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## PREVALENCE AND MANAGEMENT OF SOME MAJOR DISEASES OF MANGO AT DINAJPUR DISTRICT IN BANGLADESH

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### ABSTRACT

Islam MM, Hassan SME, Hossain SMM, Hasan MM, Islam NB (2016) Prevalence and management of some major diseases of mango at Dinajpur district in Bangladesh. *Int. J. Expt. Agric.* 6(2), 1-11.

The experiment was conducted at five different orchards of Dinajpur district in Bangladesh. Seven different diseases viz. anthracnose, die-back, powdery mildew, sooty mold, red rust, bacterial leaf blight and bacterial leaf spot were recorded. Among the diseases, anthracnose (18.54%), sooty mold (22.08%), bacterial leaf blight (21.04%) and bacterial leaf spot (11.50%) were most prevalent with high severity in Dinajpur district. Efficacy of fungicides and fungicide with insecticides viz. Indofil M-45 and Indofil M-45 with Confidor 70 WG respectively, were evaluated and found that Indofil M-45 with Confidor 70 WG were the best in controlling anthracnose, die-back, sooty mold, red rust and bacterial leaf spot. Indofil M-45 was also found effective in controlling anthracnose, die-back, powdery mildew, red rust and bacterial leaf spot disease.

**Key words:** mango, location, disease severity, chemical control

### INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important, popular nutritious fruits grown in the tropical and subtropical countries of the world as well as in Bangladesh. The quality mangoes are produced in the north-western areas especially greater Rajshahi, Dinajpur and Rangpur (Karim 1985). In Bangladesh, 889176 metric ton of mango was produced in 67842 acre of mango orchard during the period of 2013-14 (BBS 2014). The minimum dietary requirement of fruit day/head is 85 gm, whereas our availability is only 40-55 gm, which is much lower than recommended daily intake. The demand for mango fruit is increasing day by day with the increased population as well as decline in production results in scarcity every year. Disease is a major cause for lower production of mango in Bangladesh (Meah and Khan, 1987). One of the major reasons behind the low yield is diseases caused by fungi, bacteria, nematode, viruses etc. In Bangladesh, 18 mango diseases have been reported. Among these, nine are major and the rest are minor (Tripathi and Dubey, 2004). The diseases of mango are anthracnose, red rust, powdery mildew, malformation, bacterial leaf blight, sooty mold, bacterial leaf spot and die-back considered to be the major ones (Suchana 2008). Dey *et al.* (2007) conducted a survey on fruit diseases of Bangladesh in 13 districts and 102 diseases were recorded in 18 fruit trees. They reported that anthracnose, powdery mildew, sooty mold, malformation and fruit rot complex is common and destructive diseases in Bangladesh. Awasthi *et al.* (2005) found four diseases of mango namely anthracnose (*Colletotrichum gloeosporioides*), leaf blight (*Macrophoma mangiferae*) and red rust (*Cephaleuros* sp.) were in orchard and two diseases namely, vegetative malformation (*Fusarium moniliformae* var. *subglutinans*) and wilt (*Fusarium* sp.) were in the nursery. These diseases are the important problems in the tropics. Although a huge number of farmers are engaged in producing mango but they fail to produce quality fruits due to lack of their knowledge about diseases and their management. For these reasons, an integrated means of controls of mango diseases viz. anthracnose, sooty mold and powdery mildew has been studied (Anonymous 1988). There are several ways to control the diseased mentioned. Among them, chemical measure is the most effective one because of its retention, availability and broad spectrum. Eight fungicides namely Bordeaux mixture, Burgandy mixture, Dithane M-45, Antracol, Tilt 250 EC, Tri-miltox forte, Thiovit and insecticide were used. Among the fungicides tested, anthracnose was controlled by Dithane M-45 effectively on fruits followed by Antracol. In case of sooty mold, Dithane M-45 and Tri-miltox forte were equally effective in controlling the disease. All these selected fungicides against three major diseases of mango namely anthracnose, powdery mildew and sooty mold were evaluated at Mango Research Station, Chapai Nawabganj, Bangladesh (Anonymous 1989).

However, the occurrence and prevalence of mango diseases in different orchards are not yet studied in Dinajpur region but it is urgently needed and necessary to know the status of the disease for taking necessary steps to manage the diseases. For these reasons, mango productions are to be reared up with proper care in the orchards in order to avoid the diseases and to ensure quality mango production and increasing yield. It ensures good plantation and save money, labor and energy of the orchard owner and to save foreign currency. Keeping in view of the above discussion, the present study was undertaken in Dinajpur region to know the status of diseases, effect of diseases of mango and to find out the efficacy of the treatments at some selected mango orchards.

### MATERIALS AND METHODS

The experiment was conducted in five orchards of Dinajpur district in Bangladesh. The orchards selected contained several varieties of mango plants with different ages. Disease of mango on inflorescence and fruits

were not considered for the study as because the mango has alternate bearing habit. Only the infected leaves and twigs were considered by observing their symptoms and signs. Intercultural operations were done by the orchard owner as a regular and routine work. Irrigation of the plants was also done by them as a routine work during the study period. From each orchard, twelve plants were selected randomly for the study which represents four replications in each treatment. Fertilizer and manure application was done as per recommendation of Bangladesh Agricultural Research Council (BARC 2005).

Mango orchard was selected with the help of Upazilla Sub-Assistant Agriculture Officer. Mango orchard of farmer was selected in five different locations of Dinajpur Sadar Upzilla. Detailed of the locations and farmers were as follows:

No. of Orchard	Name of the farmer's	Location/Village	Total plants in the orchard	Plants age (years)	Selected plants (No.)
Orchard 1	Md. JamanUddin	Raipur	90	5-7	12
Orchard 2	Dr. Md. Zonab Ali	Shulibalter	50	8-10	12
Orchard 3	Md. Wajed Ali	Shulibalter	60	5-7	12
Orchard 4	Md. Majid Mia	Shulibalter	85	8-10	12
Orchard 5	Kripanonda Roy	Amoir	55	6-7	12

For management of mango diseases, three different treatments were applied as foliar spray at 30 days interval. The treatments were as follows:  $T_0$  = Control,  $T_1$  = Spraying of Indofil M-45@ 0.2% and  $T_2$  = Spraying of Indofil M-45@ 0.2% and Confidor 70 WG @0.02%. Indofil M-45 solution (0.2%/2g $L^{-1}$ ) and Confidor 70 WG solution (0.02%/0.2g $L^{-1}$ ) were prepared accordingly for the purpose. Required amount of spray solution of Indofil M-45 and Confidor 70 WG were prepared as mentioned above were sprayed on the selected plants. The test chemicals were sprayed twice at 30 days interval. Freshly prepared solution was used as spray solution. Adequate precautions were taken to avoid drifting spray materials from one plant to another. Special attention was taken to complete the coverage of the plants with the spray solution. In control treatment, only fresh water was sprayed at every time of chemical spray. Disease severity was assessed using the following formula of Johnston (2000):

$$\text{Percent disease severity} = \frac{\text{Area of leaf tissue infected by disease}}{\text{Total area of leaf}} \times 100$$

Branches of selected mango plants were carefully observed and symptoms of the diseases were recorded following the description of Pathak (1980), Peterson (1986) and Singh (1998). Observation of disease was done two times. Only the major diseases of mango on leaves and twigs were considered. The dates of collection of data were at the first week of every month after treatment. The time of data collection was determined on the basis of time of pesticide application during the growing season. The Data were recorded on the parameters: Severity of anthracnose, die-back, powdery mildew, sooty mold, red rust, bacterial leaf blight and bacterial leaf spot diseases. Data on Weather and climate were recorded during the experimental period.

Data on different parameters were analyzed through computer software MSTAT-C (Anonymous 1989). Duncan's Multiple Range Test (DMRT) and least significant difference (LSD) test were performed to determine the level of significant differences and to separate the means within the parameter.

## RESULTS

Seven different diseases viz. anthracnose, die-back, powdery mildew, sooty mold, red rust, bacterial leaf blight and bacterial leaf spot were recorded. The symptoms of different diseases as observed in the field were as follows:

Table 1. Symptoms of different diseases observed in the field

Name of diseases	Description of symptoms
Anthracnose	The disease developed on all the tender parts of the plant. It was found serious especially on tender twigs, leaves and tender stems. Symptoms on leaves were small, dark brown spots, which coalesced to form irregular lesions. The centers of old lesions were dried and fallen out.
Die-back	The disease was characterized by drying of twigs and branches followed by complete defoliation, which gives the tree an appearance of scorching by fire. Die-back became evident by discoloration and darkening of the bark. Finally the twig or branch dies, shrivels and falls. In old branches, brown streaking of vascular tissue was found on splitting it longitudinally.
Powdery mildew	The characteristics symptoms found were the white superficial powdery fungal growth on leaves stalk and under surface of young infected leaves. Severe infection of young leaves exhibited distorted growth.

Cont'd	
Sooty mold	The disease in the field is recognized by the presence of a black sooty mold on the leaf surface. In severe cases, the trees turn completely black due to the presence of mold over the entire surface of twigs and leaves.
Red rust	Initially the spots were found circular greenish grey in color and velvety in texture. Later they turned reddish-brown in color with bristle like structures which gave the characteristic red rust appearance.
Bacterial leaf blight	The symptoms of the disease are characterized by a rapid enlargement of necrotic lesions in buds and leaves. Disease symptoms comprise necrosis of vegetative and flower buds and bud failure before bud break. Necrotic lesions in buds occasionally outspread to the leaf petiole through the stem. Generally, a white creamy gum exudes from necrotic lesions on buds, stems, and less frequently on petioles. Lesions on leaves start as interveinal, angular, water-soaked spots (1 to 3 mm in diameter) that coalesced, becoming dark brown to black with distinctive reddish brown margins.
Bacterial leaf spot	Groups of minute, water soaked lesions were appeared towards the tip of the leaf and surface of the leaf which turned brown to black in color, surrounded by chlorotic halo and delimited by leaf veins. Large necrotic patches were also found which is formed by coalescing of several spots.

### Disease severity, efficacy of treatments at one month after pesticide application

Disease severity of anthracnose, die-back, powdery mildew, sooty mold, red rust, bacterial leaf blight and bacterial leaf spot of five mango orchard of Dinajpur were recorded after one month of pesticide application and are presented in Table 2. The severity of anthracnose varied significantly according to the location of the experiment. The highest (18.54%) severity of anthracnose was observed in orchard 1 which was followed by orchard 2, 4 and 3, respectively. On the other hand, the lowest (3.39%) severity of anthracnose was observed in orchard 5. The die-back disease of mango was also varied significantly according to location. The ranges of severity were 0.41% to 7.10%. The highest severity of die-back was found on orchard 1 which was followed by orchard 3, 2 and 4, respectively. On the contrary, the lowest die-back severity was found in orchard 5. The severity of powdery mildew was significantly varied with the location. The highest (7.91%) severity of powdery mildew was observed in orchard 2 which was followed by orchard 3, 1 and 4, respectively. And the lowest (0.47%) severity of powdery mildew was observed in orchard 5. The sooty mold disease severity was significantly varied with the location. The highest (22.08%) severity was found in orchard 2 and 4, respectively followed by orchard 3 and the lowest (3.33%) severity of sooty mold was observed in orchard 5. In case of red rust, severity was also significantly varied with location. The highest (3.06%) severity of red rust was observed in orchard 2 and the lowest (0.01%) was in orchard 4 which was statistically significant with orchard 5. On the contrary, the bacterial leaf blight was found significant variation with different locations. The highest (21.04%) severity was observed in orchard 1 which was statistically similar with orchard 3, 4 and 2, respectively. On the other hand, the lowest (4.58%) severity of bacterial leaf blight was observed in orchard 5. Finally, the bacterial leaf spot severity was observed significantly varied according to location. The highest and the lowest severity ranges of bacterial leaf spot were 11.50% to 4.33%. The highest severity was observed in orchard 3 which was followed by orchard 1, 2 and 4, respectively. The lowest severity was observed in orchard 5.

Table 2. Severity of mango diseases in different locations after one month of pesticide application

Locations	Anthracnose (%)	Die-back (%)	Powdery mildew (%)	Sooty mold (%)	Red rust (%)	Bacterial leaf blight (%)	Bacterial leaf spot (%)
Orchard 1	18.54 a	7.10 a	0.83 c	18.21 b	2.75 b	21.04 a	9.08 bc
Orchard 2	16.92 b	4.31 c	7.91 a	22.08 a	3.06 a	20.17 a	10.08 b
Orchard 3	13.25 d	6.20 b	3.75 b	18.58 b	1.20 c	20.33 a	11.50 a
Orchard 4	14.08 c	1.20 d	0.79 cd	22.08 a	0.01 d	20.25 a	8.75 c
Orchard 5	3.39 e	0.41 e	0.47 d	3.33 c	0.01 d	4.58 b	4.33 d
CV %	7.62	12.12	14.39	8.19	17.66	7.57	14.96

Each value is an average of 4 (four) replications. In a column, values having same letter do not differ significantly at  $P \geq 0.05$  level

Disease severity of anthracnose, die-back, powdery mildew, sooty mold, red rust, bacterial leaf blight and bacterial leaf spot of five mango orchard of Dinajpur in response of treatments were recorded after one month of pesticide application and are presented in Table 3. The effects of treatments were significantly varied in anthracnose diseases. The highest (16.44%) disease severity was recorded in  $T_0$ . The lowest (11.15%) disease severity was observed in  $T_1$ .  $T_2$  was used resulted lower (0.01%) disease severity. In case of die-back disease, the effects of treatments were significantly varied. The highest (4.56%) disease severity was observed in  $T_0$  and the lowest (2.95%) was in  $T_2$ . In case of powdery mildew disease, the treatments effects varied significantly. The severity range was 4.53% to 1.90%. The highest disease severity was observed in  $T_0$  treatment. The lowest

severity was observed on T<sub>2</sub> which was statistically similar with T<sub>0</sub>. In sooty mold disease, the treatments were significantly varied. The highest (21.77%) severity was found in T<sub>0</sub> treatment. The lowest (13.70%) disease severity was observed in T<sub>2</sub>. Red rust disease severity was shown significantly variation in treatment effects. The highest (1.65%) disease severity was observed in T<sub>0</sub>. The lowest disease severity was 1.30% and 1.25% which was statistically similar and found in T<sub>1</sub> and T<sub>2</sub>, respectively. The treatment effect in bacterial leaf blight severity was significantly varied. The highest (19.77%) severity was found in T<sub>0</sub>. The lowest (15.93%) disease severity was statistically similar with the treatment T<sub>1</sub>. In case of bacterial leaf spot, the treatment effect was significantly varied. The maximum (10.80%) disease severity was observed in T<sub>0</sub> and the minimum (0.01%) severity was observed in T<sub>1</sub>.

Table 3. Efficacy of pesticides on disease severity of mango after one month

Treatments	Anthracnose (%)	Die-back (%)	Powdery mildew (%)	Sooty mold (%)	Red rust (%)	Bacterial leaf blight (%)	Bacterial leaf spot (%)
T <sub>0</sub>	16.44 a	4.56 a	4.53 a	21.77 a	1.65 a	19.77 a	10.80 a
T <sub>1</sub>	11.15 c	4.03 b	1.90 c	15.10 b	1.30 b	16.13 b	7.20 c
T <sub>2</sub>	12.13 b	2.95 c	1.82 b	13.70 c	1.25 b	15.93 b	8.25 b
CV%	14.39	8.19	12.12	7.57	7.62	17.66	14.96

Each value is an average of 4 (four) replications. In a column, values having same letter do not differ significantly at  $P \geq 0.05$  level

Disease severity of anthracnose, die-back, powdery mildew, sooty mold, red rust, bacterial leaf blight and bacterial leaf spot of five mango orchard of Dinajpur in response of location and treatment effects were recorded after one month of pesticide application and were presented in Table 4. The severity of anthracnose varied significantly according to the location and treatment of the experiment. The highest (24.75%) severity of anthracnose was recorded in orchard 1 in control and the lowest (1.68%) disease severity was recorded in orchard 5 with T<sub>1</sub> treatment. The lowest (0.01%) die-back disease was observed in orchard 3 with T<sub>2</sub> treatment, in orchard 4 with T<sub>1</sub> treatment and orchard 5 with T<sub>1</sub> and T<sub>2</sub> treatment, respectively and the highest (10.50%) disease severity of die-back was observed in orchard 1 in control which is statistically similar with orchard 3 accompanied by control. The powdery mildew severity significantly varied with the location and treatment effects. The highest (11.25%) severity was found in orchard 3 with T<sub>0</sub> treatment. There lowest (0.01%) disease was observed in orchard 1 with T<sub>1</sub> and T<sub>2</sub> treatment, orchard 3 with T<sub>1</sub> and T<sub>2</sub> treatment, orchard 4 with T<sub>1</sub> and T<sub>2</sub> treatment and in orchard 4 with T<sub>1</sub> and T<sub>2</sub> treatment, respectively. In case of sooty mold, disease severity was significantly varied. The highest (34.00%) severity was recorded in orchard 3 with control (T<sub>0</sub>) treatment. The lowest (3.37%) severity was observed in orchard 5 with T<sub>2</sub> treatment. Red rust disease severity was observed significantly varied with location and treatment. The lowest (0.01%) severity was observed in orchard 3 with T<sub>2</sub> treatment, orchard 4 and 5 with T<sub>1</sub>, T<sub>2</sub> and T<sub>0</sub> treatment, respectively. The highest (4.25%) severity was recorded in orchard 2 with T<sub>0</sub> treatment. The severity of bacterial leaf blight was significantly varied with different location and treatment. The highest (25.25%) severity was recorded in orchard 2 which was statistically similar with orchard 3, 4 and 1 with T<sub>0</sub> treatment and orchard 4 with T<sub>1</sub> treatment, respectively. The lowest (1.62%) severity was observed in orchard 5 with T<sub>1</sub> treatment. Bacterial leaf spot disease severity was significantly varied with location and treatment. The highest (19.00%) severity was recorded in orchard 3 with T<sub>0</sub> treatment. On the other hand, the lowest (3.35%) severity was observed in orchard 5 with T<sub>1</sub> treatment.

Table 4. Effect of pesticides on disease severity of mango after one month of pesticide application in different orchards of Dinajpur

Locations	Treatments	Anthracnose (%)	Die-back (%)	Powdery mildew (%)	Sooty mold (%)	Red rust (%)	Bacterial leaf blight (%)	Bacterial leaf spot (%)
Orchard 1	T <sub>0</sub>	24.75 a	10.50 a	2.50 d	21.63 d	3.57 b	25.00 a	9.00 cd
	T <sub>1</sub>	15.88 d	3.56 f	0.01 f	20.00 de	1.92 f	20.00 b	9.25 cd
	T <sub>2</sub>	15.00de	7.25 c	0.01 f	13.00 g	2.75 c	18.13 b	9.00 cd
Orchard 2	T <sub>0</sub>	20.00 c	6.37 d	10.00 b	26.00 c	4.25 a	25.25 a	12.25 b
	T <sub>1</sub>	16.00 d	1.43 h	9.50 b	21.25 d	2.25 ef	16.00 c	12.00 b
	T <sub>2</sub>	14.75 def	5.12 e	4.25 c	19.00 e	2.68 cd	19.25 b	6.00 ef
Orchard 3	T <sub>0</sub>	13.50 efg	10.25 a	11.25 a	34.00 a	2.35 de	25.25 a	19.00 a
	T <sub>1</sub>	13.00 g	8.37 b	0.01 f	13.50 g	1.25 g	19.50 b	8.00 cde
	T <sub>2</sub>	13.22 fg	0.01 i	0.01 f	8.25 h	0.01 h	16.25 c	7.50 de
Orchard 4	T <sub>0</sub>	22.25 b	2.37 g	2.37 d	31.50 b	0.01 h	25.25 a	10.00 c
	T <sub>1</sub>	7.25 h	0.01 i	0.01 f	18.50 e	0.01 h	23.50 a	8.25 cd
	T <sub>2</sub>	12.75 g	1.25 h	0.01 f	16.25 f	0.01 h	12.00 d	8.00 cde
Orchard 5	T <sub>0</sub>	3.62 i	1.25 h	1.43 e	4.50 i	0.01 h	7.12 e	4.75 fg
	T <sub>1</sub>	1.68 j	0.01 i	0.01 f	2.12 j	0.01 h	1.62 g	3.75 g
	T <sub>2</sub>	4.87 i	0.01 i	0.01 f	3.37 ij	0.01 h	5.00 f	4.50 fg
CV %		14.39	8.19	12.12	7.57	7.62	17.66	14.96

Each value is an average of 4 (four) replications. In a column, values having same letter do not differ significantly at  $P \geq 0.05$  level  
T<sub>0</sub> = Control, T<sub>1</sub> = Spraying of Indofil M-45@ 0.2%, T<sub>2</sub> = Spraying of Indofil M-45@ 0.2% and Confidor 70 WG @0.02%

**Disease severity, efficacy of treatments at two months after pesticide application**

Disease severity of anthracnose, die-back, powdery mildew, sooty mold, red rust, bacterial leaf blight and bacterial leaf spot of five mango orchard of Dinajpur were recorded after two month of pesticide application and are presented in Table 5. The severity of anthracnose varied significantly according to the location of the experiment. The highest (5.16%) severity of anthracnose was observed in orchard 2 which was followed by orchard 1, 3 and 4, respectively. On the other hand, the lowest (1.33%) severity of anthracnose was found in orchard 5. The die-back, powdery mildew, sooty mold, red rust, bacterial leaf blight and bacterial leaf spot were also varied significantly according to the location. The maximum die-back severity (5.33%) was found in orchard 3 and minimum (0.01%) was in orchard 5. The powdery mildew disease severity ranged found 6.00% to 0.75%. The highest severity was observed in orchard 3 and the lowest was in orchard 4 which was statistically similar with orchard 5. The maximum (13.75%) sooty mold disease severity was observed in orchard 2 which was followed by orchard 1, 3 and 5, respectively. The lowest (0.01%) severity was found in orchard 4. In case of red rust, the highest (2.16%) severity was observed in orchard 3 which was statistically similar with orchard 2. In orchard 4 lowest (0.01%) red rust diseases was found. The maximum (2.50%) severity of bacterial leaf blight was found in orchard 2 which was statistically similar with orchard 1. The minimum (1.66%) severity was found in orchard 4 which was statistically similar with orchard 5. On the contrary, the highest (7.00%) severity of bacterial leaf spot was obtained in orchard 4 and the lowest (1.66%) was found in orchard 1, statistically similar with orchard 5.

Table 5. Severity of mango diseases in different orchards at two months after treatment

Locations	Anthracnose (%)	Die-back (%)	Powdery mildew (%)	Sooty mold (%)	Red rust (%)	Bacterial leaf blight (%)	Bacterial leaf spot (%)
Orchard 1	3.58 c	3.08 c	3.16 c	5.16 b	0.25 b	2.16 ab	1.66 d
Orchard 2	5.16 a	3.91 b	4.75 b	13.75 a	2.08 a	2.50 a	5.08 b
Orchard 3	4.33 b	5.33 a	6.00 a	5.41 b	2.16 a	2.10 b	3.58 c
Orchard 4	3.50 c	2.91 c	0.75 d	0.01 d	0.01 c	1.66 c	7.00 a
Orchard 5	1.33 d	2.08 d	0.91 d	1.66 c	0.29 b	1.70 c	1.66 d
CV %	19.87	17.71	16.32	16.19	18.98	21.90	15.43

Each value is an average of 4 (four) replications. In a column, values having same letter do not differ significantly at  $P \geq 0.05$  level

Disease severity of anthracnose, die-back, powdery mildew, sooty mold, red rust, bacterial leaf blight and bacterial leaf spot of five mango orchard of Dinajpur in response of treatments were recorded after two month of pesticide application and are presented in Table 6. The effects of treatments was significantly varied in anthracnose, die-back, powdery mildew, sooty mold, red rust, bacterial leaf blight and bacterial leaf spot diseases. The maximum (4.20%) anthracnose severity was observed in  $T_0$  treatment followed by  $T_1$ . The minimum (2.95%) severity was found in  $T_2$  treatment. The die-back disease severity was observed with higher (3.65%) in control ( $T_0$ ) treatment and which was statistically similar with  $T_1$  and  $T_2$  treatment. In case of powdery mildew disease, the highest (4.20%) severity was obtained in  $T_0$  treatment whereas the lowest (2.20%) severity was found in  $T_1$  treatment. In sooty mold disease, the maximum (6.30%) severity was found in  $T_0$  treatment and the minimum (4.30%) was found in  $T_1$  treatment. The highest (1.07%) red rust disease severity was observed in  $T_0$  treatment and the lowest (0.85%) was obtained in  $T_2$  treatment which was statistically similar with  $T_1$  treatment. In bacterial leaf blight, the maximum (2.65%) severity was observed in  $T_0$  treatment and the minimum (1.32%) in  $T_1$  treatment.  $T_0$  treatment was treated in bacterial leaf spot the maximum (4.70%) severity was exhibited and the minimum (0.01%) was found in  $T_1$  treatment.

Table 6. Efficacy of pesticides on disease severity of mango at two months after treatment

Treatments	Anthracnose (%)	Die-back (%)	Powdery mildew (%)	Sooty mold (%)	Red rust (%)	Bacterial leaf blight (%)	Bacterial leaf spot (%)
$T_0$	4.20 a	3.65 a	4.20 a	6.30 a	1.07 a	2.65 a	4.70 a
$T_1$	3.60 b	3.35 a	2.20 c	4.30 c	0.95 b	1.32 c	3.15 c
$T_2$	2.95 c	3.40 a	2.95 b	5.00 b	0.85 b	2.11 b	3.55 b
CV %	19.87	17.71	16.32	16.19	18.98	21.90	15.43

Each value is an average of 4 (four) replications. In a column, values having same letter do not differ significantly at  $P \geq 0.05$  level

Disease severity of anthracnose, die-back, powdery mildew, sooty mold, red rust, bacterial leaf blight and bacterial leaf spot of five mango orchard of Dinajpur in response of location and treatment effects were recorded after two month of pesticide application and are presented in Table 7. The severity of anthracnose and die-back were varied significantly according to the location and treatment of the experiment. The maximum (5.75%) severity of anthracnose was recorded in orchard 2 which was statistically similar with orchard 4 and 3 with control treatment. The lowest (0.01%) anthracnose disease was found in orchard 5 with  $T_2$  treatment. The

highest (6.00%) severity of die-back was observed in orchard 3 with control treatment and the lowest (0.01%) was found in orchard 4 with T<sub>2</sub> treatment which was statistically similar with orchard 5 with T<sub>1</sub> and T<sub>0</sub> treatment. The powdery mildew severity significantly varied with the location and treatment. The maximum (7.50%) severity was found in orchard 3 with control treatment. The lowest (0.01%) severity was observed in orchard 4 and 5 with T<sub>1</sub> treatment. Sooty mold disease was observed significantly varied with location and treatment. The highest (16.75%) disease severity was recorded in orchard 2 with T<sub>0</sub> treatment. The lowest (0.01%) sooty mold was observed in orchard 4 with T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub> treatment, orchard 5 with T<sub>1</sub> treatment, respectively. In case of red rust, bacterial leaf blight and bacterial leaf spot, disease severity was significantly varied. The maximum (2.75%) red rust disease severity was recorded in orchard 2 with T<sub>0</sub> treatment. The lowest (0.01%) red rust was observed in orchard 1 with T<sub>1</sub> and T<sub>2</sub> treatment, orchard 4 with T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub> treatment and orchard 5 with T<sub>1</sub> and T<sub>2</sub> treatment, respectively. The highest (3.50%) disease severity of bacterial leaf spot was recorded in orchard 2 with T<sub>0</sub> treatment. Bacterial leaf blight lowest (0.01%) was observed in orchard 4 with T<sub>1</sub> treatment. The maximum (8.00%) bacterial leaf spot was recorded in orchard 4 with T<sub>0</sub> treatment and the minimum (1.00%) was found in orchard 1 with T<sub>1</sub> treatment and which was statistically similar in orchard 5 with T<sub>1</sub> and T<sub>2</sub> treatment.

Table 7. Effect of pesticides on disease severity of mango after two months of pesticide application in different orchards of Dinajpur

Locations	Treatments	Anthracnose (%)	Die-back (%)	Powdery mildew (%)	Sooty mold (%)	Red rust (%)	Bacterial leaf blight (%)	Bacterial leaf spot (%)
Orchard 1	T <sub>0</sub>	4.50 bcd	4.25 bc	4.50 d	6.25 de	0.75 f	3.00 ab	2.00 ef
	T <sub>1</sub>	2.75 ef	2.00 gh	2.50 f	4.25 fg	0.01 g	1.50 f	1.00 g
	T <sub>2</sub>	3.50 de	3.00 def	2.50 f	5.00 ef	0.01 g	2.00 def	2.00 ef
Orchard 2	T <sub>0</sub>	5.75 a	4.00 c	6.25 b	16.75 a	2.75 a	3.50 a	7.50 ab
	T <sub>1</sub>	5.50 ab	4.00 c	3.50 e	13.25 b	1.50 e	1.75 ef	4.00 d
	T <sub>2</sub>	4.25 cd	3.75 cd	4.50 d	11.25 c	2.00 cd	2.25 cde	3.75 d
Orchard 3	T <sub>0</sub>	4.75 abc	5.00 b	7.50 a	6.50 d	2.50 ab	2.50 bcd	6.00 c
	T <sub>1</sub>	4.00 cd	5.00 b	5.00cd	4.00 fg	1.75 de	1.75 ef	2.25 ef
	T <sub>2</sub>	4.25 cd	6.00 a	5.50 c	5.75 de	2.25 bc	2.05 cdef	2.50 e
Orchard 4	T <sub>0</sub>	5.00 abc	3.50 cde	1.25 g	0.01 i	0.01 g	2.75 bc	8.00 a
	T <sub>1</sub>	2.75 ef	2.75 efg	0.01 h	0.01 i	0.01 g	0.01 g	7.00 b
	T <sub>2</sub>	2.75 ef	2.50 fgh	1.00 g	0.01 i	0.01 g	2.25 cde	6.00 c
Orchard 5	T <sub>0</sub>	2.25 f	2.25 fgh	1.50 g	3.00 gh	0.87 f	2.00 def	2.00 ef
	T <sub>1</sub>	1.75 f	2.25 fgh	0.01 h	0.01 i	0.01 g	1.62 ef	1.50 fg
	T <sub>2</sub>	0.01 g	1.75 h	1.25 g	2.00 h	0.01 g	1.50 f	1.50 fg
CV %		19.87	17.71	16.32	16.19	18.98	21.90	15.43

Each value is an average of 4 (four) replications. In a column, values having same letter do not differ significantly at  $P \geq 0.05$  level

T<sub>0</sub> = Control, T<sub>1</sub> = Spraying of Indofil M-45@ 0.2%, T<sub>2</sub> = Spraying of Indofil M-45@ 0.2% and Confidor 70 WG @0.02%

## DISCUSSION

Four fungal diseases namely anthracnose, die-back, powdery mildew, and sooty mold; two bacterial diseases namely bacterial leaf blight and bacterial leaf spot; one algal disease called red rust were identified as major disease throughout the year. The finding of this study is strongly supported by Singh (1968), Suit and Ducharme (1946), Pathak (1980), Mortuza (1990), Awasthi *et al.* (2005), Dey *et al.* (2007), Haggag (2010), Sen *et al.* (2010) and Khan *et al.* (2015). All these diseases of mango were recorded in different orchards of Dinajpur district in Bangladesh. All the diseases significantly varied according to different orchards. The variation of diseases may be occur due to different cultural operations such as fertilizer application, irrigation, weeding etc. done by orchard owner (farmers) or may be due to soil texture, soil structure, planting density and canopy density that may affect the internal microclimate of orchard. Such study was also done by many scientists, viz. Diedhiou *et al.* (2007), Simmons *et al.* (1998) and Nafees *et al.* (2013). Anthracnose observed on leaves, twigs and young's branch and numerous oval irregular brown spots of different sizes were found on leaves and sometimes coalesce to cover larger area of the leaf. This is supported by Awasthi *et al.* (2005), Sundravadana *et al.* (2006), Onyeani *et al.* (2012), and Guettia *et al.* (2014). The highest (18.54%) anthracnose severity was found in orchard 1. The minimum (0.01%) severity was observed in orchard 3. This study is strongly supported by Khan *et al.* (2015) and Onyeani *et al.* (2012). The highest (16.44%) severity of anthracnose was found in T<sub>0</sub> treatment after 1<sup>st</sup> spray of pesticide application. The lowest (2.95%) severity was found after 2<sup>nd</sup> spray of T<sub>2</sub> treatment. Such types of management were done by Chowdhury (2009), Mathews *et al.* (2009), Hossain (2007), Sundravadana *et al.* (2006).

Die-back is drying of twigs and branches followed by complete defoliation, it gives the tree an appearance of scorching by fire. The die-back disease of mango symptoms has also been observed by Mortuza (1990), Ahmed *et al.* (1995) and Haggag (2010). The disease severity was highly influenced by temperature, relative humidity and rain fall. This observation was supported by Chowdhury (2009) and Akhter *et al.* (1998). The maximum (7.10%) severity has been observed in orchard 1 and the minimum (0.41%) was observed in orchard 5 after 1<sup>st</sup> spray. The highest (4.56%) severity has been observed in T<sub>0</sub> treatment whereas minimum (2.95%) disease was observed in T<sub>2</sub> treatment, respectively. Ahmed *et al.* (1995) evaluated various fungicides against die-back disease in mango caused by *Botryodiplodia theobromae*. This observation was also supported by Mortuza (1990) and Nizamani *et al.* (2005).

The powdery mildew of mango was observed in the form of whitish or grayish powdery areas on leaves and severe infection of young leaves exhibited distorted growth and finally premature leaf drop. The findings of powdery mildew of mango of the present study are in accordance with the findings of Singh (1968), Pathak (1980) and Nasir *et al.* (2014). The sooty mold disease in the field is recognized by the presence of a black sooty mold on the leaf surface. In severe cases, the trees turn completely black due to the presence of mold over the entire surface of twigs and leaves. These symptoms were found and supported by Anonymous (1990), Mortuza (1990) and Dey *et al.* (2007). The highest (22.08%) severity was recorded at orchard 2 and the lowest (4.30%) was observed in T<sub>1</sub> treatment after 2<sup>nd</sup> spray. This study is supported by Mortuza (1990). Red rust severely infects in mango plants and it creates red rusty, circular spots mainly on leaves. Reddish brown and bearded hair like structure was also appearing on leaves. Similar symptoms were found by Suit and Ducharme (1946), Singh (1968), Pathak (1980), Mortuza (1990) and Kumar and Gupta (2015). Mortuza (1990) reported that red rust as a new disease of mango in Chapai Nawbganj and Rajshahi districts. The maximum (3.06%) red rust severity has been observed at orchard 2 and the minimum (0.85%) disease was observed in T<sub>2</sub> treatment after 2<sup>nd</sup> spray. This is supported by some researchers' like Kumar and Gupta (2015), Hossain (2011), Chowdhury (2009), Awasthi *et al.* (2005), Gupta (1990) and Prakash and Singh (1980). The symptoms of bacterial leaf blight disease are characterized by a rapid enlargement of necrotic lesions in buds and leaves. Generally, a white creamy gum exudes from necrotic lesions on buds, stems, and less frequently on petioles. Lesions on leaves start as interveinal, angular, water-soaked spots (1 to 3mm in diameter) that coalesced, becoming dark brown to black with distinctive reddish brown margins. These symptoms were supported by Islam *et al.* (2013). The highest (21.04%) severity has been observed in orchard 1. The lowest (1.32%) was recorded in T<sub>1</sub> treatment after 2<sup>nd</sup> spray. This is supported by Visser (1995), Awasthi *et al.* (2005) and Islam *et al.* (2013). Bacterial leaf spot is one of the most infectious diseases in mango plants. It was observed on leaves, petioles and tender twigs and formed groups of minute water soaked lesions on the surface of the leaf and it turned brown to black in color. The similar symptoms of bacterial leaf spot of mango have been reported by Singh (1968), Pathak (1980), and Ko *et al.* (2007). The highest (11.50%) severity was found in orchard 3 and the lowest (3.15%) was found in T<sub>1</sub> treatment after 2<sup>nd</sup> spray. This study was supported by Ko *et al.* (2007), Willis and Mabunda (2004) and Visser (1995).

For the management of these seven diseases, Indofil M-45 with Confidor 70 WG (T<sub>2</sub>) treatment showed the best result at Dinajpur district in Bangladesh.

## CONCLUSION

Indofil M-45 was found good in controlling die-back, powdery mildew, red rust and bacterial leaf blight. Indofil M-45 together with Confidor 70 WG was found more effective in controlling anthracnose, die-back, sooty mold, red rust and bacterial leaf spot. The growers may be suggested to manage the diseases by spraying Indofil M-45 with Confidor 70 WG.

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