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Bio-efficacy of some bio-pesticides against maize aphid, *Rhopalosiphum maidis;* a threatening pest of maize

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ABSTRACT

Maize (Zea mays L.) is the second cereal crop in Bangladesh as well as in the world. A huge amount of maize plants become infested due to attack of insect pests. The maize aphid, Rhopalosiphum maidis is one of the most destructive pests of maize crop. Research experiments were conducted on maize in order to evaluate the bio-efficacy of some bio-pesticides for controlling maize aphid under field conditions at the Entomology field laboratory, Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh during two consecutive rabi season of 2017-18 to 2018-19. The experiment was laid out in randomized complete block design (RCBD) with three replications. Maize var. BARI Hybrid Butta-09 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, Mahogany seed extract @ 2.0 ml/L and one chemical insecticides namely Imidacloprid 20SL @ 0.25ml/L were used as treatments. Bio-efficacy of bio-pesticides against maize aphid, R. maidis on maize revealed that the treatment of Imidacloprid 20SL was found more effective for controlling R. maidis whereas the descending order of treatments was neem leaf>garlic clove extract>lemon extract>bishkathali leaf extract>mahagany seed extract i. e. neem leaf extract @ 2.0 ml/L can act as an effective bio-pesticides control agent within five bio-pesticides against maize aphid while yield and yield attributes were also higher. On the other hand, based on the maize yield and efficacy of insecticides, the present study showed that a linear positive co-relation (significant correlation) between insect infestation control and yield increase percentage of maize i.e. yield of maize grain was increased due to increase of percentage insect infestation control in maize production.

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I. Introduction

Maize, *Zea mays* L. is one of the most important cereal crops after rice (Alam et al., 2018). It is grown all over the year in a wide spectrum of soil and climatic conditions. Maize is an essential source of food and oil for human intake and also as feed for livestock. A huge amount of maize is utilized early in Bangladesh of which only 42% is produced by the country and remaining imported from other countries (BBS, 2013). The production of maize grain is about 3.2 MT yearly and another 1.0 million tons for the growing animal feed industry (BBS, 2016). About 90% of total consumed maize is used as poultry feed and the remaining part is used as fish feed and human food products in Bangladesh (Alam et al., 2019b; BBS, 2015). The ministry of agriculture (MoA) has been considering converting all lands under tobacco cultivation into maize fields to raise the production of the cereal up to 6.0 million tonnes by 2021. Maize can be grown throughout the world (Alam et al., 2019a)**.** Panchagoar, Thakurgaon, Dinajpur, Rangpur, Bogura, Joypurhat, Rajshahi, Kushtia, Maherpur, Magura, Jhenidah, Jessor and Comilla are major maize growing areas in Bangladesh (Krishi Dairy, 2017). The traditional cereal crop including rice, mustard and wheat seem quite unable to meet up the nutritional requirements to the increasing population (Alam et al., 2015c). So, it is a high demand to introduce a new crop to the existing cropping patterns of the country (Alam et al., 2019a). Maize becomes a good source of protein, carbohydrate and lipids for the malnourished population (Iita, 2007). In 100g of dry maize grain are containing about 11.1g protein, 3.6g fat, 2.7g fibre, 348mg phosphorus, 15.9mg of total sodium, 114mg of total sulphur, 1.78 mg of total amino acid, 1.5g of total minerals, 66.2g of total carbohydrates, 10mg of total calcium, 2.3mg of total iron, 286mg of total potassium, 90ug of carotene and 0.12mg of total vitamin C (Gopalan et al., 2012).

Maize is going to be a potential grain crop for nutritional support to the country's population. It can be grown all year round in Bangladesh and can, therefore, be fitted in the gap between the main cropping seasons without affecting the major crops. Nowadays, the infestation of insects is becoming high day by day due to over cultivation of maize. Among the major insect pests maize aphid, *R maidis* is the most serious one (Alam et al., 2014). Mathur (1987) reported that more than 250 species of insects which were associated with maize in the field and storage conditions. Of these, 74 species have appeared recently and about a dozen were of potential economic importance (Alam et al., 2019b). Among them maize aphid is the most important constraint to corn production. The larva, *R. maidis* is a major agricultural pest and polyphagous attacking more than 182 plant species. The older larvae are very much aggressive and cannibalistic in nature, that is why they such a different part of the plant (Boyd, 2008). The larvae feed on all parts of plant. This damage prevents pollination and introduces various fungi into the cobs and plant. Annual yield loss ranged from 5-7% in field like mustard crop (Alam et al., 2015a) and 10-15 percent corn for human consumption (Alam et al., 2015b). The extent of damage varied from crop to crop and season to seasons like mustard and jute crop (Alam et al., 2015b; Tareq et al., 2015).

Maize aphid infested resulting in a yield loss of 0.876% in bean, sorghum, berly, cotton and others (Williams, 2007). The biochemical constituents present in quantities and proportion to each other in host plants have been reported to exert a profound influence on the growth, survival and reproduction of insects in various ways (Painter, 1951). The insect favorable plant substance present in maize, which is become the plant suitability to other insects are also likely to affect the growth and development of the pest. Significant progress in developing resistant varieties in maize has been made in Bangladesh but until now no commercial resistant variety against maize aphid have been released in Bangladesh and have no proper research for the improvement of maize variety. Better knowledge of eco-friendly insect pest management of maize, genetic diversity or genetic similarity could help to get long term selection gain in plants (Alam et al., 2019b). For all these reasons, now it is essential to search the sustainable control measures and develop a bio-pesticide based integrated pest management (IPM) package for maize aphid, *R maidis* in corn production. The concept of bio-pesticide based integrated pest management with the emphasis on host plant resistance has gained momentum. Considering the above scenario, the present study was undertaken to the observed bio-efficacy of different bio-pesticides for the management of maize aphid, *R. maidis* in field condition.

II. Materials and Methods

Experimental site and soil

Maize is the most important cereal crop after rice in Bangladesh. The country has a great potentiality to improve and expand the maize production due to the suitability of land and climates. The yield of maize is being hampered due to infestation of maize aphid, *R. maidis* as well as other insect pests. Among them, maize aphid 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 maize production. Research experiments were conducted on maize in field Laboratory under Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh during two consecutive rabi seasons of 2017-18 to 2018-19 to find out the bio-efficacy of some bio-pesticides for controlling maize aphid, *R. maidis* of maize *cv.* BARI Hybrid Bhutta-09. The research site was situated at 24.75 N latitude and 0.50 E longitudes at an average altitude of 18m above the mean sea level. The site of experiment 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 other nutrient components well (Table 02). The details of five bio-pesticides against maize aphid are presented in Table 03.

Table 01. Meteorological data recorded at the experimental site during the study period (two consecutive rabi season of 2017-18 to 2018-19)

Months	During 2017-18					During 2018-19				
	Average Temperature (ºC)		Average Relative Humidity (%)	Average Rainfall (mm)	Total Sunshine (hrs.)	Average Temperature (ºC)		Average Relative Humidity (%)	Average Rainfall (mm)	Total Sunshine (hrs.)
	Maxi.	Min.				Maxi.	Min.			
January	25.9	12.8	76.7	0.0	5.4	25.7	12.9	76.9	0.00	5.6
February	28.3	15.8	75.1	0.20	5.6	28.6	15.3	75.2	0.30	5.8
March	28.0	18.6	78.5	163.70	5.0	28.2	18.8	78.4	160.30	5.3
April	30.4	22.2	82.5	329.50	4.1	30.0	22.4	82.2	330.80	4.7
May	32.8	25.4	82.2	594.30	4.0	32.2	25.5	82.5	592.70	4.4
June	-	-	-	-	-	-	-	-	-	-
July	-	-	-	-	-	-	-	-	-	-
August	33.2	26.8	81	97.6	179.6	33.0	26.4	81.2	98.4	180.3
September	32.0	26.1	87	408.6	125.6	32.4	26.3	87.3	410.1	127.5
October	32.4	24.2	84	31.7	200.9	32.2	24.4	84.1	33.2	205.7
November	29.5	18.1	81	1.0	204.8	29.1	18.2	81.4	2.0	206.4
December	27.5	14.2	81.4	0.0	180.30	27.3	14.4	81.2	0.10	182.1

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

Table 02. Details status of soil at the research conducted area, Entomology field laboratory under Department of Entomology in Bangladesh Agricultural University (BAU), Mymensingh during the rabi season, 2017-18 to 2018-19.

Sites	pH	OM (%)	Total N (%)	(meq/100g soil)	(ug/g soil)			
				K	P	S	Zn	B
BAU Campus	6.5	1.67	0.082	0.044	8.92	26.73	1.33	0.31

Source: Alam et al., 2019b

Collection of bio-pesticides

The bio-pesticides used in this experiment were neem (*Azadirachta indica)*, bishkathali (*Persicaria acuminate)*, lemon (*Citrus limon),* garlic (*Allivum sativum) &* mahagony (*Swietenia mahagoni)* and one chemical insecticides were imidagold 20SL. Leaves of neem & bishkathali and the seed of mahagony were collected from the botanical garden of BAU, Mymensingh. Garlic cloves and lemon were bought

from K.R. market of BAU campus, Mymensingh. Chemical insecticide (Imidagold 20SL) was collected from local market of Mymensingh Sadar. 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 the oven for four (04) days at 80^{0}C. 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.

Table 03. Plants and plant's part evaluated for biocidal activities against *R. maidis*

Treatments	Local Name	Scientific Name	Family Name/ Company Name	Parts Used	Doses (ml/L)	Methods of Application
Neem	Neem	*Azadirachta indica*	Meliaceae	Leaf	2	Spraying
Bishkathali	Bishkathali	*Persicaria acuminata*	Polygonaceae	Leaf	2	Spraying
Lemon	Labu	*Citrus limon*	Rutaceae	Clove	2	Spraying
Garlic	Rashon	*Allivum sativum*	Liliaceae	Clove	2	Spraying
Mahagony	Mahagony	*Swietenia mahagoni*	Meliaceae	Seed	2	Spraying
Imidagold 20 SL	Imidagold 20 SL	Imidacloprid 20 SL	United Phosphorus Bangladesh Ltd.		0.25	Spraying
Control	Control	---	---	Fresh Water		Water Spraying

Preparation of solution for treatments

Extract of neem & bishkathali leaves and the 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^{0}C) 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 was used as volume of each treatment (Alam et al., 2019c).

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 a new bottle separately used as volume of treatments (Alam et al., 2019c).

Crop husbandry during field studies: The condition of climate was moderately cold and high humid with frequent wind during the vegetative stage. Land was prepared well through six (06) ploughing. The fertilizers were used properly. All fertilizers were applied during land preparation except urea and muriate of potash (MOP). One-fourth of urea and MOP were applied at the time of final land preparation. The nitrogen, 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., 2015a; Mollah et al., 2015a,b,c; Ahmed et al., 2011; Hossen et al., 2011; Mollah et al., 2016; Mollah et al., 2014a,b; Sanjida et al., 2019). Maize *cv.* BARI Hybride Butta-09 was sowing on 1st week of November, 2017 and 2018 in line. Remaining urea and MOP were applied three equal installments at pre-vegetative stage, full vegetative stage and early corn formation 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 two consecutive rabi seasons of 2017-18 to 2018-19. Maize *var.* BARI Hybride Butta-09 was used as an experimental crop. Herein five bio-pesticides and one chemical insecticide were used as treatments. The detail information of five bio-pesticides and one chemical insecticide has been presented in Table 03. Same doses were used in field conditions. Applications of some bio-pesticides were sprayed in the plot according to treatments. In the field experiment, 1st sprayed in treatment wise at the time of the vegetative stage, 2nd sprayed in treatment wise at the time of inflorescence and 3rd sprayed in treatment wise at the time of cob formation stage. Randomized complete block design (RCBD) with three (03) replications followed

for setting the experiments in field. Total no. of plots was 21. The unit plot size was 4m×2.5m where spacing of 70cm between two plots. Plant to plant distance was 30cm and the distance of row to row was 60cm. The yield data were recorded in treated plot wise and converted into yield per hectare according to treatment. At the time of applied treatments, different data were collected in different parameter wise. Data on percent damage before spray, percent damage after spray, percent damage control and grain yield were recorded in treatment wise. Weight of cobs was recorded and converted into t ha^{-1}. The percentage of damage of plant due to attaching of maize aphid was calculated by using the following formula (Alam et al., 2018):

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

The percentage of damage over control was calculated by using the following formula (Alam et al., 2018):

$$\text{Damage Control (\%)} = \frac{\text{Damage (\%) of control} - \text{Damage (\%) of respestive treatment}}{\text{Damage (\%) of control}} \times 100$$

The percentage yield increase over control was calculated by using the following formula (Alam et al., 2018):

$$\text{Yield Increase (\%)} = \frac{\text{Yield of control} - \text{Yield of respestive treatment}}{\text{Yield of control}} \times 100$$

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 (ANOVA) following Randomized Completely Block Design was performed by using R statistics software version 3.5.3 to see the treatment effect, and the mean differences were adjudged by Duncan's Multiple Range (DMRT) Test (Gomez and Gomez, 1984). Relation of variables with the yield increase percentage of maize and insect damage control was studied using Pearson's Correlation Coefficient and Multiple Regression analysis.

III. Results

Efficacy of bio-pesticides against maize aphid, *R. maidis*

All used bio-pesticides had a significant effect ($P \leq 0.005$) on percent infestation and crop yield over control. In 2017, the lower percent infestation (1.15%) with higher crop yield (10.56 t ha^{-1}) was observed in imidacloprid 20SL @ 0.25 ml/L. But considering the five bio-pesticides, the lower percent infestation (14.37%) with higher crop yield (7.43 t ha^{-1}) was observed in neem leaf extract @ 2ml/L whereas the highest percent infestation control (84.77%) and highest percent increase of yield (59.35%) were also found i.e. neem leaf extract @ 2ml/L was the better performance on maize aphid than other tested bio-pesticides (Table 04). On the other hand, similar type of trend of result was found at crop season 2018. All used bio-pesticides had a significant effect ($P \leq 0.005$) on percent infestation and crop yield over control. In 2018, the lower percent infestation (1.11%) with higher crop yield (10.67 t ha^{-1}) was observed in imidacloprid 20SL @ 0.25 ml/L. But considering the five bio-pesticides, the lower percent infestation (13.78%) with higher crop yield (7.65 t ha^{-1}) was observed in neem leaf extract @ 2ml/L whereas the highest percent infestation control (85.68%) and highest percent increase of yield (60.65%) were also found i.e. neem leaf extract @ 2ml/L was the better performance on maize aphid than other tested bio-pesticides (Table 05).

Relationship between insect infestation control and yield increase in maize during 2017

A linear positive correlation between percent insect infestation control and yield increase percentages was observed during 2017. The maize yield was found a significant highly positive correlation with the insect infestation control percentage in maize aphid management experiment through the application

of bio-pesticides. The equation, Yield increase (%)= 15.48 +0.897× insect infestation control (%) and R^2= 0.96 gave the fit (Figure 01). The estimated regression line indicated that the unit rises in the insect infestation control percentage during the experimentation period of the first year, there existed possibilities of yield increase by 0.89%. It may be concluded from the figure that the percentage of insect infestation control was strong as well as positively correlated with the percent yield increase of maize grain i.e. yield of maize grain was increased due to increase of percentage insect infestation control in maize production.

Table 04. Effect of bio-pesticides on maize aphid damage and grain yield in maize at Entomology field laboratory during 2017

Treatments	IBS (%)	IAS (%)	IC (%)	GY (t ha^{-1})	YI (%)
Lemon extract @ 2.0 ml/L	63.88 a	23.64 d	74.95	6.47 d	53.32
Bishkathali leaf extract @ 2.0 ml/L	65.23 a	37.96 bc	59.78	5.12 e	41.02
Garlic clove extract @ 2.0ml/L	64.57 a	19.78 e	79.04	7.01 c	56.92
Neem leaf extract @ 2.0 ml/L	65.01 a	14.37 f	84.77	7.43 b	59.35
Mahagany seed extract @ 2.0 ml/L	64.75 a	40.25 b	57.35	4.45 f	32.13
Imidacloprid 20SL @ 0.25ml/L	62.98 a	1.15 g	98.78	10.56 a	71.40
Control	65.03 a	94.39 a		3.02 g	
Level of significance	NS	*		*	
CV (%)	17.25	8.95		7.24	
LSD	2.45	2.31		0.40	
SE (±)	2.39	1.02		1.17	

In column, means followed by different letters are significantly different. In column, means followed by same letters are not significantly different. *means at 5% level of probability. NS means non-significant. IBS(%)= Percent Infestation Before Spray, IAS (%)= Percent Infestation After Spray, IC (%)= Percent of Insect Infestation Control, GY= Grain Yield, YI(%)= Percent Increase of Yield, CV= Coefficient of variation, LSD= Least significant difference and SE (±) = Standard Error.

Table 05: Effect of bio-pesticides on maize aphid damage and grain yield in maize at Entomology field laboratory during 2018

Treatments	IBS (%)	IAS (%)	IC (%)	GY (t ha^{-1})	YI (%)
Lemon extract @ 2.0 ml/L	56.02 a	22.96 d	76.14	6.52 d	53.83
Bishkathali leaf extract @ 2.0 ml/L	56.82 a	36.34 bc	62.24	5.24 e	42.56
Garlic clove extract @ 2.0ml/L	55.98 a	19.01 e	80.25	7.16 c	57.96
Neem leaf extract @ 2.0 ml/L	57.14 a	13.78 f	85.68	7.65 b	60.65
Mahagany seed extract @ 2.0 ml/L	56.27 a	37.98	60.54	4.68 f	35.68
Imidacloprid 20SL @ 0.25ml/L	56.35 a	1.11 g	98.85	10.67a	71.79
Control	56.06 a	96.24 a		3.01g	
Level of significance	NS	*		*	
CV (%)	16.49	8.95		7.24	
LSD	1.50	1.73		0.43	
SE (±)	2.53	1.12		0.96	

In column, means followed by different letters are significantly different. In column, means followed by same letters are not significantly different. *means at 5% level of probability. NS means non-significant. IBS(%)= Percent Infestation Before Spray, IAS (%)= Percent Infestation After Spray, IC (%)= Percent of Insect Infestation Control, GY= Grain Yield, YI(%)= Percent Increase of Yield, CV= Coefficient of variation, LSD= Least significant difference and SE (±) = Standard Error.

Relationship between insect infestation control and yield increase in maize during 2018

A linear positive correlation between percent insect infestation control and yield increase percentages was observed during 2018. The maize yield was found a significant highly positive correlation with the insect infestation control percentage in maize aphid management experiment through the application of bio-pesticides. The equation, Yield increase (%)=14.59 +0.884×insect infestation control (%) and R^2= 0.97 gave the fit (Figure 02). The estimated regression line indicated that the unit rises in the insect infestation control percentage during the experimentation period of first year, there existed possibilities of yield increase by 0.88%. It may be concluded from the figure that the percentage of insect infestation control was strong as well as positively correlated with the percent yield increase of maize grain i.e. yield of maize grain was increased due to increase of percentage insect infestation control in maize production.

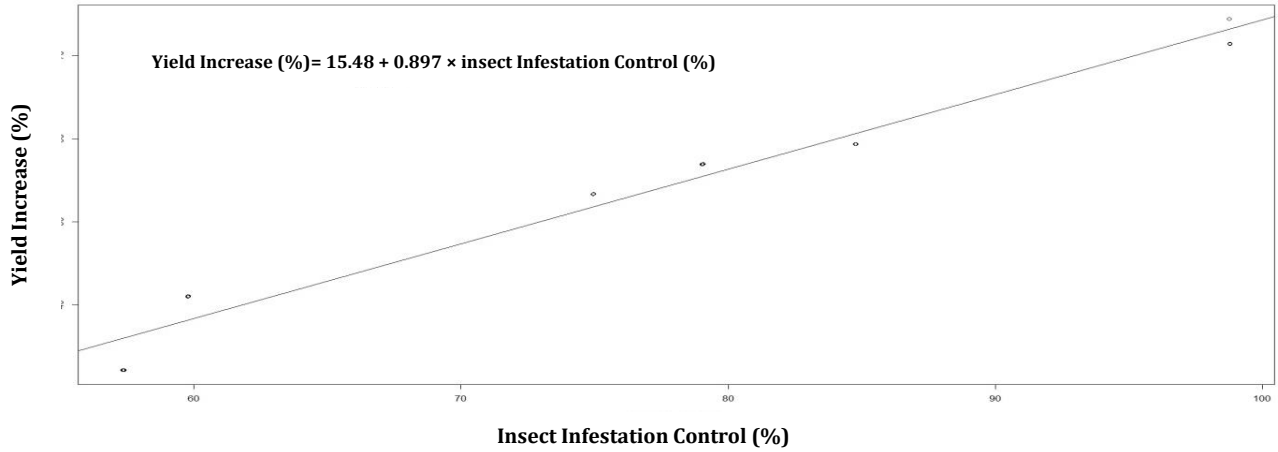

Figure 01. Relationship between percent insect infestation control and percent yield increase in maize aphid management experiment during 2017.

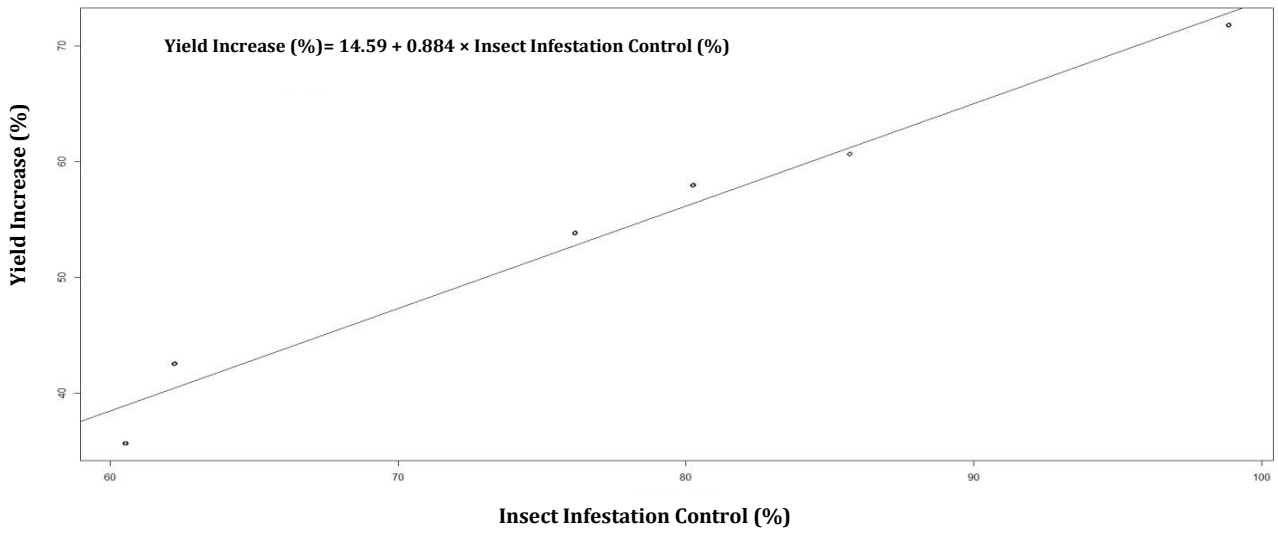

Figure 02. Relationship between percent insect infestation control and percent yield increase in maize aphid management experiment during 2018.

IV. Discussion

Imidagold 20SL is an insecticide; its formulations containing imidacloprid 20SL have been introduced in maize aphid and maize act as a controlling agent against maize aphid. The mode of action of Imidagold 20SL insecticides is systemic, contact and stomach barrier insecticides so it acts both contact and systemic mechanism. That is why it acts on the nervous system of insect and causes block the stomach system. For this reason, among the all tested insecticides, Imidagold 20SL provided the best control of maize aphid with the highest yield (Imidagold 20SL treated plot). The present findings can be compared with Suchail et al. (2001) and David et al. (2009), they reported that Imidagold 20SL was the most effective insecticide in suppressing the maize aphid, *R maidis* by 95.68%. 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. Among them, *azadirachtin* is the most important active ingredient, which is effected on insect as antifeedant, insect growth regulation, sterility and cellular processes. This *azadirachtin* can play effectively on maize aphid, *R maidis* and insect infestation control is high (Kubo et al., 2012; Frank et al., 2014). The leaf

extract of bishkathali has a strong biocidal and medicinal activity. They also 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 maize aphids with 87.6-94.5% mortality ($P \leq 0.01$) at 7 days after the application of spray at 227 L ha^{-1}. They also have strong antifeedant activity against maize aphid, 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 an octopaminergic nervous system of maize aphid which is absent in humans 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 maize aphid. Lemon, *C. limon* showed the highest repellent activity of 95% for *R. maidis* and 82.5% for *C. sinensis.* The positive control recorded 100% repellent activity, a sign of very potent repellent for controlling *R. maidis* (Frank et al., 2014).

The most identified components of garlic namely diallyl sulfphide, diallyl di-sulphide and diallyl trisulphide have antagonistic properties against several pests including maize aphid, tomato leaf miner, corn borer, potato tuber moth, red cotton bug, red palm weevil, houseflies and mosquitoes. They have lethal and repellent effects on larvae, pupae and adults of maize aphid. Within the 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 *R. maidis* between 20-40 hours after exposure. Compounds of garlic caused lethal and sub-lethal effects on *R. maidis* and, therefore, have the potential for pest control (Hamada et al., 2018; Angelica et al., 2017). All parts of mahogany were found effective against maize aphid. Different amount of concentrated extract from mahogany leaves was found to be effective and have 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 maize aphid (Gojo et al., 2018).

V. Conclusion

The current study clearly showed that yield loss is increased with the increase of infestation of maize as affected by maize aphid, *R. maidis*. Imidagold 20SL (Imidacloprid 20SL) is the highest performance on maize aphid as control agent with the highest yield. But in case of bio-pesticides performance, neem leaf extract is the best followed by garlic clove extract, lemon extract, bishkathali leaf extract and mahogany seed extract for controlling maize aphid. From the result, it also may be concluded that the percentage of insect infestation control was strong as well as positively correlated with the percent yield increase of maize grain i.e. yield of maize grain was increased due to an increase of percentage insect infestation control in maize production.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

VI. References

[1]. 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.

[2]. Alam, M. J., Ahmed, K. S., Hossen, B., Mozammel, H. and Hoque, A. B. M. Z. (2019a). 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.

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

[4]. Alam, M. J., Ahmed, K. S., Mollah, M. R. A., Tareq, M. Z. and Alam, M. J. (2015a). 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.

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

[6]. Alam, M. J., Ahmed, K. S., Rony, M. N. H., Islam, N. E. T. and Bilkis, S. E. (2019c). Bio-efficacy of bio-pesticides against tomato leaf miner, *Tuta absoluta,* a threatening pest of tomato. Journal of Bioscience and Agricultural Research, 22(02), 1852-1862. https://doi.org/10.18801/jbar.220219.229.

[7]. 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.

[8]. 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.

[9]. 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.

[10]. BBS, 2013, 2015 & 2016: Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, Bangladesh.

[11]. Boyd, B. M. (2008). Predaceous Behavior by *Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae: Heliothinae). Journal of Insect Behavior, 21, 143-46. https://doi.org/10.1007/s10905-007-9113-0.

[12]. David, P. K., Dean, G. T. and Taylor, A. S. (2009). Imidacloprid in leaves from systemically treated trees may inhibit litter breakdown by non-target invertebrates. Ecotoxicology and Environmental Safety, 72(4), 1053-1057. https://doi.org/10.1016/j.ecoenv.2008.09.017.

[13]. 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.

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

[15]. 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.

[16]. Gopalan, C., Rama, Sastri, B. V. and Balasubramanian, S. C. (2012). Nutritive value of Indian foods, National Institute of Nutrition, Indian Council of Medical Research (ICMR), Hyderabad, India. pp. 47.

[17]. 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.

[18]. 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.

[19]. 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.
[20]. Iita (2007). Research Guide 30, IITA Training Program PMB 5320, Ibadan, Nigeria 43.
[21]. Krishi Dairy (2017). Krishi Dairy of Ministry of Agriculture, Bangladesh.
[22]. 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.
[23]. Mathur, L. M. L. (1987). Bibliography of maize pests in India. AICMIP, Indian Agricultural Research Institute, New Delhi (Monograph).
[24]. Mollah, M. R. A., Ali, M. A., Ahmad, M., Hassan, M. K. and Alam, M. J. (2015). Effect of planting dates on the yield and quality of true seeds of onion. International Journal of Applied Sciences and Biotechnology, 3(1), 67-72. https://doi.org/10.3126/ijasbt.v3i1.11847.
[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, 3 (1), 01-04.
[26]. Mollah, M. R. A., Ali, M. A., Ahmed, M., Hassan, M. K. and Alam, M. J. (2014a). Effect of Fungicide Frequency on the growth, yield and quality of onion. Bangladesh Journal of Environment Science, 26, 135-138.
[27]. Mollah, M. R. A., Ali, M. A., Ahmed, M., Hassan, M. K. and Alam, M. J. (2014b). Effect of Frequency of Irrigation on the yield and quality of true seeds of onion. Bangladesh Journal of Environment Science, 26, 119-122.
[28]. Mollah, M. R. A., Ali, M. A., Ahmad, M., Hassan, M. K. and Alam, M. J. (2015b). Effect of bulb size on the yield and quality of true seeds of onion. European Journal of Biotechnology and Bioscience, 3(7), 23-27. https://doi.org/10.3126/ijasbt.v3i1.11847
[29]. Mollah, M. R. A., Ali, M. A., Ahmad, M., Hassan, M. K. and Alam, M. J. (2015c). Integrated crop management for production of true seeds of onion. World Journal of Pharmaceutical Research, 4(11), 214-225.
[30]. Painter, R. H. (1951). Insect resistance in corn plants. The University Press of Kansas, Lawrence and London. Pp. 207-212.
[31]. Sanjida, T., Alam, M. J., Rahman, M. M., Islam, M. S. and Sikdar, M. S. I. (2019). Response of mungbean growth and yield to GA_3 rate and time of application. Asian Journal of Crop, Soil Science and Plant Nutrition, 01(02), 28-36. https://doi.org/10.18801/ajcsp.010219.05
[32]. Suchail, S., David, G. and Belzunces, L. P. (2001). Discrepancy between acute and chronic toxicity induced by imidacloprid and its metabolites in *Apis mellifera*. Environmental Toxicology and Chemistry, 20(11), 2482-2486. https://doi.org/10.1002/etc.5620201113.
[33]. Tareq, M.Z., Khan, M. A., Mollah, M. A. F., Hasan, M. M. and Alam, M. J. (2015). Effect of storage environment on jute seed qualities. Bangladesh Journal of Environmental Science, 29, 45-48.
[34]. Williams, M. R. (2007). Cotton insect losses. pp. 974-1026.

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Vancouver
Alam, MJ, Ahmed, KS, Hoque, M, Mansura, A, Rony, MNH and Haque, MS. Bio-efficacy of some bio-pesticides against maize aphid, *Rhopalosiphum maidis*; a threatening pest of maize. Journal of Science, Technology and Environment Informatics. 2019 October 08(01): 563-573.