Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(3): 1064-1067

Received: 15-03-2017
Accepted: 16-04-2017

Anamika Kar
AICRP on Nematodes in Cropping System, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya Kalyani, Nadia, West Bengal, India

Correspondence
Anamika Kar
AICRP on Nematodes in Cropping System, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya Kalyani, Nadia, West Bengal, India

Bioefficacy evaluation of imidacloprid 17.8% SL and thiamethoxam against whitefly on tomato and their effect on natural enemies

Anamika Kar

Abstract
The study was conducted at the Regional Research Station, Bidhan Chandra Krishi Viswavidyalaya, Jhargram, Paschim Medinipur, West Bengal (India) during tomato growing season of 2014 and 2015 to evaluate the effectiveness of imidacloprid and thiamethoxam as foliar application against the whitefly (*Bemisia tabaci*). The experimental result revealed that imidacloprid @ 175 ml/ha was the most effective treatment with 100% control of pest population at 5 days after spray and also with minimum population at 10 and 15 days after spray. This was followed by the treatment imidacloprid @ 150 ml/ha and thiamethoxam @ 200 g/ha. Imidacloprid @ 175 ml/ha and 150 ml/ha had a better efficiency against whitefly than thiamethoxam. These two insecticides did not affect spider population but the coccinellid population was reduced with increase of doses of imidacloprid. Imidacloprid @ 175 and 150 ml/ha were found more toxic than thiamethoxam @ 200 g/ha and imidacloprid @ 125 ml/ha. This result revealed that imidacloprid had more adverse effect on coccinellids than thiamethoxam

Keywords: *Bemisia tabaci*, imidacloprid, thiamethoxam, coccinellid

1. Introduction

Tomato (*Lycopersicon esculentum* Mill.) belonging to the family Solanaceae, is one of the most popular and widely grown vegetable crops of both tropics and subtropics of the world [1]. The production of tomato is often limited to a great extent due to pest attack. The crop is infested by a number of sucking pests in vegetative stage and borers at fruiting stage. Among the sucking insects, whitefly (*Bemisia tabaci*) is one of the most damaging as it also acts as vector of tomato leaf curl virus [2].

Whitefly is an important pest under the order hemiptera and carries piercing and sucking type of mouthpart [3]. They cause direct and indirect damage to the tomato especially in the early growth stage. Both nymphs and adults suck the cell sap from the lower leaf surfaces. In addition, they disrupt transportation in conducting vessels and apparently introduce a toxin that impairs photosynthesis in proportion to the amount of feeding [4]. When several insects suck the sap from the same leaf, yellow spots appear on the leaves, followed by crinkling, curling, bronzing, and finally drying of leaves. This phenomenon is known as “hopper burn” [5]. In case of severe damage all leaves of the plants become crinkled or twisted with drastic reduction in photosynthesis which ultimately causes severe yield reduction. On the other hand, this insect is a potential vector of various viruses including tomato leaf curl and their honeydew attracts black sooty mould which inhibits photosynthesis thus reducing the yield [4].

Although insecticidal control is one of the common means against white fly, tomato being a vegetable crop, use of broad-spectrum insecticides will leave considerable toxic residues on the fruits and may cause considerable health hazards [6]. Neonicotinoid insecticides represent the fastest growing class of insecticides introduced to the market since the launch of pyrethroids [7]. The current market share of this group of insecticides is well above 600 million Euros per year, including imidacloprid as the biggest selling insecticide worldwide [8]. Another neonicotinoid commercialized since the introduction of imidacloprid, is thiamethoxam [9]. Neonicotinoid insecticides are compounds acting agonistically on insect nicotinic acetylcholine receptors (nAChR). They are especially active on hemipteran pest species such as aphids, whiteflies, and plant hoppers, but also commercialized to control many coleopterans and some lepidopteran pest species [10]. The benefits of using systemic insecticides over contact insecticides is that in most cases they provide continuous plant protection through most of the growing season without the need for repeated applications. In addition, systemic insecticides are not susceptible to ultraviolet light degradation or ''wash off'' during watering, and the risk of overexposure to applicators is minimized [11].

Keeping in view the importance of sucking insect pests on tomato and use of toxic insecticides for their control, present study was undertaken to compare effect of application of neonicotinoids (imidacloprid and thiamethoxam) on white fly infestation and occurrence of natural enemies on tomato.

2. Materials and methods

2.1 Experimental site

The experimental site is located in the hot humid subtropic at the Regional Research Station (23°N, 89°E, 9.75 m msl), Bidhan Chandra Krishi Viswavidyalaya, Jhargram, Paschim Medinipur, India. The site receives an average annual rainfall of approximately 1180 mm and experiences mean annual minimum and maximum temperatures of 12.5 and 40.2 °C, respectively.

2.2 Treatment and management

Field experiments were conducted in tomato growing season during 2014 and 2015 taking tomato (cv. Amlik-F1 hybrid) as a test crop. The experiment was laid out in Randomized Complete Block Design (RCBD) with 5m x 5m plot size using four replicates of five treatments viz., T1: Imidacloprid 17.8%SL @125 ml ha^{-1}; T2: Imidacloprid 17.8%SL @150 ml ha^{-1}; T3: Imidacloprid 17.8%SL @175 ml ha^{-1}; T4: Thiamethoxam 25% WG @200 g ha^{-1}; and T5: Untreated check (no pesticide, only normal water). The experimental plots were prepared by ploughing and cross-ploughing followed by laddering. Healthy disease free 25-day-old seedlings of tomato were planted at a spacing of 0.8 m × 0.8 m. Spraying of insecticides was given in three schedules with an interval of 15 days from first occurrence of the pest i.e. 30 days after planting. For all the treatments, the crop was grown with same dose of NPK as per State recommendation i.e. 80:40:40 kg N, P_2O_5 and K_2O ha^{-1}, respectively. Half of N along with the full amounts of P and K of inorganic fertilization were applied during final land preparation and the rest half of N was given at the time of earthing up. All intercultural operations were performed following standard package of practices.

2.3 Data collection

Observations on count of whitefly both nymphs and adults were recorded on five randomly selected plants per treated plot. Three leaves were randomly selected from each plant. Then the count of white fly populations were taken carefully (since the adults are highly mobile) from the lower side of each leaf and the nymph by using 20X lens. Finally, the results were expressed as mean populations/3 leaves/plant. First count was taken one day before first spray and post treatment counts were taken 5, 10 and 15 days after each spray. The count of natural enemies was also taken in similar manner as that of whitefly. Observation was also taken to see the phytotoxicity on 1, 3,7,10 and 15 days after spraying.

2.4 Statistical analysis

The data were compiled and tabulated for statistical analysis. Windows-based SPSS Statistics v21 program was used for analysis of variance (ANOVA) to determine the statistical significance of treatment.

3. Results and Discussion

Whitefly incidence was observed at early stage i.e. 30 days after planting (DAP) of tomato seedlings. So, the first spray of insecticide was given at 30 DAP. The insecticidal activity of imidacloprid 17.8% SL in different doses and thiamethoxam in single dose on whitefly population in tomato is presented in Table 1. There were significant reductions of pest population in tomato after 5, 10 and 15 days of application of insecticides compared to the untreated check. No whitefly population was recorded at 5 days after first spray of imidacloprid 17.8% SL @ 175 ml ha^{-1}. Similar trend was also observed in second and third sprays. It was also observed that irrespective of spray schedule, the minimum populations or maximum reduction in pest populations was observed with same dose of imidacloprid after 10 and 15 days of its application compared to other treatments. It was followed by the application of imidacloprid @ 150 ml ha^{-1}. It is essential to mention that the efficacy of both the insecticides tested against the immature stages of whitefly (nymphs) was more than the adults. It may be due to high mobility of adults that they could hide themselves in the surrounding field having alternate host. Thus the adults are in contact with the treated surface for a very short time while immature stages were found to be almost in continuous contact with the treated surface for a long time and consequently suck more toxicants [12]. It has also been reported that imidacloprid had a better efficacy against sucking pests than thiamethoxam because it is highly systemic [13, 14] reported that imidacloprid controlled those sucking pests attacking cotton for upto 8 weeks after sowing while [12] revealed that imidacloprid as well as thiamethoxam had relatively faster initial effects with long residual action against thrips and immature stages of whitefly while both had a moderate effect on jassids and adults of whitefly.

The natural enemies observed in the experimental field include spiders and coccinellids. The insecticides showed no effect on the population of spider even at higher dose of spray. On the other hand maximum reduction of coccinellid population was recorded when imidacloprid 17.8% SL was applied @ 175ml/ha followed by 150 ml/ha at 3 and 7 days after spray (Table 2). However, the natural enemy population was increased from 10 days after spray. The similar result was observed after second and third round of spray (Table 3 and 4). The side effects of neonicotinoids against non-target insects especially predators under laboratory condition were reported in the literature [15, 16]. However, results of a field study have also reported less toxicity of these insecticides for a variety of predators [17]. The toxicity of neonicotinoids varied with not only method of application, but also feeding behaviour of the predators in the laboratory. The non-selective organophosphate and pyrethroids insecticides can bring serious problems of reduction in the population of beneficial insects on the crops all over the world. Hence, in order to preserve natural enemies, selective insecticides compatible with biocontrol agents should be used to include in the programs of integrated pest management (IPM) [18]. The result also revealed that there was no phytotoxicity at 1, 3, 7, 10 and 15 days after spray even at higher doses of spray.

Table 1: Field efficacy of insecticides against white fly (*Bemisia tabaci*) in tomato after 1st, 2nd and 3rd round of spray (Pooled of two years)

Insecticides	Dosage formulation (ml/ha)	Pre treatment whitefly/3 leaves/plant	Mean number of whitefly/ 3 leaves/ plant (1st spray)			Mean number of whitefly/ 3 leaves/ plant (2nd spray)			Mean number of whitefly/ 3 leaves/ plant (3rd spray)		
			5 DAS	10 DAS	15 DAS	5 DAS	10 DAS	15 DAS	5 DAS	10 DAS	15 DAS
Imidacloprid 17.8% SL	125	4.11 (2.14)	0.71 (1.13)	0.67 (1.05)	1.44 (1.38)	0.67 (1.03)	1.89 (1.53)	1.56 (1.42)	0.33 (0.88)	0.67 (1.09)	1.67 (1.43)
Imidacloprid 17.8% SL	150	4.11 (2.13)	0.11 (0.76)	0.44 (0.94)	1.11 (1.19)	0.44 (0.92)	1.11 (1.22)	1.33 (1.33)	0.44 (0.94)	0.78 (0.98)	1.22 (1.27)
Imidacloprid 17.8% SL	175	3.56 (2.00)	0.00 (0.71)	0.11 (0.76)	0.56 (0.99)	0.00 (0.71)	0.78 (1.09)	0.89 (1.11)	0.00 (0.71)	0.33 (0.76)	0.89 (1.11)
Thiamethoxam 25% WG	200	4.11 (2.11)	0.67 (1.03)	0.89 (1.15)	2.00 (1.54)	1.44 (1.33)	2.11 (1.58)	2.11 (1.59)	0.67 (1.03)	2.33 (1.75)	2.44 (1.70)
Untreated check	--	4.56 (2.24)	2.89 (1.73)	3.33 (1.95)	5.33 (2.41)	3.89 (2.09)	4.33 (2.19)	3.44 (1.97)	3.22 (1.91)	3.33 (2.30)	4.11 (2.14)
SEM(+)		0.11	0.11	0.10	0.09	0.09	0.09	0.14	0.07	0.26	0.11
CD(5%)		0.33	0.33	0.31	0.31	0.28	0.28	0.43	0.22	0.80	0.34

DAS-Days after Spray, *Mean of three replications, Figures in parenthesis are mean square transformed values x+0.5

Table 2: Natural Enemy population in different treated plots of tomato after 1st round of spray (Pooled data of 2 years)

Treatment	Dosage formulation (ml/ha)	Spiders					Coccinellids				
		Before spray	3 DAS	7 DAS	10 DAS	15 DAS	Before spray	3 DAS	7 DAS	10 DAS	15 DAS
Imidacloprid 17.8% SL	125	1.87 (1.54)	1.74 (1.49)	1.82 (1.52)	1.93 (1.56)	2.02 (1.59)	1.19 (1.30)	0.21 (0.84)	0.72 (1.10)	1.23 (1.31)	1.57 (1.44)
Imidacloprid 17.8% SL	150	2.02 (1.59)	1.84 (1.53)	1.84 (1.53)	1.92 (1.55)	2.12 (1.62)	1.29 (1.34)	0.11 (0.78)	0.50 (1.00)	1.11 (1.27)	1.29 (1.34)
Imidacloprid 17.8% SL	175	1.98 (1.55)	1.83 (1.51)	2.02 (1.58)	1.91 (1.74)	1.81 (1.52)	1.26 (1.32)	0.00 (0.71)	0.33 (0.91)	0.84 (1.16)	1.26 (1.32)
Thiamethoxam 25 % WG	200	1.50 (1.41)	1.44 (1.39)	1.81 (1.52)	1.78 (1.51)	1.67 (1.47)	1.29 (1.34)	0.39 (0.94)	0.87 (1.17)	1.48 (1.40)	1.29 (1.34)
Untreated check	--	1.80 (1.51)	1.63 (1.46)	1.94 (1.56)	1.98 (1.57)	1.92 (1.55)	1.26 (1.33)	1.10 (1.27)	1.47 (1.40)	2.11 (1.62)	2.33 (1.68)
SEM(+)		0.11	0.09	0.08	0.08	0.06	0.04	0.02	0.05	0.05	0.4
CD(5%)		0.34	0.29	0.26	0.25	0.19	0.13	0.06	0.15	0.16	0.14

DAS-Days after Spray, *Mean of three replications, Figures in parenthesis are mean square transformed values x+0.5

Table 3: Natural Enemy population in different treated plots of tomato after 2nd round of spray (Pooled data of 2 years)

Treatment	Dosage formulation (ml/ha)	Spiders					Coccinellids				
		Before spray	3 DAS	7 DAS	10 DAS	15 DAS	Before spray	3 DAS	7 DAS	10 DAS	15 DAS
Imidacloprid 17.8% SL	125	2.02 (1.59)	1.80 (1.52)	1.91 (1.55)	2.00 (1.58)	2.10 (1.61)	1.57 (1.44)	0.21 (0.84)	0.72 (1.10)	1.23 (1.31)	1.67 (1.47)
Imidacloprid 17.8% SL	150	2.12 (1.62)	1.82 (1.52)	1.82 (1.52)	2.03 (1.59)	2.13 (1.62)	1.29 (1.34)	0.11 (0.78)	0.50 (1.00)	1.11 (1.27)	1.37 (1.37)
Imidacloprid 17.8% SL	175	1.81 (1.52)	1.81 (1.51)	1.73 (1.49)	1.80 (1.51)	1.99 (1.58)	1.26 (1.32)	0.00 (0.71)	0.33 (0.91)	0.84 (1.16)	1.19 (1.30)
Thiamethoxam 25 % WG	200	1.67 (1.47)	1.53 (1.42)	1.74 (1.50)	1.91 (1.55)	2.02 (1.59)	1.29 (1.34)	0.39 (0.94)	0.87 (1.17)	1.48 (1.40)	1.87 (1.54)
Untreated check	--	1.92 (1.55)	1.71 (1.49)	1.94 (1.56)	2.07 (1.60)	2.15 (1.63)	2.33 (1.68)	1.10 (1.27)	1.47 (1.40)	2.11 (1.62)	2.27 (1.67)
SEM(+)		0.06	0.08	0.06	0.04	0.04	0.04	0.02	0.05	0.05	0.04
CD(5%)		0.19	0.26	0.19	0.13	0.12	0.14	0.06	0.15	0.16	0.12

DAS-Days after Spray, *Mean of three replications Figures in parenthesis are mean square transformed values x+0.5

Table 4: Natural Enemy population in different treated plots of tomato after 3rd round of spray (Pooled data of 2 years)

Treatment	Dosage formulation (ml/ha)	Spiders					Coccinellids				
		Before spray	3 DAS	7 DAS	10 DAS	15 DAS	Before spray	3 DAS	7 DAS	10 DAS	15 DAS
Imidacloprid 17.8% SL	125	2.10 (1.61)	1.83 (1.53)	1.92 (1.55)	2.04 (1.59)	2.28 (1.67)	1.67 (1.47)	0.37 (0.93)	0.76 (1.12)	1.04 (1.24)	1.56 (1.43)
Imidacloprid 17.8% SL	150	2.13 (1.62)	1.85 (1.53)	1.95 (1.56)	2.08 (1.61)	2.26 (1.66)	1.37 (1.37)	0.19 (0.83)	0.55 (1.02)	0.85 (1.16)	1.31 (1.34)
Imidacloprid 17.8% SL	175	1.99 (1.58)	1.57 (1.44)	1.73 (1.49)	1.89 (1.54)	2.10 (1.61)	1.19 (1.30)	0.00 (0.71)	0.33 (0.91)	0.53 (1.01)	1.53 (1.41)
Thiamethoxam 25 % WG	200	2.02 (1.59)	1.75 (1.50)	1.79 (1.51)	1.96 (1.57)	2.27 (1.66)	1.87 (1.54)	0.45 (0.97)	0.93 (1.20)	1.21 (1.31)	1.93 (1.55)
Untreated check	--	2.15 (1.63)	2.09 (1.61)	2.15 (1.63)	2.11 (1.62)	2.42 (1.71)	2.27 (1.67)	1.24 (1.32)	1.67 (1.47)	2.00 (1.58)	2.27 (1.66)
SEM (+)		0.04	0.05	0.04	0.03	0.03	0.04	0.03	0.04	0.04	.04
CD (5%)		0.12	0.16	0.12	0.10	0.11	0.12	0.09	0.13	0.11	0.12

DAS-Days after Spray,
*Mean of three replications Figures in parenthesis are mean square transformed values x+0.5

4. Conclusion
The present study concluded that the application of imidacloprid 17.8%SL at 175 ml ha-1 was more effective in reduction of whitefly population to obtain higher fruit yield of tomato than its lower doses and thiamethoxam spray. Both the insecticides showed no or minimum suppression of natural enemies population even at higher dose of spray. Hence, neonicotinoids can suitably be included in Integrated Pest Management of sucking insect pests like whitefly in tomato because of their less toxicity to predators.

5. Acknowledgement
The author deeply acknowledge the Director of Research, BCKV, Kalyani, Nadia, West Bengal for providing the facilities for doing the experiment.

6. References

1. Govindappa MR, Bhemanna M, Arunkumar Hosmani, Ghante VN. Bio-efficacy of newer insecticides against tomato leaf curl virus disease and its vector whitefly (Bemisia tabaci) in tomato. Int J Appl Bio Pharm Tech. 2013; 4(3):226-231.
2. Dempsey M, Riley DG, Srinivasan R. Insecticidal Effects on the Spatial Progression of Tomato Yellow Leaf Curl Virus and Movement of Its Whitefly Vector in Tomato. J Econ Entomol. 2017, doi: 10.1093/jee/tox061.
3. David BV, Ananthakrishnan TN. General and Applied Entomology. Second Edition. Tata McGraw-Hill Publishing Company Ltd. 2006, 27.
4. Sharma K, Chander S. Spatial distribution of jassid *Amrasca biguttula biguttula* (Ishida) on cotton. Ind J Ent. 1998; 60(4):326-328.
5. Das G, Islam T. Relative efficacy of some newer insecticides on the mortality of jassid and white fly in brinjal. Int J Res Bio Sci. 2014; 4(3):89-9
6. Schuster DJ, Mann RS, Toapanta M, Cordero R, Thompson S. Monitoring neonicotinoid resistance in biotype B of *Bemisia tabaci* in Florida. *Pest Manag. Sci*. 2010; 66:186-195.
7. Nauen R, Bretschneider T. New modes of action of insecticides. Pestic. Outlook. 2002; 13:241-245.
8. Jemec A, Tisler T, Drobne D, Sepcic K, Fournier D, Trebse P. Comparative toxicity of imidacloprid, of its commercial liquid formulation and of diazinon to a non-target arthropod, the microcrustacean *Daphnia magna*. Chemosphere. 2007; 68(8):1408-1418.
9. Tomizawa M, Casida JE. Selective toxicity of neonicotinoids attributable to specificity of insect and mammalian nicotinic receptors. Annual Review of Entomology. 2003; 48:339-364.
10. Nauen R, Ebbinghaus-Kintscher UL, Salgado V, Kaussmann M. Thiamethoxam is a neonicotinoid precursor converted to clothianidin in insects and plants. Pestic. Biochem. Physiol. 2003; 76(2):55-69.
11. Herbert KS, Hoffmann AA, Powell KS. Assaying the potential benefits of thiamethoxam and imidacloprid for phylloxera suppression and improvements to grapevine vigour. Crop Prot. 2008; 27:1229-1236.
12. El-Dewy MHE. Toxicological studies on some pests attacking cotton. Ph. D. Thesis, Fac. Agric., Kafr El-Sheikh Univ. Egypt, 2006, 101.
13. Anonymous. Gaucho, a new generation of crop protection. In: New Approaches to crop protection. Bayer AG-Crop Protection Business Group. Dept. Agric. Environ. Leverkusen, Germany. 1992, 54-57.
14. Dhandapani N, Dhivahar P, Palanisamy S. Evaluation of new molecules, clothianidin (Poncho 600 FS) and imidacloprid (Gaucho 600 FS) as seed treatment against sucking pests of cotton. In: "Resources management in plant protection during twenty first century (B.S. Babu, K.S. Varaprasad, K. Anitha, eds.). Plant Prot. As. India, Hyderabad, India. 2002; 2:127-130.
15. Mizell RF, Sconyers MC. Toxicity of imidacloprid to selected arthropod predators in the laboratory. Florida Entomologist. 1992; 75:277-280.
16. Awasthi NS, Barkhade UP, Patil SR, GK Lande. Comparative toxicity of some commonly used insecticides to cotton aphid and their safety to predatory coccinellids. Bioscan. 2013; 8(3):1007-1010.
17. Mensah RK. Development of an integrated pest management programme for cotton. Part 2: Integration of a Lucerne/cotton interplant system, food supplement sprays with biological and synthetic insecticides. International Journal of Pest Management. 2002; 48(2):95-105.
18. Fernandes FL, Bacci L, Fernandes MS. Impact and Selectivity of Insecticides to Predators and Parasitoids. Entomo Brasilis. 2010; 3(1):01-10.