot disease Symptoms caused by *Colletotrichum piperis*

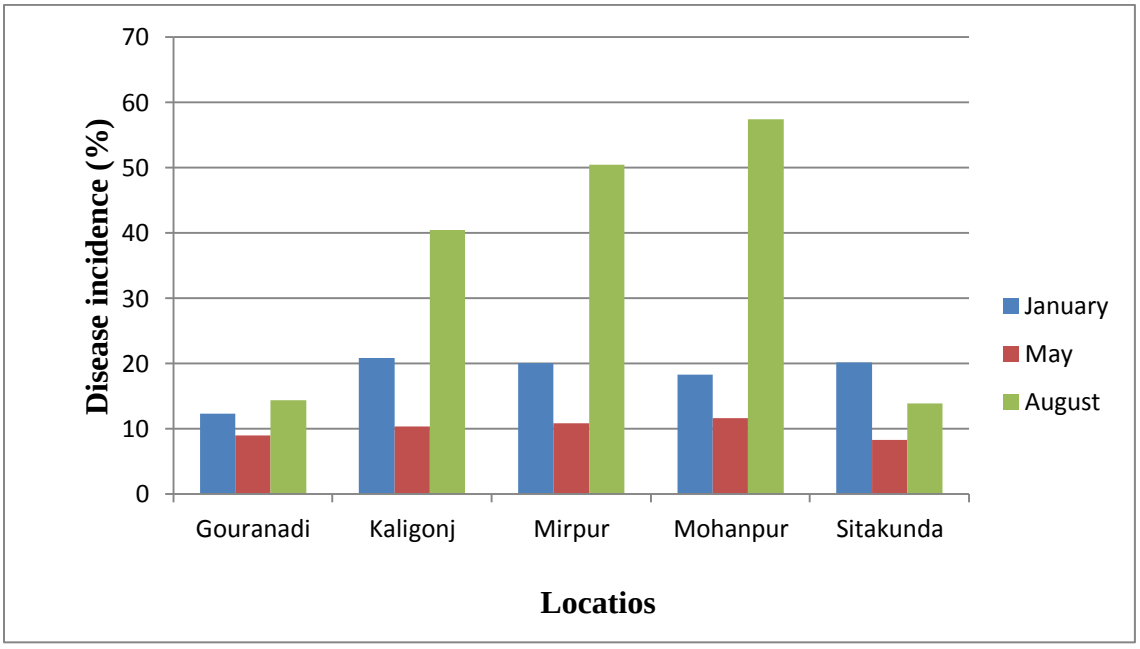

Figure 3: Mean disease incidence of betel vine leaf spot disease

Plate 4. Pure culture of *Colletotrichum piperis*

4.7. Disease severity (%) of betel vine leaf spot disease

Disease severity of betel vine leaf spot under different upazillas significantly varied from one place to another place and one season to another (Table 5). The maximum disease severity 4.824% to 28.32% were observed in Mohanpur upazilla under Rajshahi district and the minimum disease severity 2.72% to 4.97% were recorded in Gouranadi upazilla under Barisal district. The highest disease severity were found in August (4.97% to 28.32%) and the lowest in May (2.72 to 4.82%).

Table 5. Disease severity of betel vine leaf spot disease

Upazilla	**% Disease Severity (Month wise)**		
	January	May	August
Gouranadi	4.94 c	2.75 bc	4.97 b
Kaligonj	10.17 ab	4.25 ab	23.38 a
Mirpur	9.00 b	3.77 abc	25.81 a
Mohanpur	12.02 a	4.82 a	28.32 a
Sitakunda	11.58 ab	2.72 c	6.27 b
LSD	2.670	1.51	8.348
CV (%)	20.86	31.42	35.08

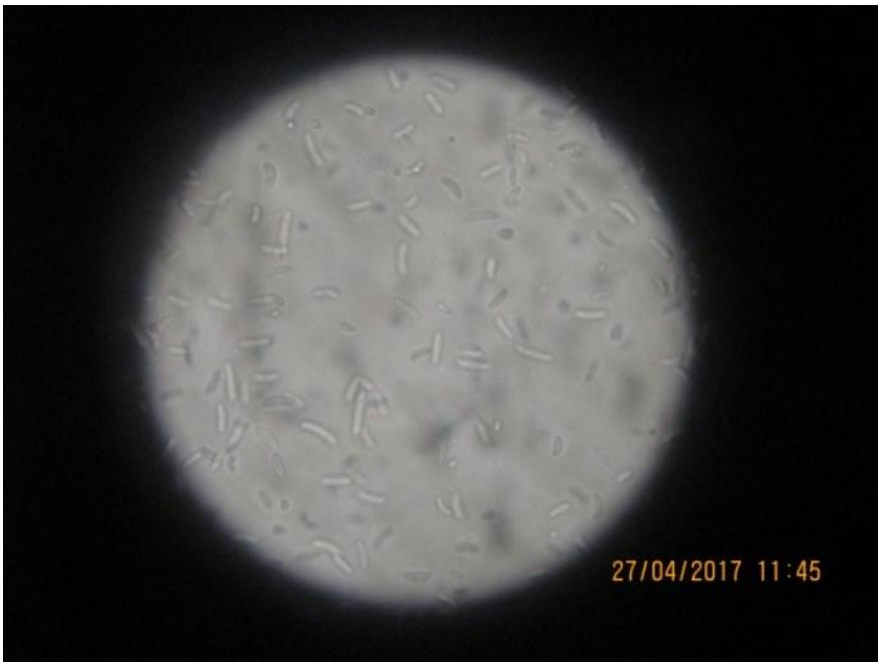

Plate 5. Conidia of *Colletotrichum piperis*

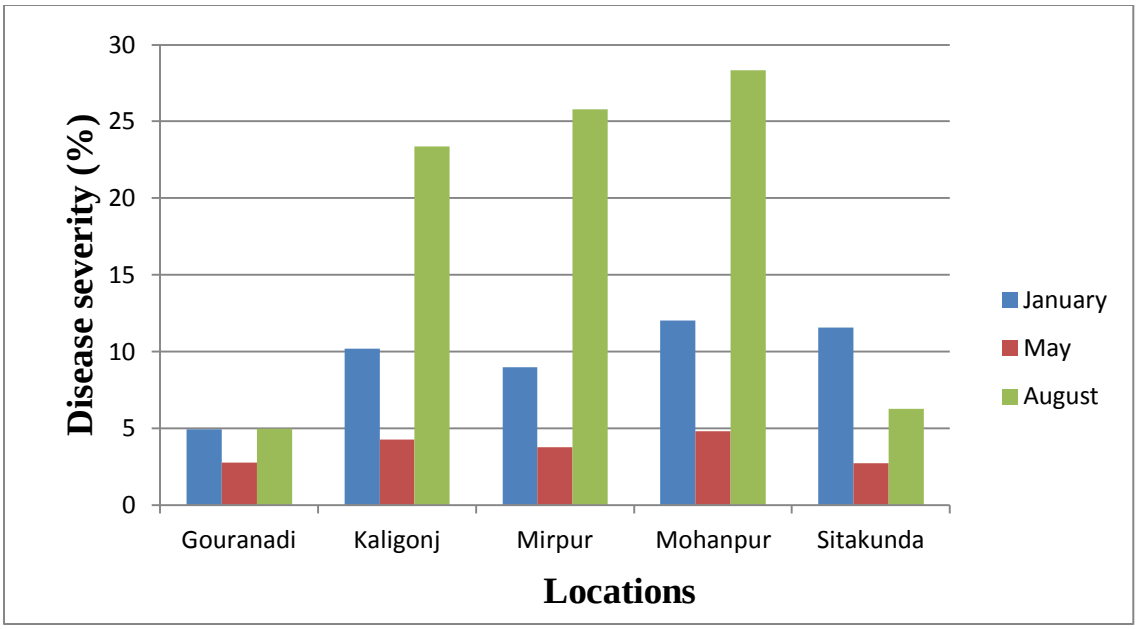

Figure 4: Mean disease severity of betel vine leaf spot disease

4.8. Disease incidence (%) of betel vine foot and root rot disease

Disease incidence of betel vine foot and root rot under different upazillas was significantly different from one location to another and one season to another (Table 6). The highest disease incidence 19.60% to 27.80% was found in Gouranadi upazilla under Barisal district and the minimum disease incidence 6% to 17% was found in Sitakunda upazilla under Chittagong district. Highest disease incidence 17.00% to 27.80% were recorded in August and lowest in May (6% to 19.60%).

Table 6: Disease incidence of betel vine foot and root rot disease

Areas	**% Disease Incidence (Month wise)**		
	January	May	August
Gouranadi	21.20	19.60 a	27.80 a
Kaligonj	18.40 ab	15.20 ab	24.60 ab
Mirpur	7.80 c	11.20 bc	22.40 abc
Mohanpur	7.80 c	10.00 bc	20.00 bc
Sitakunda	9.40 bc	6.00 c	17.00 c
LSD	7.536	6.708	6.132
CV (%)	55.05	39.96	20.45

Plate 6. Foot and root rot disease symptoms caused by *Sclerotium rolfsii*

Plate 7. *Sclerotium rolfsii* with (sclerotia)

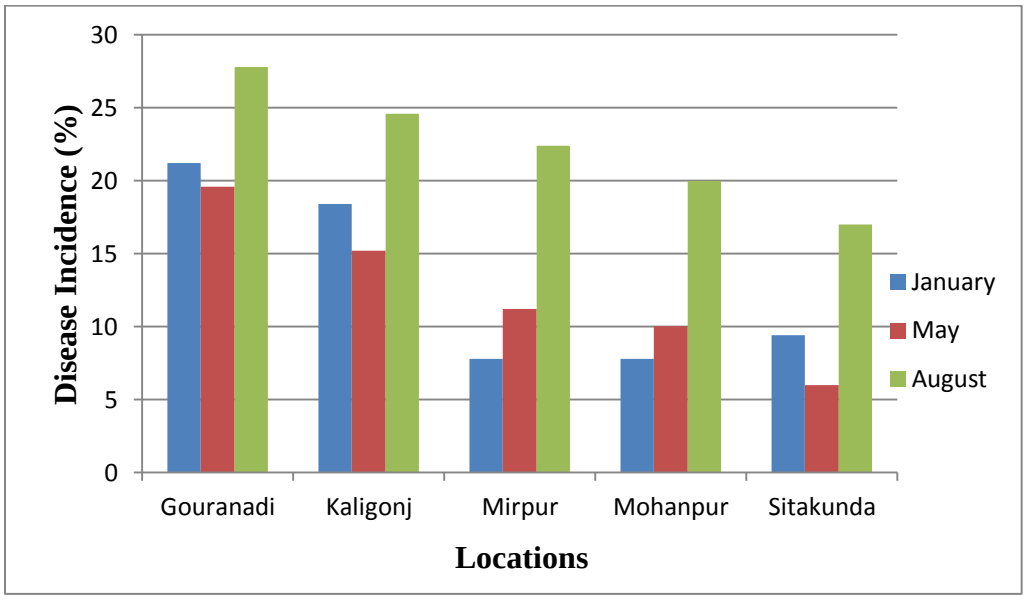

Figure 5: Mean disease incidence of betel vine foot and root rot disease

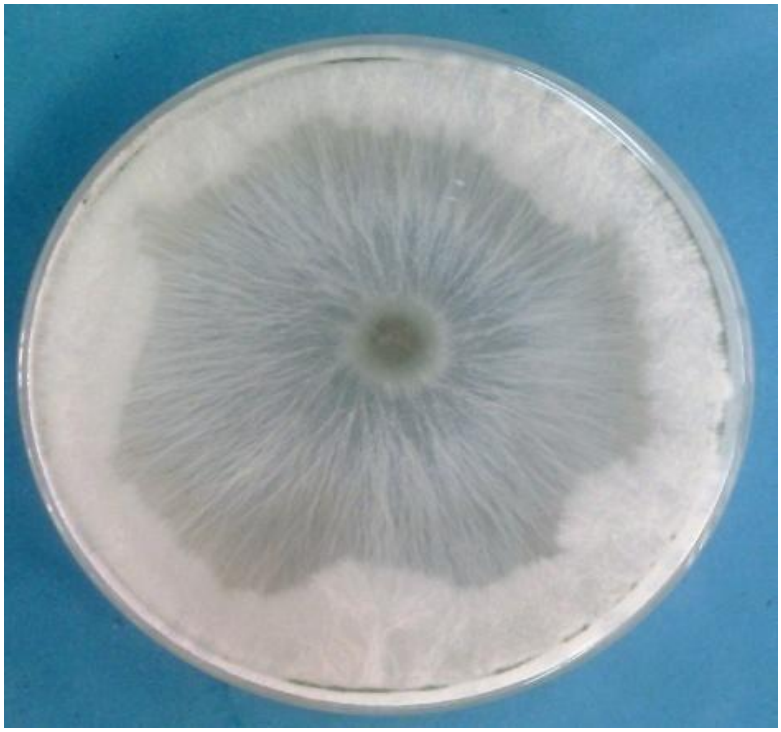

Plate 8. Pure cuultre of *Sclerotium rolfsii*.

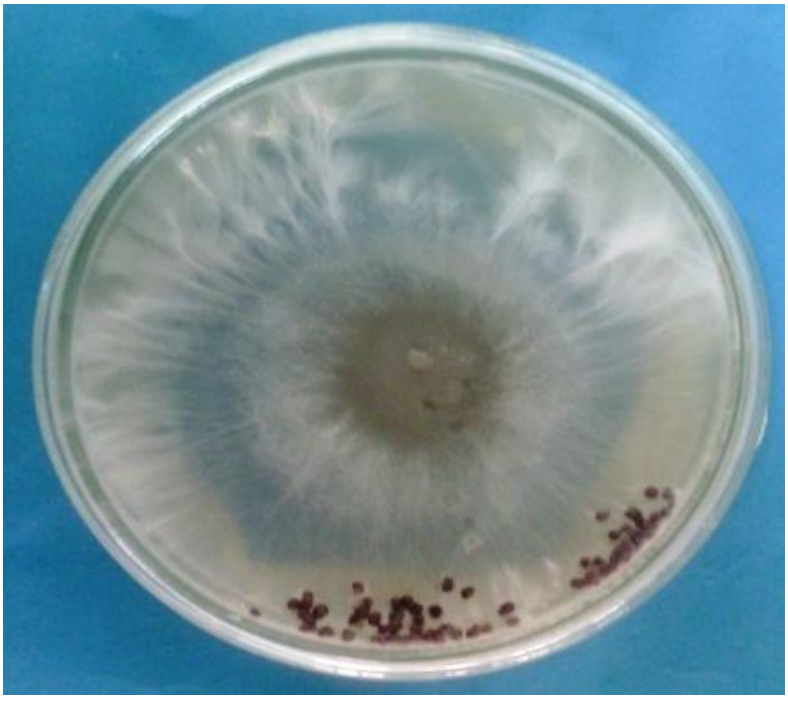

Plate 9. Formation of sclerotia by *S. rolfsii.*

Table 7. Survey on betel vine production under different upazilla

Upazilla	Cultivars name	Growing area (ha)	Production(MT)
KALIGONG	Mistipaan Banglapaan	210	450
GAURNADI	Mistipaan Banglapaan	50	150
KUSTIA SADAR	Mistipaan Banglapaan	95	170
MOHANPUR	Mistipaan Banglapaan	135	215
SITAKUNDA	Mistipaan Banglapaan	75	145
Total		**565**	**1130**

Source: (AEO of each upazilla)

CHAPTER V

DISCUSSION

Betel vine (*Piper betle* L.) is evergreen, perennial climber. It is an important cash crop grown commercially in Bangladesh. The major three diseases namely leaf spot, leaf rot and foot and root rot was found prevalent in the surveyed areas. Leaf spot was found to be caused by *Colletotrichum piperis*, leaf rot caused by *Phytophthora parasitica* and foot and root rot caused by *Sclerotium rolfsii*. The climatic condition of Bangladesh is favorable for the growth and reproduction of plant pathogens (Fakir, 2001). Betel vines are cultivated in protected areas under shady and humid conditions which is also favour for the development of many diseases (Chattopadhyay and Maiti, 1990). Bangladesh is the second largest betel vine growing country in the world. Total cultivation area about 14,100 hectares with annual production is about 72,570 tons. Anonymous (2006) the average yield is 2.28 tons per acre. The major betel vine growing areas in Bangladesh are Barisal, Cox's Bazar, Rajshahi, Maulavi- Bazar, Satkhira, Jessore, Kushtia, Jhinidah, Pabna etc.

Betel vine is cultivated mainly under an artificially made structure, locally known as "*Boroj"*, which is made by roof, jute sticks or straw on alight framework of bamboo. Three diseases viz. leaf rot, leaf spot and foot and root rot of betel vine were recorded during the investigation period. Leaf rot of betel vine disease found in all the locatios under the survey areas of five upazillas viz., Gouronadi, Kaligonj, Mirpur, Mohanpur and Sitakunda under the district of Barisal, Jhenaidah, Kushtia, Rajshahi and Chittagong, respectively. Leaf rot of betel vine was recorded as a common disease in all the growing areas.

Considering locations of survey, maximum disease incidence (41.60%) and disease severity (21.86%) of betel vine leaf rot diseases were found in August at Mohanpur upazilla under Rajshahi district with average temperature 33.4 ^{0}C, relative humidity (75%) and rainfall 335.5 mm. On the other hand lowest amount of disease incidence (4.24%) and disease severity (1.80%) of betel vine leaf rot diseases were recorded in May at Kaligonj upazilla with average temperature 33 ^{0}C, relative humidity (75.0%) and rainfall 120.7 mm in Zehnaidah district.

The maximum number of disease incidence (57.44%) and disease severity (28.32%) of betel vine leaf spot were found in August at Mohanpur upazilla under Rajshahi district having average temperature 33.4 ^{0}C, relative humidity (75%) and rainfall 330.5 mm. On the other hand lower amount of disease incidence (8.32%) and disease severity (2.74%) of betel vine leaf spot was found in May at Sitakunda upazilla under Chittagong district having average temperature 34.1 ^{0}C, relative humidity (74.0%) and rainfall 136 mm.

On the other contrary maximum disease incidence (27.80%) of betel vine foot and root rot was recorded in August at Gouranadi upazilla under Barisal district with average temperature 33.8^{0}C, relative humidity (74%) and rainfall 337 mm. Information about prevalence, epidemiology and management of betel vine diseases in Bangladesh is very few. The diseases of betel vine causing tremendous loss in leaf quality and production, it is necessary to investigate those upazillas to get information about the pathogens for drawing a suitable management practices against diseases. High temperature, relative humidity and rainfall are favorable for the growth and development of betel vine leaf rot and leaf spot diseases.

The great variation was found in incidence and severity of betel vine of leaf rot and leaf spot diseases regarding the time and location. On the other hand betel vine foot and root rot disease was found in all the locations under survey areas.

The incidence and severity of the diseases were found to different from season to season as well as Upazilla to Upazilla.

Fakir (2001) reported that the climate of Bangladesh is favorable for growth and reproduction of plant pathogens which cause different diseases of crops.

CHAPTER VI
SUMMARY AND CONCLUSION

The betel vine is a perennial dioecious crop. It is usually grown under shade or in specially constructed houses for the purpose. Leaves are used for chewing. Betel chewing is considered as a good and cheap source of dietary calcium. The volatile oil of leaves has been found to be antiseptic and is used in treatment of bronchitis, cough, cold and chills. The crop suffers from a number of diseases, among them leaf spot caused by *Colletotrichum piparis,* leaf rot caused by *Phytophthora parasitica var. piperina* and foot and root rot caused by *Sclerotium rolfsii.* which reduces its productivity considerably and limit commercial cultivation of the crop.

The highest disease incidence (41.60) and disease severity (21.86) of leaf rot disease were found in the month of August at Mohanpur upazilla under Rajshahi district. The highest disease incidence (57.44%) and disease severity (28.22%) of leaf spot were also found in the month of August at Mohanpur upazilla under Rajshahi district. In case of foot and root rot the highest disease incidence (27.80%) was recorded in the month of Augustat at Sitakundo upazilla under Chittagong district. The lowest disease incidence (4.24%) was recorded in Kaligong upazilla under Zhenaidah district while the lowest disease severity (2.83%) of leaf rot was found Gouronadi upazilla under Barisal district. respectively, the minimum disease incidence (8.32%) and disease severity (2.72%) were recorded in the month of May in Sitakundo upazilla under Chittagong district. In case of foot and root rot the lowest disease incidence (6.00%) was also recorded in Sitakundo upazilla under Chittagong district. In respect of locations and period of survey it was revealed that leaf rot (*Phytophthora parasitica*), Leaf spot (*Colletotrichum piperis*) and foot and root rot (*Sclerotium rolfsii*) of betel vine were prevalent in the month of August at Mohanpur upazilla under Rajshahi

district, Sitakundo upazilla under Chittagong district and Gouronadi upazilla under Barisal district respectively.

From the results of the present study it may concluded that leaf rot, leaf spot and foot and root rot of betel vine are the three most prevalent diseases in different upazillas of selected areas and there prevalence was higher in September and lower in May irrespective of the different betel vine growing locations under surveyed areas. Further investigations are needed to justify the present findings for consecutive years.

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Appendix 1: Month wise air temperature (^{0}C), relative humidity (%) and rainfall (mm) for, 2016 under survey areas.

Location	Month	Average air temperature (^{0}C)	Average relative humidity (%)	Total rainfall (mm)
Gouronadi	January	22.4	69	0
	May	33.3	73	107
	August	33.8	74	307
Kaligong	January	21.2	71	0
	May	33	79	109.7
	August	33.5	75	305.7
Mirpur	January	22.3	67	0
	May	34	79	101
	August	32.8	85	300
Mohanpur	January	20.8	80	0
	May	32.5	77	104.5
	August	33.4	75	305.5
Sitakundo	January	22.9	66	0
	May	32	78	106
	August	34.1	74	300.2

Appendix 2: List of abbreviations with their elaboration

Abbreviation	**Elaboration**
AEZ	Agro- Ecological Zone
et al.	And others
@	At the rate
BARC	Bangladesh Agricultural Research Council
BAU	Bangladesh Agricultural University
Cm	Centimeter
CV	Coefficient of Variance
Conc.	Concentration
^{0}C	Degree Celsius
DI	Disease incidence
DS	Disease severity
DMRT	Duncan's Multiple Range Test
FAO	Food and Agricultural Organization
Ft	Foot, feet
e.g.	For example
G	Gram
Ha	Hectare
Hr	Hour
HCl	Hydrochloric Acid
pH	Hydrogen ion conc.
i.e.	That is
IARI	Indian Agricultural Research Institute
LSD	Least significance Difference
MT	Metric ton
Ml	Mililitre
Mg	Milligram
Mm	Millimeter
Min	Minute
M	Miter
N	Normal
N	North
Psi	Per square inch
% RH	Percent Relative Humidity
%	Percentage
PDA	Potato dextrose agar
Ib	Pound

RCBD	Randomized Completely Block Design
RH	Relative Humidity
S. rolfsii	Sclerotium rolfsii
SAU	Sher-e-Bangla Agricultural University
NaOH	Sodium Hydroxide
NaOCl	Sodium Hypochlorite
m2	Square meter
sq-m	Square- meter
T	Ton
UNDP	United Nations Development Programme
Viz.	Videlicet