Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(6): 814-818

Received: 02-09-2020
Accepted: 29-10-2020

Sunil Kumar Ghosh
Department of Agri. Entomology, BCKV-Agriculture University, Kalyani, Nadia, West Bengal, India

Corresponding Author:
Sunil Kumar Ghosh
Department of Agri. Entomology, BCKV-Agriculture University, Kalyani, Nadia, West Bengal, India

Environmentally sound approach for management of tomato whitefly (*Bemisia tabaci* Genn.)

Sunil Kumar Ghosh

Abstract

Tomato crop (*Solanum lycopersicum* L.) is cultivated at a commercial scale in West Bengal, India but insect pest attack constitute limiting factors for its successful cultivation. Tomato plant is highly susceptible to whitefly (*Bemisia tabaci* Genn.). Damage caused by whitefly may be directly through phloem feeding, or indirectly by transmission of viruses such as *Tomato Yellow Leaf Curl Virus.* The incidence of whitefly population always remained higher on upper canopy of the plant followed by middle canopy and lower canopy which is important for preparation of spray schedule. Imidacloprid resulted the best suppression of whitefly population (81.48% suppression) followed by avermectin (73.33%) and mixed formulation of azadirachtin with Spilenthes (71.65%) extracts. Microbial toxin and botanicals are bio-pesticides. They have lower hazardous effects on human health and environment. Therefore, they can be used in organic farming and Integrated Pest Management (IPM) for tomato cultivation as well as vegetable cultivation. These treatments may be recommended for general use by the farmers.

Keywords: Bio-pesticides, neem, avermectin, *Spilanthes*, organic farming

Introduction

Whitefly (*Bemisia tabaci* Genn.) is an important pest infests Tomato (*Lycopersicon esculentus* L.) World-wide. Whitefly damage may be directly through phloem feeding, or indirectly by transmission of virus's *viz*. *Tomato Yellow Leaf Curl Virus* [24]. The incidence of mite/whitefly pest population always remained higher on the upper canopy of the plant [9]. White fly was found active throughout the year and highest population (1.66/leaf) on eggplant was recorded on 32nd standard week [16, 28] Reported that the maximum population of whitefly infesting tomato was during 11th - 18th standard week with peak population (0.47/leaf). White fly incidence on tomato showed non-significant negative correlation (p=0.05) with temperature and weekly total rainfall and significant negative correlation with relative humidity reported by them. [11] Reported that *Bemisia tabaci* on ladyfinger was active throughout the growing period with a peak population (3.98 white fly /leaf).

[27] reported from a an experiment on tomato in West Bengal that maximum population of spider (1.07-1.83/plant) and lady bird (0.33-1.00/plant) is observe on 3rd week of February to 2nd week of March and on 3rd week November to 1st week of January respectively [17]. Reported that predatory spider was found active throughout the year in terai region of West Bengal, India [18]. Reported from West Bengal, India that lady bird beetle / coccinellid beetle *Menochilus sexmaculatus* was an important predator of whitefly, aphid and jassid on eggplant and its feeding activity was found throughout the year. Coccinellid beetle *Coccinella septempunctata* as the generalized predatory agent has gained great scientific interest for biological control in West Bengal, India [7, 4]. The misuse and overuse of pesticides has led to problems of pesticide resistance, resurgence and contamination of different components of the environment [6]. Plant extracts act in different ways *viz.* insect growth regulators (IGR), feeding deterrents, repellents and confusants [26]. Azadiractin-rich neem formulations were effective against cotton whitefly, aphids, jassids and spotted boll worm [23]. It is reported that maximum reduction of whitefly population was found in imidacloprid treated plot [8, 30]. [12] Reported that *Polygonum hydropiper* flower extract at 5 % concentration gave more than 70 % aphid suppression. Botanical extract, *Polygonum hydropiper* floral part, pathogens, *Beauveria bassiana* and *Bacillus thuringiensis* caused significant lower killing of the predator (less than 30 %) whereas the synthetic insecticides, profenophos and methomyl caused significantly higher killing (more than 52 %) [10].

Acetamiprid was found highly efficacious against aphid and found to suppress 85.11% aphids closely followed by *neem* + *Spilanthes* (73.29% control) [14]. Synthetic insecticides, DDVP and malathion caused significantly higher killing (>50%) whereas botanical insecticide, neem caused lower killing (less than 40%) of the *Coccinella sp* [13]. [4] Reported that neemactin based solution was less lethal to *Coccinella septempunctata*. The objective of this study is to determine the efficacy of microbial toxin, the plant extracts against whitefly and to formulate suitable control measure.

Materials and Methods

Study and location

The studies were conducted at Kalyani, West Bengal India during 2019-20. The geographical details of the site are 23° N latitude, 89° E longitude and 9.75 meter above mean sea level [29]. The soil of the experimental field was typically gangetic alluvial soil (Entisol) with sandy clay loam texture [25]. The soil type of the experimental field was sandy loam with PH range 5.75 to 6.5 and climate of this zone is subtropical humid having short winter spell during December –January [3, 21]. The soil has good water holding capacity.

Distribution of whitefly within tomato plants

Tomato variety 'Pusa Ruby' was grown during 2019-20 crop seasons under recommended cultural practices in 4.0 m x 5.0 m plots. Recommended fertilizer doses were applied, N: P: K @ 100:60:60. The treatments were replicated five times in a Randomized Block Design (RBD). The total whitefly population per leaf from top, middle and bottom leaves from five randomly selected plants per replication was recorded at seven days interval (Standard Meteorological Week). Data obtained were presented graphically.

Management of whitefly

Tomato variety 'Pusa Ruby' was grown during 2019-20 crop seasons under recommended cultural practices in 4.0 m x 5.0 m plots with spacing 10 cm. X 20 cm. Recommended fertilizer doses were applied, N: P: K @ 100:60:60. The treatments were replicated three times in a Randomized Block Design (RBD). ASPEE Knapsack Sprayer with hollow cone nozzle was used for spraying with 500 L water / ha.

Treatment Details

One microbial toxin avermectin (Vertimec 1.9 EC) @ 1ml/L, one botanical insecticide azadirachtin (neem based pesticides, neemactin 0.15 EC) @ 2.5 ml/L, two botanical extracts *viz.* *Spilanthes paniculata* floral parts extract @ 8.0% (80 ml/L), and garlic bulb (*Allium sativum*) extract @ 8.0% (80 ml/L), two treatments containing mixture of azadirachtin and *Spilanthes* @ 2.5 ml + 80 ml/L and mixture of azadirachtin and garlic @ 2.5 ml + 80 ml/L were evaluated and compared with the ability of imidacloprid (Confidor 17.8 EC) @ 1ml/3 L to control the whitefly. One untreated check was taken.

Preparation of extracts

The botanical extracts, *Spilanthes paniculata* floral parts and garlic bulb were extracted in methanol following the methodology developed by [22, 15] with slight modification. After washing with water, the plant parts were made in powder form. The powder (50 g) samples of each tested plant were transferred separately to a conical flask (500 ml) and dipped in 250 ml methanol. The material was allowed to stand for 72 hours at room temperature with occasional stirring. After 72 hours the extract was filtered through Whatman 42 filter paper and residues were washed twice with methanol.

Data recording

Four spraying at 10 day intervals were made. Whitefly population was recorded 3, 6 and 9 days after each spraying. The results were expressed as whitefly population suppression (%) compared to densities recorded on the control treatment. Per cent reduction of whitefly population over control was calculated by the formula [1]. Data were analyzed by using INDO-STAT- software following randomized block design (RBD). Treatment means were separated by applying CD Test (critical difference) at 5 % level of significance.

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

Where
Pt = Corrected mortality,
Po = Observed mortality and
Pc = Control mortality.

Effect of treatments on natural enemies: Methods

Population of natural enemies *viz.* coccinellid and spider were observed before spraying. After spraying the population was recorded at 3, 6 and 9 days after each spray. The population of coccinellids and spiders were recorded on randomly selected 10 plants per plot. The data of mean population was analyzed statistically.

Results and Discussion

Distribution of whitefly within plants

Fig. 1 represents the incidence and distribution of whitefly population on upper, middle and lower canopy within the tomato plants. Whitefly was most densely populated in the upper canopy (58.37 % population) followed by middle canopy (28.07%) and lower canopy (13.56%) of tomato plant (Fig. 1). So upper canopy is damaged more due to sucking activity of whitefly and hamper the plant growth.

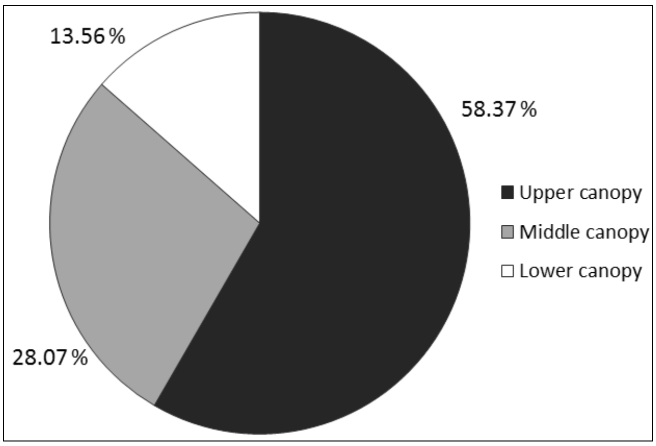

Fig 1: Per cent distribution of whitefly within tomato plants

Management of whitefly

Among the seven treatment (table 1) under the present investigation imidacloprid resulted best suppression of whitefly population (81.48 % suppression) followed by avermectin (73.33%) and mixed formulation of azadirachtin with *Spilenthes* extracts (71.65 %). However, among bio-pesticides including plant extracts avermectin was most effective for whitefly control followed by mixed formulation of azadirachtin with *Spilenthes* extracts and another mixed formulation azadirachtin with garlic (71.65% and 60.83% suppression respectively) (table 1). From overall observation it was revealed that azadirachtin and botanical extract individually did not produce good results (moderate whitefly suppression) but when azadirachtin is used as a mixture with botanical extracts like *Spilenthes*, garlic provided better results recording more than 60 % suppression. Three days after spraying, imidacloprid resulted best suppression of whitefly population (82.17 % suppression) followed by avermectin (81.07 %) and mixed formulation azadirachtin with extract *Spilanthes* extracts (73.42 %) against whitefly.

The imidacloprid and avermectin treatments were significantly different from all other treatments. Neem and botanical extracts individually does not produce higher result but when azadirachtin is used as a mixture with botanical extracts provided better results recording more than 64 % suppression. Six and nine days after spraying the results of the different treatments evaluated followed the findings of three days after spraying (table 1). Imidacloprid was found to be the superior pesticide (80.10 and 82.17% suppression respectively) against whitefly followed by mixed formulation of botanical pesticide, azadirachtin with botanical extracts *Spilanthes* (72.08 and 69.45% suppression respectively) and avermectin (72.08 and 66.85 % suppression respectively).

Table 1: Overall efficacy of pesticides against *Bemisia tabaci* on tomato crop

Treatments	Dose ml or g/L	Pre-treatment observation (w.fly/Leaf)	Overall efficacy (% reduction) Days after treatment			
			3	6	9	Mean
T_1=Avermectin (Vertimec 1.9 EC)	1 ml/L	1.78	81.07 (64.22)	72.08 (58.12)	66.85 (54.90)	73.33
T_2= *Spilanthes* flower extract (8%)	80 ml/L	2.25	57.37 (49.78)	49.75 (44.85)	41.49 (40.39)	59.53
T_3= Neem (Nemactin 0.15 EC)	2.5 ml/L	1.88	63.51 (52.82)	56.74 (48.93)	45.62 (42.49)	55.29
T_4= *Garlic 8% extract*	80 ml/L	2.22	43.65 (40.85)	34.23 (36.11)	27.39 (31.49)	35.09
T_5= Neem+*Spilanthes* extract (8%)	2.5 ml/L+ 80 ml/L	1.85	73.42 (57.95)	72.08 (58.12)	69.45 (56.86)	71.65
T_6= Neem+*Garlic* extract (8%)	2.5 ml/L+ 80 ml/L	2.09	64.59 (53.50)	59.01 (51.49)	58.90 (49.93)	60.83
T_7= Imidacloprid(Confidor 17.8 SL)	1ml/3L	2.08	82.17 (65.29)	80.10 (63.87)	82.17 (65.29)	81.48
T_8=Untreated check(control)	-	1.88	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00-
SEm(±)	-	---	1.63	1.60	1.70	-
CD (p=0.05)	-	NS	4.87	4.80	5.11	-

Figures in parentheses are angular transformed values, NS = Not significant

Effect of treatments on natural enemies, coccinellid predators of tomato ecosystem

During the period of study, natural enemy fauna were found included several species of coccinellid beetles and their grubs (*Coccinella transversalis*, *C. septempunctata*, *Cheilomenes sexmaculata* and *Micraspis discolor*), larvae of syrphid fly, chrysopids (*Chrysoperla* spp.) and spiders. Among these coccinellids and spiders were observed frequently, whereas, the population of others were scanty. The data on coccinellids and spiders on the tomato crop before and after treatment show that, none of the treatments significantly reduced the population of coccinellid and spider natural enemies than the untreated control (Table 2 and Table 3). Higher population of predators was recorded on imidacloprid treatment because of a rapid degradation of persistency [5, 19]. So imidacloprid is good pesticide for biodiversity conservation.

Table-2: Effect of treatments on the population of natural enemies (Coccinellids)

Treatments	Dose ml or g/L	Coccinellids (Population number per plant)				
		Pre-treatment population	3 DAT	6 DAT	9 DAT	Mean 3,6,and 9 DAT
T_1=Avermectin (Vertimec 1.9 EC)	1 ml/L	2.32	2.04	2.13	2.58	2.25
T_2= *Spilanthes* flower extract (8%)	80 ml/L	2.12	2.08	2.33	2.89	2.43
T_3= Neem (Nemactin 0.15 EC)	2.5 ml/L	2.40	2.09	2.38	2.77	2.41
T_4= Garlic 8% extract	80 ml/L	2.06	2.15	2.55	3.15	2.62
T_5= Neem+*Spilanthes* extract (8%)	2.5 ml/L + 80 ml/L	2.14	2.07	2.09	3.00	2.39
T_6= Neem+*Garlic* extract (8%)	2.5 ml/L + 80 ml/L	2.33	2.09	2.25	3.05	2.46
T_7= Imidacloprid (Confidor 17.8 SL)	1 ml/3L	2.15	2.05	2.26	2.42	2.24
T_8= Untreated check (control)	--	2.11	2.15	2.58	3.20	2.64
CD (p=0.05)	--	NS	NS	NS	NS	--

DAT= Date after Treatment; NS = Not significant

Table 3: Effect of treatments on the population of natural enemies (Spiders)

Treatments	Dose ml or g/L	Spiders (Population number per plant)				
		Pre-treatment population	3 DAT	6 DAT	9 DAT	Mean 3,6,and 9 DAT
T_1=Avermectin (Vertimec 1.9 EC)	1 ml/L	2.16	1.85	2.33	2.50	2.23
T_2= *Spilanthes* flower extract (8%)	80 ml/L	2.38	1.99	2.45	2.91	2.45
T_3= Neem (Nemactin 0.15 EC)	2.5 ml/L	2.44	2.00	2.38	2.81	2.40
T_4= *Garlic 8% extract*	80 ml/L	2.54	2.50	2.88	3.00	2.79
T_5= Neem+*Spilanthes* extract (8%)	2.5 ml/L + 80 ml/L	2.04	1.74	2.69	2.78	2.40
T_6= Neem+*Garlic* extract (8%)	2.5 ml/L + 80 ml/L	2.13	1.88	2.74	2.88	2.5
T_7= Imidacloprid (Confidor 17.8 SL)	1 ml/3L	2.40	1.30	2.16	2.45	1.97
T_8= Untreated check(control)	--	2.41	2.76	3.00	3.00	2.92
CD (p=0.05)	--	NS	NS	NS	NS	--

DAT= Date after Treatment; NS = Not significant

From overall observation, whitefly was found most densely populated in the new young leaves of tomato plant on upper canopy. So sprays should be carefully taken on the upper canopy. Avermectin and mixture of azadirachtin with botanical extracts gave moderate to higher whitefly suppression (more than 60% suppression). [2] reported that imidacloprid, and abamectin were safer to lady bird beetles. Considering moderate to higher efficacy as well as its low toxicity to natural enemies and human health microbial toxin, botanical insecticides, botanical extracts can be used in Integrated Pest Management (IPM) and organic farming. Azadirachtin individually did not produce higher results but when mixed with botanical extracts gave higher results of whitefly control. A rapid degradation of persistency was observed in imidacloprid and neem oil/neem based pesticides which has a great importance for vegetable fruits [19, 20, 5]. Botanical extracts may be mixed with small amount of imidacloprid. This also may be safer for vegetable cultivation. This may be recommended for general farmers' use.

Conclusion
Azadirachtin individually did not produce higher results but when mixed with botanical extracts gave higher results of whitefly control. Botanical extracts may be mixed with small amount of imidacloprid. This also may be safer for vegetable cultivation. This may be recommended for general farmers' use.

Acknowledgements
This study was carried out with the support of the Department of Agril. Entomology, BCKV, the author is grateful to Directorate of Farms, BCKV for allotting the field.

References
1. Abbott WS. A method of computing the effectiveness of an insecticide. Journal of Economic Entomology 1925;18:265-267.
2. Acharya S, Mishra HP, Dash D. Efficacy of insecticides against okra jassid (*Amrasca biguttula biguttula* Ishida). Annals of Plant Protection Science. 2002; 10(2):230-232.
3. Bala SC, Karmakar K, Ghosh SK. Population dynamics of mite, *Aceria tulipae* Keif on garlic (*Allium sativum* L.) and its management under Bengal basin. International Journal of Science, Environment and Technology 2015;4 (5):1365-1372.
4. Chakraborty K, Ghosh SK. Incidence of *Coccinella septempunctata* in brinjal with some pesticides. Current advances in Agricultural Sciences 2010;2(2):129-130.
5. Das K, Biswas S, Chakraborty G, Ghosh SK. Efficacy of insecticides against Jassid *(Amrasca biguttula biguttuka* Ishida) on okra in terai agro-ecology of West Bengal. Journal of Applied Zoological Research. 2010;21(1):33-35.
6. Dhaliwal GS, Kour O. Quest for Pest Management: From Green Revolution to Gene Revolution. Kalyani Publishers, New Delhi 2010.
7. Ghosh SK. Studies on the pest constraints of brinjal/eggplant (*Solanum melongena* L.) and their management under terai region of West Bengal, India. Ph.D. Thesis awarded by BCKV-Agriculture University, West Bengal, India 1999,43-44.
8. Ghosh SK. Integrated field management of *Bemisia tabaci* infesting ladysfinger. *Proceedings* of conference on Agriculture, Science and Engineering. Port Harcourt, Nigeria 2012;1(1):118-121.
9. Ghosh SK. Sustainable management of red spider mite (*Tetranychus sp*.) infesting eggplant (*Solanum melongena* L.) at field level. Uttar Pradesh Journal of Zoology 2013;33(2):175-180.
10. Ghosh SK. Harmful effect of insecticides in the population dynamics of spiders on lady's fingers *Abelmoschus esculentus* (L.) at field level**.** American-Eurasian Journal of Agricultural & Environmental Sciences 2013;13(9):1181-1186 ref.35
11. Ghosh SK. Incidence of *Bemisia tabaci* and their sustainable. Publisers: Johann Heinrich von Thünen-Institut Rahmann G & Aksoy U (Eds.) Building Organic Bridges 2014;2:623-626.
12. Ghosh SK. Integrated field management of aphid (*Myzus persicae* and *Aphis gossypii* Together) on potato (*Solanum tuberosum* L.) using bio-pesticides. International Journal of Science, Environment and Technology 2015;4(3):682-689.
13. Ghosh SK. Harmful effect of insecticides against predator, *Coccinella* sp. (Lady Bird beetle) on eggplant *(Solanum melongena* L.). Uttar Pradesh Journal of Zoology 2016;36(1):17-23.
14. Ghosh SK. Seasonal Incidence of aphid (*Aphis gossypii* Glove.) Infesting tomato (*Lycopersicon esculentum* L.) and their management by using botanical pesticides International Journal of Advances in Science Engineering and Technology 2017;5(3,1):14-17.
15. Ghosh SK, Chakraborty K. Incidence and abundance of predatory beetle with special reference to *Coccinella septempunctata* in sub-Himalayan region of north-east India. International Journal of Plant, Animal and Environmental Sciences 2012;2(3):157-162.
16. Ghosh SK, Laskar N, Senapati SK. Seasonal fluctuation of *Aphis gossypii* on brinjal/eggplant and field evaluation of pesticides from different origin against *A. gossypii* under tcrai region. Indian Journal of Agriculture Research 2004;38(3):171-177.
17. Ghosh SK, Laskar N, Basak SN, Senapati SK. Seasonal fluctuation of spider on brinjal and efficacy of pesticides under terai region of West Bengal. Orissa Journal of Horticulture 2006;34(1):86-91.
18. Ghosh SK, Laskar N, Senapati SK. Seasonal incidence of predator *Menochilus sexmaculatus* Berliner on brinjal and harmful effect of insecticides on the predator. Indian Journal of Agriculture Research 2007;41(2):102-106.
19. Ghosh SK, Mandal T, Biswas S, Chakraborty K. Field evaluation of cultivars and bio-efficacy of insecticides against pest complex of ladyfingers (*Abelmoschus esculentus* L.). Journal of Applied Zoological Research 2012;23(2):121-128.
20. Ghosh SK, Mandal T, Chakraborty K. Efficacy of chemical insecticides and neem oil against *Bemisia tabaci* infesting ladyfinger. International Journal of Bio-resource and Stress Management 2013;4(2):348-351.
21. Karmakar K, Bala SC, Ghosh SK. Population dynamics of sheath mite (*Stenotarsonemus spinki*) Infesting rice cultivar IET-4786 and its management under Gangetic basin of West Bengal. Journal of Entomology and Zoology Studies 2017;5(4):663-666.
22. Mandol T, Ghosh SK, Chakraborty, K. Seasonal incidence of *Thrips tabaci* infesting som plant (*Machilus bombycina*) and their management. International Journal of Science Environment and Technology 2016;5(4):2245-

2256.
23. Mann GS, Ghaliwal GS, Dhawan AK. Field efficacy of neem based insecticides against whitefly and their impact on insect pest complex of cotton. Pesticide Research Journal 2001;13(1):79-85.
24. Mehta P, Wyman J, Nakhla MK, Maxwell DP. Transmission of tomato yellow leaf curl *Gemini virus* by *Bemisia tabaci*. Journal of Economic Entomology 1994;87:1291-1297.
25. Priyadarshini S, Ghosh SK, Nayak AK. Field screening of different chilli cultivars against important sucking pests of chilli in West Bengal. Bulletin of Environment, Pharmacology and Life Sciences 2019;8(7):134-140.
26. Schmutterer H. Properties and potential of natural pesticides from the neem tree, *Azadirachta indica*. Annals of Review Entomology 1990;35:271-297.
27. Subba B, Ghosh SK. Population dynamics of Thrips (*Thrips tabaci* L.) Infesting tomato (*Lycopersicon esculentum* L.) and their sustainable management. International Journal of Agricultural Sciences and Research 2016;6(3):473-480.
28. Subba B, Pal S, Mandal T, Ghosh SK. Population dynamics of white fly (*Bemisia tabaci* Genn.) Infesting tomato (*Lycopersicon esculentum* L.) and their sustainable management using bio-pesticides. Journal of Entomology and Zoology Studies 2017;5(3):879-883.
29. Thakoor P, Ghosh SK, Nihal R, Ramya Sri N. Effect of abiotic factors on seasonal incidence and bio-efficacy of some newer insecticides against aphid (*Aphis gossypii*) in tomato (*Abelmoschus esculentus*). Journal of Entomology and Zoology Studies 2019;7(3):513-516.
30. Thakoor P, Ghosh SK, Bala SC. Effect of abiotic factors on seasonal incidence and bio-efficacy of some newer insecticides against white fly (*Bemisia tabaci*) on tomato crop (*Solanum lycopersicon* L) in West Bengal. Journal of Entomology and Zoology Studies 2020;8(3):267-271.