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Leaf spot disease of coconut seedling and its eco-friendly management

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Abstract

The effect of weather on prevalence of seedling diseases of coconut during 2010-11 and 2011-12 in different areas of Bangladesh was studied to develop an environment friendly disease management practice. *Pestalotia palmarum* was isolated and identified from leaf having spot. Incidence and severity of grey leaf spot at seedling stage were determined and significant variations were observed depending on weather factors as well as locations. Occurrence of seedling disease was significantly influenced by temperature, rainfall and relative humidity. Comparative effectiveness of BAU-Biofungicide either alone or in combination with two fungicides viz. Bavistin or Dithane M-45 was evaluated on coconut seedling in the nursery. Among the treatments applied, *Trichoderma harzianum* based BAU-Biofungicide either alone or in combination with Bavistin (0.2%) as an excellent biocontrol means in controlling leaf spot disease of coconut.

Keywords: Coconut seedling, Leaf spot disease, BAU-Biofungicide, Eco-friendly management

Introduction

Coconut (*Cocos nucifera*) is one of the most important fruits in Bangladesh. It provides coconut oil, coconut milk as well as mineral enriched water that widely used in the country. Coconut contributes a great share of the total production of fruits in the country. About 80% of families in the country consume less than the minimum recommended daily requirement of fruits. As a consequence widespread nutritional deficiencies in vitamin 'A', 'C', iron and other nutrients cause debilitating illness among the population (HKI, 2005).

The horticultural crops, especially fruits are playing a vital role in crop diversification, nutrition, economy and environment of the country. Improved varieties of fruits like mango, guava litchi, jackfruit, ber, coconut etc. are available in Bangladesh which can contribute in the poverty ridden economy and nutrition significantly (Rahim, 2009). However, the availability of Quality Planting Materials (QPM) is inadequate. Success of an orchard or homestead gardening depends on the quality of the planting material. The first and most important step is to supply farmers with seedlings that are free of diseases.

Determining the effect of temperature, rainfall and relative humidity on the formation, release and germination of inocula in different pathosystems have been focused by many researchers worldwide (Sutton, 1981; Pinkerton *et al.*, 1998; MacHardy *et al.*, 2001; Mondal & Timmer, 2002). Based on understanding the disease epidemiology, effective control measures could be developed and implemented (Hopkins and McQuilken, 2000). Disease of fruits species have been reviewed by many workers throughout the world. Plant diseases play a major role in reducing yields of horticultural crops in the tropics (Pathak, 1980; Rawal, 1990; Ploetz *et al.*, 1998; Mariau, 2001). It has been estimated that the production could be increased at least by 28% if the crop could be protected against various seedling diseases and many of these diseases have been reported that transmitted through the planting materials (Rawal, 1990).

Coconut is grown widely in Bangladesh. However, seedling diseases of coconut have not been thoroughly investigated in Bangladesh. Ghose (2000) found that coconut mainly suffered from grey leaf spot or blight caused by (*Pestalotiopsis palmarum*) and bud rot caused by *Phytophthora palmivora* in 22 countries and described distribution, alternative hosts, epidemiology, varietal reaction and management of the disease. He also reported that grey leaf spot or blight caused by *Pestalotiopsis palmarum* had no immune or resistant sources against the disease. Little information is available about the incidence, prevalence, epidemiology and management of seedling diseases of coconut in Bangladesh. Therefore, it

is imperative to investigate nurseries to get information on the incidence, severity, epidemiology and management of the pathogen that cause seedling leaf spot disease. This experiment was, therefore, undertaken to investigate the effects of temperature, rainfall and humidity on the leaf spot disease of coconut in Jessore, Jhenaidah and Faridpur and to suggest an eco-friendly management package for the disease.

Materials and Methods

Altogether 15 nurseries in three districts of Bangladesh viz. Faridpur, Jhenaidah and Jessore were surveyed and leaf spot disease of coconut seedlings were studied and information were recorded. Four visits were made in each year in the selected 15 nurseries during 2010-2012 growing season of one to two years old seedlings. During the survey in coconut nurseries, total number of coconut seedlings found in the nurseries was recorded. Total numbers of seedlings, number of healthy and diseased seedlings were counted from the selected nurseries. Then 30 seedlings were selected randomly from each of the selected nurseries. Each seedling was observed carefully and disease symptoms were recorded following the description of Singh (1996), Singh (1998) and Pathak (1980). Disease incidence was assessed as percentage of plants infected with at least one leaf spot or visible symptom. Assessment of disease incidence of coconut seedlings was calculated using formula of Rai and Mamatha (2005). Disease severity was evaluated using the method of Fagan and Goes (1999). The scale was used from 0 to 5, where 0= No visible symptoms, 1= 1-5% leaf area diseased, 2= 5.1-12% leaf area diseased, 3= 12.1-25% leaf area diseased, 4= 25.1-50% leaf area diseased and 5= >50% leaf area diseased. Moreover, data on air temperature, relative humidity and rainfall were recorded.

Eco-friendly management trial was conducted at Bangladesh Agricultural University, Mymensingh during August, 2010 to September, 2012. Pits were prepared in the field as per method of Mondal (2000). Application of fertilizers and manures were done following BARC fertilizer Recommendation Guide (FRG, 2005). The experiment was laid out in Randomized Completely Block Design (RCBD) with three replications and 15 seedlings per treatment were used. For the management of nursery diseases of coconut seven different treatments were evaluated. Two fungicides viz. Bavistin and Dithane M-45, and one *Trichoderma* based preparation known as BAU-Biofungicide were used. The fungicides were applied as foliar spray at 30 days interval, but BAU-Biofungicide was applied as foliar spray as well as drenching in the soil. The treatments were as T₁= BAU-Biofungicide applied as soil drenching @ 2%, T₂= BAU - Biofungicide applied as foliar spray @ 2%, T₃= BAU-Biofungicide applied as soil drenching and foliar spray @ 2% and 2%, respectively, T₄= Bavistin as foliar spray @ 0.2%, T₅= Dithane M-45 as foliar spray @ 0.2%, T₆= BAU-Biofungicide applied as soil drenching and Bavistin as foliar spray @ 2% and 0.2%, respectively and T₇= Untreated control. BAU-Biofungicide is a formulated product of *Trichoderma harzianum*, developed in Eco-friendly Disease Management Laboratory, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh (Hossain, 2003). BAU- Biofungicide was thoroughly mixed with the soil @ 6.4g/m² soil (Lo *et al.*, 1996). The data on different parameters were compiled and analyzed statistically with the computer software program MSTAT-C (Russell, 1986). The mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Investigation on seedling diseases of coconut in different nurseries of Jessore, Jhenaidah and Faridpur during 2010-2011 and 2011-2012 revealed that leaf spot was the most common disease in the nurseries. The leaf spot causal pathogen was identified as *Pestalotia palmarum*. Incidence of leaf spot disease in coconut seedlings varied significantly from season to season as well as location to location that ranged from 26.33 to 80.36 % in 2010-2011 and 24.89 to 74.35% in 2011-2012, respectively (Table 1). The highest incidence (80.36 %) of leaf spot was observed in October, 2010 at Faridpur followed by April, 2011 at Faridpur and the lowest (26.33 %) was observed in January, 2011 at Jessore. The similar trend was found in 2011-2012. The severity of leaf spot varied significantly from season to season as well as location to location and that ranged from 18.44 to 40.67 % in 2010-2011 and 15.73 to 27.67 % in 2011-2012, respectively (Table 1). The highest severity (40.67 %) was observed in October, 2010 followed by

April, 2011 at Faridpur but they were statistically at par. The lowest severity (18.44 %) was recorded in January, 2011 at Faridpur in 2010-2011. In 2011-2012 the highest severity (27.67 %) was recorded in October, 2011 at Jessore and the lowest (15.73 %) was recorded in January, 2012 at Faridpur but they were statistically insignificant.

Table 1. Incidence and severity of leaf spot disease of coconut seedling in different locations during July 2010 to April 2011 and July 2011 to April 2012 of Bangladesh

Locations	Data recording time (Month)	Leaf spot			
		2010-2011		2011-2012	
		Incidence (%)	Severity (%)	Incidence (%)	Severity (%)
Jessore	July	34.66g	25.96cd	27.90b	25.66
	October	57.30c	31.76bc	33.95b	27.67
	January	26.33j	24.42cd	26.59b	24.12
	April	36.13g	30.74bc	30.58b	27.13
Jhenaidah	July	45.92e	27.96cd	34.91b	24.53
	October	53.05d	31.44bc	36.78b	24.45
	January	29.04i	24.98cd	24.89b	22.63
	April	47.08e	29.46bc	35.43b	25.45
Faridpur	July	43.73f	19.60d	35.70b	17.37
	October	80.36a	40.67a	74.35a	27.20
	January	31.88h	18.44d	25.97b	15.73
	April	75.16b	37.66ab	60.45a	20.97
CV (%)		12.61	7.56	9.35	7.18

In a column, figures having same letter (s) do not differ statistically at 5% level of significance by DMRT

In 2010-2011, the highest temperature prevailed from March to May, (29.5°C), June was transitional period (29.7°C) and an equable temperature 29.4°C prevailed from July to September. A fall in temperature was observed from October (28.05°C) to the end of December (18.4°C) and the coolest period prevailed during January and February (18.3°C) as shown in (Fig. 1). About 80 % annual rainfalls occurred during the monsoon, (late May to mid-October). Total amounts of rainfall in the locations Jessore, Jhenaidah and Faridpur were 1380 mm, 1388 mm and 1409 mm, respectively. Slight rain was recorded in January, March and April were the least humid months, while the average relative humidity ranged from 69-78 %, 69-77 % and 66-78 % in Jessore, Jhenaidah and Faridpur, respectively. The relative humidity during June to October was above 80 % and during November to February was 77 %, 77 % and 75 % in Jessore, Jhenaidah and Faridpur, respectively. In 2011-2012, the weather parameters showed the similar trend as previous year. Based on the analysis of the climatic variations, four disease recording times were selected to observe the effect of weather on the incidence and severity of seedling diseases of coconut. In 2010-2011, the lowest incidence and severity of leaf spot disease of coconut (29.08 and 24.11 %, respectively) were recorded in January at temperature, relative humidity and rainfall of 16.0°C, 77 % and 00 mm, respectively. On the other hand, the highest prevalence of incidence and severity were recorded (63.57 % and 39.47 %, respectively) in October at temperature, relative humidity and rainfall of 27.9 °C, 82 % and 122mm, respectively (Fig. 1). In 2010-2011 incidence and severity of leaf spot disease of coconut under three locations viz. Jessore, Jhenaidah and Faridpur varied from 38.60-57.78 % and 22.75-34.81%, respectively (Fig.2). Statistically the highest incidence and severity were recorded at Faridpur and the lowest at Jessore. In 2011-2012, the lowest incidence and severity of leaf spot disease of coconut (29.50 and 22.28 %, respectively) were recorded in January at temperature, relative humidity and rainfall of 17.9°C, 78.6 % and 31 mm, respectively (Fig. 3). On the other hand, the highest prevalence of incidence and severity were recorded (46.79 % and 25.28 %, respectively) in October at temperature, relative humidity and rainfall of 28.2 °C, 78.3 % and 13mm, respectively. In 2011-2012 incidence and severity of leaf spot disease of coconut under three locations viz. Jessore, Jhenaidah and Faridpur varied from 29.76-49.12 % and 20.32-39.15 %, respectively (Fig. 4). The lowest incidence and severity of leaf spot disease of coconut (29.76 and 20.32 %) were recorded at Jessore and the highest prevalence of incidence and severity were recorded (49.12 % and 26.15 %) at Faridpur.

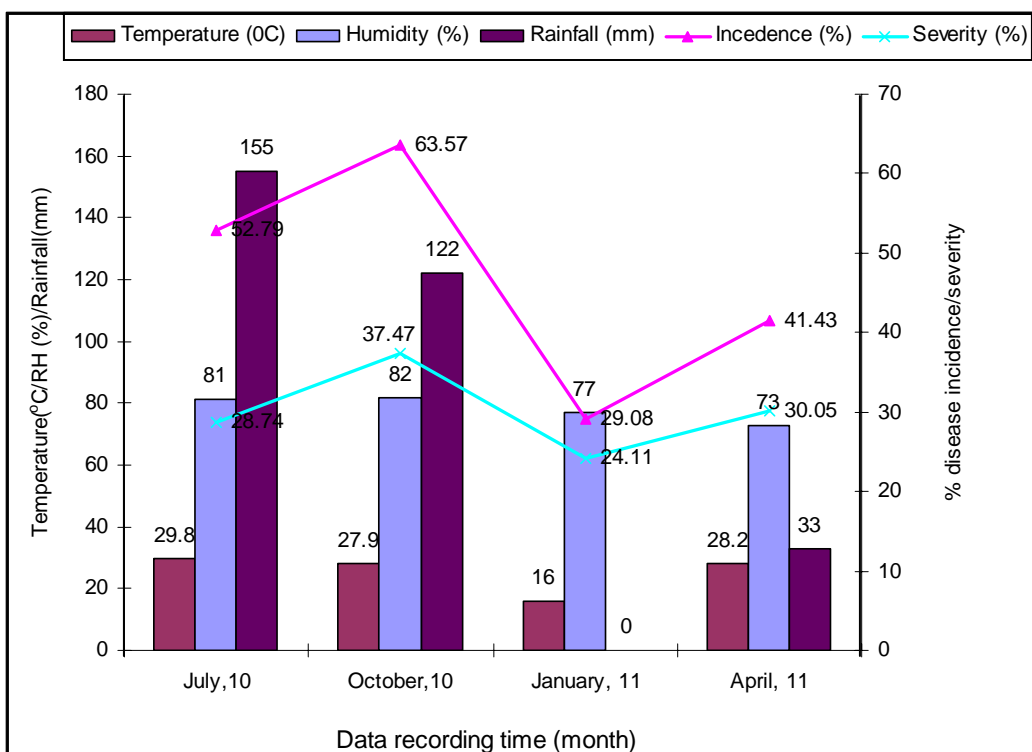


Fig. 1. Effect of different climatic factors on the incidence and severity of leaf spot disease of coconut seedlings during 2010-2011.

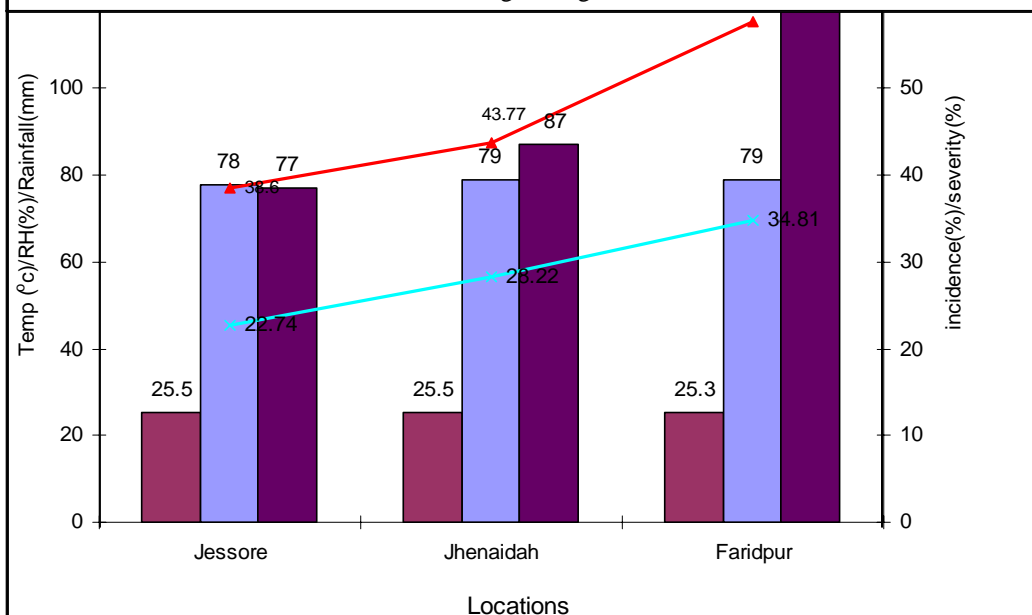
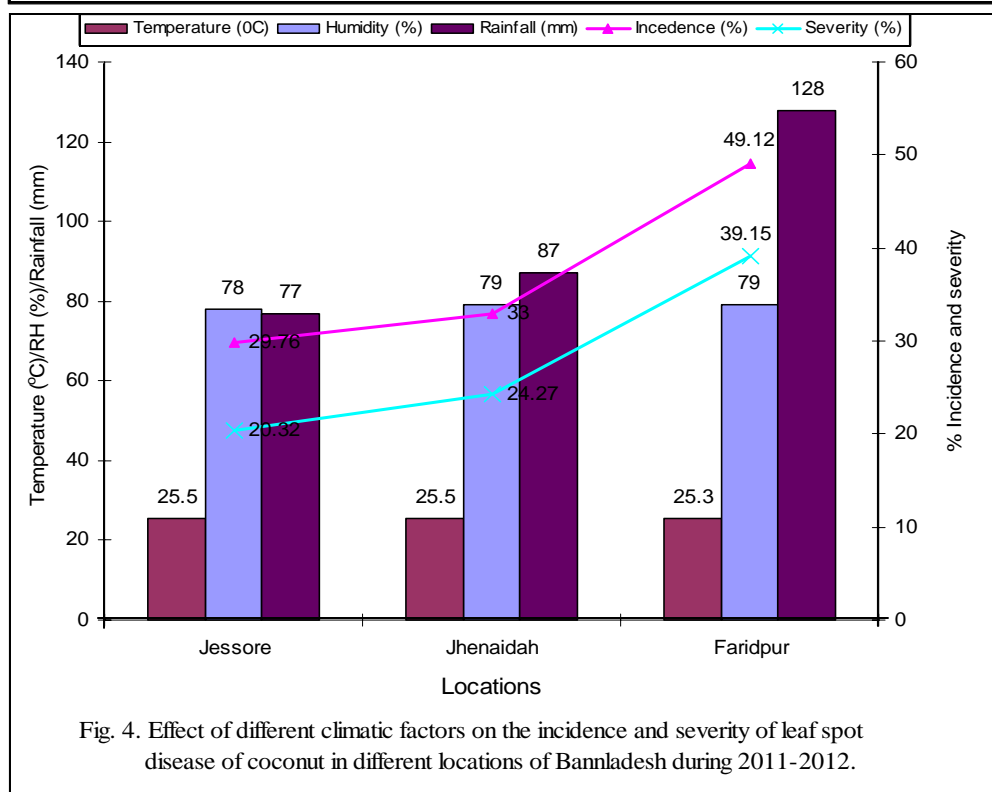
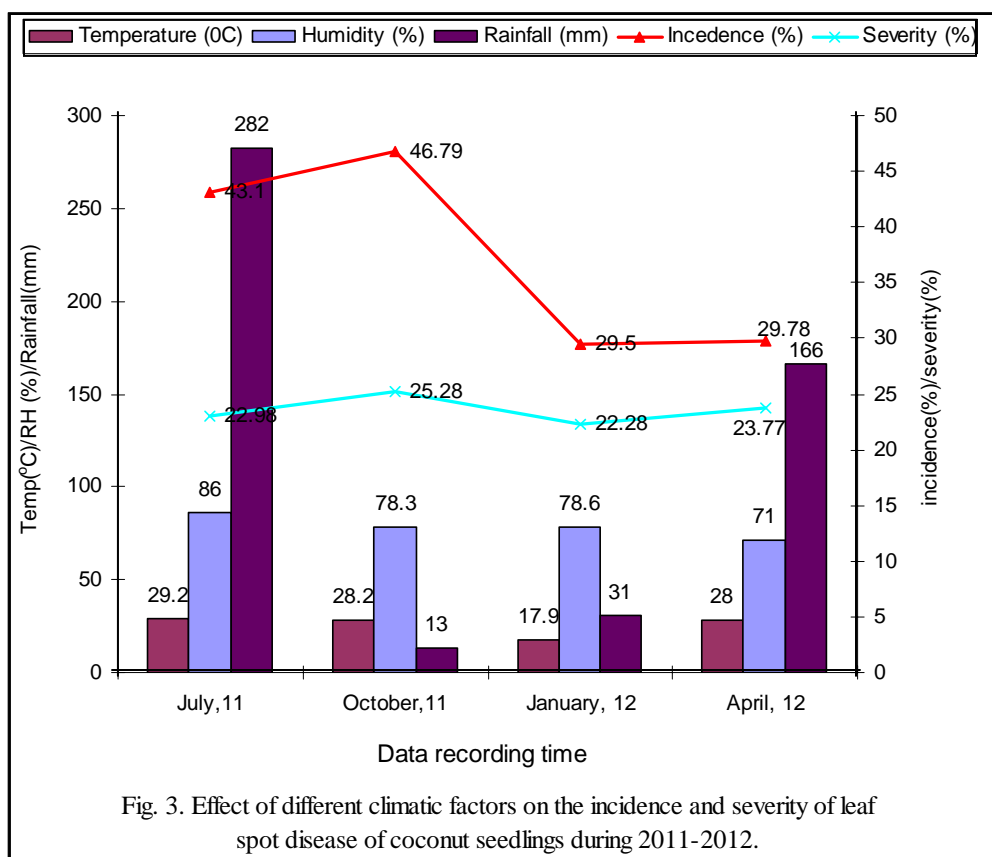


Fig. 2. Effect of different climatic factors on the incidence and severity of leaf spot disease of coconut in different locations of Bangladesh during 2010-2011.



Correlation and linear regression analysis regarding relationship between different component of climatic factors (temperature, rainfall and relative humidity) and incidence as well as severity of leaf spot disease of coconut seedlings revealed that temperature was positively correlated with both incidence ($r = 0.79$) and severity (0.71) of leaf spot disease of coconut seedlings as shown in Table 2. Effect of temperature, relative humidity, rainfall, sun shine hour and leaf wetness on the incidence and severity of disease in different pathosystems have been reported by many researchers (Pinkerton *et al.*, 1998; Mac Hardy *et al.*, 2001; Mondal and Timmer, 2002 and Chowdhury and Hossain, 2011). Fitzell and Peak (1984) stated that the conidia of *Colletotrichum gloeosporioides* were produced in lesions on leaves, defoliated branch terminals, mummified inflorescence and flower bracts over a wide range of environmental conditions (10-30°C, >95 % relative humidity). Similar prevalence of leaf spot disease caused by *Pestalotia palmarum* was reported by Islam (2011). He also observed that coconut mainly suffered from leaf spot and bud rot disease in the nurseries. Pathak (1989) investigated the diseases of coconut and stated important diseases that include leaf rot, grey leaf spot and blight caused by *Pestalotiopsis palmarum*, and bud rot caused by *Phytophthora palmivora*. Harrison and Jones (2003) reported that coconut (*Cocos nucifera*) suffered from numerous diseases such as Ganoderma bud rot, lethal yellowing caused by (*Phytoplasmas*) red ring (*Bursaphelenchus cocophilus*) and basal stem rot (BSR) disease of coconut caused by (*Ganoderma lucidum*) was a major destructive disease limiting coconut production in some regions.

Table 2. Linear regression analysis of climatic factors (temperature, rainfall and relative humidity) with the incidence and severity of leaf spot disease of coconut seedlings

Climatic factors	Slope (b)		Coefficient of determination (R^2)		Probability (P)	
	Incidence	Severity	Incidence	Severity	Incidence	Severity
Temperature	0.67	1.79	0.79	0.71	0.086	0.134
Rainfall	0.003	0.006	0.05	0.04	0.81	0.83
Relative humidity	0.062	0.35	0.03	0.04	0.88	0.87

Eco-friendly disease management trial

Comparative effectiveness of BAU-Biofungicide either alone or in combination with chemical fungicides viz. Dithane M-45 and Bavistin were evaluated for controlling seedling disease of coconut. The leaf spot disease incidence was gradually decreased from October, 2010 to September, 2011 and the lowest was during August to September, 2011 (Table 3). Highest incidence of leaf spot (77.90 %) was recorded in untreated control and the lowest incidence (42.00 %) was recorded when BAU-Biofungicide was applied in soil @ 2 % as well as foliar spray (2 %) that resulted the highest reduction of disease incidence by 46.08 % over control. In 2011-2012, the lowest incidence of disease was observed in August to September, 2012 (Table 4). The highest incidence of leaf spot (71.74 %) was recorded in untreated control and the lowest incidence (28.61 %) was recorded when BAU-Biofungicide was applied in soil @ 2% and Bavistin as foliar spray @ 0.2% that resulted the highest reduction of leaf spot disease incidence by 60.12 % over control.

The highest severity (31.27-45.96 %) of leaf spot disease was found in October, 2010 and it was decreased in the following months up to May, 2011 and remained almost static from April, 2011 to June, 2011 (Table 5). In June, the severity was the lowest and in August, the severity was little higher than in the previous months. In case of untreated control, disease severity increased gradually from October, 2010 and the highest severity (47.89 %) was observed in August, 2011 and then it suddenly decreased up to 40.36 % in the month of September, 2011. The fluctuation of disease severity might be due to environmental factors which have been supported by Chowdhury (2009). The highest leaf spot severity (44.56 %) was observed in untreated control and the lowest severity (19.93 %) was observed in BAU-Biofungicide was applied in soil @ 2 % and Bavistin as foliar spray @ 0.2 % which resulted the highest reduction (55.23 %) of disease severity over control. Results of the present investigation reveal that BAU-Biofungicide is effective for controlling leaf spot of coconut. Among the chemicals Bavistin (0.2 %) as foliar spray was also found good when incorporated with BAU-Biofungicide as soil drench for controlling coconut disease. Similar findings have also been supported by Chowdhury (2009), Hossain (2011), Akter *et al.* (2011) and Hossain *et al.* (2011).

Table 3. Effect of different management practices on the incidence of leaf spot disease of coconut seedlings during the growing period of October 2010 to September 2011

Treatments	% disease incidence													
	October 2010	November 2010	December 2010	January 2011	February 2011	March 2011	April 2011	May 2011	June 2011	July 2011	August 2011	September 2011	Mean	% reduction over control
T ₁	50.14bc	50.16bc	46.82bc	38.50cd	58.33bc	57.93b	67.24a	69.72ab	51.85c	66.67ab	41.95b	45.39bc	53.73bc	31.03
T ₂	44.45cd	44.44cd	41.11cd	40.78c	45.55de	46.89b	61.11ab	65.95ab	46.54bc	52.50bc	36.47bc	41.90cd	47.31cd	39.27
T ₃	40.00d	39.33d	33.33d	32.15d	45.67de	47.62b	51.67b	53.33bc	43.33c	50.00bc	31.66bc	35.95d	42.00de	46.08
T ₄	46.19cd	45.02cd	43.14c	41.00c	46.67cd	53.33b	61.67ab	52.38bc	52.22bc	53.33bc	20.83d	21.67g	44.79cde	42.50
T ₅	43.49cd	41.16cd	46.67bc	44.53bc	48.89cd	49.05b	60.47ab	60.31abc	49.00bc	45.83c	24.07cd	25.38fg	44.90cde	42.36
T ₆	39.05d	38.05d	40.00cd	33.33d	39.25e	50.79b	49.05b	42.38c	40.47c	38.25c	21.56d	27.31ef	38.29e	50.85
T ₇	73.89a	78.33a	80.24a	73.60a	90.00a	95.24a	86.03a	87.81a	70.55a	73.67a	65.20a	60.23a	77.90a	
CV (%)	10.59	12.74	9.20	11.40	9.97	13.45	10.78	12.60	13.35	11.40	9.21	10.03	7.83	

Data represent the mean values of 3 replications; each replication was derived from 15 plants per treatments; in a column figures having similar letter(s) do not differ statistically at 5% level of significance by DMRT

T₁ = Soil drenching with BAU-Biofungicide (2 %)

T₂ = BAU-Biofungicide as foliar spray (2 %)

T₃ = Soil drenching with BAU-Biofungicide (2%) plus foliar spray (2 %)

T₄ = Bavistin spray (0.2 %)

T₅ = Dithane M- 45 spray (0.2%)

T₆ = Soil drenching with BAU-Biofungicide (2 %) plus Bavistin spray (0.2%)

T₇ = Control (Untreated)

In 2011-2012, the highest severity (9.16-47.84 %) was found in October, 2011 and it was decreased in the following months up to September, 2012 and remained almost static from June, 2012 to September, 2012 (Table 6). In June, 2012 the severity was the lowest than in the previous months. In case of untreated control, disease severity increased gradually from October, 2011 and the highest severity (54.20 %) was observed in January, 2012 and then it decreased up to 49.78 % in the month of September, 2012. The highest leaf spot severity (50.59 %) was observed in untreated control and the lowest severity (5.69 %) was observed in BAU-Biofungicide was applied in soil and Bavistin as foliar spray that resulted the highest reduction by 55.23 % of disease severity over control. The lowest reduction (33.10) of disease severity over control was observed when BAU-Biofungicide applied in soil @ 2%.

Table 4. Effect of different management practices on the incidence of leaf spot disease of coconut seedlings during the growing period of October 2011 to September 2012

Treatments	% disease incidence													
	October 2011	November 2011	December 2011	January 2012	February 2012	March 2012	April 2012	May 2012	June 2012	July 2012	August 2012	September 2012	Mean	% reduction over control
T ₁	43.91bc	44.52bc	40.28b	40.28bc	53.31cd	55.55c	53.17bc	40.73cd	46.50bc	44.11b	38.89b	29.52bc	44.23bc	38.35
T ₂	38.72c	42.06c	41.74b	36.50c	43.53de	49.05cd	45.40cd	33.68e	29.52e	30.16c	30.16bc	25.81bc	37.19cd	48.16
T ₃	37.30c	37.30c	34.08bc	33.31c	35.39f	42.06d	34.72d	35.71d	26.22e	26.97c	26.19bc	17.87bc	32.26de	55.03
T ₄	19.44e	20.63d	30.95bc	35.12c	58.72c	56.55c	55.59bc	43.81cd	41.11c	36.50bc	34.92b	31.14b	38.71cd	46.04
T ₅	27.58d	19.05e	35.65bc	37.50c	62.10bc	59.52bc	61.74b	47.01bc	30.95de	37.89bc	37.90b	31.74b	40.80c	43.13
T ₆	27.31d	20.83d	19.91c	22.62d	42.06ef	39.06d	41.11cd	37.06d	29.10e	30.74c	17.49c	16.05c	28.61e	60.12
T ₇	56.41a	56.50a	68.05a	72.22a	90.47a	90.47a	82.22a	79.00a	64.44a	68.89a	68.89a	63.33a	71.74a	
CV (%)	8.43	8.08	8.50	9.56	8.70	6.66	7.35	9.22	7.48	8.95	6.97	8.09	7.03	

Data represent the mean values of 3 replications; each replication was derived from 15 plants per treatments; in a column figures having similar letter(s) do not differ statistically at 5% level of significance by DMRT

T₁ = Soil drenching with BAU-Biofungicide (2 %)

T₂ = BAU-Biofungicide as foliar spray (2 %)

T₃ = Soil drenching with BAU-Biofungicide (2%) plus foliar spray (2 %)

T₄ = Bavistin spray (0.2 %)

T₅ = Dithane M- 45 spray (0.2%)

T₆ = Soil drenching with BAU-Biofungicide (2 %) plus Bavistin spray (0.2%)

T₇ = Control (Untreated)

Table 5. Effect of different management practices on the severity of leaf spot disease of coconut seedlings during the growing period of October 2010 to September 2011

Treatments	% disease severity													
	October 2010	November 2010	December 2010	January 2011	February 2011	March 2011	April 2011	May 2011	June 2011	July 2011	August 2011	September 2011	Mean	% reduction over control
T ₁	35.16c	35.13b	32.65b	30.74b	35.94bc	35.49bc	27.28bc	23.89bc	25.09b	24.90b	26.06b	25.40b	29.81b	33.10
T ₂	31.82c	29.46bc	28.22bc	27.79b	32.11cd	32.02cd	22.95cd	22.64c	15.97de	15.26de	15.82de	14.06cd	24.01cd	46.12
T ₃	31.27c	26.44c	24.09cd	23.33bc	23.46e	25.69e	20.59de	21.54c	15.18e	13.08e	12.42f	8.21f	20.44d	54.13
T ₄	35.78c	31.33bc	24.48cd	23.71bc	27.66de	27.04de	25.17cd	22.36c	17.15de	13.64e	12.21f	9.41f	22.50d	49.51
T ₅	35.90c	28.14c	16.57d	21.94bc	28.89d	28.14d	25.80c	23.66c	19.06cd	18.06cd	17.55cd	13.42d	23.09d	48.18
T ₆	36.64bc	29.70bc	19.88cd	18.77c	23.16e	23.51e	18.92e	16.98d	15.99de	12.95e	13.10ef	9.55ef	19.93d	55.27
T ₇	45.96a	45.97a	46.90a	47.70a	47.84a	48.08a	43.69a	42.33a	42.00a	44.95a	47.89a	40.36a	44.56a	
CV (%)	11.18	10.11	7.98	8.41	7.08	7.09	9.28	9.09	9.50	7.76	12.76	8.19	6.67	

Data represent the mean values of 3 replications; each replication was derived from 15 plants per treatments; in a column figures having similar letter(s) do not differ statistically at 5% level of significance by DMRT

T₁ = Soil drenching with BAU-Biofungicide (2 %)

T₂ = BAU-Biofungicide as foliar spray (2 %)

T₃ = Soil drenching with BAU-Biofungicide (2%) plus foliar spray (2 %)

T₄ = Bavistin spray (0.2 %)

T₅ = Dithane M- 45 spray (0.2%)

T₆ = Soil drenching with BAU-Biofungicide (2 %) plus Bavistin spray (0.2%)

T₇ = Control (Untreated)

Table 6. Effect of different management practices on the severity of leaf spot disease of coconut seedlings during the growing period of October 2011 to September 2012

Treatments	% disease severity													
	October 2011	November 2011	December 2011	January 2012	February 2012	March 2012	April 2012	May 2012	June 2012	July 2012	August 2012	September 2012	Mean	% reduction over control
T ₁	28.56b	27.60b	16.10b	15.92b	14.77b	14.30b	13.50b	14.15b	11.40b	11.24b	11.99b	11.82b	15.95b	68.47
T ₂	16.08c	13.90c	10.18c	8.48de	6.44ef	6.44ef	6.71d	5.10d	3.24e	3.31e	3.66de	3.60de	7.26d	85.65
T ₃	12.55de	13.75cd	6.47e	5.33g	6.30ef	6.26ef	3.59e	2.63e	2.22f	2.26f	3.41e	3.53e	5.69e	88.75
T ₄	11.75ef	12.37de	9.91c	6.72ef	7.66de	7.49de	7.07cd	6.57cd	5.66cd	5.35cd	4.34d	4.19d	7.42d	85.33
T ₅	12.36e	12.50d	10.78c	9.03cd	8.83c	8.83c	6.93d	6.60cd	5.64cd	5.31cd	4.65cd	4.68cd	8.01c	84.17
T ₆	9.16f	10.66e	7.69de	6.24fg	6.11f	6.89e	6.05d	6.05d	4.68d	4.65d	3.28e	3.13e	6.22de	87.71
T ₇	47.84a	44.85a	44.75a	54.20a	52.47a	53.42a	53.36a	51.37a	51.76a	52.61a	50.66a	49.78a	50.59a	
CV (%)	10.18	8.06	6.79	9.62	7.15	7.88	6.94	9.88	11.05	9.78	11.89	7.91	7.11	

Data represent the mean values of 3 replications; each replication was derived from 15 plants per treatments; in a column figures having similar letter(s) do not differ statistically at 5% level of significance by DMRT

T₁ = Soil drenching with BAU-Biofungicide (2 %)

T₂ = BAU-Biofungicide as foliar spray (2 %)

T₃ = Soil drenching with BAU-Biofungicide (2%) plus foliar spray (2 %)

T₄ = Bavistin spray (0.2 %)

T₅ = Dithane M- 45 spray (0.2%)

T₆ = Soil drenching with BAU-Biofungicide (2 %) plus Bavistin spray (0.2%)

T₇ = Control (Untreated)

Application of treatments resulted gradual decrease of incidence in the months of August, 2011 to September, 2012. This might be due to growth and flashes of new leaves which were not attacked by the pathogen. Coconut main growth flushes appeared once in a year from July to September. The fluctuation of disease incidence might be due to environmental factors which have been supported by Chowdhury (2009). The highest reduction of disease incidence by 60.12 % was observed when BAU-Biofungicide was applied in soil @ 2% and Bavistin as foliar spray @ 0.2% over control. The lowest severity of the disease was observed in September 2011 and it became almost static in October 2011 to November 2011 and then it was gradually decreased in the following months up to September 2012. This might be due to use of eco-friendly management treatments in a regular interval. Results of the present investigation reveal that BAU-Biofungicide was effective for controlling leaf spot of coconut. Among the

chemicals Bavistin (0.2 %) as foliar spray was also found good when incorporated with BAU-Biofungicide as soil drench for controlling coconut disease. Similar findings have also been supported by Chowdhury (2009), Hossain (2011), Akter *et al.* (2011) and Hossain *et al.* (2011). From the study it may be concluded that leaf spot disease of coconut was influenced by weather factors. Out of the control measures employed, BAU-Biofungicide was found superior for controlling the diseases of coconut. BAU-Biofungicide (2 %) either alone or in combination with Bavistin (0.2%) was found as an excellent biocontrol means for controlling leaf spot disease of coconut.

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