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Bio-efficacy of bio-pesticides against tomato leaf miner, *Tuta absoluta*, a threatening pest of tomato

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ABSTRACT

Tomato (Solanum lycoperdicum L.) is the most popular vegetable crop in Bangladesh as well as in the world. Huge amount of Tomato fruits became lost due to attack of insect pest. The yield of tomato decrease due to increase of infestation. Experiments were conducted at the Entomology laboratory and field laboratory under the Department of Entomology in Bangladesh Agricultural University (BAU), Mymensingh during Rabi season (01 October, 2018 to 15 March, 2019) in order to evaluate the bio-efficacy of some bio-pesticides for controlling tomato leaf miner, Tuta absoluta. The experiment was laid out in complete randomized design (CRD) with five (05) replications and randomized complete block design (RCBD) with three (03) replications in laboratory and field condition, respectively. Tomato var. BARI tomato-09 (Lalima) variety was used as experimental crop. Five (05) bio-pesticides viz. Neem leaf extract @ 2.0 ml/L, Bishkathali leaf extract @ 2.0 ml/L, Lemon extract @ 2.0 ml/L, Garlic clove extract @ 2.0ml/L and Mahagany seed extract @ 2.0 ml/L were used as treatments. From the result, it clearly revealed that, among five (05) bio-pesticides, neem leaf extract @ 2.0 ml/L is the best followed by garlic clove extract, lemon extract, bishkathali leaf extract and mahagany seed extract for controlling tomato leaf miner in both laboratory and field condition i.e. neem leaf extract @ 2.0 ml/L can act as an effective bio-pesticides control agent against tomato leaf miner while yield and yield attributes were also higher. On the other hand, based on the tomato yield and percentage of tomato fruit infestation, the present study showed that positive co-relation (significant correlation) existed between percent infestation of test fruit and yield loss of tomato. It could be recommended that further trail of this work in different doses and the effect of toxicity on human, soil and environment is needed for researcher and farmers.

Key words: *Bio-efficacy, bio-pesticides, tomato, leaf miner, Tuta absoluta and threatening pest*

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I. Introduction

Tomato (*Solanum lycopersicum* L.) botanically referred to the family *Solanaceae* is one of the most important and popular vegetable crop in Bangladesh as well as in the world. Its annual production accounts for 107 million metric tons with fresh market tomato representing 72 % of the total (FAO, 2002). In Bangladesh, the area of cultivation is about 13,066 ha with the production of about 74,000 M tons. Tomato contains 94g water, 0.5g minerals, 0.8g fibre, 0.9g protein, 0.2g fat and 3.6g carbohydrate and other elements like 48mg calcium, 0.4mg iron, 356mg carotene, 0.12mg vitamin B-1, 0.06mg vitamin B-2 and 27mg vitamin-C in each 100g edible ripen tomato (BARI, 2010). In Bangladesh, it is mainly cultivated as winter vegetable, which occupies an area of 58,854 acres in 2011-12 with the total production of tomato, was 190 thousand metric tons (BBS, 2013). Due to increasing consumption of tomato products, the crop is becoming promising. In Bangladesh, the yield of tomato is not enough satisfactory in comparison with other tomato growing countries of the World (Aditya et al., 2010; Alam et al., 2015). Tomato is susceptible to insect pests and all parts of the plant including leaves, stems, flowers and fruits are subjected to attack by the pest. This crop is mainly attacked by tomato fruit borer, tomato leaf miner, tomato fruit worm, tomato aphid, stink bugs and leaf footed bugs, hornworms, silver leaf, whitefly etc. Among them tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is one of the most important pests of tomato and damage by this pest may be up to 50-80% (Haque, 2015). *Tuta absoluta* in only a few years has become a serious threat to global tomato production. It is now considered to be one of the most invasive pests of tomatoes in the Mediterranean Basin countries such as Egypt, Tunisia, Bangladesh, Libya, Morocco and Algeria (Haque, 2015). In Bangladesh, tomato leaf miner, *Tuta absoluta* (Meyrick) is a key oligophagous pest of tomato. It causes reductions in yield and fruit quality, to a tune of 50-100% loss in either greenhouses or fields. Plants are damaged by direct feeding on leaves, stems, buds, calyces, and young & ripe fruits and by caterpillars and the invasion of secondary pathogens which enter through the wounds made by the pest (EPPO, 2005). In Bangladesh, its infestation was first recorded from Northern part of our country and subsequently spread to other tomato growing districts *viz.*, Kurigram, Dinajpur, Bogura, Munshiganj. Now it covers all over the country. Larvae feed on the mesophyll tissue of the leaves, leaving only the epidermis intact. They often cause conspicuous irregular leaf blotches which later turned to necrotic. Tomato plants, from seedlings to mature stage, attacked by this pest. On fruits, small minute pin sized hole is often visible. Damage fruits with galleries of open areas acts as entry paths for invasion by secondary pathogens, leading to fruit rot. The insect deposits eggs usually on the underside of leaves, stems and to a lesser extent on fruits. After hatching, young larvae penetrate into tomato fruits, leaves on which they feed and develop creating mines and galleries. On leaves, larvae feed only on mesophyll leaving the epidermis intact (EPPO, 2005). Tomato plants can be attacked at any developmental stage, from seedlings to mature stage. Thousands of tomato farmers in Bangladesh are suffering from serious production losses due to devastating pest that destroyed their precious crop. *T. absoluta* can be spread by seedlings, infested vines with tomato fruit, tomato fruit and used containers. Outdoor markets, vegetable repacking and distribution centers are potential introduction points in the spread of this pest (Retta and Berhe, 2015; Alam et al., 2015; Alam et al., 2019).

The use of chemical pesticides as its control measure is highly sought and the most effective method to reduce *T. absoluta* treat level. However, the need for alternative control methods is encouraged, considering that, the pest has developed resistance to dozens of the pesticides and the negative side effects of pesticides over-use to the environment and beneficial arthropods (Bawin et al., 2014; Alam et al., 2015). To control these pests effectively, it is critical to combine all available control measures including cultural methods, biological control agents and the correct use of registered pesticides (Gozel and Kasap, 2015; Alam et al., 2014). An Integrated Pest Management (IPM) strategy that employs bio-chemical, biological, physical and cultural methods is the only best option we had at time. According to Haque, 2015, Bangladeshi farmers' had poor classification and low knowledge on *Tuta absoluta* and its control; what makes the matter more complicated. For better management *T. absoluta*, perception of farmers on current management, knowledge of its biology, information on effective chemicals, its spray technique and time is a prerequisite. Further, to develop economically feasible management strategy and to reduce unnecessary pesticide load in the environment, safer pesticides like microbial derivatives, botanicals, and growth regulators knowledge on cost effective management is also essential. In view of above facts and scarcity of related information on *T. absoluta*, with special reference to tomato, the present research will be undertaken to observe bio-efficacy of

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different bio-pesticides for management of tomato leaf miner, *T. absoluta* in both laboratory and field condition.

II. Materials and Methods

Experimental site and soil

Tomato is the most important vegetable crop in Bangladesh. The country has a great potentiality to improve and expand the tomato production. The yield of tomato is being hampered due to infestation of tomato lead miner as well as other insects. Among them tomato leaf miner, *T absolute* is the most serious pest in the context of food security. However, a suitable biology based insect pest management is the prime requirement of reducing insect infestation during tomato production. Experiments were conducted in both laboratory and field Laboratory under Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh during Rabi season (07 November, 2018 to 15 March, 2019) to find out the bio-efficacy of some bio-pesticides for controlling tomato leaf miner, *T. absoluta,* of tomato cv. BARI tomato-09 (Lalima). The experimental field was situated at 24.75 N latitude and 0.50 E longitudes at an average altitude of 18m above the mean sea level. The experimental site belongs to the Sonatola series of the dark grey floodplain soil type under Old Brahmaputra Floodplain Agro-Ecological Zone (AEZ-9). Weather information regarding temperature, relative humidity, rainfall and sunshine hours prevailed at the experimental site during the study period is presented in Table 01. The field was a medium high land with well drained silty-loam texture having pH value 6.5 and moderate fertility level with 1.67% organic matter content and others nutrient components well (Table 02). The details of five bio-pesticides against tomato leaf miner are presented in Table 03.

Table 01. Meteorological data recorded at the experimental site during the study period (Rabi season, 2018-19)

Months	During Experimental Period (2018-19)					
	Average Temperature (^{0}C)			Average Relative Humidity (%)	Average Rainfall (mm)	Total sunshine (hrs.)
	Maxi.	Min.	Mean			
January	25.9	12.8	19.4	76.7	0.0	5.4
February	28.3	15.8	22.1	75.1	0.20	5.6
March	28.0	18.6	23.3	78.5	163.70	5.0
April	30.4	22.2	33.7	82.5	329.50	4.1
May	32.8	25.4	29.1	82.2	594.30	4.0
June	-	-	-	-	-	-
July	-	-	-	-	-	-
August	33.2	26.8	30.0	81	97.6	179.6
September	32.0	26.1	29.1	87	408.6	125.6
October	32.4	24.2	28.3	84	31.7	200.9
November	29.5	18.1	23.4	81	1.0	204.8
December	27.5	14.2	21.1	81.4	0.0	180.30

Source: Weather Yard, Department of Irrigation and Water Management, BAU, Mymensingh.

Table 02. Details status of soil at research conducted area, Entomology field laboratory under department of Entomology in Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh during the rabi season (07 November, 2018 to 15 March, 2019).

Sites	pH	OM (%)	Total N (%)	(meq/100g soil)	(ug/g soil)			
				K	P	S	Zn	B
BAU Campus	6.24	1.06	0.082	0.044	8.92	26.73	1.33	0.31

Source: Alam et al., 2019

Culture of tomato leaf miner, *T. absoluta*

Parent stock (Adult insect) of *T. absoluta* was obtained from infested plant of tomato in farmer's field for the purpose of rearing of insect so that insect becomes available for experiments. Then this parent stocks were transferred on petri dishes in insect growth chamber at the maintain of 28±2^{0}C and related humidity of 28±2% respectively in Entomology research laboratory, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh (Alam et al., 2019). The food materials (pesticide less

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fresh leaf of tomato) were used for food supplementary of stock insect. This established culture was maintained as new generation emerged.

Table 03. Plants and plant's part evaluated for biocidal activities against *T. absoluta*

Symbol of Treatments	Common/ Local Name	Scientific Name	Family Name	Parts used	Doses (ml/L)	Methods of Application
T_1	Neem	*Azadirachta indica*	Meliaceae	leaf	2	Spraying
T_2	Bishkathali	*Persicaria acuminata*	Polygonacease	Leaf	2	Spraying
T_3	Lemon	*Citrus limon*	Rutaceae	clove	2	Spraying
T_4	Garlic	*Allivum sativum*	Liliaceae	clove	2	Spraying
T_5	Mahagony	*Swietenia mahagoni*	Meliaceae	Seed	2	Spraying
T_6	Control	---	---	Fresh Water	2	Water Spraying

Collection of bio-pesticides

The bio-pesticides used in this experiment were, Neem (*Azadirachta indica)*, Bishkathali (*Persicaria acuminate)*, lemon (*Citrus limon),* Garlic (*Allivum sativum)* and Mahagony (*Swietenia mahagoni)*. Leaves of neem & bishkathali and seed of Mahagony were collected from the botanical garden of BAU, Mymesingh. Garlic cloves and lemon were bought from K. R market of BAU campus, Mymensingh. The collected leaves were washed with sterile distilled water until the dirt was completely removed and allowed to shade for removing water and then it was dried by oven for four (04) days at 80^0C. Then the dried materials were finely ground using motor and pestle until the powdered form was obtained. The powders were stored separately in dark bottles for extraction.

Preparation of solution for treatments

Extract of Neem & Bishkathali leaves and seed of Mahagony: 50g of powdered biocidal material from each was weighed and transferred to a cellulose extraction thimble (Whatman, UK). These materials were extracted using 250ml ethanol (78^oc) for 5 hours in a Soxhlet apparatus (250ml) and the extracts were decanted from the flask separately. Then the volume of each extracted was measured and each was made to a final volume of 200ml and transferred separately into round bottom flasks. From this volume, finally 2ml per litter of each solution of treatments were used as volume of each treatment.

Extract of garlic cloves and lemon: 50g Garlic cloves & lemon and seed of mahagony were taken and ground well separately using mortar and pestle to obtain paste form. Then 25ml of distilled water is added to the paste separately and shaken well. The mixture was kept for 15 minutes; strained using a clean muslin cloth and the volume was made to 50ml by adding further 25ml of water, shaken well and stored in a dark bottle. 2ml solution from each of the initially prepared botanical extracts was transferred into new bottle separately used as volume of treatments.

Evaluation of bio-efficacy of some bio-pesticidals against tomato leaf miner

Laboratory studies: The laboratory experiment was conducted at the laboratory of Department of Entomology, BAU, Mymensingh during 01 October, 2018 to March, 2019. Herein five bio-pesticides were used as treatments. The detail information of five bio-pesticides has been presented in Table 03. Same doses were used in both laboratory and field condition. Complete randomized design (CRD) with five (05) replications followed for setting the experiments. Treatments were sprayed on both side of leaves in treatment wise and then it was dried in the air. 10 larvae of tomato leaf miner were released into treated leaf in each petri dish in treatment wise. Total number of petri dish was 30. During laboratory experiment, data was collected on the basis of mortality of larvae in once time per 12 hours up to 72 hours of application, and the percentage of mortality was calculated. The percentage of infestation was calculated by using the following formula (Alam et al., 2018; Alam et al., 2019):

$$\text{Mortality (\%)} = \frac{\text{Total number of release larvae per treatment} - \text{total number of died larvae per treatment}}{\text{Total number of release larvar per treatment}} \times 100$$

Field studies

Crop husbandry during field studies: The climatic condition was moderately cold and high humid with frequent wind during vegetative stage. Land was prepared well through six (06) ploughing. The fertilizers were used in properly. All fertilizers were applied during land preparation except urea and MoP. One-fourth of urea and MoP were applied at the time of final land preparation. The nitrogen,

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phosphorus, potassium, sulphur and zinc fertilizers were applied in form of urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate at the rate of 220, 100, 60, 60 and 10 kg ha-1, respectively (Alam et al., 2015; Mollah et al., 2016; Ahmed et al., 2011; Hossen et al., 2011). After germination of seed of mentioned variety, 10 days age seeding of tomato cv. BARI tomato-09 (Lalima) was transplanting on 07 November, 2018 in line. Remaining urea and MoP were applied three equal installments at pre-vegetative stage, full vegetative stage and early fruiting stage. Weeding, irrigation and other intercultural operation were done as and when necessary.

Experimental design and application of treatments during field studies

The field experiment was carried out at Entomology field Laboratory under the Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh, during 01 October, 2018 to March, 2019. Tomato *var.* BARI tomato-09 (Lalima) was used as experimental crop. Herein five bio-pesticides were used as treatments. The detail information of five bio-pesticides has been presented in Table 03. Same doses were used in both laboratory and field condition. Applications of some bio-pesticides were sprayed in the plot according to treatments. In field experiment, 1st sprayed in treatment wise at the time of early fruit setting and 2nd sprayed in treatment wise at the time of over mid fruit setting. Randomized complete block design (RCBD) with three (03) replications followed for setting the experiments in field. Total no. of plots was 18. The unit plot size was 1m X 1m where spacing of 50cm between two plots. The yield of tomato was recorded in treated plot wise and converted into yield per hectare according to treatment. At maturity, different data were collected in different parameter wise. Data on larva per plant, percent infested leaves per plant, percent healthy & infested plant per plot and percent healthy & infested fruit per plot were recorded in treatment wise. Weight of fruits were recorded and converted into t ha^{-1}. The percentage of leaf infestation was calculated by using the following formula (Alam et al., 2018):

$$\text{Infested leaves (\%)} = \frac{\text{Total number of leaves per plant} - \text{total number of healthy leaves per plant}}{\text{Total number of leaves per plant}} \times 100$$

The percentage of healthy plant was calculated by using the following formula (Alam et al., 2018; Alam et al., 2019):

$$\text{Healthy plant (\%)} = \frac{\text{Total number of plants per plot} - \text{total number of infested plants per plot}}{\text{Total number of plants per plot}} \times 100$$

The percentage of plant infestation was calculated by using the following formula (Alam et al., 2018):

$$\text{Infested plant (\%)} = \frac{\text{Total number of plants per plot} - \text{total number of healthy plants per plot}}{\text{Total number of plants per plot}} \times 100$$

Data analysis

The obtained data were statistically analyzed to find out the significance of differences among the treatments. The mean values of all the characters were evaluated and analysis of variance was performed by using R statistics software version 3.5.3 and the mean differences were adjudged by Duncans Multiple Range (DMRT) Test (Gomez and Gomez, 1984). Relation of variables with the yield loss and fruit infestation of tomato was studied using Pearson's Correlation Coefficient and Multiple Regression analysis.

III. Results

Evaluation of bio-pesticidal activates of some bio-pesticides against tomato leaf miner, *T. absoluta* under laboratory and field condition

Five (05) bio-pesticides *viz.* Neem leaf extract @ 2.0 ml/L, Bishkathali leaf extract @ 2.0 ml/L, Lemon extract @ 2.0 ml/L, Garlic clove extract @ 2.0 ml/L and Mahagony seed extract @ 2.0 ml/L were used as treatments in order to evaluated the performance against tomato leaf miner under field and laboratory condition during 01 October, 2018 to March, 2019 at the Entomology Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh. Observations were made on the morphological and yield attributes of tomato, and their results are presented in Table 04 to 06 below.

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Bio-efficacy of Some Bio-pesticides on Mortality of Tomato Leaf Miner, *T. absoluta* Under Laboratory Condition

The percent mortality of larva of *T. absoluta* caused by the tested different bio-pesticides at different time interval is depicted in Table 04. The effect of different bio-pesticides was observed up to 72 hours after application. The percent mortality of larva differed significantly (P≤0.05) among the treatments. The percent mortality of larva of tomato was recorded in the range of 0.0 to 67.47. The results clearly revealed that different botanical had significant effect (P≤0.05) on the mortality of tomato leaf miner and the effect was clearly time dependent. At 12 HAT, among the different bio-pesticides, the highest percentage of larva mortality (21.23%) was found in T_1 which was followed by 18.64%, 16.78%, 8.57% and 6.53% in T_4, T_3, T_2 and T_5, respectively, whereas the lowest (0.0%) larva mortality of tomato leaf miner was recorded in T_6. At 24 HAT, among the different bio-pesticides, the highest percentage of larva mortality (34.67%) was found in T_1 which was followed by 30.21%, 25.74%, 15.67% and 11.53% in T_4, T_3, T_2 and T_5, respectively, whereas the lowest (0.89%) larva mortality of tomato leaf miner was recorded in T_6. At 48 HAT, among the different bio-pesticides, the highest percentage of larva mortality (47.82%) was found in T_1 which was followed by 36.47%, 33.12%, 23.56% and 20.34% in T_4, T_3, T_2 and T_5, respectively, whereas the lowest (1.01%) larva mortality of tomato leaf miner was recorded in T_6. On the other hands, similar type of trend of result was found at 72 HAT and they also showed similar type of significant (P≤0.05). Among the different bio-pesticides, Neem leaf extract treatment (T_1) showed the highest (67.47%) percentage mortality of larva which was followed by 60.36%, 55.59%, 36.14% and 31.85% in T_4, T_3, T_2 and T_5, respectively, whereas the lowest (1.20%) larva mortality of tomato leaf miner was recorded in T_6. From the result of average percent mortality of larva, the highest (42.79%) percent mortality of larva was recorded in T_1 followed by 36.42%, 33.61%, 20.98% and 17.46% in T_4, T_3, T_2 and T_5, respectively, whereas the lowest (0.78%) larva mortality of tomato leaf miner was recorded in T_6. The present findings are in agreement with the findings with Alam et al. (2019) who reported that Neem leaf extract @ 2.0ml/L is highly potential against tomato leaf miner. The present result is also in agreement with the findings of Bawin et al. (2014) and Angelica et al. (2017).

Table 04. Bio-efficacy of some bio-pesticides on mortality of tomato leaf miner, *T. absoluta* at different time interval after treatment under laboratory condition

Treatments	Larva Mortality (%) of *T. absoluta* at				Average Mortality (%)
	12 HAT	24 HAT	48 HAT	72 HAT	
T_1= Neem leaf Extract @ 2.0 ml/L	21.23 a	34.67 a	47.82a	67.47 a	42.79 a
T_2= Biskatali leaf Extract @ 2.0 ml/L	8.57 c	15.67 c	23.56 c	36.14 c	20.98 c
T_3= Lemon Extract @ 2.0 ml/L	16.78 b	25.74 bc	33.12bc	55.59 b	33.61 bc
T_4= Garlic clove Extract @ 2.0 ml/L	18.64 b	30.21b	36.47 b	60.36 b	36.42 b
T_5= Mahagony seed Extract @ 2.0 ml/L	6.53 c	11.53 cd	20.34 cd	31.85 c	17.46 cd
T_6= Control	0.00 d	0.89 e	1.01 e	1.20 d	0.78 e
Level of significant	*	*	*	*	*
CV (%)	6.82	7.77	9.68	7.74	8.32
LSD	2.55	4.40	3.30	4.50	3.55
SE (±)	1.27	1.02	0.87	1.25	1.03

In column, means followed by different letters are significantly different. *means at 5% level of probability, CV= Coefficient of Variation, LSD= Least Significant Different, SE=Standard Error

Bio-efficacy of some bio-pesticides on various morphological attributes of tomato as affected by *T. absoluta* under field condition

At 1st spray of treatments: Considering the number of larva plant^{-1}, they were differed significantly (P≤0.05) among the treatments. The number of larva per plant was recorded in the range of 3.10 to 21.11 (Table 05). The highest (21.11) number of larva per plant was recorded in T_6 (control) which was followed by T_5(12.44), T_2(10.84), T_3(7.98) and T_4(3.60), respectively, whereas the lowest number of larvae per plant was observed in T_1(3.10). On the other hand, based on percent infested leaves per plant, the highest (86.76%) percent of infested leaves plant^{-1} was found in T_6 (control) followed by 65.31%, 62.55%, 49.78% and 30.41% in T_5, T_2, T_3 and T_4, respectively, whereas the lowest (25.73%) percent of infested leaves was recorded in T_1 (Table 05). In case of healthy plant plot^{-1}, the percent healthy plant per plot was differed at 5% level of significant among the treatments. The highest (68.34%) percent of healthy plant plot^{-1} was observed in T_1 which was followed by T_4(65.76%),T_3(52.10%),T_2(42.24%) and T_5(37.57%), respectively, whereas the lowest percentage of

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healthy plant was found in T_6(19.78%) (Table 05). Based on infested plant plot^{-1}, the percent infested plant per plot was differed significantly (P≤0.05) among the treatments. The highest (80.22%) percent of infested plant plot^{-1} was found in T_6 (control) followed by 62.43%, 57.76%, 47.90% and 34.24% in T_5, T_2, T_3 and T_4, respectively, whereas the lowest (31.66%) percent of infested plant was recorded in T_1 (Table 05).

At 2nd spray of treatments: Considering the number of larva plant^{-1}, the number of larva per plant was differed significantly (P≤0.05) among the treatments. They were recorded in the range of 3.25 to 21.50 (Table 05). The highest (21.50) number of larva per plant was recorded in T_6 (control) which was followed by T_5(12.55), T_2(10.95), T_3(8.01) and T_4(3.75), respectively, whereas the lowest number of larvae per plant was observed in T_1(3.25). On the other hand, based on percent infested leaves per plant, the highest (86.86%) percent of infested leaves plant^{-1} was found in T_6 (control) followed by 65.39%, 62.59%, 49.84% and 30.50% in T_5, T_2, T_3 and T_4, respectively, whereas the lowest (25.83%) percent of infested leaves was recorded in T_1 (Table 05). In case of healthy plant plot^{-1}, the percent healthy plant per plot was differed at 5% level of significant among the treatments. The highest (68.42%) percent of healthy plant plot^{-1} was observed in T_1 which was followed by T_4(65.86%),T_3(52.20%),T_2(42.32%) and T_5(37.67%), respectively, whereas the lowest percentage of healthy plant was found in T_6(19.88%)(Table 05). Based on infested plant plot^{-1}, the percent infested plant per plot was differed significantly (P≤0.05) among the treatments. The highest (80.12%) percent of infested plant plot^{-1} was found in T_6 (control) followed by 62.33%, 57.68%, 47.80% and 34.14% in T_5, T_2, T_3 and T_4, respectively, whereas the lowest (31.58%) percent of infested plant was recorded in T_1 (Table 05). This is directly in agreements with the findings of Aditya et al. (2010) who stated that the damage of plant and leaves was increased due to increase of infestation of tomato leaf miner.

Table 05. Bio-efficacy of some bio-pesticides on various morphological attributes of tomato plant as affected by tomato leaf miner, *T. absoluta* after 1st and 2nd spray under field conditions

Treatments	1st Spray				2nd Spray			
	Larva Plant^{-1}	Infested leaves (%) Plant^{-1}	Healthy plant (%) Plot^{-1}	Infested plants (%) Plot^{-1}	Larva Plant^{-1}	Infested leaves (%) Plant^{-1}	Healthy plant (%) Plot^{-1}	Infested plants (%) Plot^{-1}
T_1	3.10 d	25.73 de	68.34 a	31.66 de	3.25 d	25.83 de	68.42 a	31.58 de
T_2	10.84 bc	62.55 b	42.24 d	57.76 bc	10.95 bc	62.59 b	42.32 d	57.68 bc
T_3	7.98 c	49.78 c	52.10 c	47.90 c	8.01 c	49.84 c	52.20 c	47.80 c
T_4	3.60 d	30.41 d	65.76 ab	34.24 d	3.75 d	30.50 d	65.86 ab	34.14 d
T_5	12.44 b	65.31 b	37.57 de	62.43 b	12.55 b	65.39 b	37.67 de	62.33 b
T_6	21.11 a	86.76 a	19.78 f	80.22 a	21.50 a	86.86 a	19.88 f	80.12 a
Level of sig.	*	*	*	*	*	*	*	*
CV (%)	6.78	8.63	9.74	7.71	6.88	8.73	9.94	7.81
LSD	1.65	2.81	4.70	4.69	1.68	2.82	4.75	4.70
SE (±)	1.24	0.98	1.11	1.07	1.12	0.87	1.04	1.17

In column, means followed by different letters are significantly different. *means at 5% level of probability, CV= Coefficient of Variation, LSD= Least Significant Different, SE=Standard Error, T_1= Neem leaf extract @ 2.0 ml/L, T_2= Bishkathali leaf extract @ 2.0 ml/L, T_3= Lemon extract @ 2.0 ml/L, T_4= Garlic clove extract @ 2.0 ml/L, T_5= Mahagony seed extract @ 2.0 ml/L and T_6= Control

Bio-efficacy of some bio-pesticides on different yield attributes of tomato as affected by *T. absoluta*

Considering the infested fruits plant^{-1}, based on percent infested fruits per plant, the highest (82.12%) percent of infested fruits plant^{-1} was found in T_6 (control) followed by 61.31%, 57.66%, 40.90% and 35.38% in T_5, T_2, T_3 and T_4, respectively, whereas the lowest (30.59%) percent of infested leaves was recorded in T_1 (Table 06). In case of healthy fruits plant^{-1}, the percent healthy fruits plant^{-1} was differed at 5% level of significant among the treatments. The highest (69.41%) percent of healthy fruits plant^{-1} was observed in T_1 which was followed by T_4(64.62%),T_3(59.10%),T_2(42.34%) and T_5(38.69%), respectively, whereas the lowest percentage of healthy plant was found in T_6(17.88%) (Table 06). On the other hand, considering the tomato yield (kg ha^{-1}), the tomato yield was differed significantly (P≤0.05) among the treatments. The yield of tomato was recorded in the range of 8.10 to 35.42 t ha^{-1} (Table 06). The maximum yield of tomato (35.42 t ha^{-1}) was observed in T_1 which was followed by T_4 (32.50 t ha^{-1}), T_3 (25.64 t ha^{-1}), T_2 (20.33 t ha^{-1}) and T_5 (18.72 t ha^{-1}), respectively,

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whereas the minimum yield of tomato (8.10 t ha^{-1}) was recorded in T_6. Based on percent increase yield of tomato over control, the maximum percent yield (77.13%) was produced in T_1 which was followed by T_4(75.08%), T_3(68.41%) and T_2(60.16%), respectively, whereas the minimum (56.73%) percent yield of tomato was produced in T_5. The results of present study are similar with the study of Alam et al. (2018), Frank et al. (2014) and Gojo et al. (2018). They reported that yield and yield attributes was directly decreased with the increase of infestation of tomato leaf miner during fruit setting and maturity stage of tomato.

Table 06. Bio-efficacy of some bio-pesticides on yield attributes of tomato plant as affected by tomato leaf miner, *T. absoluta* after spray under field conditions

Treatments	Infested fruits (%) plant^{-1}	Health fruits (%) plant^{-1}	Yield of Tomato (t ha^{-1})	Increase yield (%) over control
T_1= Neem leaf Extract @ 2.0 ml/L	30.59 a	69.41 a	35.42 a	77.13
T_2= Bishkathali leaf Extract @ 2.0 ml/L	57.66 d	42.34 d	20.33 d	60.16
T_3= Lemon Extract @ 2.0 ml/L	40.90 c	59.10 c	25.64 c	68.41
T_4= Garlic clove Extract @ 2.0 ml/L	35.38 ab	64.62 ab	32.50 ab	75.08
T_5= Mahagony seed Extract @ 2.0 ml/L	61.31 de	38.69 d	18.72 d	56.73
T_6= Control	82.12 f	17.88 e	8.10 e	
Level of significant	*	*	*	
CV (%)	8.47	9.32	6.85	
LSD	4.81	4.82	2.95	
SE (±)	1.25	1.17	1.01	

In column, means followed by different letters are significantly different. *means at 5% level of probability, CV= Coefficient of Variation, LSD= Least Significant Different, SE=Standard Error

Correlation between percentage of infested fruits and yield loss of tomato caused by tomato leaf miner, *Tuta absoluta*

Five bio-pesticides have significantly effect on tomato leaf miner. They reduce tomato leaf miner during tomato production. But the effects of five pesticides are not equal. Correlation study was done to establish the relationship between percentage tomato fruit infestation and the percentage loss of yield. From the Figure 01 it was revealed that highly positive correlation was observed between the parameters. It was evident that the equation, Y=3.08 + (0.65)× X, where Y= yield loss (%) and X= fruit infestation (%) gave a good fit to the data and the co-efficient of determination (R^2 = 0.98) fitted regression line had a significant regression co-efficient. The yield of tomato was affected by increasing the tomato leaf miner infestation. In this case, the percent yield loss increased would increase tomato leaf miner and fruit damage. The maximum amount of grains loss was occurred in control condition.

IV. Discussion

Active ingredient of neem *viz.* gedunin, azadirachtin, nimbolinin, nimbin, nimbidin, nimbidol, sodium nimbinate, salannin, quercetin, nimbanene, nimbandiol, nimbolide, ascorbic acid etc. are present in different parts of neem. The most important active ingredient is azadirachtin which is effect on insect as antifeedancy, insect growth regulation, sterility and cellular processes. This azadirachtin can play effectively on *T. absoluta* and mortality is high (Kubo et al., 2012; Frank et al., 2014). The leaf extract of Bishkathali have a strong biocidal and medicinal activities. They have antibacterial, antifungal, antifeedant, anti-inflammatory, antinociceptive, and antiallergic properties; polygonolide had anti-inflammatory activity. Hot water extract of *P. hydropiper* leaves was significantly effective against the bean aphids, *Aphis craccivora,* with 87.6-94.5% mortality (P≤0.01) at 7 days after the application of spray at 227 L ha^{-1}. They also have strong antifeedant activity against Tomato leaf miner (*T. absoluta),* African armyworms (*Spodoptera exempta),* African or Egyptian cotton leaf worm (*Spodoptera littoralis*) and Whiteflies (*Bemisia tabaci*) (Hussain et al., 2010). Some constituents of the lemon extract interfere with octopaminergic nervous system of tomato leaf miner which are absent in human and fishes, thereby giving it its safety and selectivity. Lemon extract has the highest limonene composition which could be a reason for the lemon show high lethal activity against tomato leaf miner. Lemon, *C. limon* showed the highest repellent activity of 95%, 92.5% for *C. aurantifolia* and 82.5% for *C. sinensis.* The positive control recorded 100% repellent activity, a sign of very potent repellent for controlling *T. absoluta* (Frank et al., 2014).

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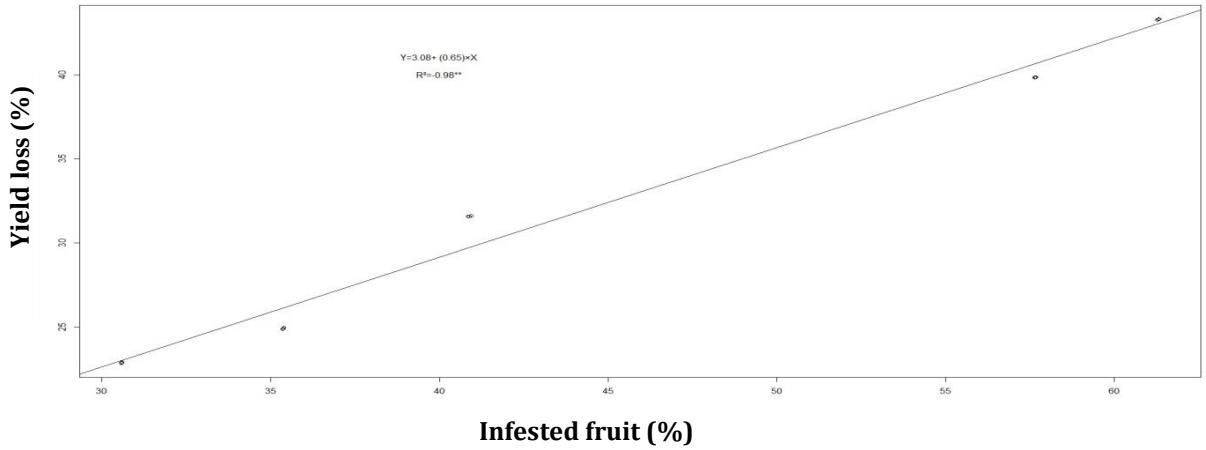

Figure 01. Relationship between percentage of infested fruits and yield loss (%) of tomato by tomato leaf miner, *Tuta absoluta*

The most identified components of garlic namely diallyl sulfphide, diallyl di-sulphide and diallyl trisulphide have antagonistic properties against several pests including tomato leaf miner, corn borer, maize aphid, potato tuber moth, red cotton bug, red palm weevil, houseflies and mosquitoes. They have lethal and repellent effects on larvae, pupae and adults of tomato leaf miner. In toxic compounds, diallyl disulfide was the most toxic than diallyl sulfide for pupa > larva > adult, respectively, and showing lethal effects at different time points. It can induce symptoms of intoxication and necrosis in larva, pupa, and adult of *T. absoluta* between 20-40 hours after exposure. Compounds of garlic caused lethal and sub-lethal effects on *T. absoluta* and, therefore, have the potential for pest control (Hamada et al., 2018; Angelica et al., 2017). All parts of mahogany were found effective against tomato leaf miner, *T. abosulata*. Different amount of concentrated extract from mahogany leaves were found to be the most effective and have the most potential as bio-pesticide. Phytochemicals with known insecticidal property that were detected from the different extracts of mahagony seeds; triterpenes, steroids, phenols, coumarines, tannins, alkaloids, flavonoids, anthrones, anthraquinones and fatty acids which are also effective against tomato leaf miner (Gojo et al., 2018).

V. Conclusion

The current study clearly showed that yield loss is increased with the increase of infestation of tomato as affected by tomato leaf miner, *T. absoluta*. Among the bio-pesticides, neem leaf extract is the best followed by garlic clove extract, lemon extract, bishkathali leaf extract and mahagony seed extract for controlling tomato leaf miner.

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VI. References

[1]. Aditya, T. L., Rahman, L., Alam, M. S. and Ghoseh, A. K. (2010). Correlation and path co-efficient analysis in tomato. Bangladesh Journal of Agricultural Science, 26(1), 119-122.

[2]. Ahmed, N., Ali, M. A., Baten, M. A., Alam, M. J. and Rubel, M. H. (2011). Tillage operations and water management on Methane (CH_4) emission and rice productivity. Bangladesh Journal of Seed Science and Technology, 15 (1 & 2), 159-164.

[3]. Alam, M. J., Ahmed, K. S. and Mollah, M. R. A. (2014). Survey of insect pests of maize crop and their identification in Shibganj upazilla under Bogra district. Bangladesh Journal of Seed Science and Technology, 18 (1 & 2), 73-77.

Published with open access at journalbinet.com
EISSN: 2312-7945,

[4]. Alam, M. J., Ahmed, K. S., Hossen, B., Mozammel, H. and Hoque, A. B. M. Z. (2019). Storage pests of maize and their status in Bangladesh. Journal of Bioscience and Agriculture Research, 20(02), 1724-1730. https://doi.org/10.18801/jbar.200219.210

[5]. Alam, M. J., Ahmed, K. S., Mollah, M. R. A., Tareq, M. Z. and Alam, M. J. (2015). Effect of planting dates on the yield of mustard seed. International Journal of Applied Sciences and Biotechnology, 3 (4), 651-654. https://doi.org/10.3126/ijasbt.v3i4.13974

[6]. Alam, M. J., Ahmed, K. S., Mollah, M. R. A., Tareq, M. Z. and Chowdhury, M. M. I. (2015). Effect of spacing on mustard yield at Shibganj and Sadar upazila of Bogra district. Bangladesh Journal of Environmental Science, 28, 133-136.

[7]. Alam, M. J., Ahmed, K. S., Mollah, M. R. A., Tareq, M. Z. and Mottalib, M. A. (2015). Effect of seed rate and sowing method on the yield of mustard. Bangladesh Journal of Environment Science, 29, 37-40.

[8]. Alam, M. J., Ahmed, K. S., Sultana, A., Firoj, S. M. and Hasan, I. M. (2018). Ensure food security of Bangladesh: Analysis of post-harvest losses of maize and its pest management in stored condition. Journal of Agricultural Engineering and food technology, 5(1), 26-32.

[9]. Alam, M. J., Hoque, M., Mansura, A., Rony, M. N. H. and Haque, M. S. (2019). Sustainable management of corn borer, *Helicoverpa zea* of maize through using some chemicals and bio-rational insecticides. Journal of Science, Technology and Environment Informatics, 06(02), 474-488.

[10]. Angelica, P. R., Luis Carlos, M., Marcelo, H. D. S. and Lemes, M. (2017). Insecticidal activity of garlic essential oil and their constituents against the meal worm beetle, *Tenebrio molitor* L. Scientific Reports, 7(1), 40-52. https://doi.org/10.1038/srep46406

[11]. Bangladesh Agricultural Research Institute (BARI) (2010). Krishi Projukti Hatboi. Bangladesh Agricultural Research Institute, Joydevpur, Gazipur. p. 304.

[12]. Bawin, T., Backer, D. L. and Dujeu, D. (2014). Infestation level influences oviposition site selection in the tomato leaf miner, *Tuta absoluta* (Lepidoptera: Gelechiidae). Insects, 5(4), 877-884. https://doi.org/10.3390/insects5040877

[13]. BBS (2013). Yearbook of Agricultural Statistics of Bangladesh, 2014. Bangladesh Bureau of Statistics, Dhaka.

[14]. EPPO (2005). European and Mediterranean Plant Protection Organization, *Tuta absoluta*. Bulletin OEPP/ EPPO Bulletin, 35, 434-435. https://doi.org/10.1111/j.1365-2338.2005.00852.x

[15]. FAO (2002). Production year book 2000. 54, FAO. Italy

[16]. Frank, A., Mensah, I., Eyiah, I., Caleb, M., Agbale, N. and Adua, E. (2014). Comparative Evaluation of the Insecticidal and Insect Repellent Properties of the Volatile Oils of *Citrus Aurantifolia* (Lime), *Citrus Sinensis* (Sweet Orange) and *Citrus Limon* (Lemon) On *Camponotus Nearcticus* (Carpenter Ants). International Journal of Novel Research in Interdisciplinary Studies, 1 (2), 19-25.

[17]. Gojo, C., Nunez, P. H., Anulacion, R. L. and Gregorio, N. A. (2018). Insecticidal property and phytochemical screening of mahogany (*Swietenia macrophylla* king) leaves, barks and seeds as an alternative insecticide against fungi growing termites (*Macrotermes gilvus* hagen). International Journal of Biology, Pharmacy and Allied Science, 7(8), 1521-1528. https://doi.org/10.31032/IJBPAS/2018/7.8.4504

[18]. Gomez, K. A. and Gomez, A. A. (1984). Statistical procedures for agricultural research (2nd Edition). An International Rice Research Institute Book. John Wiley and sons, New York, USA. P-680.

[19]. Gozel, C. and Kasap, I. (2015). Efficacy of entomopathogenic nematodes against the Tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in tomato field. Turkiye Entomoloji Dergisi, 39(3), 229-237. https://doi.org/10.16970/ted.84972

[20]. Hamada, H. M., Awad, M., Ei-Hefny, M. and Mousafa, M. A. (2018). Insecticidal Activity of Garlic (*Allium sativum*) and Ginger (*Zingiber officinale*) Oils on the Cotton leaf worm, *Spodoptera littoralis* (Boisd.). African Entomology, 26(1), 84-94. https://doi.org/10.4001/003.026.0084

[21]. Haque, M. M. (2015). Insect pests of tomato In: Curriculum Outline and Training Support Materials, Training Manual: Winter Vegetables and Spices Production. Horticulture Research and Development Project, DAE, BADC, Dhaka. p. 180-181.

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[22]. Hossen, K., Bhuiya, M. S. U., Begum, M., Alam, M. J. and Rubel, M. H. (2011). Intercropping of *Sesbania rostrata* with T. aman rice and their economic performance. Bangladesh Journal of Seed Science and Technology, 15 (1 & 2), 165-172.
[23]. Hussain, F., Ahmad, B., Hameed, I., Dastagir, D., Sanaullah, P. and Azam, S. (2010) Antibacterial, antifungal, and insecticidal activities of some selected medicinal plants of Polygonaceae. African Journal of Biotechnology, 9 (1), 5032-5036.
[24]. Kubo, I., Lee, Y. W., Pettei, M., Pilkiewicz, F. and Nakanishi, K. (2012). Army worm antifeedants from the east African Neem plants. Journal of the Chemical Society, Chemical Communications, 24 (1), 1023-1030.
[25]. Mollah, M. R. A., Ali, M. A., Prodhan, M. Z. H., Rahman, M. M. and Alam, M. J. (2016). Effect of containers on storability of true seeds of onion. European Journal of Biomedical and Pharmaceutical Sciences, (1), 01-04.
[26]. Retta, A. N. and Berhe, D. H. (2015). Tomato leaf miner, *Tuta absoluta* (Meyrick), a devastating pest of tomatoes in the highlands of Northern Ethiopia: A call for attention and action. Research Journal of Agricultural and Environmental Management, 4(6), 264-269.

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Harvard
Alam, M. J., Ahmed, K. S., Rony, M, N. H., Islam, N. E. T. and Bilkis, S. E. 2019. Bio-efficacy of bio-pesticides against tomato leaf miner, *Tuta absoluta,* a threatening pest of tomato. Journal of Bioscience and Agriculture Research, 17(02), pp. 1852-1862.

Vancouver
Alam, MJ, Ahmed, KS, Rony, MNH, Islam, NET and Bilkis, SE 2019. Bio-efficacy of bio-pesticides against tomato leaf miner, *Tuta absoluta,* a threatening pest of tomato. Journal of Bioscience and Agriculture Research, 2019 November 22(02): 1852-1862.

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