J. Soils and Crops 28 (2) 265-272, December 2018

ISSN 0971-2836
NAAS Rating - 4.46
Scientific Journal Impact Factor - 4.338

SPECIES DIVERSITY, INFESTATION INTENSITY AND MANAGEMENT OF MANGO FRUIT WEEVIL IN THE HILLY AREAS OF BANGLADESH

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ABSTRACT

The present study was conducted at the farmer's orchard in Bandarban, Rangamati and Khagrachari districts, during the period from January to July, 2017 to study the species diversity, infestation intensity and management of mango fruit weevil. The treatments of the experiment were T_1 = Improved pest management practices (5 times spraying of Ripcord 10EC @ 1.0 ml l^{-1} water on 30 January, 28 February, 30 March, 28 April, 30 May along with cultural practices), T_2 = Farmer's practice (2 times spraying of Ripcord 10EC @ 1.0 ml l^{-1} water from January to May) and T_3 = Untreated control. The experiment was laid out in a Randomized Complete Block Design (RCBD) with ten replications. Among weevil species only *Sternochetus frigidus* was found at three hill districts. The lowest number of fruit infestation (19.62% at Bandarban, 19.73% at Rangamati and 19.22% at Khagrachari districts) was recorded from improved management practice of the plant. On the other hand the highest number of fruit infestation (81.46% at Bandarban, 80.40% at Rangamati and 80.19% at Khagrachari districts) was recorded from untreated control. Improved management practice decreased more than 70.00% infested fruits over control (75.91% at Bandarban, 75.44% at Rangamati and 76.02% at Khagrachari districts). Among three treatments improved management practice was the most effective against mango fruit weevil.

(Key words:Mango Fruit Weevil, Species Diversity, Infestation Intensity, Management)

INTRODUCTION

Mango (*Mangifera indica* Linn.) is the most popular fruit in the oriental region. It has great economic importance in the tropical and subtropical region (Atwal and Dhaliwal, 2007). It is regarded as the King of the fruits of the world (Mollah and Siddique, 1973). It is considered to be the choicest of all indigenous fruit and one of the important fruits in Bangladesh. In area, production, nutritive value and popularity of appeal, no other fruit can compete with it. Mango is now the most important fruit item by tonnage production and widely cultivated in all the districts of Bangladesh. Mango contributes 0.945 million MT from local production. The fruit has really of immense value in respect of money and prosperity. Bangladesh is one of the major mango producing countries along with India, Pakistan, Mexico, Brazil, the Philippines, etc. (Alexander, 1989). In Bangladesh, mango occupies about an area of 61,997 ha with a production of 1018112 metric tons during 2014-15 (Anonymous, 2015).In nutritional aspects, both ripe and unripe mango is rich in several vitamins as well as minerals (Paramanik, 1995). Besides, mango contains appreciable quantity of iron, vit-C, carotene and soluble sugar. Moreover, it provides a lot of energy (as much as 74 kcal 100 g^{-1} edible portion) which is nearly equals the energy values of boiled rice of similar quantity by weight (Hossain, 1989). Over 175 species of insects have been reported damaging mango trees (Fletcher, 1970; Nayar *et al.,*1976). Out of these the *Sternochetus frigidus* (Fabr.) is one of the serious and specific pest of mango. *Sternochetus frigidus* is spread mainly by infested fruits because the weevil develops within the mango pulp (Griesbach 2003). Lefroy (1906) was the first to report *Sternochetus frigidus*as a pest of mango in Bangladesh and at present the pest is quite serious in south eastern part of Bangladesh. The mango fruit weevil is considered a major pest as it causes significant damage to the mango fruit contaminating the edible portion. Proper management of the mango fruit weevil is a prerequisite to meet the quality demanded in the competitive export market (Braimah *et al.,* 2010). The use of synthetic insecticides to manage insect pests has arguably been the mainstay of fruit crop production. However, the increasing demand for organically grown foods in the face of environmental and health concerns has downplayed reliance on synthetic pesticides to manage pests and the identification of eco-

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friendly and reliable alternatives would be an incentive to minimize reliance on synthetic insecticide use. Effective management of mango weevil using indigenous technical knowledge at the farm level will serve as an incentive to increase mango production for the local market and export (Anonymous, 2011).A fragmentary work has been done on biology and control of this pest by different workers like Subramanyam (1925), Balock and Kozuma (1964)in different parts of the world but in Bangladesh research work on mango fruit weevil is scanty. Thus, the research work on Pest Management Analysis of mango fruit weevil in hilly areas of Bangladesh is required to be under taken aiming to identify pests concern for the mango cultivation and evaluate their risk as well as to identify suitable management options.

Keeping such necessity in mind, present work was done mostly to study the species diversity of mango fruit weevil in Bandarban, Rangamati and Khagrachari districts as well as to determine the infestation, intensity by mango fruit weevil at hilly areas in Banglades and to evaluate the performance of management approaches against mango fruit weevil in farmers field.

MATERIALS AND METHODS

Experimental site

Experiment was conducted at the farmer's orchard in Bandarban, Rangamati and Khagrachari districts during the period from January to July 2017. The experiment was conducted at the farmer's orchard of three hill districts of Bangladesh. Experimental sites were selected at orchards of three farmers named SingpatMro, Hemokumar Chakma and Bayes Miaat at Bandarban, Rangamati and Khagrachar districts respectively. These three districts belong to the Chittagong Hill tracts under the Agro Ecological Zone (AEZ) 29 (Northern and Eastern hills). The experimental sites are located at high hill.The climate of the experimental site is sub-tropical characterized by heavy rainfall during April to September and sporadic during the rest of the year.

Variety of the mango

Mango variety, Amrapali or BARI Mango 3, was the cultivated variety for the experiment. Each of the orchards contained at least 30 mango trees which were considered an experimental unit.

Treatments

Three treatments were used in this study, which were same at Bandarban, Rangamati and Khagrachari districts. Details of treatments used in this study are shown in Table 1.

Table 1. Treatments for the management of mango weevil and their application time

Treatments	Description
T_1	Improved pest management practices (5 times spraying of Ripcord 10EC @ 1.0 ml l^{-1} water on 30 January, 28 February, 30 March, 28 April, 30 May along with cultural practices like clean cultivation through the removal of fallen mango fruits, leaves, weeds and parasitic plants, light pruning of the dead branches of previous year, avoidance of naturally grown forest plants with minimum economic value etc.)
T_2	Farmer's practice (2 times spraying of Ripcord 10EC @ 1.0 ml l^{-1} water from January to May)
T_3	Untreated control

Design and layout of the experiment

The experiment was laid out in a Randomized Complete Block Design (RCBD) with ten replications. Each mango tree was considered one experimental unit. Thus 10 mango trees were selected for 10 replications and a total of 30 mango trees were considered for this experiment in each district. Same treatments were used for each of three hill districts.

Intercultural operations and manure-fertilizer application

The experimental orchards were prepared by removing bushes and weeds followed by cleaning and weeding during December to January, 2017. Then, necessary weeding and other intercultural operations were done as per necessity. Age of all the mango trees using as a block in this experiment were within 4 (Four) to 10 (Ten) years. So, manures and fertilizers with their doses and their methods of application followed in the study have been recommended in Hand Book on Agro-technology by BARI (Mondal *et al.,* 2014).

Treatment application

For chemical insecticide spray, 10.0 ml of Ripcord 10EC was mixed with 10.0 liters water to make the spray solution. Spray mixture was applied with the help of foot pump sprayer for each treatment and Fungicide Tilt 250EC @ 0.5 ml l^{-1} was applied with each insecticidal spray as cover spray for the management of fungal disease. No control measure was applied in untreated control trees.

Harvesting

Harvesting of mango fruit was done during 20th June to 20th July, 2016. That time period was suitable for harvesting because the mangoes were matured and ready to sell in the local market. It was taken three to four days, to harvest all of the mangoes in a plot. Mangoes were harvested according to the treatments though each tree was treated as a treatment. After harvesting of one treatment, harvesting of another treatment was started. During the time of harvesting, mangoes were counted and mangoes were

looked and tested thoroughly as it was infested or not. Then the mangoes were kept in a specific site.

Data collection

After harvest healthy and infested fruits tree^{-1} were sorted out visually and recorded separately for each treated and untreated tree in each district. Total number of fruits tree^{-1} was calculated by addition of healthy and infested fruits tree^{-1}.

Per cent total fruit infestation

Per cent total fruit infestation for each tree was calculated by using the following formula

$$\text{Total fruit infestation (\%)} = \frac{\text{No. of infested fruits tree}^{-1}}{\text{Total no. of fruits tree}^{-1}} \times 100$$

Fruit infestation by fruit weevil

Twenty fruits were selected randomly from each tree and dissected longitudinally by knives. Number of healthy fruits and weevil infested fruits out of 20 fruits from each tree were recorded separately. Per cent fruit infestation by fruit fly and fruit weevil was calculated separately for each treatment in each district:

$$\text{Fruit infestation by weevil (\%)} = \frac{\text{No. of fruit weevil infested fruits}}{20} \times 100$$

Per cent increase of healthy fruits tree^{-1}

The per cent increase of healthy fruits tree^{-1} in treated tree over untreated control tree was computed by using the following formula:

$$\text{Increase of healthy fruits tree}^{-1}\text{ over control (\%)} = \frac{\text{healthy fruits in treatments-healthy fruits in control}}{\text{healthy fruits in control}} \times 100$$

Per cent decrease of infested fruits tree^{-1}

The per cent decrease of infested fruits tree^{-1} in treated tree over untreated control tree was computed by using the following formula:

$$\text{Decrease of infested fruits over control (\%)} = \frac{\text{infested fruits in control-infested fruits in treatments}}{\text{infested fruits in control}} \times 100$$

Per cent decrease of fruit infestation

$$= \frac{\text{fruit infestation in control - fruit infestation in treatment}}{\text{fruit infestation in control}} \times 100$$

Statistical analysis of data

The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package MSTAT program (Gomez and Gomez, 1976). The treatment means were separated by Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

The experiment was conducted at farmer's orchard at Cramadipara in Bandarban, Shukarchari in Rangamati and Borobil in Khagrachari districts during January to July 2017 to study diversity, damage assessment and management of mango fruit weevil. The results of the present study have been presented and discussed under the following sub-headings:

Species diversity of mango weevil

The result indicates that only pulp weevil, *S. frigidus* species was recorded at hilly areas of Bangaladesh (Figure 1) and no stone weevil *S. mangiferae* was recorded in those areas. Alam (1962) reported both species of mango fruit in Bangladesh with no detail information.

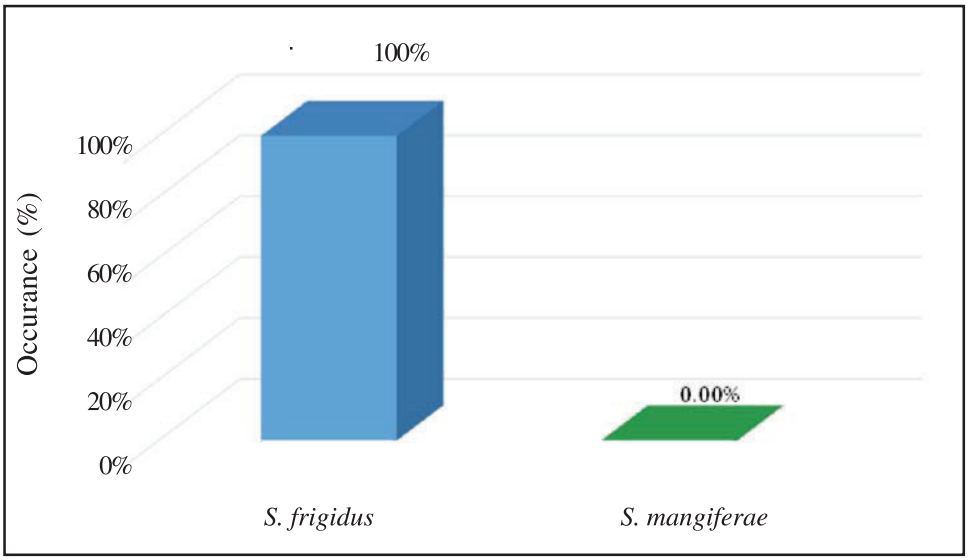

Figure 1. Weevil species attacking mango at Bandarban, Rangamati and Khagrachari Infestation intensity of mango fruit weevil at hilly areas in Bangladesh

Mango fruit weevil *S. frigidus* caused huge infestation of mango fruits at Bandarban, Rangamati and Khagrachari districts in 2017 (Figure 2). The figure demonstrated that the highest fruit infestation (81.46%) was recorded at Bandarban followed by 80.40% in Rangamati and 80.19% in Khagrachari districts. Results on infestation level of mango fruit weevil at three hill districts agree with the findings of other researchers. Alam (1962) reported both species of mango weevil *S. frigidus* and *S. mangiferae* in south eastern part of Bangladesh with no detail information.

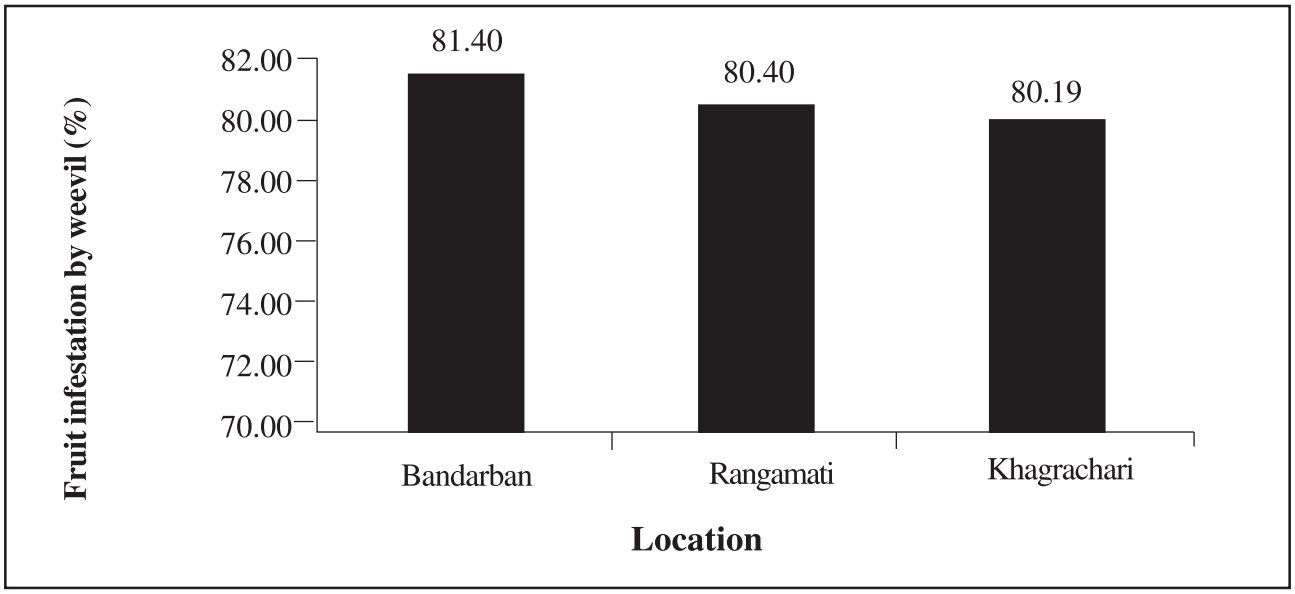

Figure 2. Per cent fruit infestation by *S. frigidus* at experimental field in the hilly areas

Effect of management practices on mango fruit production and

Effect of different treatments on production of mango fruits

Total number of mango fruits tree^{-1} varied significantly in different treatments at Bandarban, Rangamati and Khagrachari districts. Data in table 2 indicate that the highest number of total fruits tree $^{-1}$(458.90 tree^{-1}) was recorded from T_1 treatments at Cramadipara (Bandarban) having significant difference with T_2 (405.60) and T_3 (370.00) treatments. In contrast the lowest number of total fruits tree $^{-1}$(370.00) was observed in T_3 (control) which was significantly different from other treatments. Similar trend of total number of mango production was found at Shukurchari (Rangamati) and Borobil (Khagrachari) for all treatments.

Table 2. Number of total fruits tree^{-1} under different treatments at Bandarban, Rangamati and Khagrachari districts in 2017

Treatments	Total no. of fruits plant^{-1}		
	Bandarban	Rangamati	Khagrachari
T_1	458.90 ± 18.06 a	254.90 ± 10.10 a	370.20 ± 16.42 a
T_2	405.60 ± 13.49 b	219.40 ± 8.37 b	311.70 ± 10.68 b
T_3	370.00 ± 13.92 c	208.30 ± 7.36 c	257.20 ± 9.55 c
CV (%)	3.72	4.38	3.36
$S_{\bar{x}}$	4.84	3.15	3.33

In a column, means having same letter(s) are statistically similar at 5% level of significance by DMRT

Effect of different treatments on healthy mango fruits production

Significant variation was observed for total number of mango fruits tree^{-1} at three hill districts. Data (Table 3) indicate that the highest number of healthy fruits tree^{-1} (368.90) was recorded from T_1 treatments at Cramadipara (Bandarban) having significant variation with all other treatments. On the other hand, the lowest number of healthy fruits tree^{-1} (68.70) was observed in T_3 (control) which was significantly lower than other treatments. This result may be explained by the findings of Schoeman (1987), who reported that the weevils flew from tree to tree during March to April fed on leaves and deposited eggs at dusk.

Table 3. Number of healthy mango fruits tree $^{-1}$at Bandarban, Rangamati and Khagrachari in 2017

Treatments	Total no. of healthy fruits tree^{-1}		
	Bandarban	Rangamati	Khagrachari
T_1	368.90 ± 15.49 a	204.70 ± 11.09 a	299.10 ± 14.92 a
T_2	237.50 ± 10.19 b	131.70 ± 6.41 b	183.40 ± 8.17 b
T_3	68.70 ± 8.34 c	40.80 ± 5.01 c	51.00 ± 5.39 a
CV (%)	5.32	6.87	4.74
$S_{\bar{x}}$	3.79	2.73	2.67

In a column, means having same letter(s) are statistically similar at 5% level of significance by DMRT

Improved management practice increased more than 80.00% healthy fruits tree^{-1}over control at Bandarban, Rangamati and Khagrachari districts and T_3 (Untreated control) showed the lowest number healthy fruits tree^{-1} over control at Bandarban, Rangamati and Khagrachari respectively (Figure 3).

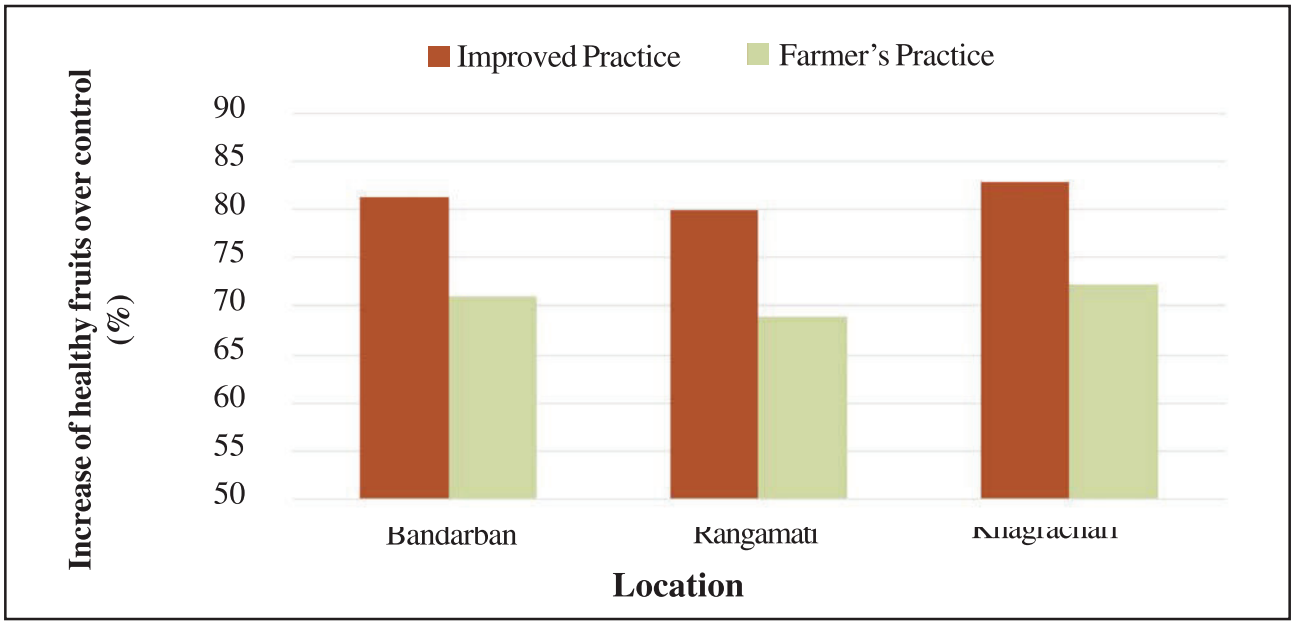

Figure 3. Per cent increase of healthy fruits over untreated control at Bandarban, Rangamati and Khagrachari districts

Effect of different treatments on mango fruits infestation

The lowest number of infested fruits tree^{-1} (34.40 fruits tree $^{-1}$at Bandarban, 21.30 fruits tree^{-1} at Rangamati and 30.80 fruits tree^{-1} at Khagrachari districts) was recorded from improved management practiced plant followed by farmer's practice (90.00 fruits tree^{-1} at Bandarban, 50.20 fruits tree^{-1} at Rangamati and 71.10 fruits tree^{-1} at Khagrachari districts) having significant difference between them(Table 4). On the other hand the highest number of infested fruits tree^{-1} (301.30 at Bandarban, 167.50 fruits tree^{-1} at Rangamati and 206.20 fruits tree^{-1} at Khagrachari districts) was recorded from untreated control which was significantly higher than all other treatments.

Table 4. Number of infested fruits tree^{-1} at Bandarban, Rangamati and Khagrachari in 2017

Treatments	No. of infested fruits tree^{-1}		
	Bandarban	Rangamati	Khagrachari
T_1	90.00 ± 3.56 c	50.20 ± 2.35 c	71.10 ± 3.78 c
T_2	168.10 ± 5.32 b	87.70 ± 4.27 b	128.30 ± 5.69 b
T_3	301.30 ± 10.36 a	167.50 ± 8.24 a	206.20 ± 7.28 a
CV (%)	3.84	4.95	4.09
$S_{\bar{x}}$	2.26	1.59	1.75

In a column, means having same letter(s) are statistically similar at 5% level of significance by DMRT

Improved management practice decreased more than 60.00% infested fruits over control (70.09% at Bandarban, 69.99% at Rangamati and 65.46% at Khagrachari districts) and farmer's practice decreased more than 35% infested fruits over control at three hill districts (Figure 4).

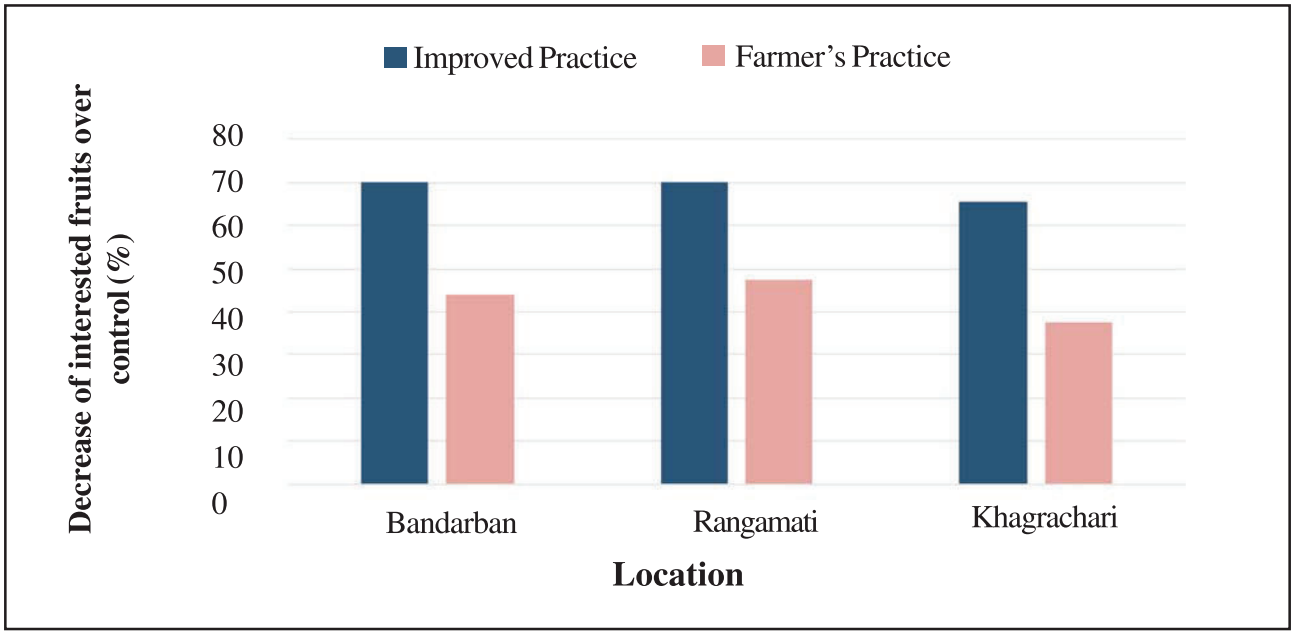

Figure 4. Per cent decrease of infested fruits over untreated control at Bandarban, Rangamati and Khagrachari districts

Effect of different treatments on per cent fruits infestation

The lowest per cent of fruit infestation (19.62% at Bandarban, 19.73% at Rangamati and 19.22% at Khagrachari districts) was recorded from improved management practiced plant followed by farmer's practice (41.46% at Bandarban, 39.98% at Rangamati and 41.17% at Khagrachari districts) having significant difference between them(Table 5). On the other hand, the highest per cent of fruit infestation (81.46% at Bandarban, 80.40% at Rangamati and 80.19% at Khagrachari districts) was recorded from untreated control which was significantly higher than all other treatments.

Table 5. Per cent fruit infestation at Bandarban, Rangamati and Khagrachari in 2017

Treatments	Per cent fruit infestation		
	Bandarban	Rangamati	Khagrachari
T_1	19.62 ± 0.52 c	19.73 ± 1.37 c	19.22 ± 0.98 c
T_2	41.46 ± 0.97 b	39.98 ± 1.48 b	41.17 ± 1.42 b
T_3	81.46 ± 1.81 a	80.40 ± 2.36 a	80.19 ± 1.72 a
CV (%)	2.69	3.47	3.09
$S_{\bar{x}}$	0.40	0.51	0.46

In a column, means having same letter(s) are statistically similar at 5% level of significance by DMRT.

Improved management practice decreased more than 70.00% infested fruits over control (75.91% at Bandarban, 75.44% at Rangamati and 76.02% at Khagrachari districts) and farmer's practice decreased more than 45% infested fruits over control at three hill districts (Figure 5).

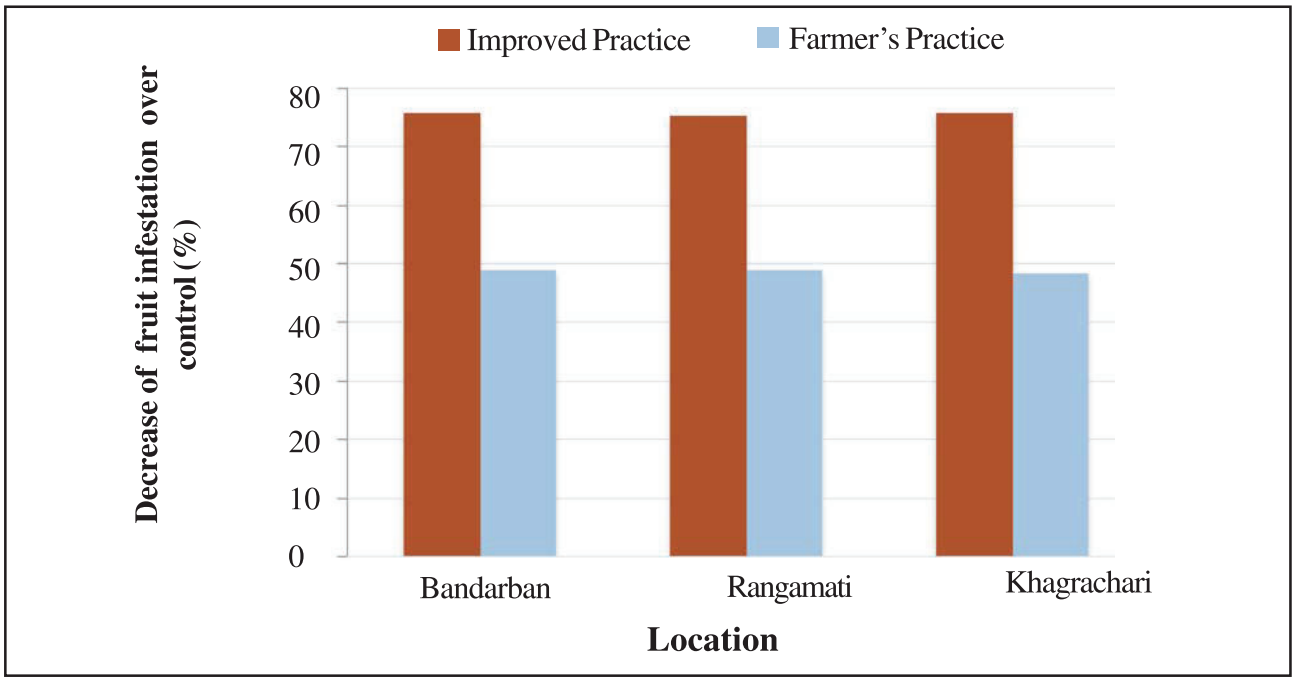

Figure 5. Per cent decrease of fruit infestation over untreated control at Bandarban, Rangamati and Khagrachari districts

Occurrence of mango pulp weevil *S. frigidus*, species at Bandarban, Rangamati and Khagrachari districts was 100% and no seed weevils, *S. mangiferae* was found in this region.Total number of mango fruits tree^{-1}was highest at improved management practices in Bandarban (458.90), Rangamati (254.90) and Khagrachari (370.20) districts respectively. Again, the lowest number of total fruits tree^{-1} was found in untreated control at three hill districts.The highest number of healthy fruits tree^{-1}was found in T_1 treatments at Bandarban, Rangamati and Khagrachari

districts (368.90, 204.70 and 299.10 respectively) and the lowest number of healthy fruits tree $^{-1}$was found in untreated control in three hill districts. Improved management practice increased more than 80.00% healthy fruits tree^{-1}over control at three locations and T_3 (untreated control) showed the lowest number healthy fruits tree^{-1}over control at Bandarban, Rangamati and Khagrachari respectively. The lowest number of infested fruits tree^{-1}was found in T_1 treatments at Bandarban, Rangamati and Khagrachari districts (90.00, 50.20 and 71.10 respectively) and the highest number of infested fruits tree $^{-1}$was found in untreated control (301.30, 167.50 and 206.20) in three hill districts. Improved management practice decreased more than 60.00% infested fruits over control (70.09% at Bandarban, 69.99% at Rangamati and 65.46% at Khagrachari districts) and farmer's practice decreased more than 35% infested fruits over control at three hill districts.The lowest number of fruit infestation (19.62% at Bandarban, 19.73% at Rangamati and 19.22% at Khagrachari districts) was recorded from improved management practice plant. On the other hand, the highest number of fruit infestation (81.46% at Bandarban, 80.40% at Rangamati and 80.19% at Khagrachari districts) was recorded from untreated control which was significantly higher than all other treatments. Improved management practice decreased more than 70.00% infested fruits over control (75.91% at Bandarban, 75.44% at Rangamati and 76.02% at Khagrachari districts) and farmer's practice decreased more than 45% infested fruits over control at three hill districts.

The present study was conducted at the farmer's orchard in Bandarban, Rangamati and Khagrachari districts, during the period from January to July, 2017 to study the species diversity, infestation intensity and management of mango fruit weevil as this notorious pest is a burning issue of the hilly areas in Bangladesh. Three treatments were used with ten replications.Occurrence of mango pulp weevil *S. frigidus*, species at Bandarban, Rangamati and Khagrachari districts was 100% and no seed weevils, *S. mangiferae* was found in this region.Total number of mango fruits tree $^{-1}$was highest at improved management practices in Bandarban (458.90), Rangamati (254.90) and Khagrachari (370.20) districts respectively. Again, the lowest number of total fruits tree^{-1}was found in untreated control at three hill districts.The highest number of healthy fruits tree^{-1} was found in T_1 treatments at Bandarban, Rangamati and Khagrachari districts (368.90, 204.70 and 299.10 respectively) The lowest number of infested fruits tree^{-1} was found in T_1 treatments at Bandarban, Rangamati and Khagrachari districts (90.00, 50.20 and 71.10 respectively). The lowest number of fruit infestation (19.62% at Bandarban, 19.73% at Rangamati and 19.22% at Khagrachari districts) was recorded from improved management practiced plant. Considering the result of the present study it may be concluded that improved pest management practices (5 times spraying of Ripcord 10EC @ 1.0 ml l^{-1} water on 30 January, 28 February, 30 March, 28 April, 30 May along with traditional cultural practices like clean cultivation through the removal of fallen mango fruits, leaves, weeds and parasitic plants, light pruning of the dead branches of previous year, avoidance of naturally grown forest plants with minimum economic value etc.) was the most effective management practices against mango fruit weevil. This treatment may be used for the overall management of mango insect pests but needs further trial for validation in large area.

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Rec. on 30.08.2018 & Acc. on 20.07.2018