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FIELD EFFICACY OF SELECTED BIO-PESTICIDES AND SYNTHETIC INSECTICIDES AGAINST SUCKING PESTS OF COTTON AND THEIR IMPACT ASSESSMENT ON SPIDER

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ABSTRACT

The study was carried out to evaluate the efficacy of Toximite 1.8 EC, Ecomec 1.8 EC, Tundra 20 SP, Marshal 20 EC, Dursban 20 EC, Imitaf 20 SL, Haymidor 70 WG against sucking insect pests of cotton. Data regarding sucking pest infestation and prevalence of beneficial insects was recorded days before spray and, 3 and 7 days after spray. The results indicated that at 3 and 7 DAS, Imidacloprid (Haymidor 70 WG) provided the lowest number of jassid per leaf (2.75 and 1.75, respectively) with the highest population reduction (44.85%) over pre-treated population. At 3 and 7 DAS of second spray, the lowest number of jassid per leaf (1.17 and 1.42) was recorded in the Abamectin (biopesticide 1) and Acetamiprid (Tundra 20 SP) treated plot but the highest population reduction (67.56%) over pre-treated population was found in Imidacloprid (Imitaf 20 SL) treated plot. At 3rd spray, the highest population reduction (67.63%) was found in Carbosulfan (Marshal 20 EC) treated plot. The highest per cent reduction (38.19%) of mite infested leaf per plant was found in the Abamectin followed by Imidacloprid (Imitaf 20 SL) (33.33%) treated plot. At 3 DAS of first spray, the lowest number of spiders was recorded from the Imidacloprid (Imitaf 20 SL) (0.08) treated plot, implied that Imidacloprid adversely affect the spider population. The results revealed that the treatment Imidacloprid was identified as the superior and promising insecticide among the treatments against all the sucking pests of cotton followed by Acetamiprid (Tundra 20 SP). Biopesticides as Abamectin (Toximite 1.8 EC) and Azadirachtin (Ecomec 1.8 EC) were found as less toxic against spider compared to other tested insecticides.

Keywords: Biopesticides, cotton, efficacy, insecticides, sucking pests

INTRODUCTION

Cotton *Gossypium* spp. is one of the most commercially important fiber crops in the world. It provides raw material for Bangladesh textile industry and plays a key role in the national economy through employment generation and foreign exchange. Cotton is grown commercially in the temperate and tropical regions of more than 70 countries. Bangladesh primarily produces American upland (*Gossypium hirsutum*) cotton in the southwestern, northern and central regions yielding 95% of total production. It is also grown in three southeastern hill areas of Bangladesh (Mahmud 2019). Cotton is cultivated in about 49000 acres yielding 147000 bales in 2019-2020 which is less than our country demand (8.5 million bales) (BBS 2020).

The low production of cotton is due to small scale cultivation, insect pest and attack, farmers choice on other cash crop and lack of government initiative. But insect pests are one of the major limiting factors in cotton production. A total of 162 species of insect pests have been recorded among them 15 species are considered as major pests (Bohmfalk *et al*. 1996). In Bangladesh 29 species of pests were recorded and among them 13 species are major causes considerable damage of cotton in field every year (Ahmed *et al.* 2016). The yield and quality of different cotton cultivars are reduced by the attack of various sucking insects, predominantly aphid *Aphis gossypii* Clover, Jassid *Amrasca bigutulla*, white fly *Bemisia tabaci* Gennadius and thrips *Thrips tabaci* Lindeman Amin *et al.* 2008, Vennila *et al*. 2000. It is reported that, about 35–50% yield reduction is caused by sucking insect pests every year (Khan 2010, Majeed *et al*. 2016, Shah *et al*. 2017) and cotton jassid up to 23.67% (Razaq *et al*. 2005).

A wide range of systemic pesticides are being used against sucking pests without any notable success (Ahmad 1999, Luttrell *et al*. 2015). Most of the conventional chemicals are broad spectrum, persistent is in nature and have long residual action (Grundy *et al.* 2000). The beneficial insects and nontarget organisms were adversely affected when systemic insecticides applied (Khattak *et al.* 2004). Pietrantonio and Benedict (1999) were also observed simillar bad impact of systemic insecticides against predators.

Growth regulators and neonicotinoids are tested effective insecticides against cotton white fly of Bt cotton. So far these insecticides are considered less toxic to the predators of sucking insects pests (Solangi and Lohar 2007, Asi *et al.* 2008, Frank 2012). The neonicotinoids are a new class of insecticides which includes the commercial products viz. Imidacloprid, Acetamiprid, Thiacloprid and Thiamethoxam. These insecticides are important in agriculture because of their activity against sucking insect pests (Carvalho *et al*. 2010, Zhang *et al*. 2011).

Inappropriate use of non-selective pesticides cause harmful effects on crops, natural enemies and other environmental matrices. Insecticides are the part of pest management programme, used as a last option at recommended dose to keep pest populations below economic threshold (ET). So, the use of selective pesticides is very important for controlling of such sucking pests of cotton. Therefore, the present research was conducted to determine the field efficacy of some selective bio-pesticide and insecticides on sucking pest and their impacts on natural enemies and to develop an effective management strategy with a comparatively safe insecticide.

Materials and Methods

Location of the study: The field study on the efficacy of some pesticides against sucking insect pests of cotton was conducted at Cotton Research Training and Seed Multiplication Farm, Sadarpur, Dinajpur, Bangladesh during July to December, 2020.

Selection and collection tested pesticides: Eight treatments (T) including an untreated control were selected as follows:

Lay-out and design: The field layout was made after final land preparation. The experiment was conducted in randomize complete block design with three replications. The unit plot size was 9.8m x 3.6m and the spacing between block-to-block and plot-to-plot were 1.5m and 1m, respectively. The seeds of cotton variety CB 14 were sown maintaining spacing 90×30 m. Each plot had 4 rows and each row contained 28 plants. A total of 112 plants were cultivated in each plot. Intercultural operations such as irrigation and weeding were taken as and when necessary for proper growth and development of the plants.

Treatments application and data collection: The observations on sucking pests viz. jassids *Amrasca biguttula*, mite *Tetranychus urticae* infested leaves and their natural enemies such as spider *Oxyopes salticus* and lady bird beetle were recorded as number of insects per 3 leaves on randomly selected 4 plants from each treatment. Mean number of insect population were calculated per leaf. All the insecticidal treatments were applied three times according to the crop growth stages at 40, 55 and 70

Table 1. List of pesticides, their generic name, doses and manufacturer used in the study

Treatments-Trade name	Generic name	Doses	Manufacturer
Toximite 1.8 EC (biopesticide 1)	Abamectin	10 ml/ 10L water	Square Pharmaceuticals Ltd.
Ecomec 1.8 EC (biopesticide 2)	Azadirachtin	10 ml/ 10L water	Ispahani Agro Ltd.
Tundra 20 SP	Acetamiprid	5 gm/ 10L water	Auto Crop Care Ltd.
Marshal 20 EC	Carbosulfan	30 ml/ 10L water	FMC Chemical Int. AG
Dursban 20 EC	Chlorpyriphos	14 ml/ 10L water	Auto Crop Care Ltd.
Imitaf 20 SL	Imidacloprid (1)	2.5 ml/ 10L water	Auto Crop Care Ltd.
Haymidor 70 WG	Imidacloprid (2)	2 gm/ 10L water	Padma Oil Company Ltd.
Control	-	-	-

The selected pesticides were collected from the dealer shop of the local market of Dinajpur, Bangladesh.

days after sowing (DAS). Insect number was recorded at 1 day before spray (pretreated condition) and, 3 and 7 days after each spray (after treatment application). Percentage reduction of insect on leaf over pretreated population was calculated using the following formula.

% reduction of insect over pretreated condition = (MC–MT)/Mc ×100

Where, MC = mean number of insects in pretreated condition and

MT = mean number of insects in the treatment.

Statistical analysis: The data were analyzed by MSTAT-C program and treatment means were compared by following Duncan's Multiple Range Test (DMRT). All % data were transformed by square root transformation method.

Results and Discussion

Efficacy data of pesticides against the population level of jassids at different growth stages of cotton field at first spray schedule are presented in Table 2. The results showed that the jassid population before the first spray varied significantly ($P< 0.05$, $F = 2.971$, $df =7$) among the treatments ranged from 2.92 to 6.58 individuals per leaf. In this spray schedule jassids population observed in lower at 3 DAS and 7 DAS compared to control . The lowest number of jassid per leaf (2.75 and 1.75, respectively) was recorded in the Imidacloprid-2 (Haymidor 70 WG) at 3 DAS and 7 DAS. The highest population reduction (44.85%) over pre-treated population was also found in the Imidacloprid-2 (Haymidor 70 WG) followed by the treatment of Imidacloprid-1 (Imitaf 20 SL) (38.88%). The population was increased (3.32%) in control over pretreated treatment.

The jassid population before 1 day of the application of second and third spray of insecticides varied significantly ($P< 0.01$, $F = 6.851$, $df =7$) and ($P< 0.01$, $F = 6.861$, $df =7$) among the treatments ranged from 1.75 to 6.58 and 1.42 to 7.25 individuals per leaf respectively (Table 3 and 4). After 3 and 7 days of second spray, the lowest number of jassid (1.17 and 1.42) was recorded in the Abamectin (biopesticide 1) (Toximite 1.8 EC) and Acetamiprid (Tundra 20 SP) treated plot, respectively (Table 3). The population reduction over pre-treated population was the highest (67.567%) in Imidacloprid-1 (Imitaf 20 SL) treated

Table 2. Efficacy of pesticides against jassid on cotton field at first spray

Treatments	Number of jassid per leaf				% reduction over pretreated population
	1DBS	3DAS	7 DAS	Cumulative mean of 3 and 7 DAS	
Bio-pesticide -1 (Abamectin)	3.17±0.44 b (1.91)	2.92±0.17 bc (1.85)	3.00±0.14 bcd (1.87)	2.95	6.94
Bio-pesticide -2 (Azadiractin)	3.92±0.51 ab (2.09)	4.08±0.98 abc (2.12)	2.33±0.60 cd (1.67)	3.20	18.37
Acetamiprid	4.50±0.43 ab (2.23)	3.50±0.50 abc (1.99)	3.75±0.72 bc (2.05)	3.62	19.55
Carbosulfan	6.58±1.31 a (2.64)	6.00±1.13 ab (2.53)	4.08±0.60 b (2.13)	5.04	23.41
Chlorpyriphos	2.92 ±0.08 b (1.85)	3.33±0.82 abc (1.93)	2.33±0.65 cd (1.66)	2.83	3.08
Imidacloprid -1	4.50±0.52 ab (2.23)	3.00±0.58 bc (1.86)	2.50±0.25 bcd (1.73)	2.75	38.88
Imidacloprid -2	4.08±1.34 ab (2.10)	2.75±1.15 c (1.71)	1.75±0.25 d (1.50)	2.25	44.85
Control	6.33±0.68 a (2.61)	6.33±0.55 a (2.61)	6.83±0.58 a (2.70)	6.54	-3.32
LSD	0.50	0.64	0.40	-	-
CV (%)	13.23	17.87	12.24	-	-
Level of sig.	*	*	**	-	-

Means within a column followed by different letters are significantly different at 0.05%. DBS: Days before spray, DAS - Days after spray, Figures in the parentheses are √(x+0.5) transformed values, ** indicates 1% level of significance and * indicates 5% level of significance.

Table 3. Efficacy of pesticides against jassid on cotton field at second spray

Treatments	Number of jassid per leaf				% reduction over pretreated population
	1DBS	3DAS	7 DAS	Cumulative mean of 3 and 7 DAS	
Bio-pesticide 1 (Abamectin)	3.17±0.44 b (1.91)	1.17±0.08 b (1.29)	2.08±0.30 b (1.60)	1.63	48.58
Bio-pesticide 2 (Azadiractin)	3.92±0.51 ab (2.09)	1.92±0.36 b (1.55)	2.58±0.74 b (1.73)	2.25	42.60
Acetamiprid	4.50±0.43 ab (2.23)	1.58±0.60 b (1.41)	1.42±0.30 b (1.38)	1.50	66.67
Carbosulfan	6.58±1.31 a (2.64)	2.33±0.98 b (1.63)	2.67±0.68 b (1.76)	2.50	62.01
Chlorpyriphos	2.92 ±0.08 b (1.85)	1.42±0.08 b (1.38)	1.83±0.33 b (1.52)	1.63	44.18
Imidacloprid	4.50±0.52 ab (2.23)	1.25±0.14 b (1.32)	1.67±0.36 b (1.46)	1.46	67.56
Imidacloprid	4.08±1.34 ab (2.10)	1.25±0.25 b (1.32)	2.00±1.00 b (1.52)	1.63	60.05
Control	6.33±0.68 a (2.61)	6.67±0.71 a (2.67)	7.25±0.72 a (2.78)	6.96	-9.95
LSD	0.5046	0.4345	0.5135	-	-
CV (%)	13.23%	16.01%	17.23%	-	-
Level of sig.	*	**	**	-	-

Means within a column followed by different letters are significantly different at 0.05%. DBS: Days before spray, DAS - Days after spray, Figures in the parentheses are √(x+0.5) transformed values. ** indicates 1% level of significance and * indicates 5% level of significance.

plot and the second highest was recorded in Acetamiprid (Tundra 20 SP) (66.67%) treated plot. At second spray schedule the population was increased (9.95%) over pretreated treatment in control. In third spray schedule the number of jassid population (1.50 and 1.67) was recorded the lowest in the treatment of Acetamiprid (Tundra 20 SP) treated plot at 3 DAS and 7 DAS with population reduction over pretreated treatments was 64.89% (Table 4). And the highest jassid population reduction (67.63%) was recorded in the treatment of carbosulfan (Marshal 20 EC) treated plot followed by Acetamiprid (Tundra 20 SP). But the percent jassid population was increased (23.06%) over pretreated control was noticed in the control treatment (Table 4).

Findings of the present study are consistent with the study conducted by Razaq *et al.* (2005). They also found minimum population of jassids (0.43 jassid / leaf) in plots treated with Acetamiprid followed by Thiamethoxam (0.95 jassid / leaf), Diafenthiuron (1.06 jassid/leaf) at 7 days after application. Sreekanth and Reddy (2011) noticed that the most effective insecticides for aphids and leafhoppers up to seven days were Imidacloprid and Acetamiprid. At 3 and 7 DAS, Imidacloprid recorded maximum mortality of 89.13% and 96.50% of jassid population, respectively.

The data regarding mite infestation at 1 day before and, 3 and 7 days after first, second and third spray are presented in Table 5, 6 and 7. The result revealed that 1 day before first spray, average mite infested leaf per plant ranged from 7.00 to 13.75 which was statistically different ($P< 0.05$, $F = 3.222$, $df =7$) from other treatments. However, 3 DAS of first spray, the mite infested leaf per plant was found to decrease in all pesticidal plot but in control treatments there were no changes. Meanwhile, a steady number of mite infested leaf per plant was noticed at 7 DAS. The lowest number of mite infested leaf per plant4.08 and 4.67, respectively was recorded from Imidacloprid-2 (Haymidor 70 WG) treated plot after 3 and 7 days, respectively of first spray and statistically differed ($P< 0.05$, $F = 3.457$, $df =7$) and ($P< 0.01$, $F = 7.466$, $df =7$) from other treatments. The next decrease of mite infested leaf per plant (4.42 and 5.58, respectively) was recorded

Table 4. Efficacy of pesticides against jassid on cotton field at third spray

Treatments	Number of jassid per leaf				% reduction of jassid population over pretreated population
	1DBS	3DAS	7 DAS	Cumulative mean of 3 and 7 DAS	
Bio-pesticide 1 (Abamectin)	3.17±0.44 b (1.91)	2.17±0.08 b (1.63)	3.08±0.08 b (1.89)	2.63	17.03
Bio-pesticide 2 (Azadiractin)	3.92±0.51 ab (2.09)	2.67±1.04 b (1.74)	2.92±1.17 bc (1.80)	2.79	28.83
Acetamiprid	4.50±0.43 ab (2.23)	1.50±0.25 b (1.41)	1.67±0.30 c (1.47)	1.58	64.89
Carbosulfan	6.58±1.31 a (2.64)	2.00±0.14 b (1.58)	2.25±0.14 bc (1.66)	2.13	67.63
Chlorpyriphos	2.92 ±0.08 b (1.85)	1.67±0.08 b (1.47)	2.00±0.14 bc (1.58)	1.84	36.98
Imidacloprid	4.50±0.52 ab (2.23)	1.58±0.08 b (1.44)	2.17±0.17 bc (1.63)	1.88	58.22
Imidacloprid	4.08±1.34 ab (2.10)	2.25±0.76 b (1.63)	2.25±0.38 bc (1.65)	2.25	44.85
Control	6.33±0.68 a (2.61)	7.58±0.79 a (2.84)	8.00±0.25 a (2.91)	7.79	-23.06
LSD	0.5046	0.4240	0.3712	-	-
CV (%)	13.23%	14.30%	11.81%	-	-
Level of sig.	*	**	**	-	-

Means within a column followed by different letters are significantly different at 0.05%. DBS: Days before spray, DAS - Days after spray, Figures in the parentheses are √(x+0.5) transformed values. ** indicates 1% level of significance and * indicates 5% level of significance.

Table 5. Efficacy of pesticides against mite on cotton field at first spray

Treatments	Number of mite infested leaf per plant				% reduction over pretreated population
	1DBS	3DAS	7 DAS	Cumulative mean of 3 and 7 DAS	
Bio-pesticide 1 (Abamectin)	12.83±1.67 a (3.63)	8.00±1.01 ab (2.91)	8.08±0.79 bc (2.92)	8.04	37.33
Bio-pesticide 2 (Azadiractin)	11.50±1.15 ab (3.45)	10.25±1.42 a (3.26)	10.25±0.95 ab (3.27)	10.25	10.87
Acetamiprid	11.00±1.53 ab (3.38)	9.58±2.07 a (3.14)	10.83±1.58 ab (3.35)	10.21	7.18
Carbosulfan	11.75±0.58 ab (3.50)	10.33±0.74 a (3.29)	11.47±1.74 a (3.47)	11.50	2.13
Chlorpyriphos	7.00±1.51 c (2.71)	6.42±1.09 b (2.62)	5.58±1.42 cd (2.59)	5.00	28.57
Imidacloprid	12.75±2.17 a (3.75)	7.50±2.57 ab (2.73)	8.75±1.15 bc (3.03)	8.13	36.23
Imidacloprid	7.67±0.51 bc (2.85)	4.08±1.40 b (2.09)	4.67±1.20 d (2.24)	4.38	42.89
Control	11.58±0.51 ab (3.47)	11.58±0.74 a (3.47)	10.92±0.30 ab (3.38)	11.25	2.85
LSD	0.6216	0.8579	0.5015	-	-
CV (%)	10.63	17.01	9.42	-	-
Level of sig.	*	*	**	-	-

Means within a column followed by different letters are significantly different at 0.05%. DBS: Days before spray, DAS - Days after spray, Figures in the parentheses are √(x+0.5) transformed values, ** indicates 1% level of significance and * indicates 5% level of significance.

Table 6. Efficacy of pesticides against mite on cotton field at second spray

Treatments	Number of mite infested leaf per plant				% reduction over pretreated population
	1DBS	3DAS	7 DAS	Cumulative mean of 3 and 7 DAS	
Bio-pesticide 1 (Abamectin)	12.83±1.67 a (3.63)	8.0±2.40 a (2.90)	8.00±1.76 a (2.90)	8.00	37.65
Bio-pesticide 2 (Azadiractin)	11.50±1.15 ab (3.45)	10.25±1.51 a (3.36)	11.58±1.62 a (3.48)	10.92	5.04
Acetamiprid	11.00±1.53 ab (3.38)	11.42±1.17 a (3.41)	9.00±0.82 ab (3.18)	10.21	7.18
Carbosulfan	11.75±0.58 ab (3.50)	8.92±1.99 abc (3.10)	7.42±0.88 a (3.30)	8.17	30.47
Chlorpyriphos	7.00±1.51 c (2.71)	5.17±0.65 c (2.37)	5.33±1.24 b (2.44)	5.25	25.00
Imidacloprid	12.75±2.17 a (3.75)	8.67±1.52 abc (3.01)	8.33±1.83 a 2.98)	8.50	33.33
Imidacloprid	7.67±0.51 bc (2.85)	4.08±2.20 bc (2.20)	4.53±2.38 b (2.22)	4.31	43.81
Control	11.58±0.51 ab (3.47)	10.75±0.38 ab (3.35)	10.25±0.38 a (3.28)	10.50	9.32
LSD	0.6216	0.8158	0.6142	-	-
CV (%)	10.63	14.50	11.04	-	-
Level of sig.	*	*	**	-	-

Means within a column followed by different letters are significantly different at 0.05%. DBS: Days before spray, DAS - Days after spray, Figures in the parentheses are √(x+0.5) transformed values, ** indicates 1% level of significance and * indicates 5% level of significance.

from Chlorpyriphos (Dursban 20 EC) treated plot. These two treatments were found significantly superior than the other. Present investigation clearly indicates that insecticidal treatments were highly efficient in managing the sucking insect pests than biopesticides.

The highest % reduction (42.89%) of mite infested leaf per plant over pre-treated population was found in the treatment of Imidacloprid-2 (Haymidor 70 WG) followed by the treatment of biopesticide 1 (Abamectin: Toximite 1.8 EC) (37.33%) and Imidacloprid-1 (Imitaf 20 SL) (36.23%) (Table 5). In control treatment, the population was slightly decreased (2.85%) over pretreated treatment. At 3 and 7 DAS, % reduction of mite infested leaf per plant was also observed. At second spray the highest % reduction (43.81%) of mite infested leaf per plant over pre-treated population was found in the treatment of Imidacloprid-2 (Haymidor 70 WG) followed by the treatment of biopesticide 1 (Abamectin: Toximite 1.8 EC) (37.65%) and Imidacloprid-1 (Imitaf 20 SL) (33.33%) (Table 6). On the other hand the highest % reduction (38.19%) of mite infested leaf per plant over pre-treated population was found in the biopesticide 1 (Abamectin: Toximite 1.8 EC) followed by Imidacloprid-1 (Imitaf 20 SL) (33.33%) (Table 7).

It is evident from the present findings that Imidacloprid is effective to control the mites. Imidacloprid (Haymidor 70 WG) is a systemic insecticide belonging to the chemical class of neonicotinoids and is very effective against various insect pests (Tomizawa and Casida 2005). Haymidor 70 WG is a product of most advanced technology which dissolves very fast in the water and forms a uniform and stable spray suspension. It is safe for the plant and has better spread faster absorption of active ingredient by the plants resulting in better efficacy (Carvalho *et al*. 2010, Zhang *et al*. 2011). In the present study, biopesticide-1 was also found the effective against mite pests. Abamectin, showed potent activity against arthropods in preliminary laboratory evaluations and was subsequently selected for development to control phytophagous mites and insect pests on a variety of agricultural and horticultural crops worldwide (Lasota and Dybas 1990). Abamectin has shown low toxicity to non-target beneficial arthropods which has accelerated its acceptance into Integrated Pest

Table 7. Efficacy of pesticides against mite on cotton field at third spray

Treatments	Number of mite infested leaf per plant				% reduction over pretreated population
	1DBS	3DAS	7 DAS	Cumulative mean of 3 and 7 DAS	
Bio-pesticide 1 (Abamectin)	12.83±1.67 a (3.63)	8.33±1.17 a (2.97)	7.53±1.97 a (2.870)	7.93	38.19
Bio-pesticide 2 (Azadiractin)	11.50±1.15 ab (3.45)	11.50±0.38 abc (3.46)	10.00±1.13 ab (3.30)	10.75	6.52
Acetamiprid	11.00±1.53 ab (3.38)	9.12±0.95 abc (3.10)	8.58±0.58 a (3.00)	8.85	19.54
Carbosulfan	11.75±0.58 ab (3.50)	10.08±1.16 bc (3.25)	10.25±1.46 ab (3.31)	10.17	13.44
Chlorpyriphos	7.00±1.51 c (2.71)	5.42±1.61 ab (2.50)	5.17±1.46 a (2.43)	5.30	24.28
Imidacloprid	12.75±2.17 a (3.75)	8.17±0.96 cd (2.93)	8.83±1.10 b (3.04)	8.5	33.33
Imidacloprid	7.67±0.51 bc (2.85)	6.33±0.74 d (2.46)	5.58±1.08 b (2.42)	5.96	22.29
Control	11.58±0.51 ab (3.47)	11.58±0.85 bcd (3.46)	10.92±0.42 ab (3.38)	11.25	2.97
LSD	0.6216	0.4032	0.5340	-	-
CV (%)	10.63	6.90	8.89	-	-
Level of sig.	*	**	*	-	-

Means within a column followed by different letters are significantly different at 0.05%. DBS: Days before spray, DAS - Days after spray, Figures in the parentheses are √(x+0.5) transformed values, ** indicates 1% level of significance and * indicates 5% level of significance.

Table 8. Impact of pesticides on spider associated with sucking pests in the cotton field after 1st, 2nd and 3rd spray

Treatments	Number of spiders per plant								
	1st spray			2nd spray			3rd spary		
	1DBS	3DAS	7 DAS	1DBS	3DAS	7 DAS	1DBS	3DAS	7 DAS
Bio-pesticide 1 (Abamectin)	0.17±0.17 a (0.80)	0.17±0.08 b (0.81)	0.17±0.08 a (0.81)	0.17±0.08 a (0.81)	0.17±0.17 a (0.80)	0.17±0.17 a (0.80)	0.17±0.17 a (0.80)	0.00±0.00 a (0.71)	0.17±0.08 a (0.81)
Bio-pesticide 2 (Azadiractin)	0.33±0.17 a (0.90)	0.58±0.22 ab (1.03)	0.08±0.08 a (0.76)	0.08±0.08 a (0.76)	0.25±0.00 a (0.87)	0.42±0.17 a (0.95)	0.42±0.17 a (0.95)	0.17±0.08 a (0.81)	0.17±0.08 a (0.81)
Acetamiprid	0.67±0.55 a (1.02)	1.08±0.51 a (1.22)	0.50±0.25 a (0.99)	0.50±0.25 a (0.99)	0.08±0.08 a (0.76)	0.33±0.17 a (0.90)	0.33±0.17 a (0.90)	0.25±0.25 a (0.84)	0.17±0.17 a (0.80)
Carbosulfan	0.08±0.08 a (0.76)	0.25±0.25 b (0.84)	0.50±0.25 a (0.99)	0.50±0.25 a (0.99)	0.42±0.08 a (0.96)	0.25±0.14 a (0.86)	0.25±0.14 a (0.86)	0.33±0.08 a (0.91)	0.50±0.29 a (0.98)
Chlorpyriphos	0.42±0.30 a (0.93)	0.42±0.08 ab (0.96)	0.58±0.30 a (1.02)	0.58±0.30 a (1.02)	0.08±0.08 a (0.76)	0.17±0.17 a (0.80)	0.17±0.17 a (0.80)	0.42±0.22 a (0.94)	0.08±0.08 a (0.76)
Imidacloprid	0.67±0.36 a (1.05)	0.08±0.08 b (0.76)	0.33±0.33 a (0.88)	0.33±0.33 a (0.88)	0.33±0.08 a (0.91)	0.08±0.08 a (0.76)	0.08±0.08 a (0.76)	0.50±0.29 a (0.98)	0.17±0.17 a (0.80)
Imidacloprid	0.42±0.42 a (0.91)	0.58±0.17 ab (1.03)	0.25±0.14 a (0.86)	0.25±0.14 a (0.86)	0.33±0.22 a (0.90)	0.00±0.00 a (0.71)	0.00±0.00 a (0.71)	0.33±0.17 a (0.90)	0.17±0.17 a (0.80)
Control	0.00±0.00 a (0.71)	0.17±0.17 b (0.80)	0.08±0.08 a (0.76)	0.08±0.08 a (0.76)	0.08±0.08 a (0.76)	0.08±0.08 a (0.76)	0.08±0.08 a (0.76)	0.33±0.08 a (0.91)	0.17±0.08 a (0.81)
LSD	0.4447	0.3284	0.3284	0.3284	0.1974	0.2322	0.2322	0.2844	0.2625
CV (%)	28.91%	20.18%	21.46%	21.46%	13.77%	16.29%	16.29%	18.62%	18.34%
Level of sig.	NS	*	NS	NS	NS	NS	NS	NS	NS

Means within a column followed by different letters are significantly different at 0.05%. DBS: Days before spray, DAS - Days after spray, Figures in the parentheses are √(x+0.5) transformed values, ** indicates 1% level of significance and * indicates 5% level of significance.

Management programs (IPM) (Lasota and Dybas 1990). Rabbi *et al.* (2021) stated that in the laboratory trials, abamectin caused 100% mortality of *T. urticae* within 3 hours.

Many beneficial insects and arthropods like coccinellid, spider, ant, lacewing bug, etc. are associated with agricultural crop fields as predators of variuos of pest. Cotton ecosystem also comprises of wide range of such fauna. In the experimental area, population of non-target general predators associated with cotton was moderate during the experimental period where spiders, lady bird beetle and mirid bug was found predominant. The stated species of spiders were recorded and presented in table 8. The non-target beneficial predator like spider has a direct role in controlling the population of different soft bodied insects below threshold

The spider population ranged from 0.08 to 0.67 which was not statistically different from other treatment. At 3 DAS of first spray, the highest number of spiders was recorded in the Acetamiprid (Tundra 20 SP) treatment (1.08) followed by Azadirachtin (biopesticide 2) Ecomec 1.8 EC (0.58) and Chlorpyriphos (Dursban 20 EC) (0.42). But at 7 DAS, there were no significant different among the treatments. A steady number of spider populations was found in the control treatments after first, second and third spray of insecticides. The result reveals that Abamectin (biopesticide 1) Toximite 1.8 EC and Azadirachtin (biopesticide 2) Ecomec 1.8 EC were found safer compared to other insecticides applied. Reported that beneficial insect fauna (lady bird beetle, spider, mirid bug) were adversely affected when systemic insecticides were applied to kill the cotton pests (Khattak *et al.,* 2004). Hossain *et al.* (2013) also found that Imidacloprid reduced the population of spider and other predators on cotton field.

Conclusion

Based on these findings, the treatment Imidacloprid was identified as the superior and promising insecticide among the treatments against the sucking pests of cotton followed by Acetamiprid (Tundra 20 SP) whereas, biopesticides were less effective against the sucking pests compared to synthetic insecticides. But biopesticides- Abamectin (Toximite 1.8 EC) and Azadirachtin (Ecomec 1.8 EC) were found as less toxic against natural enemies compared to insecticides.

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REFERENCES

Ahmed HU, Latif MA, Huq MF, Mia AT, Latif MA, Ahmed S and Awal MR. 2016. Pest risk analysis (PRA) of cotton in Bangladesh, SPCB Project, Plant Quarantine Wing, DAE. P. 48-55.

Amin MR, Ahad MA, Hossain MH, Hossain SMA and Tithi DA. 2008. Characteristics of some cotton varieties in relation to seasonal abundance of pests, predators and their impact on yield and quality. Journal of Agroforestry and Environment, *2*: 67-70.

Amin MR, Tithi DA and Kwon YJ. 2011. Characteristics of three cotton varieties and their impact on feeding and growth of cotton armyworm. Entomological Research, *41*: 151-156.

Asi MR, Afzal M, Anwar SA and Bashir MH. 2008. Comparative efficacy of insecticides against sucking insect pests of cotton. Pakistan Journal of Life and Social Sciences, *6*: 140-142.

BBS (Bangladesh Bureau of Statistics). 2020. Statistical year book of Bangladesh. Bangladesh Bureau of Statistics. Planning division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh, p. 143.

Bohmfalk GT, Frisbie RE, Sterling WL, Metzer RB and Knutson AE. 1996. Identification, biology and sampling of cotton insects. Texas Agricultural Extension Services. The Texas A and M University System.

Carvalho GA, Godoy MS, Parreira DS, Lasmar O, Souza JR and Moscardini VF. 2010. Selectivity of growth regulators and neonicotinoids for adults of *Trichogramma pretiosum* (Hymenoptera: Trichogrammatidae). The Revista Colombiana de Entomología, *36*: 195-201.

Frank SD. 2012. Reduced risk insecticides to control scale insects and protect natural enemies in the production and maintenance of urban landscape plants. Environmental Entomology, *41*: 377-386.

Grundy PR, Maelzer D, Collins PJ and Hassan E. 2000. Potential for integrating eleven agricultural insecticides with the predatory bug *Pristhesancus plagipennis* (Hemiptera: Reduviidae). Journal of Economic Entomology, *93*:584-589. DOI 10.1603/0022-0493-93.3.584.

Hossain SMA, Baque MA and Amin MR. 2013. Comparative effectiveness of seed treating and foliar insecticides against sucking pests of cotton and impact on their natural enemies. Bangladesh Journal of Agricultural Research, *38*: 61-70.

Khan I. 2010. Efficacy of different insecticides against army worm, *Spodoptera litura* from different districts of Punjab. MSc thesis, Agriculture College, Gomal University, Dera Ismail Khan, Pakistan, P. 176.

Khattak MK, Khan SD, Khan L and Shah GS. 2004. Efficacy of various insecticides on the damage and incidence of cotton boll worms and beneficial fauna. Pakistan Entomologist, *26*: 19-23.

Lasota JA and Dybas RA. 1990. Abamectin as a pesticide for agricultural use. Acta Leiden. *59*: 217-25.

Luttrell RG, Teague TG and Brewer MJ. 2015. Cotton insect pest management. Cotton, *57*: 509-546.

Mahmud T. 2019. Bangladesh cotton and products annual. USDA Foreign Agricultural Service. GAIN Report Number: BG 1904. p. 2.

Majeed MZ, Javed M, Riaz MA and Afzal M. 2016. Population dynamics of sucking pest complex on some advanced genotypes of cotton under unsprayed conditions. Pakistan Journal of Zoology, *48*: 475-480.

Rabbi A, Uddin M. N, Alim MA, Bachchu MAA, Bhuyain MMH and Akter S. 2021. Efficacy of some pesticides against *Tetranychus urticae* Koch (Acari: Tetranychidae) and their residual effects on *Coccinella septempunctata* (L.) (Coleoptera: Coccinellidae). International Journal of Tropical Insect Science, https://doi.org/10.1007/s42690-021-00581-w.

Razaq M, Suhail A, Aslam M, Arif MJ, Saleem MA and Khan MHA. 2005. Evaluation of neonicotinoids and conventional insecticides against cotton jassid, *Amrasca devastans* (Dist.) and cotton whitefly, *Bemisia tabaci* (Genn.) on cotton. Pakistan Entomologist, *27*: 75-78.

Shah SIA, Malik TH, Khan IR and Hussain Z. 2017. Screening of USDA cotton accessions against sucking insect pests complex and cotton leaf curl virus (CLCuV) disease with major emphasis on abiotic factors. Pakistan Journal of Zoology, *49*: 1159-1173.

Solangi BK and Lohar MK. 2007. Effect of some insecticides on the population of insect pests and predators on okra. Asian Journal of Plant Sciences, *6*: 920-926.

Sreekanth PN and Reddy KS. 2011. Efficacy of different insecticides against sucking pests of cotton. Environment and Ecology, *29*: 2035-2039.

Tomizawa M and Casida JE. Neonicotinoid insecticide toxicology: mechanisms of selective action. Annual Review of Pharmacology and Toxicology, *45*: 247-68.

Vennila S, Ramasundram P, Sheo R and Kairon MS. 2000. Cotton IPM and its current status. Central Institute for Cotton Research Technical Bulletin*, 8*: 1-13.

Zhang L, Greenberg SM, Zhang Y and Liu TX. 2011. Effectiveness of thiamethoxam and imidacloprid seed treatments against *Bemisia tabaci* (Hemiptera: Aleyrodidae) on cotton. Pest Management Science, *67*: 226-232.