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Research Article

Development of bio-rational management approach against mango hopper, *Idioscopus nagpurensis* (Pruthi) in Bangladesh

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ABSTRACT: A field experiment was conducted during the 2016-17 mango cropping season in farmers' fields of Gazipur, Rajshahi and Chapainawabgonj districts of Bangladesh to find an effective bio-rational management option for controlling the mango hopper, *Idioscopus nagpurensis* (Pruthi) (Hemiptera: Cicadellidae). Randomized Complete Block Design was used incorporating 8 treatments with 3 replications. The treatments were pruning of overcrowded and overlapping branches, spraying of azadirachtin, *Beauveria bassiana* (Lycomax, Russel IPM), imidacloprid insecticide, installation of yellow sticky grey and blue sticky trap and untreated control. Lowest leafhopper population was recorded in *B. bassiana* (3.0 hoppers/sweep/tree) followed by imidacloprid (3.7 leafhoppers/sweep/tree) treatments. Highest number of fruit retention was recorded in imidacloprid (40.00 fruits/20 inflorescence/tree) followed *B. bassiana* (32.67 fruits/20 inflorescence/tree) and azadirachtin (24.00 fruits/20 inflorescence/tree). Imidacloprid treatment offered maximum marginal benefit cost ratio (5.60). Increasing trend of hopper population was recorded in control. Considering health and environment issues, spraying of *B. bassiana* @ 5.0g/L of water at flower initiation stage, flowering stage and pea stage may be recommended for controlling mango hopper.

KEY WORDS: Azadirachtin, bio-rational, *Beauveria bassiana*, imidacloprid, mango hopper

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INTRODUCTION

Mango is an important and popular fruit crop in Bangladesh. Of the many aspects responsible for low mango yields, pests and diseases are considered the major factors. Among insect pests, the mango hoppers, *Idioscopus* spp. (Hemiptera: Cicadellidae) may cause upto 100% loss of the crop (Karim, 1989). Damage is mostly caused by the nymphs and adults that suck sap from the inflorescences and tender leaves. The affected inflorescences and leaves may wither, turn brown and drop. These hoppers secrete honeydew which favors the development of sooty mould on leaves, shoots and inflorescences. This sooty mould interferes with photosynthetic activity of affected plant parts resulting in low or no fruit setting (Karim, 1989; Wen and Lee, 1978). Farmers use chemical pesticides indiscriminately, even mixtures of two or three chemicals at frequent intervals and doses to save the mango crop. This has several limitations including ineffectiveness, killing of pollinators, parasitoids and predators, resurgence of other pest populations, development of resistant insect biotypes and excessive residues in marketable fruits (Debach and Rosen, 1991; Pedigo, 1999; Irshad and Gilani, 1990). With these views, the present study was undertaken to identify the most effective bio-rational management option(s) against mango leafhoppers.

MATERIALS AND METHODS

Study sites

Multi-site field studies were conducted in farmers' fields at three locations, viz., Gazipur, Rajshahi, and Chapainawabgonj districts of Bangladesh. These three sites represent the commercial production areas as well as different climatic zones for mango.

Plot layout and data collection

Studies were conducted during mango growing season of 2016-2017 following a Randomized Complete Block Design (RCB) incorporating 8 treatments with 3 replications. The treatments were as follows: 1) Pruning of overcrowded and overlapping branches before flowering (in December), 2) Three foliar sprays of azadirachtin (Bio-Neem plus 1EC) @ 1ml/L of water at flower initiation stage, before flower opening stage and pea stage, 3) Three foliar sprays of a talc based powder formulation of *Beauveria bassiana* (Lycomax, Russel IPM) @ 5.0g/L of water at the flower initiation stage, before flower opening and pea stages, 4) Installation of yellow sticky traps during flower initiation stage from December 2016 to March 2017, 5) Installation of grey sticky traps during flower initiation stage from December 2016 to March 2017, 6) Installation of blue sticky traps during the flower initiation stage from December 2016 to March 2017, 7). Three sprays with imidacloprid (confidor 70WG) insecticide @ 0.2g/L of water at flower initiation stage, flowering stage and pea stage and 8) Control. Each mango tree was considered as one replication. About 10-12 year old mango trees (BARI Aam-4) were used in this trial.

Each spray was done by foot pump sprayer to cover the whole mango tree. Mancozeb (indofil M-45) @ 2.0 g/L of water was sprayed after each spray of assigned spray schedule. Twenty inflorescences were selected randomly and tagged in each tree to count fruit retention upto mature stage. The mango hopper population was counted by collecting with sweep net at 7 DAS (Days After Spraying). First, second and third spraying dates were February 07, February 28 and March 20, respectively.

Harvestable fruits were collected and sorted into infested and healthy ones and weighed. Then marketable yield was calculated by weighing only ripen uninfested fruit. Costs of treatments and labor were recorded. The monetary returns from the harvests were calculated at the prevailing market price of mango. Number of infested fruit, number of healthy fruit, marketable yield per plant and Marginal Benefit Cost Ratio (MBCR) were calculated for each treatment. Marginal BCR was calculated as follows:

$$\text{Marginal BCR} = \frac{\text{Benefit on control}}{\text{Cost of treatment}}$$

Where, Cost of treatment = price of insecticide/ biopesticides + cost of labour spraying.

Data analysis

The data recorded for different parameters were analyzed statistically by using MSTAT-C software for analysis of variance. ANOVA was made by F- variance test and the differences between treatment means were compared by LSD test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect on population of mango hopper

Efficacy of different treatments against the mango hopper population at different places, during 2016-2017, is presented in Table 1. After the first spray, the lowest

Table 1. Efficacy of different treatments on hopper population at different location during 2016-2017

Treatment	Mean population of mango hopper/sweep/tree								
	After First spray (February 07)			After 2nd spray (February 28)			After 3rd spray (March 20)		
	Gazipur	Rajshahi	Chapai	Gazipur	Rajshahi	Chapai	Gazipur	Rajshahi	Chapai
T_1	4.33bc	3.33bc	6.67bc	5.67b-d	8.00b	8.33b	7.33e	7.00bc	10.67c
T_2	2.66c	1.67c	4.67bc	3.00cd	5.00b	3.67b	5.33f	3.33c	4.00d
T_3	2.00c	1.67c	3.33bc	2.00d	2.67b	3.00b	3.00g	2.00c	3.00d
T_4	5.00bc	5.33bc	9.33bc	7.00a-d	7.00b	12.33b	11.67c	10.33b	13.67bc
T_5	5.00bc	6.33b	10.33b	10.00ab	6.33b	11.33b	10.33d	10.67b	16.00b
T_6	6.00b	5.33bc	10.00b	9.67a-c	5.33b	13.00b	13.00b	10.00b	15.00bc
T_7	2.00c	2.00c	2.67c	4.33bd	3.67b	4.00b	2.33g	2.67c	3.67d
T_8	12.33a	17.33a	24.33a	13.33a	30.33a	37.33a	14.67a	35.67	33.00a
Level of significance	**	**	**	**	**	**	**	**	**
%CV	25.16	29.17	33.12	40.20	54.93	37.29	5.84	20.49	15.98

*Means having same letter(s) did not differ significantly; *Treatments: T_1=Pruning of overcrowded and overlapping branches before flowering (in December), T_2=Three foliar spray of azadirachtin (Bio-Neem plus 1EC) @ 1ml/L of water at flower initiation stage, flowering stage and pea stage, T_3= Three foliar spray of powder formulation of *Beauveria bassiana* (Lycomax, Russel IPM) @ 5.0g/L of water at flower initiation stage, flowering stage and pea stage, T_4 = Installation of yellow sticky trap during flower initiation stage December 2016 to March 2017, T_5=Installation of grey sticky trap during flower initiation stage December 2016 to March 2017, T_6=Installation of blue sticky trap during flower initiation stage December 2016 to March 2017, T_7=Three sprays with imidacloprid (Confidor 70WG) insecticide @ 0.2g/L of water at flower initiation stage, flowering stage and pea stage and T_8=Control.

Table 2a. Efficacy of different treatments on fruit retention at Gazipur during 2016-2017

Treatments	Mean number of fruits /20 inflorescences/tree			% fruit increased fruit retention over control		
	Pea stage	Marble stage	Mature stage	Pea stage	Marble stage	Mature stage
T_1	66.67c	16.33d	7.67d	1.52	-5.77	4.13
T_2	191.33ab	48.67ab	24.00bc	191.35	180.84	200.00
T_3	225.00a	62.33a	32.67ab	242.62	259.67	308.38
T_4	132.33b	36.33bc	18.33c	101.51	109.64	129.13
T_5	134.33b	33.33bc	20.00c	104.55	92.33	150.00
T_6	137.67b	28.33cd	16.33cd	109.64	63.47	104.125
T_7	228.33a	63.67a	40.00a	247.69	267.40	400.00
T_8	65.67c	17.33d	8.00d	-	-	-
Level of significance	**	**	**			
%CV	17.95	16.55	20.12			

Table 2b. Efficacy of different treatments on fruit retention at Rajshahi during 2016-2017

Treatments	Mean number of fruits /20 inflorescences/tree			% fruit increased fruit retention over control		
	Pea stage	Marble stage	Mature stage	Pea stage	Marble stage	Mature stage
T_1	102.67bc	26.33cd	11.67bc	413.35	203.69	250.45
T_2	128.33b	37.00bc	19.33b	541.65	326.76	480.48
T_3	192.00a	52.00b	35.33a	860.00	499.76	960.96
T_4	99.33bc	22.67c-e	11.00bc	396.65	161.48	230.33
T_5	89.67c	18.00de	8.33c	384.35	107.61	150.15
T_6	101.00bc	17.33de	9.67c	405.00	99.88	190.39
T_7	212.00a	73.00a	43.33a	960.00	741.98	1201.20
T_8	20.00d	8.67a	3.33c	-	-	-
Level of significance	**	**	**			
%CV	11.73	19.81	21.84			

Table 2c. Efficacy of different treatments on fruit retention at Chapainawabgonj during 2016-2017

Treatments	Mean number of fruits /20 inflorescences/tree			% fruit increased fruit retention over control		
	Pea stage	Marble stage	Mature stage	Pea stage	Marble stage	Mature stage
T_1	35.00d	14.33c	6.33c	77.94	48.19	0.00
T_2	123.67b	37.00b	19.67b	528.72	282.63	210.74
T_3	182.33a	49.67a	28.00a	826.94	413.65	342.34
T_4	72.67	16.33c	8.33c	269.45	68.87	31.60
T_5	68.67c	15.33c	7.00c	249.11	58.53	10.58
T_6	61.00c	15.00c	7.00c	210.12	55.12	10.58
T_7	178.33a	51.00a	30.33a	806.61	427.40	379.15
T_8	19.67d	9.67c	6.33c	-	-	-
Level of significance	**	**	**			
%CV	9.18	16.62	15.78			

*Means having same letter(s) did not differ significantly, Treatments: Same as indicated under Table 1.

hopper population (1.67 hoppers/sweep/tree) was recorded in the treatments of the powder formulation of *B. bassiana* (Lycomax, Russel IPM) (T_3) and azadirachtin (Bio-Neem plus 1EC) (T_2) followed by (2.00 hoppers/sweep/tree) in imidacloprid (Confidor 70WG) (T_7). The highest hopper population was recorded in the control. Similar trends were found after the 2nd and 3rd sprays at all locations.

Effect on fruit retention

Efficacy of different treatments on fruit retention at the pea stage, marble stage and mature stage at Gazipur, Rajshahi and Chapainawabgonj during 2016-17 is presented in Tables-2a, 2b and 2c, respectively. In Gazipur, the highest number of fruit retained in imidacloprid (Confidor 70WG) sprayed trees (T_7), followed by powder formulation of *B. bassiana* (Lycomax, Russel IPM) (T_3) and Azadirachtin (Bio-Neem plus 1EC) (T_2). Accordingly, the highest percent fruit retention over control (400%) was recorded in imidacloprid (Confidor 70WG) sprayed trees (T_7) followed by powder formulation of *B. bassiana* (T_3) (308%) and azadirachtin (Bio-Neem plus 1EC) (T_2) sprayed trees (T_7) (200%). In case of Rajshahi and Chapainawabgonj the similar trends of results were found.

Sticky trap catches

Fig. 1 shows that the highest number of trapped hoppers was in the blue sticky trap followed by the yellow sticky trap. The lowest number was trapped in the grey sticky trap.

Economic analysis

The highest marginal benefit cost ratio was found in imidacloprid (Confidor 70WG) sprayed trees (T_7). (5.60) followed by azadirachtin (Bio-Neem plus 1EC) (T_2) sprayed trees (T_7) (3.64) and powder formulation of *Beauveria bassiana* (T_3) (1.94).

Three sprays of the powder formulation of *B. bassiana* (Lycomax, Russel IPM) at the flower initiation stage, before flower opening stage and pea stage resulted in lowest hopper population but spraying of imidacloprid (Confidor 70WG) provided maximum fruit retention and marginal benefit cost ratio. These findings support previous study that the application of Myco-jaal of *B. bassiana* @ 6ml/L at field condition reduced 81.67% hopper population (Prabhakara *et al*., 2011). Powder formulation of *B. bassiana* is effective against mango hopper because it infects the hopper and cause the white mascardine disease of hopper. While the upfront cost was *B. bassiana* was relatively high than other treatments like, spraying of azadirachtin (Bio-Neem plus 1EC) and imidacloprid (Confidor 70WG) but considering health and environment issues and quality of mango, this

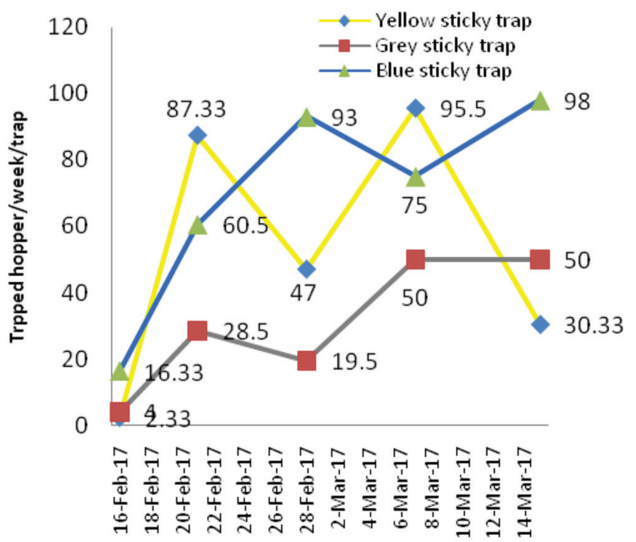

Fig.1. Effect of use of sticky traps in reducing mango hopper population.

Table 3. Economic analysis of different treatments for control of the mango hopper at Chapainawabgonj during 2016-2017

Treatments	Pest management cost (Tk.)	Marketable yield (Kg)	Gross return (Tk.)	Net Return (Tk.)	Adjusted Net Return (Tk.)	Marginal Benefit Cost Ratio
T_1	230.00	36.26	1994.30	1764.30	-216.00	-0.94
T_2	475.00	76.08	4184.40	3709.40	1729.00	3.64
T_3	850.00	81.52	4483.60	3633.00	1653.00	1.94
T_4	225.00	46.23	2542.65	2317.65	337.65	1.50
T_5	225.00	43.00	2365.00	2140.00	160.00	0.71
T_6	225.00	40.73	2240.15	2015.15	35.00	0.15
T_7	450.00	90.00	4950.00	4500.00	2520.00	5.6
T_8	0	36.00	1980.00	1980.00		-

Cost of sticky trap: @ Tk 100.00; Cost of motor oil : 250/L; Cost of *B. bassiana*: 2500tk./kg; Cost of Bioneem plus 1.0EC: @ Tk 3000.00/L; Cost of imidacloprid (Confidor @ 15000.00Taka/L); Cost of Indofil M-45 @ 735 Tk/kg; Cost of labourer/day @ Tk 450.00/day; Spray volume required: 30L /tree; Farm gate price of 55tk./kg (during June, 2017); Treatments: Same as Tables1 and 2 above.

could be accepted by the growers as well as consumers. Considering the deleterious affect caused by chemical to the beneficial organisms in mango ecosystem and the demand of for safe mango production, there is a need of eco-friendly management strategy for the control of mango hopper.

From the results, it could be concluded that three sprays of the powder formulation of *B. bassiana* (Lycomax, Russel IPM) at the flower initiation stage, flowering stage and pea stage resulted in lowest hopper population followed by azadirachtin (Bio-Neem plus 1EC). Spraying of imidacloprid (Confidor 70WG) provided maximum fruit retention and marginal benefit cost ratio. Considering health and environment issues, spraying of *B. bassiana* @ 5.0g/L of water at flower initiation stage, flowering stage and pea stage may be recommended for controlling mango hopper.

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