



Management of sucking insect pests of tomato (*Solanum lycopersicum*) with insecticides and their impact on beneficial arthropods

AMBIKA RANI MONDAL¹, MD RAMIZ UDDIN MIAH¹, MD YUNUS MIAH¹, MANSURA AFROZ¹, MD KHAIRUL MAZED¹, SANG JAE SUH² and MD RUHUL AMIN^{1*}

Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh

Received: 6 March 2023; Accepted: 12 June 2023

ABSTRACT

The present study was carried out at the research field of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh, during the tomato (*Solanum lycopersicum* L.) growing seasons of 2021 and 2022 to evaluate the pest management benefit of 4 insecticides, viz. Karate 2.5 EC (λ -cyhalothrin), Ripcord 10 EC (cypermethrin), Marshal 20 EC (carbosulfan), and Shobicron 425 EC (profenofos Q + cypermethrin) against sucking insect pests (aphids, jassids, whiteflies and thrips) of tomato. The abundance of the sucking pests was significantly lower in the insecticide treated plots compared with the untreated control. During both the years, carbosulfan was the most effective insecticide against aphids (3.1 and 0.8 aphids/3 leaves, respectively), jassids (0.1 and 0.7 jassid/3 leaves, respectively), and thrips (1.9 and 1.1 thrips/3 leaves, respectively), whereas the profenofos Q + cypermethrin decreased the abundance of whiteflies (1.4 and 2.0 whiteflies/3 leaves, respectively). However, these insecticides had negative effects on the pollinator insect and natural enemies of sucking pests in tomato fields. The insecticide-treated plots showed a significantly lower number of predators and pollinator than the untreated control plots. In the 1st and 2nd years, plots treated with cypermethrin (1.1 predators/plant) and λ -cyhalothrin (1.2 predators/plant), respectively, showed the highest abundance of predators. Among the insecticide-treated plots, profenofos Q + cypermethrin treated plots showed the highest abundance of pollinator in both years (1st year: 0.7/ plot and 2nd year: 0.9/ plot). Carbosulfan treated plot showed the highest mean yield (58.7 tonnes/ha) with the highest marginal benefit-cost ratio (5.1).

Keywords: Marginal benefit-cost ratio, Pollinator, Predator, Sucking insects

Tomato (*Solanum lycopersicum* L.), a member of the Solanaceae family, is one of the commonly grown vegetables worldwide. In Bangladesh, the total tomato production in 2020 was 447,815.4 m tonnes and the area of cultivation was approximately 29,492.9 ha (BBS 2021). The yield of tomato in Bangladesh is very low because of the infestation of sucking insects. The major sucking insects of tomato are thrips (*Scirtothrips dorsalis*), aphids (*Aphis gossypii*), whiteflies (*Bemisia tabaci*), and jassids (*Amarasca biguttula biguttula*). These insects suck sap from infested plants using their piercing and sucking type mouthparts, resulting in the curling and withering of leaves, followed by leaf and fruit drop. These pests can transmit different types of viruses that cause the leaf curl disease. Yield losses in tomato due to the direct and indirect damages caused by whiteflies and thrips were reported 20–100% and 23.7%, respectively, in

Ethiopia (Agegnehu *et al.* 2014). The tomato yellow leaf curl virus (TYLCV) has been found to significantly reduce tomato production in Bangladesh with yield losses of 93.95% (Alam *et al.* 2016).

Tomato growers depend on synthetic insecticides to combat sucking insect pests. Insecticide use affects insect predators. In addition, synthetic insecticides can cause serious harm to pollinator insects as they are delicate and vulnerable organisms. Thus, the frequent application of insecticides negatively affects crop production by reducing natural insect pollination and pest controlling agents. Furthermore, continuous and indiscriminate use of synthetic insecticides results in the development of insecticidal resistance in insect pests; thus, regular analysis of the efficacy of these insecticides is essential. So far, only a few studies (Jha and Kumar 2017, Wagh *et al.* 2017) have assessed the effectiveness of insecticides against sucking pests of tomato, and studies on their negative effects on beneficial insects visiting tomato fields are scarce. Therefore, in the present study, we aimed to determine the efficacy of some selected insecticides against sucking insect pests of tomato and to evaluate the effects of these insecticides on

¹Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh; ²Kyungpook National University, Daegu, Korea. *Corresponding author email: mramin@bsmrau.edu.bd

the incidence of pollinator insects visiting tomato crops and the natural enemies of sucking insect pests.

MATERIALS AND METHODS

Study site and condition: The present study was carried out in the crop fields of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh during tomato growing season of two consecutive years (from December 2020 to March 2021 and October 2021 to February 2022). The site is located at 25°25' N and 89°5' E and has mean maximum temperature of 36.0°C, mean minimum temperature of 12.7°C, 65.8% relative humidity, and 237.6 cm annual rainfall.

Experimental materials: Four insecticides, namely, λ -cyhalothrin (Karate 2.5 EC: Syngenta, Switzerland) cypermethrin (Ripcord 10 EC: BASF Canada Inc), carbosulfan (Marshal 20 EC: FMC Insecticide, India) and profenofos Q + cypermethrin (Shobicron 425 EC: Syngenta, Switzerland) which are frequently applied in the tomato fields of Bangladesh, were used in this study (Table 1). The variety BARI Tomato-14 was cultivated for this experiment, and its seeds were procured from the Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh.

Experimental design: The 30-days old seedlings were transplanted to the field on December 24, 2020, in the first year and on November 10, 2021, in the second year. Owing to unfavorable weather conditions, crop cultivation was delayed in the first year. The plants were cultivated in a randomized complete block design with a plot size of 3.0 m \times 2.0 m in three replicates. The spacing between blocks and between plots was 1.0 m. The spacing between plants and between rows was 60 cm and 66 cm, respectively. There were 225 plants in the experimental field (15 plants per plot). The untreated control plots did not receive insecticidal treatment.

Observation of sucking pests, their predators and insect pollinator: After the build-up of the sucking pest population on tomato plants, insecticides were sprayed on the experimental field three times at 10-day intervals. The insecticides were sprayed ensuring thorough coverage of the foliage by using knapsack sprayers. Three plants from each plot were randomly selected for data collection. The abundance of the insects was observed on three randomly chosen leaves (from the top, middle, and bottom positions on the selected plants) for each of the three replicates. Data were collected 3, 7, and 10 days after the insecticidal spray during both the years. Predators were counted per plant, and pollinator was counted per plot after 3, 7, and 10 days of insecticidal sprays. For efficacy evaluation, the per cent

reduction in the abundance of insects over the untreated control was estimated.

Calculation of yield and marginal benefit-cost ratio: During both the years, the first harvest of tomato fruit was obtained 8 weeks after flowering. Healthy and marketable mature fruits from each plot were handpicked and their weights were measured. The yield of each plot was converted into tonnes/ha. The economic analysis and marginal benefit-cost ratio (MBCR) calculation were performed using the total expenditure for each treatment and the total return per hectare, were based on the pooled data of two years. The total expenditure for treatment indicates the costs of labour and inputs. The gross return of the treatment was the total price obtained from the total yield of the treatment. The net return was calculated by subtracting the expenditure on treatment from the gross return. The adjusted net return of each treatment was calculated by subtracting the net return of the control from the net return of the treatment, and the MBCR was calculated as:

$$\text{MBCR} = \frac{\text{Adjusted net return}}{\text{Total cost}}$$

Data analysis: Data on the effects of different treatments on abundance of sucking pests, their predators, insect pollinator and crop yield were analyzed using one-way analysis of variance (ANOVA). Mean values were separated according to Tukey's HSD posthoc test at a significance level of 5%. T-statistics was used to compare the abundance of sucking pests, their predators and pollinator insects between the years. All analyses were performed using IBM SPSS 20.0 software (IBM SPSS statistics v.20.0, Georgia, USA).

RESULTS AND DISCUSSION

Incidence of sucking insects on tomato: The insecticide-treated plots showed a significantly lower number of sucking insects than the untreated control plot (Table 2). The Marshal 20 EC-treated plot showed the lowest (1st year: 3.1 aphids/ 3 leaves, 2nd year: 0.8 aphid/ 3 leaves) mean aphid abundance among the treatments in both the years. T-statistics showed that there was a significantly lower aphid population in the second year than in the first year.

According to the current findings, Marshal 20 EC containing carbosulfan resulted in the highest aphid population reduction, which is consistent with previous research findings. Faheem *et al.* (2016) reported that carbosulfan significantly lowered the population of wheat aphids in Pakistan. Saad *et al.* (2007) also found that carbosulfan is effective against bean aphids in Egypt. El-Dewy *et al.* (2018) reported that carbosulfan was

Table 1 Details of insecticides used in the experiment for their comparative effectiveness

Trade name	Active ingredient	Mode of action	Recommended dose (ppm)
Karate 2.5 EC	λ -Cyhalothrin	Contact	1000
Ripcord 10 EC	Cypermethrin	Contact and stomach action	1000
Marshal 20 EC	Carbosulfan	Contact and stomach action	3000
Shobicron 425 EC	Profenofos Q + Cypermethrin	Contact and stomach action	2000

Table 2 Effects of different insecticides on the abundance (number/three leaves) of sucking insects on tomato plant

Treatment	Abundance of aphid									T statistics (df)	P value
	1 st year			Mean	2 nd year			Mean			
	3 DAT	7 DAT	10 DAT		3 DAT	7 DAT	10 DAT				
Karate 2.5 EC	2.9 ± 0.2bc	5.8 ± 0.8b	6.8 ± 0.7ab	5.1	0.9 ± 0.2ab	1.9 ± 0.2bc	2.3 ± 0.6ac	1.7	4.2 (8)	<0.01	
Ripcord 10 EC	3.5 ± 0.3b	6.2 ± 1.2b	6.4 ± 0.7ab	5.4	0.9 ± 0.1ab	3.2 ± 0.3ab	2.8 ± 0.3ab	2.3	4.5 (8)	<0.01	
Marshal 20 EC	1.7 ± 0.2d	3.4 ± 0.1b	4.2 ± 0.2b	3.1	0.7 ± 0.2b	0.7 ± 0.2c	1.0 ± 0.3c	0.8	6.3 (8)	<0.001	
Shobicron 425 EC	2.2 ± 0.2cd	4.4 ± 0.3b	5.1 ± 0.3b	3.9	0.7 ± 0.3b	0.9 ± 0.1c	1.2 ± 0.5bc	0.9	6.0 (8)	<0.001	
Control	5.2 ± 0.4a	12.3 ± 1.2a	8.3 ± 1.0a	8.6	2.0 ± 0.5a	3.9 ± 0.6a	3.9 ± 0.4a	3.2	5.8 (8)	<0.001	
<i>Abundance of jassid</i>											
Karate 2.5 EC	0.6 ± 0.2ab	0.9 ± 0.4ab	1.0 ± 0.3ab	0.8	1.2 ± 0.2b	1.5 ± 0.2b	1.3 ± 0.2b	1.3	-2.4 (8)	<0.05	
Ripcord 10 EC	0.6 ± 0.2ab	0.4 ± 0.2bc	0.8 ± 0.2ac	0.6	1.0 ± 0.0bc	1.3 ± 0.1b	1.4 ± 0.2b	1.2	-5.0 (8)	<0.01	
Marshal 20 EC	0.1 ± 0.1b	0.04 ± 0.0c	0.06 ± 0.1c	0.1	0.2 ± 0.1c	0.9 ± 0.1b	0.9 ± 0.2b	0.7	-4.3 (8)	<0.01	
Shobicron 425 EC	0.2 ± 0.1d	0.2 ± 0.1bc	0.3 ± 0.2bc	0.2	0.7 ± 0.2bc	0.9 ± 0.1b	1.2 ± 0.1b	0.9	-6.0 (8)	<0.001	
Control	1.3 ± 0.3a	1.5 ± 0.2a	1.3 ± 0.2a	1.4	2.1 ± 0.4a	2.3 ± 0.3b	2.3 ± 0.2a	2.2	-2.8 (8)	<0.05	
<i>Abundance of whitefly</i>											
Karate 2.5 EC	2.1 ± 0.2b	2.2 ± 0.2b	2.2 ± 0.3b	2.2	2.1 ± 0.2b	3.8 ± 0.5b	3.9 ± 0.5bc	3.3	-2.9 (8)	<0.05	
Ripcord 10 EC	1.8 ± 0.2bc	2.0 ± 0.4b	2.3 ± 0.2b	2.0	2.3 ± 0.3b	3.9 ± 0.4b	4.7 ± 0.5b	3.6	-2.9 (8)	<0.05	
Marshal 20 EC	1.7 ± 0.2bc	1.9 ± 0.2b	1.6 ± 0.3b	1.7	1.6 ± 0.3b	2.5 ± 0.2bc	2.9 ± 0.3bc	2.3	-2.7 (8)	<0.05	
Shobicron 425 EC	0.9 ± 0.1c	1.7 ± 0.3b	1.7 ± 0.2b	1.4	1.8 ± 0.3b	2.1 ± 0.2c	2.1 ± 0.3c	2.0	-2.7 (8)	<0.05	
Control	3.8 ± 0.4a	3.4 ± 0.4a	3.6 ± 0.3a	3.6	7.1 ± 0.6a	7.7 ± 0.5a	7.8 ± 1.0a	7.5	-6.5 (8)	<0.001	
<i>Abundance of thrips</i>											
Karate 2.5 EC	1.2 ± 0.3b	3.3 ± 0.9b	3.2 ± 0.8b	2.6	1.1 ± 0.3b	1.2 ± 0.1ab	1.8 ± 0.4ab	1.4	2.8 (8)	<0.05	
Ripcord 10 EC	1.3 ± 0.2b	1.6 ± 0.2b	3.1 ± 0.5b	2.0	1.0 ± 0.3b	1.2 ± 0.3ab	1.9 ± 0.3ab	1.4	2.8 (8)	<0.05	
Marshal 20 EC	0.8 ± 0.1b	2.3 ± 0.3b	2.8 ± 0.4b	1.9	0.8 ± 0.4b	0.9 ± 0.1b	1.7 ± 0.2b	1.1	3.6 (8)	<0.01	
Shobicron 425 EC	1.3 ± 0.2b	1.7 ± 0.2b	4.3 ± 0.8b	2.4	0.9 ± 0.2b	1.1 ± 0.1b	1.3 ± 0.3b	1.1	2.7 (8)	<0.05	
Control	3.9 ± 0.6a	6.6 ± 0.9a	8.0 ± 1.5a	6.1	2.8 ± 0.4a	1.8 ± 0.2a	3.1 ± 0.5a	2.6	4.0 (8)	<0.01	

Data are expressed as mean ± S.E. Means within a column followed by no common letter(s) for each of the sucking insects are significantly different by Tukey's post hoc test at $P \leq 0.05$. DAT = Days after treatment.

moderately effective against cotton aphids (77.47% reduction in population).

In both years, Marshal 20 EC-treated plots showed the lowest mean abundance of jassids (0.1 and 0.7 jassid/3 leaves, respectively). T-statistics showed that the abundance of jassids in the two different years was different and significantly higher in the second year than in the first year.

In the present study, carbosulfan was very effective in managing jassid infestations in tomato. These results are similar to the findings of Asif *et al.* (2017), who observed that carbosulfan reduced the highest number (by 42.06%) of jassids in cotton fields. Bisht *et al.* (2017) found that Karate 2.5 EC (λ -cyhalothrin) (3.42 jassids/3 leaves) was the least effective against jassid in okra fields, which is in line with the present findings.

All insecticide-treated plots showed statistically significant differences and lower whitefly abundance than the untreated control plot. T-statistics showed that the abundance of whiteflies in the two different years was significantly different. However, Shobicron 425 EC-treated

plots showed the lowest mean abundance of whiteflies in both the years (1st year: 1.4 whiteflies/ 3 leaves; 2nd year: 2.0 whiteflies/ 3 leaves).

Present study showed that Shobicron 425 EC, which contains profenofos Q + cypermethrin was effective against whiteflies. Jha and Kumar (2017) also found that profenofos + cypermethrin (42.20%) was effective against whiteflies in tomato fields. Sinha and Nath (2009) reported that polytrin (profenofos 40% + cypermethrin 4%) was effective against whiteflies on okra. On the other hand, Kady and Devine (2003) found that whiteflies showed resistance to carbamates (carbosulfan), which is in contrast to the present findings. A recent review of insecticide control and resistance levels in whitefly populations worldwide showed that resistance to carbamates, pyrethroids and organophosphate insecticides has been documented for parts of Asia so overuse of these compounds is not recommended (Horowitz *et al.* 2020).

In the first year, the Marshal 20 EC-treated plot showed the lowest abundance (1.9 thrips/3 leaves), and in the second year, both, plots treated with Marshal 20 EC (1.1 thrips/3

Table 3 Yield and details of variable cost under different pest management approaches (mean data of 2021 and 2022), and marginal benefit:cost ratio analysis of different treatments against sucking pests of tomato

Treatment	Yield (tonnes/ ha)	Cost (Taka)					Gross return	Net return	Adjusted net return	MBCR
		Insecticide	Fertilizer	Labour	Sprayer rent	Total expenditure				
Karate 2.5 EC	46.9	1690	25000	10800	900	38390	469000	430610	102610	2.7
Ripcord 10 EC	49.6	1950	25000	10800	900	38650	496000	457350	129350	3.3
Marshal 20 EC	58.7	5600	25000	10800	900	42300	587000	544700	216700	5.1
Shobicon 425 EC	51.4	4160	25000	10800	900	40860	514000	473140	145140	3.6
Control	35.3	-	25000	-	-	25000	353000	328000	-	-

Labour cost: 600 Taka/day/person, Sprayer rent: 50 Taka/day. Marketing package size and price details of the insecticides: Karate 2.5 EC (100 ml) at 140 Taka, Ripcord 10 EC (100 ml) at 132 Taka, Marshal 20 EC (100 ml) at 172 Taka, and Shobicon 425 EC (50 ml) at 120 Taka. Market price of tomato: 10 Taka/Kg. One USD equivalent to 110 Taka.

leaves) or Shobicon 425 EC (1.1 thrips/3 leaves) showed the lowest and statistically comparable mean abundance of thrips. T-statistics revealed that the abundance of thrips was significantly different between the years and showed a decrease in the second year.

Asif *et al.* (2017) observed that carbosulfan reduced 56.60% of the thrips population in cotton fields. Khoso *et al.* (2017) also found that carbosulfan was effective against onion thrips (97.79% reduction in population). The findings of the present study showed agreement with these findings, as Marshal 20 EC containing carbosulfan was effective in controlling thrips on tomato.

Effects of insecticides on beneficial insects (predator and pollinator): The abundance of predators (ladybird beetles and spiders) and pollinator (carpenter bees) in different insecticide-treated plots 3, 7, and 10 days after spraying was statistically different in both years (Supplementary Table 1). All insecticide-treated plots showed a statistically lower number of predators than the untreated control plot. Among the different insecticides, Ripcord 10 EC (1.1 predators/plant) and Karate 2.5 EC (1.2 predators/plant) resulted in the highest mean abundance of predators in the first and second year, respectively. T-statistics showed that the abundance of predators in the two different years was not statistically different.

All insecticide-treated plots showed a statistically lower number of pollinator than the untreated control plots. Among the different insecticides, Shobicon 425 EC (1st year: 0.7/plant; 2nd year: 0.9/plant) resulted in the highest mean abundance of pollinator in both the years. Furthermore, T-statistics showed that the abundance of pollinator in the two different years was not statistically different.

Chemical insecticides negatively affects both beneficial and pest insects. El-Dewy *et al.* (2018) found that carbosulfan was moderately harmful to predator insects and reduced their population in cotton by 31.7% in 2017 and by 44.3% in 2018. Kenko *et al.* (2023) observed that cypermethrin and lambda-cyhalothrin were highly risky for bees. In the present study, we also found that the insecticide-treated plots showed a lower abundance of predator and pollinator insects than the untreated control plot.

Marginal benefit-cost ratio (MBCR): Yield, details of total variable cost and MBCR analysis of different treatments against the major sucking pests of tomato are presented in Table 3. The insecticide-treated plots showed higher yield, gross and net returns than the untreated control plot. Marshal 20 EC-treated plots showed the highest yield (58.7 tonnes/ha). The highest and lowest adjusted net returns were obtained from Marshal 20 EC (216,700 BDT) and Karate 2.5 EC (102,610 BDT) treatments, respectively. Again, Marshal 20 EC and Karate 2.5 EC had the highest (5.1) and lowest (2.7) MBCR, respectively.

Although similar insecticides were applied in both years, the abundance of insects differed between the years. This might be due to variations in the planting time and weather conditions. In the first year, planting was performed late in the season, whereas in the second year, planting was performed early. As a result, tomato plants experienced different weather conditions during the two years, which might have influenced the abundance and infestation of sucking insect pests on tomato.

From the present study, it is concluded that the studied insecticides, Karate 2.5 EC, Ripcord 10 EC, Marshal 20 EC and Shobicon 425 EC, reduced the abundance of sucking insect pests of tomato where Marshal 20 EC and Shobicon 425 EC were more effective. However, all of the tested insecticides negatively affected the abundance of pollinator insects and natural enemies of the pests, resulting in their lower abundances in the insecticide-treated plots than in the untreated control plots.

REFERENCES

- Agegnehu E, Ousma Y and Ayalew A. 2014. Screening of some foliar chemical insecticides against whitefly (*Bemisia tabaci*) on tomato at Metema District, North Gondar, Ethiopia. *Open Access Library Journal* 1: 1–7.
- Alam M M, Islam M N, Haque M Z, Humayun R and Khalequzzaman K M. 2016. Bio-rational management of whitefly (*Bemisia tabaci*) for suppressing tomato yellow leaf curl virus. *Bangladesh Journal of Agricultural Research* 41(4): 583–97.
- Asif M U, Muhammad R, Akber W and Tofique M. 2017. Relative efficacy of some insecticides against the sucking insect pest complex of cotton. *The Nucleus* 53: 140–46.

- BBS (Bangladesh Bureau of Statistics). 2021. Yearbook of Agricultural Statistics. Statistics and Informatics Division (SID), Ministry of Planning, Government of the People's Republic of Bangladesh, pp. 340–41.
- Bisht K, Mishra V K, Rai V L and Singh S. 2017. Comparative efficacy of some insecticides against *Amrasca biguttula biguttula* Ishida on okra crop. *Annals of Plant Protection Science* **25**(1): 28–31.
- El-Dewy M E, Sadek A S and El-Sarand E S A. 2018. Impact of synthetic insecticides against *Aphis gossypii* Glover, *Bemisia tabaci* (Genn.) and their associated predators on cotton plants. *Alexandria Science Exchange Journal* **39**: 669–75.
- Faheem M, Sajjad A, Shafique R M, Rehman A and Aslam M N. 2016. Field evaluation of different insecticides against wheat aphids and their natural enemies in Pakistan. *Asian Journal of Agriculture Biology* **4**(4): 126–33.
- Horowitz A R, Ghanim M, Roditakis E, Nauen R and Ishaaya I. 2020. Insecticide resistance and its management in *Bemisia tabaci* species. *Journal of Pesticide Sciences* **93**: 893–10.
- Jha S K and Kumar M. 2017. Relative efficacy of different insecticides against whitefly, *Bemisia tabaci* on tomato under field condition. *Journal of Entomology and Zoology Studies* **5**(5): 728–32.
- Kady H E and Devine G J. 2003. Insecticide resistance in Egyptian populations of the cotton whitefly, *Bemisia tabaci* (Hemiptera: Aleyrodidae). *Pest Management Science: formerly Pesticide Science* **59**(8): 865–71.
- Kenko D B N, Ngameni N T, Awo M E, Njikam N A and Dzemo W. D. 2023. Does pesticide use in agriculture present a risk to the terrestrial biota?. *Science of The Total Environment* **861**: 160715.
- Khoso N, Marri J, Khoso F N, Solangi B K, Ahmed A M, Iftikhar Y and Rehman T U. 2017. Assessment of botanical insecticides against onion thrips, *Thrips tabaci* (L.) (Thysanoptera: Thripidae). *Journal of Entomology and Zoology Studies* **5**(6): 572–75.
- Saad A S S, Massoud M A, Abdel-Megeed A A M, Mourad A K K, Hamid N A and Barakat A S T. 2007. An approach for IPM program to control sucking pests infesting garden bean plants (*Phaseolus vulgaris* L.) in Egypt. *Communications in Agricultural and Applied Biological Sciences* **72**(3): 568.
- Sinha S R and Nath V. 2009. Efficacy of insecticides and mixtures against insect pest of okra. *Annals of Plant Protection Sciences* **17**(2): 328–31.
- Wagh B M, Pagire K S, Thakare D P and Birangal A B. 2017. Management of sucking pests by using newer insecticides and their effect on natural enemies in tomato (*Lycopersicon esculentum* Mill.). *International Journal of Current Microbiology and Applied Sciences* **6**(4): 615–22.