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EFFECT OF INSECTICIDES ON POPULATION REDUCTION OF SUCKING INSECTS AND LADY BIRD BEETLE IN EGGPLANT FIELD

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Abstract

This study evaluated the field efficacy of three newly introduced synthetic insecticides namely, Python 20SL (Nitenpyrum), Plenum 50WG (Pymetrozin), Polo 500SL (Diafentiuron) along with commonly used chemical Admire 200SL(Imidacloprid) against sucking insects of eggplant such as aphid, jassid, white fly and thrips. The effect of the insecticides on the population reduction of the novel predator lady bird beetle was also studied. Among the chemicals, Polo 500SC was found to be the most effective followed by Plenum 50WG against the sucking insects by reducing significant percentages of their population at 3 and 7 days after spray. Polo 500SC and Plenum 50WG were found to be the least deleterious against lady bird beetle since it caused lowest population reduction. Considering the higher percentages of population reduction of the pests and significantly lower affect on the predator, Polo 500SC and Plenum 50WG may be considered as a tool of IPM for management of sucking insects in the eggplant field.

Keywords: Hemipteroid insects, insecticides, predator, *Solanum melongina*.

Introduction

The eggplants *Solanum melongina* L. are grown throughout the year in Bangladesh. But its production is seriously impeded due to increasing threats from different sucking insect pests such as aphid *Aphis gossypii* Glover, jassid *Empoasca devastans* Distant, white fly *Bamisia tabaci* Gennadius and thrips *Frankliniella occidentalis* Pergande (Dutta *et al.,* 2012). The nymphs and adults of these hemipteroid insects ingest cell sap from the leaves of the plants with their piercing sucking mouthparts. The infested plants lead to crinkling and yellowing of the leaves, and reduce growth and vigour. While sucking the plant sap, jassids inject toxic saliva into the plant tissues which results to yellowing. When several insects attack the same plant, yellow spots appear on the leaves, become bronzing, wither and show "hopper burn" symptom. The leaves and fruits of the thrips infested plants appear cosmetic silvery color and become unhealthy (Srinivasan, 2009). The lady bird beetles are well known beneficial

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arthropods found in many habitats (Ali and Rizvi, 2009). The adults and larvae of lady bird beetles attack aphids, whiteflies, psyllids, scales and many other soft bodied insects and found to be an effective predatory fauna in eggplant ecosystem (Ali *et al.*, 2009).

The eggplant growers of Bangladesh mostly rely on broad spectrum insecticides to suppress sucking insects. The injudicious application of synthetic insecticides creates threats to eggplant ecosystem causing death of the pollinators and natural enemies of the pests. Pesticide residues in eggplant fruits are of great concern from the point of view of domestic consumption and export as well (Rashid *et al.,* 2003). The risk of using chemical insecticides in the management strategies can be reduced by incorporating safer molecules of chemicals. It is therefore, very essential to select insecticides that are very selective in action as well as safer to different beneficial fauna (Soni *et al.,* 2004).

Admire 200 SL is the most widely used insecticide for management of sucking pests of eggplant in Bangladesh. The farmers in Bangladesh often do not get desired result by spraying Admire and other conventional insecticides. More effective and safer insecticides must be introduced into IPM programs to provide alternatives to Admire and other conventional insecticides. Therefore, some new insecticides such as Python 10SL, Plenum 50WG and Polo 500SL have been registered.

The new insecticides that have achieved registration within the current regulatory environment of Bangladesh have reduced-risk and less toxicity to the pollinators, predators and parasitoids. These insecticides could be a potential tool in IPM programs. Therefore, this study was designed with the new insecticides Python 10SL, Plenum 50WG and Polo 500SL in comparison with Admire 200SL to find out the most effective chemical for managing sucking insects in the eggplant field, as well as safer to the lady bird beetles.

Materials and Methods

Study site and climatic conditions

The study was conducted in the field laboratory of the Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh (25°25′N, 89°5′E) during September 2014 to March 2015. The mean annual maximum and minimum temperatures, relative humidity, and rainfall in this area were 36.0°C and 12.7°C, 65.8%, and 237.6 cm, respectively.

Cultivation of the egg plant

The eggplant seedlings (variety BARI Begun-8) were collected from the Horticulture Research Center of BARI and transplanted in the field with an area of 5.5 m × 4.0 m. The experimental design was randomized complete block. The

spaces between blocks and between plots were 0.5 m and 1.0 m, respectively. Seedlings were planted on 5th September 2014 in rows. Each plot contained 1 row with 5 plants separated by 60 cm. A total of 75 plants were grown in 15 rows. The manures and fertilizers were applied according to the recommended doses of the BARI. Mulching, weeding and irrigation were done whenever necessary, and the shoot and fruit borer *Leucinodes orbonalis* Guenee (Pyralidae: Lepidoptera) was controlled mechanically.

Monitoring of the pests and application of the treatments

After transplanting, the plants were monitored weekly to observe the abundance and infestations of the sucking insects (aphid, jassid, white fly and thrips). The newly introduced insecticides Python 20 SL (Nitenpyrum), Plenum 50WG (Pymetrozin), Polo 500 SC (Diafenthiuron) and Admire 200 SL (Imidacloprid) were applied with concentrations of 1mL/L, 0.5g /L, 1mL/L and 0.5mL/L water after the infestation had occurred. An untreated control observation was made with spraying water. Each of the treatment was applied in three plots and each plot indicated a replication. All the treatments were sprayed four times at fortnightly interval with a hand sprayer.

Collection of pest and predator population data

Insect population abundance on the eggplants was recorded one day before spraying and, 3 and 7 days after spraying. The numbers of sucking insects (aphid, jassid, white fly and thrips) and lady bird beetles were recorded from the middle plant of each row during early morning. Five leaves were observed from different heights of each plant to record the population (both nymphs and adults) of the sucking pests, while total number of lady bird beetles present on the plant was also recorded. It is noted that two species of lady bird beetles (*Menochilus sexmaculatus* Fab. and *Micraspis discolor* Fab.) were abundant but data were taken together. The observed population reductions of the pests and predator were corrected according to Abbott (1925).

$$Pt = \frac{Po - Pc}{100 - Pc} \times 100$$

Where, Pt = Corrected population, Po = Observed population, Pc = Control population.

Statistical analysis

Data were analyzed by analysis of variance using SPSS (IBM SPSS statistics 21, Georgia, USA) software and means were separated by Duncan's Multiple Range Test (DMRT).

Results and Discussion

The tested insecticides showed significant difference ($F_{3, 8} = 4.3$, $p < 0.05$) in reducing aphid population after 3 days of spray (Table 1). The population reduction varied from 83.1 ± 4.0 to 92.0 ± 3.1% and the highest and lowest results were obtained in Polo 500SL and Admire 200SL, respectively. Plenum 50WG revealed statistically similar result to Polo 500SL. After 7 days of spray, aphid population reduction ranged from 91.9 ± 2.7 to 93.4 ± 2.2%, and there was no significant difference ($F_{3,8} = 0.23$, $p = 0.87$) (Table 1). T statistics showed that the aphid population reduction between 3 and 7 days after spray in each treatment was statistically insignificant.

Table 1. Effect of different insecticidal treatments on the population reduction of aphid in eggplant field

Insecticides	%Reduction		T statistic		
	3 day after treatment	7 day after treatment	d.f.	t	p
Python 20SL	89.3 ± 2.5 ab	92.6 ± 2.1 a	2	3.7	0.07
Plenum 50WG	91.2 ± 3.5 a	93.2 ± 2.3 a	2	0.8	0.51
Polo 500SC	92.0 ± 3.1 a	93.4 ± 2.2 a	2	1.7	0.23
Admire 200SL	83.1 ± 4.0 b	91.9 ± 2.7 a	2	4.1	0.06

Data express as mean ± SD. Means within a column followed by same letter(s) are not significantly different by DMRT ($p \leq 0.05$).

Table 2. Effect of different insecticidal treatments on the population reduction of jassid in eggplant field

Insecticides	%Reduction		T statistic		
	3 day after treatment	7 day after treatment	d.f.	t	p
Python 20SL	68.7 ± 1.1 a	72.1 ± 5.2 ab	2	0.9	0.46
Plenum 50WG	67.9 ± 2.8 a	70.4± 3.1 b	2	1.8	0.20
Polo 500SL	71.6 ± 3.1 a	77.8 ± 2.8 a	2	2.4	0.14
Admire 200SL	52.9 ± 2.5 b	59.3 ± 3.0 c	2	3.67	0.07

Data express as mean ± SD. Means within a column followed by same letter(s) are not significantly different by DMRT ($p \leq 0.05$).

There was found significant difference ($F_{3, 8} = 33.5$, $p < 0.001$) in reducing jassid population after 3 days of spray (Table 2). The population reduction varied from 52.9 ± 2.5 to 71.6 ± 3.1% and the lowest result was obtained by Admire 200SL. The other three treatments revealed statistically similar result. After 7 days of spray, jassid population reduction ranged from 59.3 ± 3.0 to 77.8 ± 2.8 %, and there was found significant difference ($F_{3,8} = 13.1$, $p < 0.001$) (Table 2). T statistics showed that the jassid population reduction between 3 and 7 days after spray in each treatment was statistically insignificant.

In table 3 significant difference ($F_{3, 8} = 258.2$, $p < 0.001$) was found in reducing whitefly population after 3 days of spray. The population reduction varied from 36.7 ± 2.1 to 83.5 ± 1.7%, and the highest and lowest results were found in Polo 500SL and Admire 200SL, respectively. After 7 days of spray, whitefly population reduction ranged from 41.4 ± 3.0 to 85.7 ± 1.6%, and there was found significant difference ($F_{3,8} = 250.6$, $p < 0.001$) (Table 3). T statistics showed that the whitefly population reduction between 3 and 7 days after spray in each treatment was statistically insignificant.

Table 3. Effect of different insecticidal treatments on the population reduction of white fly in eggplant field

Insecticides	%Reduction		T statistic		
	3 day after treatment	7 day after treatment	d.f.	t	p
Python 20SL	56.9 ± 2.81 c	58.7 ± 1.4 c	2	1.3	0.31
Plenum 50WG	77.5 ± 2.3 b	78.3 ± 2.3 b	2	2.7	0.12
Polo 500SL	83.5 ± 1.7 a	85.7 ± 1.6 a	2	2.9	0.10
Admire 200SL	36.7 ± 2.1 d	41.4 ± 3.0 d	2	1.7	0.23

Data express as mean ± SD. Means within a column followed by same letter(s) are not significantly different by DMRT ($p \leq 0.05$).

Table 4. Effect of different insecticidal treatments on the population reduction of thrips in eggplant field

Insecticides	%Reduction		T statistic		
	3 day after treatment	7 day after treatment	d.f.	t	p
Python 20SL	58.4 ± 3.7 b	62.2 ± 2.0 b	2	2.6	0.13
Plenum 50WG	72.4 ± 4.5 a	74.6 ± 1.5 a	2	0.6	0.59
Polo 500SL	74.0 ± 1.1a	76.3 ± 2.0 a	2	1.8	0.21
Admire 200SL	48.7 ± 0.7 c	55.7 ± 4.8 c	2	2.3	0.15

Data express as mean ± SD. Means within a column followed by same letter(s) are not significantly different by DMRT ($p \leq 0.05$).

Table 4 indicated that the population reduction of thrips after 3 and 7 days of spray varied from 48.7 ± 0.7 to 74.0 ± 1.1% and 55.7 ± 4.8 to 76.3 ± 2.0%, respectively, and the results differed significantly (3 days after spray: $F_{3,8} = 48.6$, $p < 0.001$; 7 days after spray: $F_{3,8} = 35.8$, $p < 0.001$). Among the treatments Polo 500SL and Plenum 50WG revealed statistically similar and higher percentages of population reduction both in 3 and 7 days after spray, while the Admire 200SL revealed the lowest percentages of reduction.

Diafenthiuron acts specifically on sucking pests namely aphid, whitefly and mites (Kadir and Knowles, 1991; Ishaaya *et al*. 1993). The findings of this study indicated that Diafenthiuron (Polo 500SL) followed by Pymetrozine (Plenum

50WG) provided higher effectiveness in controlling sucking insect pests as compared to others. However, Nitenpyram (Python 10SL) showed comparatively higher effectiveness to Imidacloprid (Admire 200SL) in reducing population of aphid, jassid, whitefly and thrips. Nitenpyrum showed statistically identical effectiveness to Diafenthiuron in reducing jassid population at 3 days after spray.

Imidacloprid controlled sucking insects attacking cotton (El-Naggar, 2006; El-Seady, 2009; Hossain *et al.*, 2012). In our study, Imidacloprid resulted poor performances in reducing aphid, jasssid, whitefly and thrips. It may be the cause that inadvertent use of Imidacloprid in Bangladesh might have developed certain level of resistance against sucking insect pests.

It is found from table 5 that the population reduction of lady bird beetle after 3 days of spray ranged from 34.4 ± 2.6 to 58.7 ± 2.8%, and after 7 days of spray from 39.1 ± 1.9 to 63.1 ± 3.2%. The percentages of population reduction both in 3 and 7 days after spray differed significantly ($F_{3,8} = 49.3$, $p < 0.001$ and $F_{3,8} = 41.3$, $p < 0.001$, respectively). The treatments Polo 500SL and Plenum 50WG revealed statistically identical as well as lower percentages of population reduction.

Table 5. Effect of different insecticidal treatments on the population reduction of lady bird beetle in eggplant field

Insecticides	%Reduction		T statistic		
	3 day after treatment	7 day after treatment	d.f.	t	p
Python 10SL	55.4 ± 2.8 a	63.1 ± 3.2 a	2	2.5	0.13
Plenum 50WG	36.1 ± 4.0 b	41.1 ± 2.9 b	2	2.2	0.16
Polo 500SL	34.4 ± 2.6 b	39.1 ± 1.9 b	2	3.5	0.07
Admire 200SL	58.7 ± 2.8 a	62.2 ± 5.2 a	2	1.6	0.26

Data express as mean ± SD. Means within a column followed by same letter(s) are not significantly different by DMRT ($p \leq 0.05$).

Considering safety to predators, our results clearly indicated that the two Neonicotinoid insectcicides (Admire 200 SL and Nitenpyrum 10 SL) were relatively toxic and Polo 500 SL and plenum 5 WG were relatively less toxic to lady bird beetles. A laboratory study by Bozsik (2006) indicated harmful effect of Imidacloprid on the lady bird beetle *Coccinella septempunctata* L. compared to other insecticides. Hossain *et al.* (2013) observed significantly lower abundance of lady bird beetle in the Imidacloprid treated cotton field compared to the field treated with Monocrotophos 40WSC. Ishaaya *et al.* (2007) observed that Plenum has no detrimental effect on natural enemies and on the environment, and as such is considered a potential component of IPM programs. Carbal *et al.* (2008) in a laboratory study observed that Pymetrozine had no adverse effects on immature or adult stages of *Coccinella undecimpunctata* L.

and hence are suitable for IPM of sucking pests. However, Ahmed *et al.* (2014) observed that Neonictinoids can be a suitable tool for inclusion in integrated pest management of sucking insect pests in major cotton growing areas because these have proved comparatively less toxic to predators as compared to non-selective insecticides.

From the standpoint of safety to lady bird beetles, Polo 500 SL followed by Plenum 50 WG appeared much safer than Python 20 SL and Admire 200 SL. Adoption of Polo 500 SL and Plenum 50 WG in eggplant IPM programs in Bangladesh will benefit producers and consumers by reducing total insecticide applications and subsequent costs for sucking pest control, as well as limiting further resistance development in pest populations. However, the efficacy of Polo 500 SL and Plenum 50 WG should be evaluated across the different locations and varied ecology in Bangladesh.

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