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Research Article

Development of biorational management for tomato leaf miner, *Tuta absoluta*

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ABSTRACT: The experiment was carried out in farmers' fields of Chaklarhat, Tunirhat, Panchagarh and Research Field of Horticulture Research Center, Bari, Gazipur from October 2017 to June 2018 to findan effective and suitable management approach against tomato leaf miner, *Tuta absoluta*. There was a total of ten treatments, *viz*., Treatment 1 = Application of *Metarrhizium anisolpiae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water, Treatment 2 = Foliar spray of azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water), Treatment 3 = Foliar spray of *Bacillus thuringiensis* (Biocure) @ 2g/L of water, Treatment 4 = Mass trapping through installation of delta sex pheromone trap, Treatment 5 = Spraying of spinosad (Tracer 45WSC) @ 0.5ml/L of water, Treatment 6 = Spraying with chlorantraniprole (Coragen 20SC) @ 0.5ml/L of water, Treatment 7 = Hand picking and destruction of infested leaf and fruit, Treatment 8 = Foliar spray of *B. thuringiensis* (Biocure) @ 2g/L of water + mass trapping through installation of delta sex pheromone trap + application of *M. anisolpiae* biopesticide in soil @ 5g/L of water, Treatment 9 = Foliar spray of azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water) + mass trapping through installation of delta sex pheromone trap + Application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water and Treatment 10 = untreated control were evaluated against *T. absoluta* following RCB design with three replications. Results revealed that foliar spray of azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water) + mass trapping through installation of delta sex pheromone trap + application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water performed best in reducing *T. absoluta* infestation, increase of marketable yield and highest marginal benefit cost ratio.

KEY WORDS: Biopesticides, management, neem, pheromone traps, *Tuta absoluta*

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INTRODUCTION

Tomato is a popular vegetable in Bangladesh and it can be grown year-round. However, the South American tomato leaf miner, *Tuta absoluta* (Lepidoptera: Gelichiidae) is a devastating pest of tomatoandit is very difficult to control. It is known to cause 80 to 100 % crop loss in tomato (Desneux *et al.,* 2010). The infestation of *T. absoluta* has also been reported on potato, eggplant and some solanaceous weeds (Urbaneja *et al*., 2013). This pest can complete 10-12 generations a year. Each female can lay 250-300 eggs in its life time. In 2006, it was identified in Spain and after that in a decade it has spread to most of Europe, Africa, West, Central and South Asia (Sridhar *et al*., 2014; Venkatramanan *et al*., 2017). In 2016, *T. absoluta* got introduced to Bangladesh (Hossain *et al*., 2016). This experiment was conducted to identify a non-chemical pesticide approach to manage *T. absoluta* in Bangladesh.

MATERIALS AND METHODS

Study sites

Studies were carried out at farmers' field (26.2019°N and 88.3745°E) of Panchagarh and research field of Bangladesh Agricultural Research Institute, Gazipur (23.5937°N and 90.2432°E) district, Bangladesh. These two sites represent the commercial production areas as well as different climatic zones for tomato production in Bangladesh.

Plot layout and data collection

Studies were conducted following a Randomized Complete Block design with 10 treatments and 3 replications per location in two consecutive tomato growing seasons from October 2017 to June 2018. BARI tomato-17 and Indian Hybrid tomato variety 501 were used as test crops for winter and summer season, respectively. The treatments were Treatment 1 = application of *Metarhizium anisopliae* (Lycomax, Russel

IPM) biopesticide in soil @ 5g/L of water; Treatment 2 = Foliar spray of azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water); Treatment 3 = Foliar spray of *Bacillus thuringiensis* (Biocure) @ 2g/L of water; Treatment 4 = Mass trapping through installation of delta sex pheromone trap; Treatment 5 = Spraying of spinosad (Tracer 45WSC) @ 0.5ml/L of water; Treatment 6 = Spraying with chlorantraniprole (Coragen 20SC) @ 0.5ml/L of water; Treatment 7 = Hand picking and destruction of infested leaf and fruit; Treatment 8 = Foliar spray of *B. thuringiensis* (Biocure) @ 2g/L of water + mass trapping through installation of delta sex pheromone trap + application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water; Treatment 9 = Foliar spray of azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water) + mass trapping through installation of delta sex pheromone trap + application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water; Treatment 10 = control. Foliar sprays were applied by knap-sack sprayer. Data on number of healthy and infested plants; leaf and fruit infestation by leaf miner from the whole plot was recorded weekly. On the other hand, per cent plant infestation, leaf infestation per plant and fruit damage (visual estimation) by leaf miner was calculated.

The monetary return from the yield was calculated on the basis of farm gate price during April-June, 2018. Parameters of economic analysis were computed according to following formulas:

Gross return = Yield × Sale price,

Net return for treatment = Adjusted return – Cost of treatment

$$\text{Marginal Benefit Cost Ratio} = \frac{\text{Adjusted return due to treatment}}{\text{Cost of treatment}}$$

Data analysis

The data recorded on different parameters were analyzed statistically by using MSTAT-c software for analysis of variance after transformation. 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 of different treatments on plant, leaf and fruit infestation

Effect of different treatments on percent plant, leaf and fruit infestation by *Tuta absoluta* at Panchgarh and Gazipur are presented in Table 1. The lowest plant (45.23%) and leaf (14.55%) infestation was recorded in T_9 treatment (Application of *Metarhizium anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water + foliar spray

Table 1. Effect of different treatments on per cent plant and leaf infestation by *Tuta absoluta* at Panchagarh and Gazipur during 2017-18

Treatment	Dosage	% plant infestation		% reduction over control		% leaf infestation		% reduction over control	
		Panchagarh	Gazipur	Panchagarh	Gazipur	Panchagarh	Gazipur	Panchagarh	Gazipur
T_1	5 kg/ha	58.64 (49.96)b	10.21 (18.61)c	30.72	70.36	19.22(4.38)c	7.58(2.75)c	24.33	51.22
T_2	1.0ml/L	60.20 (50.90)b	8.64 (16.97)c	28.88	74.92	17.69(4.20)d	7.26(2.67)c	30.35	53.28
T_3	2 g/L	58.99 (50.17)b	7.23 (15.58)c	30.30	79.01	16.97(4.12)de	5.93(2.43)c	33.19	61.84
T_4	-	80.43 (63.74)a	17.30 (24.59)b	4.97	49.78	23.35(4.83)b	10.09(3.18)b	8.07	35.07
T_5	0.5ml/L	46.63 (43.04)c	9.86 (18.27)c	44.91	71.38	15.07(3.88)fg	7.53(2.74)c	40.67	51.54
T_6	0.5ml/L	49.14 (44.49)c	10.99 (19.31)bc	41.94	68.09	16.06(4.00)ef	7.20(2.68)bc	36.77	53.67
T_7	-	81.28 (64.40)a	23.07 (28.69)b	3.97	33.03	23.43(4.84)b	14.52(3.81)b	7.76	6.56
T_8	-	46.40 (42.91)c	9.09 (17.54)c	45.18	73.61	14.76(3.84)fg	6.41(2.52)c	41.89	58.75
T_9	-	45.23 (42.24)c	6.78 (15.09)c	46.56	80.32	14.55(3.81)g	5.06(2.25)c	42.72	67.44
T_{10}	-	84.64 (66.94)a	34.45 (35.87)a	-	-	25.40(5.03)a	15.54(3.94)a	-	-
Level of significance		**	**			**	**		
CV%		5.37	8.56			3.05	5.71		

[Treatments: $Treatment_1$ = Application of *Metarhizium anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water; $Treatment_2$ = Foliar spray of Azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water); $Treatment_3$ = Foliar spray of *Bacillus thuringiensis* (Biocure) @ 2g/L of water; $Treatment_4$ = Mass trapping through installation of Delta sex pheromone trap; $Treatment_5$ = Spraying of Spinosad (Tracer 45WSC) @ 0.5ml/L of water; $Treatment_6$ = Spraying with Chlorantraniprole (Coragen 20SC) @ 0.5ml/L of water; $Treatment_7$ = Hand picking and destruction of infested leaves and fruits; $Treatment_8$ = Foliar spray of *B. thuringiensis* (Biocure) @ 2g/L of water + Mass trapping through installation of Delta sex pheromone trap + Application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water; $Treatment_9$ = Foliar spray of Azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water) + Mass trapping through installation of Delta sex pheromone trap + Application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water; $Treatment_{10}$ = untreated control]

of azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water) + mass trapping through installation of delta sex pheromone trap followed by T_8 treatment (foliar spray of *Bacillus thuringiensis* (Biocure) @ 2g/L of water + mass trapping through installation of delta sex pheromone trap + application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water) at Panchagarh. Per cent reduction of infestation over control were also exhibited the same trend. At Gazipur, the lowest plant (6.78%) and leaf (5.06%) infestation were recorded in T_9 treatment (application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water + foliar spray of azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water) + mass trapping through installation of delta sex pheromone trap) followed by T_8 treatment (foliar spray of *B. thuringiensis* (Biocure) @ 2g/L of water + mass trapping through installation of delta sex pheromone trap + application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water). Both of them were statistically at par with each other. Accordingly, per cent reduction of infestation over control were also exhibited the same trend. On the contrary maximum infestation was recorded in untreated control plot both at Panchagarh and Gazipur.

Effect of different treatments on per cent fruit infestation by *T. absoluta* at Panchagarh and Gazipur during 2017-18 is presented in Table 2. At Panchagarh, the treatment T_9 had the lowest fruit infestation (10.92%) followed by T_8 treatment (11.00%). Maximum fruit infestation (19.97%) was recorded in control plot. Accordingly, maximum reduction of fruit infestation over control was also found in Treatment T_9 (45.32%) followed by T_8 treatment (44.92%). The similar trend was also found at Gazipur.

Effect of different treatments on marketable yield

The results indicated that T_9 treatment (application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water + foliar spray of azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water + mass trapping through installation of delta sex pheromone trap) provided the highest marketable yield(51.07ton/ha) followed by T8 treatment (foliar spray of *B. thuringiensis* (Biocure) @ 2g/L of water + mass trapping through installation of delta sex pheromone trap + application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water) (49.41ton/ha) at Panchagarh (Table 3). Accordingly 39.65% and 35.11% marketable yield were increased in T_9 treatment and T_8 treatment respectively over untreated control.

But in case of Gazipur, T_8 treatment (application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water + foliar spray of azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water) + mass trapping through installation of delta sex pheromone trap) provided the highest marketable yield (64.20 ton/ha) followed by T_9 (foliar spray of *B. thuringiensis* (Biocure) @ 2g/L of water + mass trapping through installation of delta sex pheromone trap+ Application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water) treatment (62.21 ton/ha). Accordingly, the same trend was found in increased marketable yield over control treatment.

Table 2. Effect of different treatments on per cent fruit infestation by *Tuta absoluta* at Panchagarhand Gazipur during 2017-18

Treatment	Dosage	% fruit infestation		% reduction over control	
		Panchagarh	Gazipur	Panchagarh	Gazipur
T_1	5kg/ha	13.23 (3.64)bcd	1.67(1.29)c	33.75	49.24
T_2	1.0ml/L	13.37 (3.66)bcd	1.66(1.23)c	33.05	49.54
T_3	2 g/L	12.80 (3.58)bcd	1.77(1.33)c	35.90	46.20
T_4	-	18.29 (4.28)ab	2.02(1.41)bc	8.41	38.60
T_5	0.5ml/L	11.44 (3.38)cd	1.44(1.11)c	42.71	56.23
T_6	0.5ml/L	16.98 (4.05)abc	1.32(1.14)c	14.97	59.88
T_7	-	16.42 (4.05)abcd	2.71(1.64)ab	17.78	17.63
T_8	-	11.00 (3.36)cd	1.63(1.27)c	44.92	50.45
T_9		10.92 (3.30)d	1.27(1.12)c	45.32	61.39
T_{10}	-	19.97 (4.47)a	3.29(1.81)a	-	-
Level of significance		**	**		
CV%		17.00	9.16		

(Treatments: Same as indicated under Table 1)

Table 3. Effect of different treatments on marketable yield at Panchagarh and Gazipur during 2017- 2018

Treatment	Dosage	Marketable yield (ton/ha)		% increaseover control	
		Panchagarh	Gazipur	Panchagarh	Gazipur
T_1	5kg/ha	38.41cd	40.39ef	5.03	7.53
T_2	1.0 ml/L	39.52cd	46.47c-e	8.07	23.72
T_3	2 g/L	38.78cd	42.88d-f	6.04	14.16
T_4	-	37.96cd	42.13ef	3.80	12.17
T_5	0.5ml/L	39.06bc	43.10d-f	6.80	14.75
T_6	0.5ml/L	40.85b	51.36bc	11.70	36.74
T_7	-	37.96cd	40.28ef	3.80	7.24
T_8	-	49.41 a	64.20a	35.11	70.93
T_9	-	51.07a	62.21ab	39.65	65.63
T_{10}	-	36.57d	37.56f	-	-
Level of significance		**	**		
CV%		7.10	5.63		

(Treatments: Same as indicated under Table 1)

Table 4a. Benefit/cost analysis of different treatments against tomato leaf miner, *Tuta absoluta* at Panchagarh

Treatment	Cost of Treatment (Tk/ha)	M. yield (ton/ha)	Gross return from produce (Tk/ha)	Net return (NR) from Treatment (Tk/ha)	Adjusted net return (Tk/ha)	MBCR
1	2	3	4	5(4-2)	6	7(6/2)
T_1	5900.00	38.41	960250.00	954350.00	46000.00	7.80
T_2	12050.00	39.52	988000.00	975950.00	61700.00	5.12
T_3	22000.00	38.78	969500.00	947500.00	33250.00	1.51
T_4	12500.00	37.96	949000.00	936500.00	22250.00	1.78
T_5	9500.00	39.06	976500.00	967000.00	52750.00	5.55
T_6	26375.00	40.85	1021250.00	994875.00	80625.00	3.06
T_7	9000.00	37.96	949000.00	940000.00	25750.00	2.86
T_8	40400.00	49.41	1235250.00	1194850.00	280600.00	6.95
T_9	30450.00	51.07	1276750.00	1246300.00	332050.00	10.91
T_{10}	-	36.57	914250.00		-	-

(Treatments: Same as indicated under Table 1)

Benefit cost analysis

Benefit cost analysis of different treatments for managing *T. absoluta* is presented in Tables 4a and b at Panchagarh and Gazipur, respectively. At Panchagarh, the Marginal Benefit Cost Ratio (MBCR) was the highest (10.91) in T_9 treatment (application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water + foliar spray of azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water) + mass trapping through installation of delta sex pheromone trap) treated plots followed by that of T_8 treatment (foliar spray of *B. thuringiensis* (Biocure) @ 2g/L of water + mass trapping through installation of delta sex pheromone trap + application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil 5g/L of water) (6.95) treated plots.

At Gazipur, the Marginal Benefit Cost Ratio (MBCR) was the highest (7.09) in T_9 (foliar spray of *B. thuringiensis* (Biocure) @ 2g/L of water + mass trapping through installation of delta sex pheromone trap + application of *M.*

Table 4b. Benefit/cost analysis of different treatments against tomato leaf miner, *Tuta absoluta* at Gazipur

Treatment	Cost of Treatment (Tk/ha)	M. yield (ton/ha)	Gross return from produce (Tk/ha)	Net return (NR) from Treatment (Tk/ha)	Adjusted net return (Tk/ha)	MBCR
1	2	3	4	5(4-2)	6	7 (6/2)
T_1	5900.00	40.39	403900	398000	22400	3.80
T_2	12050.00	46.47	464700	452650	77050	6.39
T_3	22000.00	42.88	428800	406800	31200	1.42
T_4	12500.00	42.13	421300	408800	33200	2.66
T_5	9500.00	43.10	431000	421500	45900	4.83
T_6	26375.00	51.36	513600	487225	111625	4.23
T_7	9000.00	40.28	402800	393800	18200	2.02
T_8	40400.00	64.20	642000	601600	226000	5.59
T_9	30450.00	62.21	622100	591650	216050	7.09
T_{10}	-	37.56	375600	375600	-	-

Cost of *Metarrhizium anisopliae* (Lycomax, Russel IPM) biopesticide: 5000 Tk/kg; Cost of Bioneem plus: @ Tk 2800.00/L; Cost of *Bacillus thuringiensis* (Biocure): @ Tk 3500.00/kg; Cost of *Tuta* Lure + trap: @300Tk/Lure; Cost of Spinosad: @4000Tk/L; Cost of Coragen: @17500Tk/L; Cost of hand picking: Two labourers/ha @ Tk 450.00/day; Cost of spray: Two Cost labourers/ spray/ha @ Tk 450.00/day; Spray volume required: 500L /ha; Farm gate price of Tomato: Tk 25.00/ kg (During May, 2018); **[Treatments:** Same as indicated under Table 1]

anisopliae (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water) treated plots followed by that of T_8 treatment (application of *M. anisolpiae* biopesticide in soil @ 5g/L of water + foliar spray of azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water) + mass trapping through installation of delta sex pheromone trap) (5.59) treated plots.

The T_9 (application of *M. anisopliae* (Lycomax, Russel IPM) biopesticide in soil @ 5g/L of water + foliar spray of azadirachtin (Bio-Neem plus 1EC @ 1ml/L of water) + mass trapping through installation of delta sex pheromone trap) proved to be effective considering reduction of *T. absoluta* infestation, increase of marketable yield and marginal benefit cost ratio. So, considering the result of two consecutive seasons at two locations, T_9 treatment package may be recommended for controlling tomato leaf miner, *T. absoluta.*

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